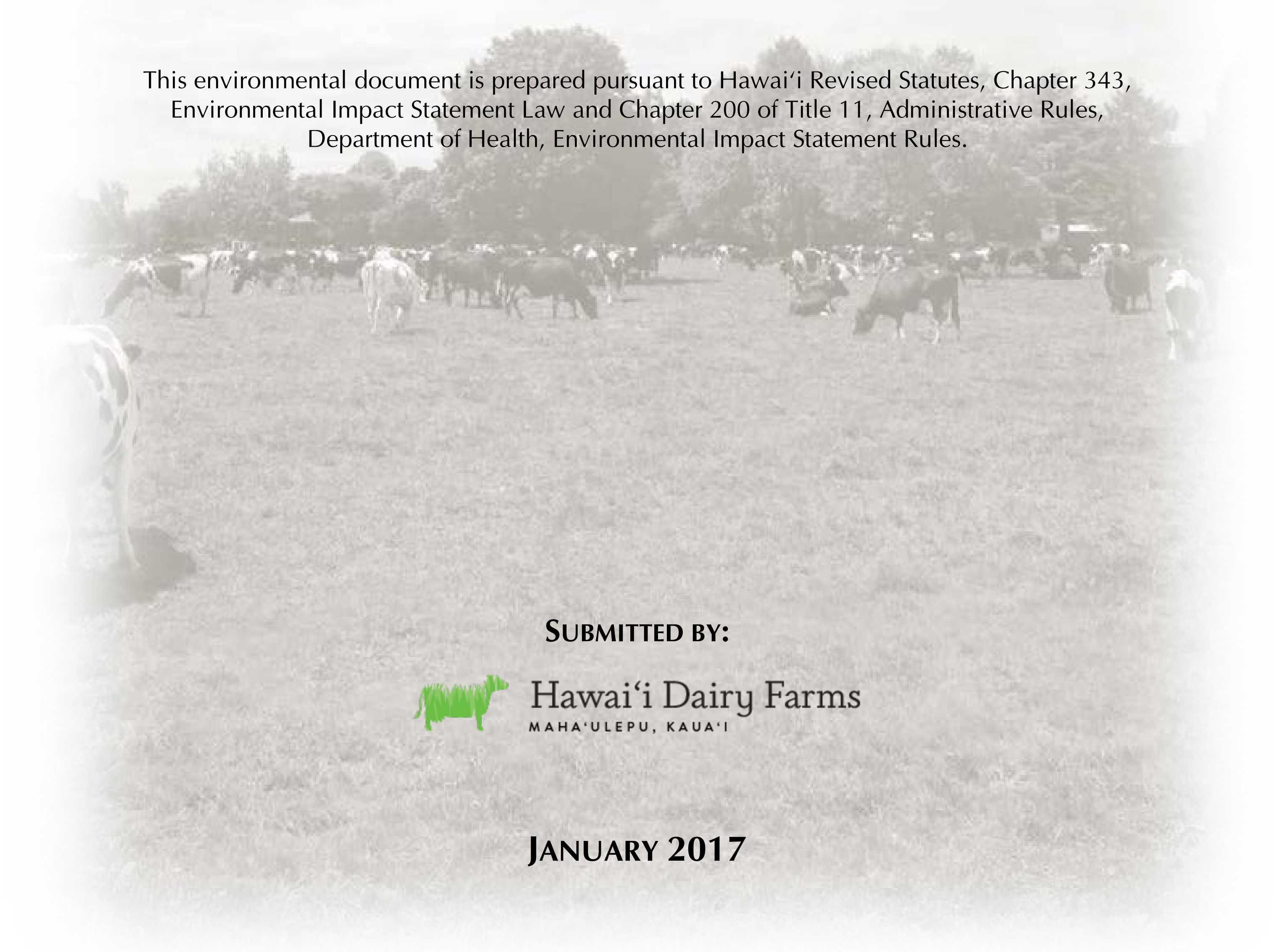
HAWAIʻI DAIRY FARMS

FINAL ENVIRONMENTAL IMPACT STATEMENT

VOLUME 5
KAWAILOA DEVELOPMENT COMMENT LETTER, APPENDICES, AND RESPONSES

This environmental document is prepared pursuant to Hawaiʻi Revised Statutes, Chapter 343, Environmental Impact Statement Law and Chapter 200 of Title 11, Administrative Rules, Department of Health, Environmental Impact Statement Rules.



SUBMITTED BY:

Hawaiʻi Dairy Farms
MAHAʻULEPU, KAUAʻI

JANUARY 2017

HAWAIʻI DAIRY FARMS

FINAL ENVIRONMENTAL IMPACT STATEMENT

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KAWAILOA DEVELOPMENT COMMENT LETTER, APPENDICES, AND RESPONSES

SUBMITTED BY:

Hawaiʻi Dairy Farms
MAHAʻULEPU, KAUAʻI

PREPARED BY:

GROUP 70 INTERNATIONAL

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JANUARY 2017

FINAL ENVIRONMENTAL IMPACT STATEMENT
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EXHIBIT

1 LETTER (WITHOUT ENCLOSURES) TO THE HAWAIʻI STATE DEPARTMENT OF HEALTH ("DOH"), CLEAN WATER BRANCH AND WASTEWATER BRANCH FROM J. FUKADA OF KAWAILOA DEVELOPMENT LLP DATED APRIL 9, 2014 (RE: HDF'S PROJECT IN MAHAʻULEPU)

2 LETTER TO WEST KAUAI SOIL & WATER CONSERVATION DISTRICT ("WKSWCD") FROM L. BAIL, ESQ. OF GOODSILL ANDERSON QUINN & STIFEL LLP ("GOODSILL") DATED MAY 7, 2014 (RE: HDF'S PROPOSED DAIRY FARM IN MAHAʻULEPU, KAUAʻI)

3 LETTER TO WKSWCD AND U.S. DEPARTMENT OF AGRICULTURE, NATURAL RESOURCES CONSERVATION SERVICE ("NRCS") FROM L. BAIL, ESQ. OF GOODSILL DATED MAY 16, 2014 (RE: HDF)

4 LETTER FROM WKSWCD DATED MAY 23, 2014 TO L. BAIL, ESQ. OF GOODSILL (RE: HDF)

5 LETTER TO HDF, DOH WASTEWATER BRANCH, WKSWCD, MAYOR BERNARD P. CARVALHO, JR., HAWAIʻI DEPARTMENT OF LAND AND NATURAL RESOURCES, AND COUNTY OF KAUAʻI DEPARTMENT OF PUBLIC WORKS FROM L. MUNGER, ESQ. AND L. BAIL, ESQ. OF GOODSILL DATED MAY 30, 2014 (RE: FAILURE TO COMPLY WITH HAWAII REVISED STATUTES CHAPTER 343)

6 LETTER TO L. BAIL, ESQ. OF GOODSILL FROM WKSWCD DATED JULY 26, 2014

7 WASTE MANAGEMENT PLAN DATED JULY 23, 2014

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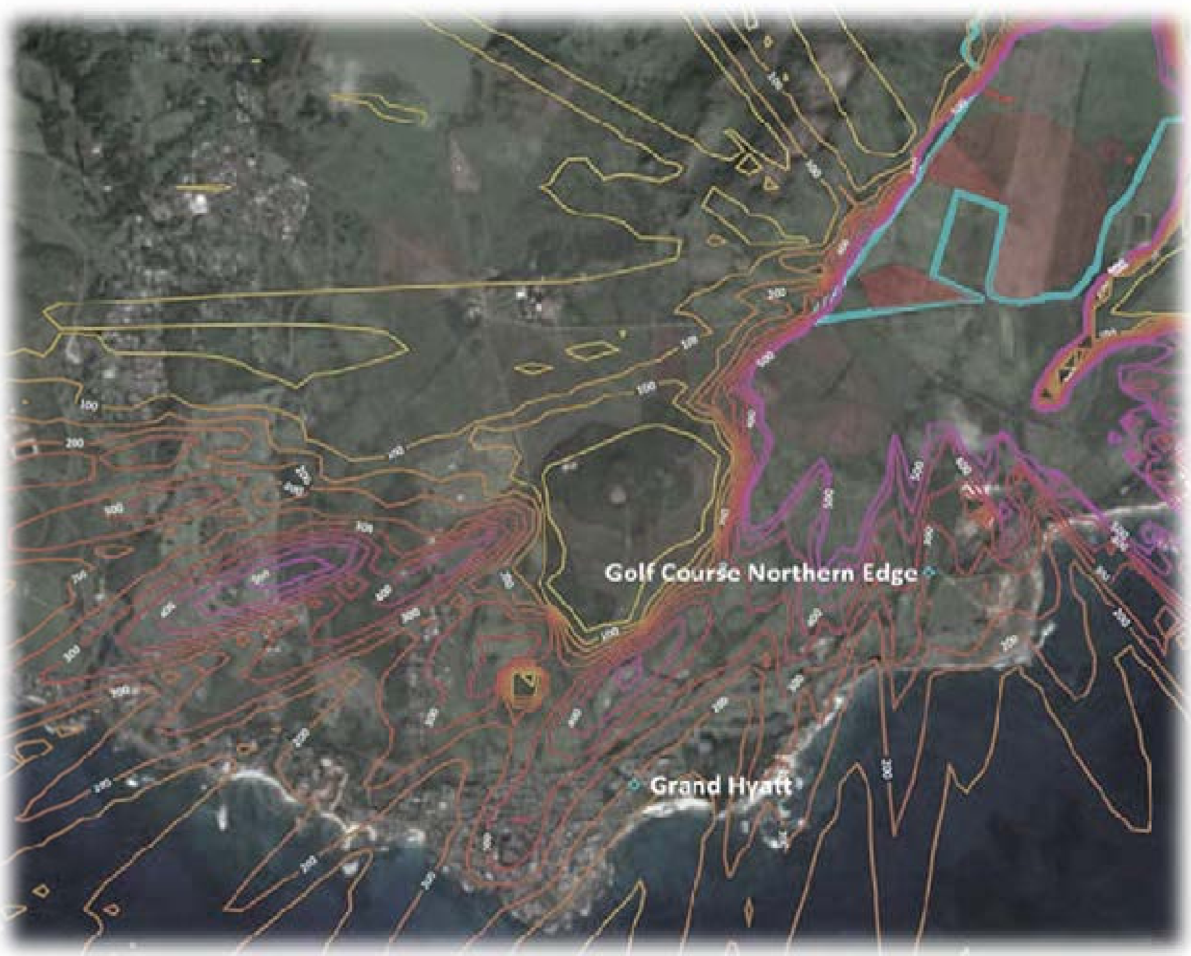
COMMENT LETTER FROM KAWAILOA DEVELOPMENT

Comments Regarding
Hawai‘i Dairy Farms’
Draft Environmental Impact Statement

Submitted by:

Kawailoa Development LLP
July 25, 2016



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EXHIBITS

1	Letter (without enclosures) to the Hawai'i State Department of Health ("DOH"), Clean Water Branch and Wastewater Branch from J. Fukada of Kawailoa Development LLP dated April 9, 2014 (Re: HDF's Project in Maha'ulepu)
2	Letter to West Kauai Soil & Water Conservation District ("WKSWCD") from L. Bail, Esq. of Goodsill Anderson Quinn & Stifel LLP ("Goodsill") dated May 7, 2014 (RE: HDF's Proposed Dairy Farm in Maha'ulepu, Kaua'i)
3	Letter to WKSWCD and U.S. Department of Agriculture, Natural Resources Conservation Service ("NRCS") from L. Bail, Esq. of Goodsill dated May 16, 2014 (Re: HDF)
4	Letter from WKSWCD dated May 23, 2014 to L. Bail, Esq. of Goodsill (Re: HDF)
5	Letter to HDF, DOH Wastewater Branch, WKSWCD, Mayor Bernard P. Carvalho, Jr., Hawai'i Department of Land and Natural Resources, and County of Kaua'i Department of Public Works from L. Munger, Esq. and L. Bail, Esq. of Goodsill dated May 30, 2014 (Re: Failure to Comply with Hawaii Revised Statutes Chapter 343)
6	Letter to L. Bail, Esq. of Goodsill from WKSWCD dated July 26, 2014
7	Waste Management Plan dated July 23, 2014
8	Letter to DOH Wastewater Branch from L. Munger, Esq. of Goodsill dated August 11, 2014 (Re: Comments on HDF's Waste Management Plan)
9	Letter to DOH Wastewater Branch from L. Munger, Esq. of Goodsill dated August 21, 2014 (Re: Additional Comments re HDF's Waste Management Plan, dated July 23, 2014)
10	Letter to DOH Wastewater Branch from L. Munger, Esq. of Goodsill dated August 25, 2014 (Re: Additional Comments re HDF's Waste Management Plan, dated July 23, 2014)
11	Letter to DOH Wastewater Branch from L. Bail, Esq. of Goodsill dated September 12, 2014 (Re: Status of Kawailoa's Requests Submitted in the Letter Dated August 11, 2014)
12	Letter from DOH Wastewater Branch to L. Munger, Esq. of Goodsill dated September 23, 2014 (Subject: Status of Kawailoa's requests Submitted in Letter Dated August 11, 2014) with enclosure (Letter from DOH Wastewater Branch to Group 70 International dated September 15, 2014 Re: Waste Management Plan)

13	Letter to DOH Deputy Director, Sanitation Branch, Clean Water Branch, Wastewater Branch, and Office of Environmental Quality Control from L. Munger, Esq. of Goodsill dated September 30, 2014 (Re: Chapter 343 Environmental Rreview as a Condition Precedent to the Approval of HDF's Waste Management Plan dated July 24, 2014)
14	Letter to DOH Deputy Director and Sanitation Branch from L. Munger, Esq. of Goodsill dated October 15, 2014 (Re: Chapter 343 Environmental Review as a Condition Precedent to the Approval of HDF's Proposed Dairy Farm Plans)
15	Letter to U.S. Army Corps of Engineers from L. Bail, Esq. of Goodsill dated November 3, 2014 (Re: Review of HDF's Proposed Dairy Farm Plans)
16	Letter to DOH Environmental Planning Office, J. Overton of Group 70 International, Inc. and HDF from L. Bail, Esq. of Goodsill dated February 23, 2015 (Re: Comments on the HDF's Environmental Impact Statement Preparation Notice)
17	Letter to State Historic Preservation Division from L. Bail, Esq. of Goodsill dated May 8, 2015 (Re: HDF Archaeological Inventory Survey dated February 25, 2015)
18	Letter to WKSWCD and NRCS from L. Bail, Esq. of Goodsill dated May 22, 2015 (Re: Rescission of Approval of HDF's Soil Conservation Plans - Endangered Species)
19	Letter to WKSWCD and NRCS from L. Bail, Esq. of Goodsill dated July 20, 2015 (Re: Rescission of Approval of HDF's Soil Conservation Plan – Endangered Species)
20	Letter to NRCS and WKSWCD from L. Bail, Esq. of Goodsill dated June 4, 2015 (Re: Rescission of Approval of HDF's Soil Conservation Plans - Historic Properties)
21	Letter to M. Moule, P.E., County of Kaua'i Department of Public Works ("Kaua'i DPW) from L. Bail, Esq. of Goodsill dated June 4, 2015 (Re: Rescission of Agricultural Exemption for HDF - Endangered Species)
22	Letter to M. Moule, P.E., Kaua'i DPW dated from L. Bail, Esq. of Goodsill dated June 4, 2015 (Re: Rescission of Agricultural Exemption for HDF - Historic Properties) (without enclosure)
23	Letter to Hawai'i Water Commission from L. Bail, Esq. of Goodsill dated June 24, 2015 (Re: HDF Well Construction Permits)(without enclosures)
24	Memorandum from P. McHenry to the State of Hawaii and County of Kauai dated June 12, 2014 (Re: The "Wastewater Treatment Unit" Trigger for the Preparation of Environmental Assessments in Hawaii Revised Statutes Chapter 343")
25	Updates to Waste Management Plan dated May 25, 2016

26	Letter from S. Pruder of DOH Wastewater Branch to Group 70 dated June 15, 2016 (Re: Review of Updated Waste Management Plan)
27	USDA, National Agricultural Statistics Service, 2012 Census of Agriculture – County Data
28	USDA, National Agricultural Statistics Service Press Release dated February 2, 2015, Hawaii Cattle Inventory Up 2 Percent From January 1, 2014
29	E-mails dated March 30, 2016 between T. Eisen, L. Segundo, E. Bohlen, S. Glenn and L. McIntyre (Re: "dairy farm distr matrix")
30	E-mails dated April 14 - 15, 2016 between T. Eisen, L. Segundo, E. Bohlen, S. Glenn and L. McIntyre (Re: "HDF developments")
31	*Mahaulepu Kauai*, M.D. Monsarrat (August 8, 1896)
32	*Hawaii Territory Survey, Kauai*, Walter E. Wall (undated)
33	Letter from State Historic Preservation Division to A. Hennessy dated July 15, 2015 (Re: Chapter 6E-42 Historic Preservation Review – Revised Archaeological Inventory Survey) *Note that this letter is misdated and should be July 15, 2016, as it refers to the AIS received on June 1, 2016
34	Letter from U.S. Army Corps of Engineers to Group 70 International dated October 22, 2014 (Re: Clean Water Act Exemption for Proposed Maintenance of Existing Drainage Ditches of the Hawaii Dairy Farm in Mahaulepu, Island of Kauai, Hawaii)
35	U.S. Army Corps of Engineers Response to FOIA Request dated October 17, 2014 (Re: E-mails between U.S. Army Corps of Engineers and Group 70 International relating to Section 404 exemption)
36	E-mails between T. Eisen and G. Scott dated June 3, 2016 (Re: HRS 343)

7-25-16 COMMENT LETTER

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July 25, 2016

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Re: Kawailoa Development LLP's Comments on Hawai'i Dairy Farms' <u>Draft Environmental Impact Statement</u>

Dear Dr. Pressler and Ms. McIntyre:

This letter, along with the appendices and exhibits attached hereto, sets forth the comments of Kawailoa Development LLP ("Kawailoa Development" or "Kawailoa") on the Draft Environmental Impact Statement ("DEIS"), published in the Environmental Notice on June 8, 2016, for the dairy farm ("Dairy") proposed by Hawai'i Dairy Farms ("HDF") in Māhā'ulepū, Kaua'i.

I. <u>EXECUTIVE SUMMARY</u>

This Dairy project is large, and in Hawai'i, without precedent. As of January 2015, there were a total of 2,200 milk cows in multiple locations throughout the entire state. Ex. 28. And in 2012, there were no milk cows at all on Kaua'i. Ex. 27. With HDF's planned operation of up to 2,000 cows, the state-wide number will nearly double, with impacts concentrated in Māha'ulepū, an unspoiled area with such natural and cultural resources as to have been considered as a National Park location. *See* U.S. National Park Service Reconnaissance Survey, attached to Ex. 8.

The public interest in the Dairy is extremely high, as it well should be. Both the law and the public interest require a full and complete DEIS. That the DEIS is adequate is far from the case. In the minds of the developers of the Dairy, the decision to proceed with the Dairy has already been made. The DEIS is therefore presented in such a way that there is no option but to accept it. The proposed location is the only site considered. Construction started well before the

DEIS started, and significant expenditures have already been made to prepare the site for the Dairy.

At the end of the day, the Dairy will not only be an ecological disaster, but will have widespread economic impacts to the Po'ipū and Kōloa areas, if not all of Kaua'i. Whether harmful algae blooms, the introduction and increasing populations of exotic species, or threats to threatened and/or endangered endemic species, none of the harmful effects to the ecosystem of Māhā'ulepū Valley are addressed in the DEIS.

The accounting for the numbers of animals, animal productivity, estimates of feed intake, estimates of nutrient composition of feed intake, and pasture management are not fully presented or are ignored. The DEIS glosses over the fact that the Dairy will be heavily dependent upon imported feed. The image of a pastoral farm that HDF would want the public to believe is not the reality. The Dairy will be more akin to an industrialized factory.

With such intense usage of the limited space in Māhā'ulepū Valley, adverse environmental consequences can be expected. There will be runoff and water quality impacts to groundwater and surface water, including to the Waiopili Stream and the ocean. Nutrients (nitrogen and phosphorus) will leave the site by surface and groundwater flow.

Of particular concern is the odor and flies that will be emitted by the Dairy. Odor emissions will include and extend past Po'ipū. The flies will include biting stable and horn flies. Flies can travel long distances, with a reach beyond the Po'ipū area.

"Bad smell" events and biting flies occurrences do not have to be constant to deter visitors. Traveler perceptions of both natural as well as man-made disasters can endure well beyond the particular event. If visitors do not come to Po'ipū, the businesses in the tourist destinations in Po'ipū and elsewhere in Kaua'i will suffer.

It should go without saying that if visitor spending declines, there will be significant losses in jobs and tax revenues. For just the Grand Hyatt Kauai, the losses of revenue in the first year alone could impact tax revenues by as much as $4.9 million. Moreover, the employment impact could be as much as 337 jobs directly tied to the Grand Hyatt Kauai, and 599 jobs tied to the local and state economy. The impact to the surrounding community will of course be even greater. In stark contrast, the DEIS represents that the Dairy will add just five farm jobs.

The DEIS is inadequate. The DEIS falls far short of informing the public of HDF's plans, of the environmental consequences of the Dairy or of any certain and enforceable mitigation measures. The DEIS does not allow careful public review and comment, let alone informed decision making by regulators. As detailed in the technical and legal sections that follow, a supplemental draft EIS must be prepared to address these deficiencies and comply with the law.

II. TECHNICAL COMMENTS

The technical and scientific reports attached to this letter demonstrate that the proposed Dairy plans are not fully described, that the discussion of environmental impacts either are incorrect or are not supported with sufficient detail, that the scientific methods used to assess the impacts are inadequate and that the alternatives considered are limited (and where considered, are not discussed in sufficient detail).

Key findings of the reports prepared by the experts who have reviewed the DEIS are summarized below. The full reports are included in the Technical Appendices A through H.

A. Economic Impact (Appendix A)

Assessment of Economic Impacts of the Proposed Hawai'i Dairy Farms Facility
BRG, July 2016

The DEIS largely ignores the potential economic impacts of the proposed Dairy on tourism in Kaua'i generally and the impacts to the Grand Hyatt Kauai specifically. Tourism is important to Kaua'i and Po'ipū in particular, since the largest share of visitor units on Kaua'i is located in the Po'ipū/Kukui'ula area. The economy of Kaua'i is more dependent on tourism than the other Hawaiian Islands. The potential negative impacts of the Dairy exceed the benefits estimated in the DEIS by a wide margin.

The DEIS does not consider, at all, the significant losses in jobs and tax revenues resulting from the Dairy. Odors and flies are not compatible with resort operations, and as a result, the businesses in the tourist destinations in Po'ipū and elsewhere in Kaua'i will suffer.

The Grant Hyatt Kauai Resort and Spa is the closest hotel to the proposed Dairy. This resort provides 602 visitor units, and is the largest private employer on Kaua'i. In 2014, it employed 941 workers.

In the first year alone, losses of revenue at the Grand Hyatt Kauai alone could exceed $53.0 million, and the total economic impact (direct and indirect) could reach $97.5 million. The ensuing impact on taxes could be $4.9 million. The employment impact could be as many as 337 jobs directly tied to the Grand Hyatt Kauai, and 599 jobs in total to the local and state economy. Even assuming economic benefit from the Dairy (per the DEIS, just five farm jobs added to the economy), HDF completely ignores the negative economic byproduct to the surrounding community.

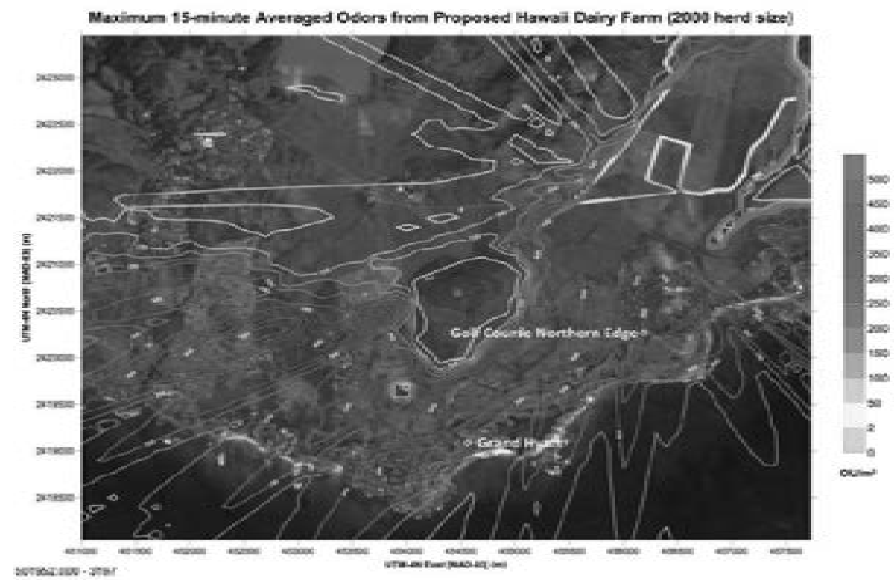
Recognition of the agricultural tax credit for HDF implies a negative state tax revenue position if it operates. Adding to this burden on state tax revenues, the visitor expenditures

threatened by the HDF operations result in a potential further loss of tax revenue of up to $3.7 million annually.

B. Odor Impact (Appendix B)

Technical Memorandum, Hawaii Dairy Farm Odor Impact Assessment
Exponent, July 2016

Odor from the Dairy will have a profound effect on the Grand Hyatt Kauai and the Poipu Bay Golf Course. Odor emissions will include and extend past Po'ipū.



The DEIS misrepresents and fails to disclose the extent of the odor emissions plume. The DEIS used odor detection thresholds that are too high – assuming that it was okay for some people to smell odor some of the time. The odor detection threshold used in the DEIS is not appropriate for a sensitive population such as hotel guests at a resort area, nor is it appropriate for workers or residents. Further, the DEIS disingenuously presents only odors perceived over a one hour period. Odors are perceived over much shorter time periods than one hour.

Additionally, odor emissions for some sources in the DEIS were significantly underestimated. For example, HDF failed to include the odor emissions from fields that had received effluent irrigation or slurry in the hours before the one being modeled and grossly underestimated the odor strengths from several sources.

By setting odor criteria that are not reasonable, the DEIS depicts an artificial and wholly unrealistic odor plume. The odor plume shown in the DEIS does not extend as far as the odor will actually spread because the odor threshold in the DEIS is much higher than the odor that will be actually be perceived by the resident and visitor population. The DEIS ignores odors that are below its stated threshold but that are nonetheless offensive.

Exponent's air quality dispersion modeling which used the same odor emissions as in the DEIS indicated that objectionable odors would reach the Kawailoa property. For a herd size of 699 cows, odor 15-minute averaged concentrations up to 25 OU/m^3 (odor units per cubic meter) were predicted on the Kawailoa property.

Exponent's air quality dispersion modeling conducted with more appropriate odor emissions from the Dairy indicate much larger maximum odor concentrations on the Kawailoa property. For a herd size of 699 cows, 15-minute averaged odor concentrations up to 150 OU/m^3 were predicted on the Kawailoa property, using Exponent's estimated worst-case odor emissions.

The lowest odor emissions from HDF would occur during hours when there is no fresh application of slurry or irrigation with effluent. Exponent estimates that even during these low emission periods, the maximum 15-minute averaged concentrations at the Kawailoa property with a herd size of 699 cows would be as high as 30 OU/m^3. These concentrations would still be in excess of the 2 OU/m^3 odor threshold.

Exponent's modeling results, with their worst-case and lowest-case odor emissions, estimate that during at least 450 hours each year, HDF odor impacts at the Kawailoa property could exceed the 2 OU/m^3 odor threshold. Values could possibly be as high as 150 OU/m^3 during hours with worst-case emissions. These impacts could result in conditions that visitors at the Kawailoa properties would likely find offensive. The odor emissions data provided in the DEIS are substantially understated. Essentially, more odor from a number of sources in the Dairy will be emitted than is represented in the DEIS. The report of odor impacts in the DEIS is deficient and should be redone.

C. Manure-Related Insects (Appendix C)

A Review of the Arthropod-Related Sections of the
Hawai'i Dairy Farms Draft Environmental Impact Statement
Pacific Analytics, L.L.C., July 2016

Pest Flies.

There are multiple species of pest flies, including biting flies, from dairies. The DEIS fails to address the significant amounts of manure and the number of pest flies that will breed in that manure.

The DEIS fails to address the dispersal capability or range of biting flies, the potential impacts of nuisance flies and mosquitoes, and the qualitative and quantitative analyses for pest species. Depending upon the wind, biting stable and horn flies will reach beyond the Po'ipū area. Biting flies can migrate long distances driven by wind. In Florida, large swarms of stable flies are driven by wind up to 140 miles away. With a 5-8 kph wind, biting stable flies can disperse up to 6.5 km. And with the prevailing wind, biting horn flies can disperse up to 11 km in ten hours.

Biting Stable Fly Dispersal Map

Mosquitoes. Mosquitoes are not dung-dwelling flies, but the proposed Dairy could generate large populations of these pests in standing water, ponds, ditches and pasture divots. The DEIS does not mention mosquitoes, and includes no analysis of the potential impacts of mosquitoes on HDF neighbors or the ability of mosquitoes to spread disease to native Hawaiian endangered birds.

Dung Beetles. The plan in the DEIS to use dung beetles to hasten the breakdown of manure, and to minimize pest fly populations and odor, is unlikely to succeed. Although the DEIS states that dung beetles can bury a dung pat in one to three days, there are no references or evidence to support this claim. The DEIS ignores an extensive published field study demonstrating that up to 80% of dung remains unburied after seven days.

It is unlikely that HDF will achieve significant pest fly control with dung beetles. HDF has failed to consider that excessive moisture, clay soils, and trampling by cows will negatively impact dung beetle dung-burying capacity. Published literature establishes that dung beetles are less efficient burying dung pats on clay soils than sandy soils. Further, the DEIS neglects to mention studies showing that soils that are too wet will support fewer dung beetles than drier soils, and that excess moisture results in higher mortality of dung beetle eggs and larvae. HDF's clay soils will likely be saturated or nearly saturated most of the year, due to rainfall patterns and irrigation that spreads liquid manure from wash-down in the HDF milking parlors. Notably, HDF's own manure-related arthropod survey states that both dung beetles and the biting stable fly were abundant during the survey.

The DEIS does not consider the potential impacts predators may have on dung beetle establishment. Although HDF intends to translocate dung beetles from other locations, the DEIS fails to address the possibility of translocating other invasive species, or the accidental release of other pest species collected with the dung beetles.

Up to 8 million actively feeding adult dung beetles could be required on any given day to effectively suppress fly development. The DEIS neglects to provide sufficient information about how they intend to capture the large numbers of dung beetles necessary to control pest flies and process manure pats.

Integrated Pest Management Plan. The DEIS relies upon an Integrated Pest Management plan and a Best Management Practices plan in order to control pests, neither of which is provided. HDF fails to provide details of how various control measures would be integrated.

Part of HDF's plan is to use chemical controls, but the quantity and type of chemicals is not identified, the thresholds for chemical application decision-making are not provided, and the location of chemical applications is not identified. The DEIS neglects to address the effectiveness of chemical controls on target species, and fails to provide any information about chemical control of mosquitoes. Further, the DEIS fails to consider the impacts of chemical

control on beneficial species such as dung beetles and other non-target arthropods. As with other aspects of the DEIS, comments cannot be provided upon mitigation plans that are not available or may not even exist.

The DEIS says that HDF will release insect parasites and predators to control fly populations, but fails to identify the parasite and predator species which will be used, the effectiveness of these parasites and predators, and the impacts on non-target species. Additionally, HDF fails to describe how it will prevent the accidental release of invasive species.

Endangered Arthropods. The DEIS fails to present a complete arthropod survey and assessment, does not provide complete information about potential impacts on Kauai's endangered cave arthropods, and fails to adequately assess potential impacts to Kauai's endangered cave arthropods: the Kauaʻi Cave Wolf Spider and the Kauaʻi Cave Amphipod. These unusual animals are known only from caves, subterranean cracks, and microcaverns (voids and inaccessible passages) in the Kōloa District on Kauaʻi. They are particularly vulnerable to pesticides and contaminants because their exoskeletons are permeable to water. The DEIS fails to disclose or discuss the impacts to Kauaʻi cave arthropods from chemicals that will be used by the Dairy, including pharmaceuticals typically used by dairies, including antibiotics, anthelmintics and parasiticides, some of which have long half-lives.

Presumed and known distribution of these arthropods is adjacent to HDF. The habitat for these cave arthropods is not exclusively large caves as assumed by HDF. They also live in interstitial spaces and cracks that form in lava as it cools. These small spaces are known as microcavernous habitat. It is likely that the lava tube system below HDF is connected to the cave habitat of these two endangered species.

Native Insects. The DEIS identifies only 16 arthropod species in its manure-related arthropod survey. A similar study of similar landscape less than 15 miles from HDF identified 238 insect species, about 10% of which were native Hawaiian species. The DEIS failed to conduct a standard arthropod survey and assessment.

D. Pathogen Impacts (Appendix D)

Technical Memorandum, Expert Report on Pathogens, Hawaiʻi Dairy Farms
Draft Environmental Impact Statement, May 2016
Exponent, July 2016

Notwithstanding the warm and wet conditions that exist in the soils and manure at the proposed Dairy site and the pathogen and fecal indicator bacteria growth likely to be harbored, the DEIS fails to acknowledge the potential impact of microbial pathogens and fecal indicator bacteria ("FIB"), and fails to adequately characterize the human health or ecological impacts of microbial pathogens discharged from the Dairy.

Dairy wastes, and more specifically cattle manure, contain a diverse range of microorganisms at high concentrations, including human pathogens and FIB and are widely recognized as a potential source of FIB and pathogens to local watersheds. Human pathogens in cow manure can include *E. coli* O:157, *Listeria, Salmonella, Campylobacter, Cryptosporidium*, and viruses. Pathogens are able to survive days to months within cow patties and in effluent ponds which will allow time for transportation offsite. Pathogens related to livestock manure have been implicated in multiple outbreaks of human illness. Due to conditions at the proposed HDF site, pathogens in manure may impact surface and groundwater quality and poses risks to human and ecological health.

Unlike nutrients, which the DEIS asserts will remain constant with the proposed change from a 699-head up to a 2,000-head farming operation (assuming the appropriate adjustments in fertilizer applications), pathogens would be expected to scale proportionally with the change in manure input. This is not addressed in the DEIS.

Further, the taro farm which is nearly enclosed by the HDF property has fields with standing water and represents another potential receptor for pathogens which was not considered by HDF in the DEIS.

HDF proposes the use of unlined burial pits for deceased cattle. This is part of HDF's Animal Mortality Management Plan included in its Waste Management Plan. Without a liner, any water from precipitation flowing through the preferential flowpaths created by the digging of pits can leach pathogens from the decaying cow carcass and transport them to downstream receptors. This practice has been banned in many places, including the European Union. The Hawai'i Cooperative Extension Service also indicates that disposing of dead animals on property without composting is considered "high risk" operation due to the fact that decomposing animals can be a concentrated source of pollutants including nutrients and microorganisms. The animal carcasses present an additional risk for pathogen transport. The location of the cemetery is in an area where all buried cows will likely come in direct contact with the groundwater, which is known to discharge to surface water downstream of this location. The practice of burying cows where the water table is elevated above the depth of the hole is not recommended due to the risk to groundwater.

In the DEIS, HDF relied on two studies to characterize the baseline pathogen concentrations in and around the proposed Dairy site, as indicated by the presence of FIB. However, information provided in the DEIS was incomplete with regard to describing pathogen/FIB baseline conditions and did not show an understanding of pathogen risks in the environment. Despite dairy cows being a known source of fecal pathogens to stream and ground waters, and the environment of the proposed Dairy location being specifically suited to pathogen survival and transport, the DEIS failed to include an analysis of the potential impact of pathogens and FIB produced by the proposed Dairy. HDF fails to propose any method for the HDF operators or others to determine whether impacts are occurring, as no monitoring program is

proposed for pathogens. As the potential impacts and FIB were not specifically assessed in the DEIS, no mitigation measures were proposed to address any impacts.

Given that there is the potential for pathogen transport to surface and ground water as well as taro farm crops, the HDF should have a monitoring program to determine the extent of any impact from the HDF, and response measures should be described if an impact is observed.

The project site is subject to rain, and pathogens and fecal indicator bacteria would be expected to survive or possibly grow between rainfall events to facilitate transport off the pasture during the next rainfall event. The DEIS does not evaluate the potential for pathogens to be transported to surface and ground water, as well as to the taro farm crops located adjacent to the proposed Dairy.

The DEIS as written has failed to acknowledge the potential impact of microbial pathogens and FIB and has failed to adequately characterize the human health or ecological impacts of microbial pathogens discharged from the proposed Dairy.

E. Ecological Impacts (Appendix E)

Technical Memorandum, Comments on Ecological Assessment in Hawai'i Dairy Farms Draft Environmental Impact Statement, May 2016
Exponent, July 2016

The DEIS does not address harmful algae blooms, the introduction and increasing populations of exotic species, and threats to threatened and endangered endemic species. In addition, the DEIS does not propose management plans for addressing many of the concerns previously expressed by the U.S. Fish and Wildlife Service ("USFWS").

The botanical survey assessing the proposed project area is insufficient to predict the potential impacts to both exotic plants and threatened native plants. Sampling was only conducted in the dry seasons, so wet season annual plants were likely missed or under-represented.

The avian surveys assessing the bird populations and long term planned habitat changes were insufficient to predict the potential impacts to threatened and endangered endemic birds and to predict whether exotic bird populations would increase. The entire survey involved only 168 minutes of census time, and an avian census that only takes samples once fails to address temporal and temporospatial variation in bird presence and distribution

Four endemic waterbirds were found on the property: the Hawaiian Duck, the Hawaiian sub-species of the Common Gallinule, the Black-necked Stilt, and the Hawaiian coot. While the paddocks are proposed to be fenced, cattle can often breach fencing barriers. HDF has failed to disclose what cleaning products and medicines will be used at the Dairy, and if endemic waterbirds will be exposed to them through their direct use as part of the Dairy's operations or from the use of the effluent settling or storage ponds.

The DEIS states that endangered Nēnē "probably" nest on the site. Cattle are known to lower nesting success of ground nesting birds such as the Nēnē, and HDF will need to implement weekly surveys by certified biologists during Nēnē nesting season, as was highly recommended by the USFWS. Additionally the USFWS highly recommended that electric fencing not be used as part of the project due to impacts on Nēnē. The DEIS failed to consider this recommendation and does not provide justification for disregarding a federal agency's recommendation. The Dairy will provide ideal conditions for supporting additional numbers of Cattle Egrets, rats and feral cats, all of which have the potential to result in increased Nēnē predation. In addition, infection of Nēnē by the protozoan parasite *Toxoplasma gondii* has been transmitted by domestic cats and historically caused mortality in native Hawaiian birds.

The Dairy will provide ideal conditions for supporting additional numbers of invasive species including Cattle Egrets, Barn Owls, and Common Myna. Barn Owls (which are different from *pueo*) are the target of eradication efforts by USFWS and their predation on Hawaiian seabirds is well-documented.

The mammalian survey assessing mammal populations and long-term planned habitat changes was insufficient to predict the potential impacts to the endangered Hoary bat and to predict the effects of increased pest mammal species. Although USFWS was quite concerned that the Hoary bats would be impacted by the use of barbed wire fencing and specifically requested that it not be used in the proposed project, HDF does not analyze collision risk from structures, electric fences or barbed wire fences. Barbed wire will still be used. DEIS at 1-9, 3-21.

HDF did not survey aquatic resources, and thus its assessment was insufficient to predict the potential impacts to the freshwater and marine communities from HDF activities. No evaluation was performed as to the potential impacts to corals from the direct connection of the proposed project to the marine system. Increased nutrients (from manure or fertilizer) stimulate phytoplankton and macroalgae growth that can affect corals. The DEIS fails to include a monitoring plan to assess the health of the fringing reefs near the discharge point of the Waiopili Stream.

The DEIS did not address the endangered Hawaiian monk seal. Foraging and haul-out areas used by the monk seals include Gillin's Beach, and discharges from the Waiopili Stream during HDF's operation will likely increase exposure of the monk seals to pathogen pollution from the outflow of the proposed Dairy. NOAA has stated that the risk of exposure to pathogens introduced from livestock and feral animals could have on a "catastrophic" effect to the immunologically naïve monk seal population. The DEIS does not discuss this risk.

Sea turtles haul-out on beaches, including areas near the Waiopili Stream. Thus, Dairy operations will increase the risk of sea turtle exposure to pathogen pollution. The DEIS does not discuss this risk.

The DEIS does not address the potential for harmful algal blooms in water at the Dairy to spread into the nearby marine system. Cyanobacterial harmful blooms are harmful ecologically and the accurate detection of harmful cyanotoxins has become increasingly important in the protection of human and ecological health.

The DEIS does not address controls necessary to stop further invasive species from arriving to Kaua'i during transportation of equipment and feed, relocation of invertebrates such as dung beetles, and attraction of exotic species due to habitat changes (e.g., settling or storage ponds). Little fire ants are an invasive pest on the Big Island. When transporting equipment, feed or invertebrates such as dung beetles from the Big Island, HDF fails to identify methods used to control ant introductions. Thus, the analysis of the DEIS is insufficient in its assessment of the impacts from the proposed action.

F. Impacts from Animals and Manure (Appendix F)

Comments on Animal and Manure Management in
Hawai'i Dairy Farms Draft Environmental Impact Statement
Deanne Meyer, Ph.D, July 2016

The DEIS does not provide sufficient detail to evaluate potential direct, indirect and cumulative impacts from the proposed project with respect to numbers of animals, animal productivity, estimates of feed intake, estimates of nutrient composition of feed intake, and pasture management. Insufficient or incorrect information appears to have been provided with respect to increases in nutrients and the potential for nutrient runoff or infiltration at the proposed Dairy location as well as elsewhere where animals are reared offsite.

The information that is lacking in the DEIS is of the nature and detail that would typically be required by regulators in other jurisdictions, such as California, to assess nutrients and water cycling, animal and manure management and potential impact to existing water resources. It is commonplace and should have been provided.

The DEIS fails to disclose the total number of dairy animals (832 dry and milking cows, and 205 calves) associated with the project phase of 699 milking cows, and fails to disclose the total number of dairy animals associated with the project as a whole.

HDF has underestimated manure production, erroneously discounting manure production from cows during hours of resting. HDF estimates manure production of 90.8 lbs/day/cow. Dr. Meyer has calculated, however, that a lactating cow at HDF will produce 122 lbs/day of manure.

HDF has also underestimated its nutrient output by ignoring excretions from replacement animals, dry cows and heifers. The nutrients excreted from dry cows and heifers are a significant contribution to the overall nutrient load from the project.

HDF has underestimated the vehicle trips that will leave or enter the Dairy daily by failing to account for transportation of cows for herd management, trucking of fluid milk, delivery of feed and fertilizer, and additional service professionals such as veterinary services, equipment dealer services, inspectors and other services needed to operate a dairy (refuse removal, delivery of supplies, etc.)

HDF has also failed to quantify solid waste impacts to landfill capacity, and failed to consider reasonable alternatives.

G. Hydrology and Water Quality (Appendix G)

Water and Water Quality Impacts, Hawaii Dairy Farms DEIS,
Māhāʻulepū, Kauaʻi
Exponent, July 2016

HDF's discussion of runoff and water quality impacts to groundwater and surface water, including to the Waiopili Stream and the ocean, does not consider important hydrologic processes and data. The quantity of nutrients (nitrogen and phosphorus) that are expected to leave the site by surface and groundwater flow is not considered. The impacts due to pathogens from manure at the facility are ignored. Best Management Practices are not described in enough detail to be meaningful, their effectiveness is not modeled or quantified, and there is no assurance that they are enforceable.

Specifically, the DEIS evaluated runoff and water quality impacts to groundwater and surface water, including to the Waiopili Stream and the Pacific Ocean, using overly broad, general assumptions, and without considering important hydrologic processes and data. The DEIS makes significant and unfounded assumptions regarding the quantity of nutrients (nitrogen and phosphorus) that are expected to leave the site by surface and groundwater flows, and does not adequately consider impacts due to pathogens from manure at the facility. The DEIS fails to evaluate impacts related to erosion and the transport of sediment and other potential contaminants to the nearshore ocean.

Although the DEIS asserts that best management practices ("BMPs") proposed to address water quality impacts will minimize water quality impacts, BMPs are not described in detail, and their effectiveness is not modeled or quantified. It is not clear that the wastewater management practices proposed for the ponds at the facility are adequately designed or how they will be operated, and it is likely that the effluent ponds onsite will exhibit poor water quality and produce noxious odors. It is also not clear that the proposed onsite effluent handling measures, which involve the distribution of both liquid and solid manure at the site via the site irrigation

systems, are feasible or that they could be implemented without exacerbating water quality impacts.

Although baseline water quality sampling is reported in the DEIS, water quality data for existing conditions are not adequate to describe the full range of conditions; notably, the limited sampling that was conducted did not include wet weather events. The DEIS does not describe how baseline monitoring will be used, the monitoring and sampling regime proposed to evaluate project impacts, whether sampling data gathered after the project is implemented will be shared with agencies or the public, or the actions that will be taken if water quality impacts are observed.

The proposed irrigation practices at the site will cause a significant increase in the amount of water applied to the site. The poorly drained soils over much of the site are expected to be saturated, or nearly saturated, much of the time, including in the area of the site where manure solids are proposed to be applied as slurry via gun irrigation. As a result of the soil types and irrigation practices proposed for the facility, the amount of water leaving the site as surface water runoff will increase. There is a likelihood of significant water quality impacts due to nitrogen, phosphorus, pathogens and sediment. Water quality would be lessened and would result in degradation of the Waiopili Stream and the ocean, including damage to coral, marine life and human health. The Dairy can be expected to cause exceedances of water quality standards that would not have occurred without the project.

H. Nutrient Mass Balance (Appendix H)

Review Comments on: Draft Environmental Impact Statement for
Hawaiʻi Dairy Farms, Māhāʻulepū, Kauaʻi, May 2016
CH2M, July 2016

The DEIS uses general estimates of the yield and nutrient uptake of kikuyu grass, among other things, as uniform every day of the year on every soil type and slope, whether irrigated or non-irrigated. Such simplifications result in incorrect estimates of nutrient losses to the environment. The DEIS does not reflect correct nutrient balance, and underestimates the impacts of the proposed Dairy.

To have a basis for comparison to the DEIS, CH2M modeled the soil, water and nutrient movement through the root zone of kikuyu grass with a detailed model that calculates crop yield, water and nutrient uptake, and nutrient losses to the environment considering the variables of climatic conditions and how these variables influence crop growth and nutrient removal.

The scenario modeled for HDF was for 2,000 cows with wetter than average climatic conditions, no commercial fertilizer application, and optimal irrigation water application to meet all crop needs but not over-irrigate. Models of the soil, water, and nutrient movement through the root zone of kikuyu grass predict high nitrogen loss, with a total discharge of nitrogen from the Dairy to the water environment of 335,934 pounds per year. Without modeling and with oversimplification and averaging of variables, the DEIS makes a first order approximation of 10,000 pounds per year of nitrogen discharged to the environment, which is a significant under-estimation.

The DEIS uses rainfall data from a local rain gauge which has hundreds of missing data points in 30 years of record and over 50 missing data points in every year of record. This station is not suitable for irrigation scheduling or manure management. HDF's use of this poor quality partial data set for the critical climatic input to Dairy management decisions has resulted in the DEIS recommending over-irrigation, unrealistic yield estimates, and nutrient discharges that are an order of magnitude too low.

HDF claims to have one of the highest yields in the world for kikuyu grass pasture but does not provide any scientific design for sampling or farm trial quality control. The Dairy does not currently have cows, so yield estimates are for clipped samples which over-estimate actual yields from cattle grazing. The nitrogen removal rates of 1,090 pounds per acre per year presented in the DEIS are unprecedented and are not supported by scientific data or references for pastures in Hawai‘i grazed by cattle on an 18 day rotation. The nitrogen removal rates are presented as the same for non-irrigated areas and irrigated areas even though kikuyu grass in Hawai‘i is documented to have half the yield when non-irrigated.

HDF proposes to apply manure slurry with big gun irrigation sprinklers with a trajectory radius of 65 ft. This method of slurry application is the poster child of manure odor complaints as it creates a plume with a wide range of droplet sizes and mist that can drift in the wind and volatilize odor agents over a large area. Big gun sprinkler irrigation has a higher instantaneous application rate than almost all sprinkler, spray, or drip irrigation systems and is prone to creating ponding and runoff from poorly drained and sloped soils. The risk of runoff from big gun sprinklers for applying manure slurry is increased by the additional use of big gun sprinklers for irrigation water application on the same fields as the DEIS states will be done with the 2,000 head dairy.

HDF has already built smart valve center pivot irrigation machines that cross drainage ways and Waiopili Stream on narrow bridges multiple times in every rotation. The many valves on individual sprinklers on these pivots are programmed to stop manure effluent irrigation as the machine approaches the stream or drainage and reopen when the machine is on the other side. These machines are the most complex center pivot irrigation equipment available and contain hundreds of additional components when compared to standard center pivot machines, including GPS guidance, an air control pilot tube to every valve and a programmable controller. It is because of the increased complexity that these machines fail more often than standard center pivots. The use of manure effluent increases the risk of corrosion, scale build-up and plugging failures. There appears to be no precedent for use of these machines to apply manure while crossing a stream and the time to failure is unknown.

The soil conditions across the Dairy vary significantly in infiltration rate, texture, water holding capacity, background nutrient content, slope, and yield potential, yet the DEIS ignores all variables and selects a condition to use as average for all paddocks. The selected condition is not average or worst case, and it under-represents the risk of nutrient losses to the environment.

III. HDF'S DEIS IS FLAWED PROCEDURALLY AND SUBSTANTIVELY

The purpose of Chapter 343 is "to establish a system of environmental review which will ensure that environmental concerns are given appropriate consideration in decision making along with economic and technical considerations." Hawai‘i Revised Statutes ("HRS") § 343-1. To be sufficient, an EIS must satisfy both the procedural and the substantive requirements of Chapter 343. An essential procedural step is the public's opportunity to provide meaningful comment on the DEIS. The DEIS here is fatally flawed and does not satisfy this critical procedural step.[1] For the reasons set forth below, there must be full disclosure to the public, and a supplemental draft EIS is required to satisfy Chapter 343.

A. HDF Has Failed to Satisfy the Requirement in HAR § 11-200-3(d) to Identify the Triggers for Environmental Review

The notice in the Office of Environmental Quality Control ("OEQC") Environmental Notice for the DEIS is fatally flawed. Hawai‘i Administrative Rules ("HAR") § 11-200-3(d) requires that "[a]ll submittals to the office for publication in the bulletin shall be accompanied by a completed informational form which provides whatever information the office needs to properly notify the public." The OEQC has prepared such a form which includes the requirement to list the "HRS §343-5 Trigger(s)," in other words, as provided by rule, "a citation of the applicable federal or state statutes requiring preparation of the document." *Id*. HDF failed to do so, and instead said: "To be determined." Ex. 36. OEQC has already determined the "trigger" is an essential element of the information to be provided to notify the public. HDF has failed to provide this essential notice, as surely the public needs to know that there are two triggers: a wastewater treatment plant and use of state funds. The failure to follow the procedural requirements violates Chapter 343. A supplemental draft EIS with proper disclosures is required.

1. HDF's Fails to Disclose that its Proposed Wastewater Treatment Unit Triggers Chapter 343

Chapter 343 is not satisfied by HDF asserting in the Environmental Notice that its EIS trigger is "[t]o be determined" or by stating elsewhere that its EIS is "voluntary." The EIS

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[1] Kawailoa has raised these and other legal issues in its correspondence to various agencies. Kawailoa attaches and incorporates by reference these various statements (Exs. 1-3, 5, 8-11, 13-23), and requests that the Final EIS respond to all issues raised in Kawailoa's letters. These statements and requests were ignored. *See, e.g.*, Exs. 4, 12.

process is one to be taken seriously. It is triggered by conditions specified in Chapter 343. In no instance does Chapter 343 contemplate that an applicant may evade the requirements of Chapter 343 by filing a "voluntary" EIS. A Draft EIS must follow the requirements of Chapter 343.

OEQC instructed HDF "to drop any reference to 'voluntary' in materials related to the EIS." Ex. 30. Even the DOH has acknowledged that "the use of the adjective 'voluntary,' . . . does not obviate the possibility of any legal challenges to the document under Section 7 of HEPA." Ex. 29. *See also id*. ("I quite agree with you, that the EIS would be subject to challenge per 343-7, even if it were processed as a 'voluntary' EIS.").

The use of the term "voluntary" is an attempt by HDF to distract from the more significant point that HDF is proposing to construct a wastewater treatment unit, which in fact clearly triggers Chapter 343. *See* HRS § 343-5(a)(9)(a) ("an environmental assessment shall be required for actions that . . . propose any . . . Wastewater treatment unit, except an individual wastewater system or a wastewater treatment unit serving fewer than fifty single-family dwellings or the equivalent.") It is clear from the express language of Chapter 343 and its administrative rules, as well as the legislative history[2] and HDF's counsel's analysis (Ex. 24), that wastewater treatment units include liquid wastes from animals or agriculture.

HDF ignores its own documents (and excludes them from the DEIS), which demonstrate that it proposes a wastewater treatment unit. Section 7.0 of HDF's Waste Management Plan describes "Wastewater Treatment." Ex. 7 at 41-42.[3] The animal waste involved in the project will be huge. Since each cow will produce an average of 143 lbs. of manure per day, *id.* at 42,

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[2] First, Act 55, Session Laws of Hawai'i 2004, expressly reflected the legislature's intent to have the environmental review process cover newly proposed wastewater facilities. Act 55 (H.B. No. 1294) (2004). The purpose of the 2004 amendment was to "close loopholes in the environmental review process" by including proposals for any privately financed wastewater facilities on private lands that otherwise failed to trigger environmental review under prior law. *Id*. Second, the amendments to Chapter 343 in 2005 incorporated the Department's wastewater definitions set forth in its then administrative rules. Act No. 130 (H.B. No. 408) (2005). HAR § 11-62-3 (then as well as now) defines "wastewater" as "any liquid waste, whether treated or not, and whether animal, mineral or vegetable, including agricultural, industrial and thermal wastes." (Emphases added). The term "wastewater treatment unit" is defined as "any plant or facility used in the treatment of wastewater." HRS § 343-2.

[3] HDF's Waste Management Plan describes the wastewater treatment as consisting of two effluent ponds, a settling pond and a storage pond, which will be constructed "for effluent collection, management and proper utilization of nutrients available from livestock waste." *Id.* The Plan refers to the "water treatment system," *id*. at 41, "wastewater treatment ponds," *id*. at 42, and "NRCS Waste Storage Structure Practice Code 319 and Practice Code 359, Waste Treatment Lagoon," *id.* at 51. In the settling pond, a stirrer pump will operate for two hours per day to break up the solids in the settling pond. *Id.* at 43.

the 2,000 total cows at the Dairy will produce 286,000 lbs. of manure per day.[4] "Livestock waste and wastewater generated from the Dairy facility, including any runoff, will be collected, treated and reused on the farm." *Id.* at 41. While the entire Dairy facility, including the wastewater treatment ponds and other infrastructure, is being sized and constructed for the 2,000-cow scenario, the calculations in the Waste Management Plan are based only on the 699-cows scenario. *Id*. at 42; *see also* DEIS at 1-20.

HDF does not disclose this critical information to the public. The DEIS by and large conveniently minimizes any "treatment" of wastewater. In contrast to the prior Waste Management Plan, the DEIS makes only brief mention of the treatment process (notably, without using the word "treatment") as follows:

> The pasture-based dairy relies on 100 percent of the nutrients from manure deposited on the pasture, with application of manure captured in the effluent ponds, to grow the majority of forage for the herd. Collection and storage of effluent provide a tool for the dairy manager to control the schedule, timing, and mix of nutrients to be applied. . . Wash water from the milking parlor will be routed to the settling pond through a pipe. . . Solids are retained in the settling pond through filters.

DEIS at 3-14, 3-16.

Kawailoa was only able to locate one reference to the wastewater treatment process. Table 5-2 of the DEIS clearly acknowledges that HDF's "nutrient management plan is designed to collect, ***treat***, and reuse ***all livestock waste and wastewater*** generated from the facility." DEIS at 5-12 (emphases added). This reference is not sufficient disclosure. The trigger must be stated in the OEQC Environmental Notice, and the system must be fully described in a supplemental draft EIS.

2. HDF Failed to Disclose that its Use of State Tax Credits Triggers Chapter 343

HDF has availed itself of an agricultural state tax credit and this use of state funds is another trigger requiring environmental review under Chapter 343. HDF's principal has

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[4] In its May 2016 Waste Management Plan updates (Ex. 25), which were not included in the DEIS, HDF revised its manure production estimate downward from 143 lbs per day to 90.8 lbs per day. This downward revision was purportedly based on "forage testing," copies of which HDF has also not made available for comment as part of the DEIS process. In contrast to HDF's manure estimates, Dr. Deanne Meyer, estimates that each cow will produce 122 lbs of manure per day, utilizing Standard D384.2, Manure Production and Characteristics. (Appendix F hereto).

obtained a substantial Hawai‘i state tax credit, the purpose of which is to help the taxpayer offset expenditures on "qualified agricultural costs," *see* HRS § 235-110.93.

HRS § 343-5(a) provides that "an environmental assessment shall be required for actions that: (1) Propose . . . the use of state or county funds . . . ." (Emphasis added). HAR § 11-200-5(c) in implementing Chapter 343, provides that the "[u]se of state or county funds shall include ***any form of funding assistance*** flowing from the State or county . . . ." (Emphasis added).

A tax credit constitutes a "form of funding assistance" that "flow[s] from the State." The statute authorizing the tax credit makes it clear that the credit is designed to be exactly that – a form of funding assistance to entities investing in agricultural lands or enterprises. For example, the tax credit is available only to those entities that incur "qualified agricultural costs." HRS § 235-110.93(a). Relevant to HDF, a "qualified agricultural cost" is defined as "expenditures for," among other things, "[a]gricultural processing facilities in the State, primarily for agricultural purposes, where the majority of the crops or livestock processed, harvested, treated, washed, handled, or packaged are from agricultural businesses." Thus, the tax credit is clearly designed to assist the recipient in funding agricultural expenditures and is exactly what triggers an EIS under HRS § 343-5(a). The trigger must be stated in the OEQC Environmental Notice, and the tax credit must be fully described in a supplemental draft EIS.

B. HDF Has Improperly Segmented Its Project

The DEIS does not accurately describe the "action" that is the subject of the EIS. The "action" is "any program or project to be initiated by any agency or applicant." HRS § 343-2; HAR § 11-200-2. A group of actions proposed by an applicant shall be treated as a single action when the component actions are phases or increments of a larger total undertaking. HAR § 11-200-7 provides:

> A group of actions proposed by an agency or an applicant ***shall be treated as a single action*** when: (1) The component actions are phases or increments of a larger total undertaking; (2) An individual project is a necessary precedent for a larger project; (3) An individual project represents a commitment to a larger project; or (4) The actions in question are essentially identical and a single statement will adequately address the impacts of each individual action and those of the group of actions as a whole.

(Emphasis added). Where, as here, HDF has admitted that its plan is to build and operate a Dairy for up to 2,000 mature milking cows, the entire plan must be studied at the outset. HDF's statement that "additional regulatory review and public input would be required" for 2,000 cows (DEIS at 1-4) cannot apply to Chapter 343. The "contemplated herd" cannot be segmented into two separate projects, thereby evading public input. Compliance with Chapter 343 cannot be delayed.

The DEIS is cleverly crafted to evade environmental review of the complete project. On the one hand, HDF suggests the DEIS is meant to "document[] the potential impacts from both herd sizes for comparative purposes and full disclosure." DEIS at 1-4. On the other hand, the larger total undertaking is a large Concentrated Animal Feeding Operation ("CAFO") with more than 2,000 cows, which is only described in the DEIS as a "possible expansion." (DEIS at 1-4), a "possible expanded herd" (DEIS at 1-12), "potential implementation of a contemplated herd size of up to 2,000 mature milking cows" (DEIS at 1-14), and as an "upper scale . . . at the dairy [that] may or may not ultimately occur." (DEIS at 1-16). The summary of probable impacts for a 2,000 herd size are discussed in table form in only a few brief pages beginning on page 4-102 of the DEIS. Most of these additional impacts are described as "no change" with little explanation. It is not sufficient to include limited discussion of these impacts in a table buried nearly 200 pages into the DEIS.

The Hawai‘i Supreme Court has repeatedly ruled that the entire "larger total undertaking" must be studied; to do otherwise is impermissible segmentation. *See, e.g. Kahana Sunset Owners Association v. County of Maui*, 86 Hawai‘i 66, 74, 947 P.2d 387, 386 (1997). In contrast to this well-established authority, the DEIS does not consider the entire CAFO with more than 2,000 cows as the "action" here, only a possibility or a potential. The DEIS repeatedly tells the reader that this project is a dairy with 699 cows and describes the impacts of less than the total undertaking. This construct misleads the public, and denies the opportunity for meaningful public comment as required by Chapter 343.

In contrast, the technical comments provided in Appendices A through H hereto show very different, and more significant, impacts from a 2,000 head herd, including increased manure, increased flies, increased odor, increased discharge of pathogens, and increased discharge of water and nutrients. Indeed, the lay reader would have no knowledge of this from reading the DEIS and would therefore completely miss the opportunity to comment on the Large CAFO in the DEIS process. This is improper and constitutes segmentation.

C. HDF Has Failed to Identify Its Complete "Action"

The DEIS must fully and completely describe the proposed action. HDF has been selective in the information that it has disclosed in the DEIS, however. It has not provided critical information and documentation that it has already submitted to government agencies in connection with its plans. The proposed action is not described in the following respects:

- *Wastewater treatment*. The DEIS nowhere mentions the wastewater treatment process that was described and discussed in the Waste Management Plan (Exs. 7, 25) previously submitted by HDF to the Hawaiʻi Department of Health ("DOH").[5] Wastewater treatment is significant as it is one of the explicit triggers requiring environmental review. "Wastewater treatment" is not mentioned in the description of the proposed project in section 1.2 of the DEIS.

- *New Drains*. The DEIS discloses that drains will be constructed to remove surface water. DEIS Appendix C at 94-95 ("Drains may also be installed and used to remove non-nutrient laden water from the surface of these areas to reduce soil dry time and to restore grazing). HDF's discussion of adding drains is buried in the technical appendices and only vaguely referenced in the DEIS. Of significance, no discussion of the impacts of these drains is included. Mark Madison, however, documents that they will discharge additional nutrients to surface water. (Appendix H at p. 43, "Any Drain will be a short circuit of manure directly to the stream."). New drains are not mentioned in the description of the proposed project in section 1.2 of the DEIS.

- *The total number of cows*. The DEIS represents that there will be between 699 and 2,000 dairy cows but does not factor the number of calves that will be on site at the Dairy. Per the Waste Management Plan Update, there will be 150 calves on site if under 90 days of age or if under 250 lbs. Ex. 25. In order to maintain a 699 cow dairy, 832 animals would need to calve each year, and 205 calves would be maintained at the Dairy location (Report of Deanne Meyer, Appendix F). The total number of cows and calves would be larger for a 2,000 cow dairy. Whether maintained on site or offsite, the impacts of these additional animals are not presented in the DEIS. A total of 832 cows and 205 calves (or even 150 calves) is not mentioned in the description of the proposed project in section 1.2 of the DEIS.

- *Offsite locations*. Although HDF acknowledges that its operations will require that certain cows will be managed offsite and rotated from the Dairy (DEIS at p. 3-36), such offsite locations and the impacts from such offsite operations are not discussed or evaluated in the DEIS. Operations at offsite locations are not mentioned in the description of the proposed project in section 1.2 of the DEIS.

- *Use of public roads and highways*. The DEIS acknowledges that Poipu Road in front of the Grand Hyatt Kauai and Poipu Bay Golf Course will be used regularly for heavy truck access (including but not limited to the transport of livestock and the feed for livestock), (DEIS at 4-68), the impacts of using this and other roads are not stated. Use of public

[5] HDF further updated its Waste Management Plan by a submittal to the Hawaiʻi Department of Health Wastewater Branch dated May 25, 2016 ("Waste Management Plan Update"), (Ex. 25), and the Wastewater Branch submitted comments on it (Ex. 26), but HDF did not include such updates in its DEIS.

roads and highways, including Poipu Road, is not mentioned in the description of the proposed project in section 1.2 of the DEIS.

- *Dung beetle collection and translocation*. HDF proposes to collect dung beetles from locations elsewhere on Kauaʻi or in the State of Hawaiʻi and to transport them to the proposed Dairy location. The DEIS does specifically describe collection locations, quantities or methods. Nor does it evaluate the risks of transporting invasive insect species with the collected dung beetles. *See* report by Pacific Analytics, attached as Appendix C. Importation of dung beetles is not mentioned in the description of the proposed project in section 1.2 of the DEIS.

- *Transportation of equipment and feed*. The transporation of equipment and feed is not identified as part of the proposed project in section 1.2 of the DEIS. The DEIS does not address environmental impacts from this transportation, including controls necessary to stop further invasive species from arriving to Kauaʻi during transportation of equipment and feed.

- *Milk transportation and processing*. Section 1.2 of the DEIS fails to identify the transportation and processing of milk as part of the proposed project. The DEIS does not address the environmental impacts from this transportation.

These omissions mislead the public, and deny the opportunity for meaningful public comment as required by Chapter 343. This information should be presented in a supplemental draft EIS.

D. HDF Fails to Disclose the Use of Public Funds

The DEIS fails to comply with the Content Requirements set forth in HAR §11-200-17 for Draft EISs. HAR §11-200-17(e) provides that the "draft EIS ***shall*** contain a project description which ***shall*** include the following information … (4) Use of public funds or lands for the action…" (Emphasis added.) This requirement is in addition to the requirement to list the use of public funds as a trigger, as discussed above. Use of public funds, in the form of an agricultural tax credit, is not mentioned in the description of the proposed project in section 1.2 of the DEIS, and the DEIS fails to disclose or mention any use of public funds. Again, this information is critical to the review of the document by the public; this information should be presented in a supplemental draft EIS.

E. HDF Fails to Discuss Significant Adverse Impacts

The DEIS fails to comply with the Content Requirements set forth in HAR § 11-200-17 for Draft EISs. HAR § 11-200-17(b)(2) requires the DEIS to discuss "Significant beneficial and adverse impacts (including cumulative impacts and secondary impacts)." If HDF contends that (1) the non-lactating cows on premises and/or (2) its movement of cows and calves around

Kaua'i ("musical cows"); (3) wastewater treatment; (4) new drains, (5) use of public roads and highways; (6) dung beetle collection and translocation; (7) transportation of equipment and feed; and (8) milk transportation and processing are not part of the "action," they are necessarily secondary or cumulative impacts of the action.

"Secondary impacts" are the "effects that are ***caused by the action*** and are later in time or ***farther removed in distance***, but are still reasonably foreseeable." (Emphasis added.) The secondary impacts analysis claims that there will be "no impact" from cows other than lactating cows at the Dairy itself. Offsite transportation is "not anticipated to generate significant secondary impacts," but it is not studied. The analysis in the DEIS only considers the 699 cow herd size; there is no secondary impacts analysis of the action as a whole. This lack of analysis is not acceptable under Chapter 343, and a supplemental draft EIS is required.

Cumulative impacts require an analysis of "the incremental impact of the action, when added to other past, present and reasonably foreseeable actions regardless of what agency or person undertakes such other actions." A cumulative impacts analysis of the proposed action – which must be 2,000 cows – has not been performed. The DEIS reaches the remarkable conclusion at page 4-109 that "cumulative impacts from both the committed herd size and the contemplated herd size are not significant." It strains credulity to suggest that a project of this magnitude, nearly doubling the number of milk cows in the state, will not have significant cumulative impacts. These conclusory statements do not pass muster under Chapter 343. The lack of a meaningful analysis denies the opportunity for public comment as required by Chapter 343, and a supplemental draft EIS is required.

F. HDF's Alternatives Analysis is Inadequate

The DEIS fails to comply with the "alternatives analysis" requirement of the Content Requirements set forth in HAR § 11-200-17 for Draft EISs. HAR § 11-200-17(f) provides that the draft EIS shall include a separate and distinct section on alternatives. The DEIS has such a section but it fails to comply with the rule in four key respects.

First, the DEIS fails to study the "alternative of no action." HAR § 11-200-17(f)(1). The "no action" alternative is designed to present the status quo so the reader can better understand the consequences of the action. In startling contrast, the "no action" alternative described in the DEIS in section 1.7.1 is not the use of the land as it has been since 1986 when the sugar mill closed, but an alternative of grazing for 2,000 animals and/or other intensive agricultural uses with no management, no operational controls, and storm runoff of animal waste and suspended sediment. This horrific "no action" alternative never existed (Kawailoa hopes) and would be a change from recent conditions. As a matter of law, a different project cannot be the "no action" alternative. The failure to include a true "no action" alternative so the public can compare the project to current conditions violates Chapter 343.

The second missing requirement is to study "the alternative of postponing action pending further study." HAR § 11-200-17(f)(4). In light of the substantive inadequacies presented in the appendices, this seems a worthy option. Technical appendices A through H demonstrate extensive additional study is needed in areas including, but limited to, the following: economic impacts from flies and odor; the efficacy of dung beetles in controlling pest fly populations and odor; a standard arthropod survey and assessment; impacts on endangered arthropods; pathogen impacts; impacts of harmful algal blooms; impacts of introduction and increasing populations of invasive and/or exotic species; impacts to threatened and endangered endemic species (including the Hoary bat, monk seals and green sea turtles); impacts to coral; runoff and water quality impacts; and additional nutrient balance analysis).

Further study has also been required by the State Historic Preservation Division ("SHPD"), which ten days ago sent a letter dated July 15, 2016 to HDF regarding review of HDF's revised Archaeological Inventory Survey ("AIS"). Ex. 33. SHPD is requiring additional revisions to the AIS, including additional information regarding historic sites, consultation with OHA and other interested parties, additional research into interpretation of traditional Hawaiian sites, and the impacts of the project on historic sites. *Id*. The AIS attached to the DEIS as Appendix G is missing the further study requested by SHPD. HDF must therefore postpone action pending this further study, then make the further study available in a supplemental draft EIS.

HDF's third failure is to study "alternatives which could attain the objectives of the action" as required by § 11-200-17. HDF admits that HAR chapter 11-200 "requires a discussion of alternatives that ***could attain the objectives of the action***, regardless of cost," DEIS Response Letter to Kawailoa at 3 (emphasis added). The objectives of the proposed action are stated on page 1-3 of the DEIS and include, for example, providing milk for the community, growing local grass as a primary feedstock, and effectively integrating Dairy operations within the island community setting. Inexplicably, Section 6.2 of the DEIS fails to consider alternatives sharing these same objectives. Instead, Section 6.2 examines alternative uses for Grove Farm's property, including rezoning the land for resort or residential development, condemnation for conservation, development of an agricultural park and processing center, or development of an agricultural subdivision. None of these alternatives could attain the stated objectives of the proposed Dairy as none involve dairy operations.

Fourth, HDF fails to study the "alternative locations for the proposed project." HAR § 11-200-17(f)(5). Kawailoa Development stated in its February 23, 2015 comments on HDF's EIS Preparation Notice that locations should not be arbitrarily limited to the island of Kaua'i, as set forth in that notice. The DEIS imposes further limitations on alternative locations, considering only "972 acres of Grove Farm land at Puhi" but within a single sentence deemed that alternative "less suitable . . . due to land tenure, greater slopes, higher rainfall and less sunlight . . ..”[6] DEIS at 1-19. Further, the discussion in Section 6.0, relating to the 972 acres at Puhi (Kīpū), makes clear that these lands were only evaluated as an alternative location. Since then, the land has been contracted for sale to another landowner who is not planning to develop a pasture-based dairy. DEIS at 6-15. There are therefore ***no*** present alternative locations described in the DEIS for the proposed project – all have been ruled out in their entirety, and no non-Grove Farm lands are considered.

No alternative sites outside Kaua‘i were considered. *See, e.g., ‘Ilio‘ulaokalani Coalition v. Rumsfeld*, 464 F.3d 1083, 1095 (9th Cir. 2006) (“The agency must look at every reasonable alternative within the range dictated by the nature and scope of the proposal. The existence of reasonable but unexamined alternatives renders an EIS inadequate.”). The DEIS should have, but did not consider sites where dairies are already established, and where existing milk processing facilities are located, such as those on the island of Hawai‘i, for example. Alternate multiple locations were also not studied.

The DEIS also acknowledges that, “[t]he project purpose is to establish ***a sustainable, pastoral rotational-grazing dairy farm*** that will increase current local milk production, bolster Hawaii’s declining dairy industry, and reduce reliance on imported milk from the mainland United States.” DEIS at 1-3 (emphasis added). The stated purposes suggest that the Dairy has a statewide purpose, both with respect to the dairy industry and the market that the Dairy intends to serve. Despite this stated purpose, no statewide locations are considered. Such locations should be studied in the supplemental draft EIS.

G. HDF Fails to Disclose Enforceable Mitigation Measures

While the DEIS describes various “mitigation” measures, those mitigation measures cannot be used to reduce the impacts of the proposed action. In order to reduce the significance of an impact, the mitigation must be well-defined and there must be an enforceable commitment to the mitigation. Here there is no clear plan or enforceable commitment to mitigation. Promises are not enough to reduce the substantial adverse impacts of this project.

1. HDF Fails to Adequately Describe Mitigation Measures

The DEIS fails to adequately describe mitigation measures, establish reduction of impacts to insignificant levels, or provide a basis for considering those levels acceptable. HAR § 11-200-7 (“Description of any mitigation measures included in the action plan to reduce significant,

[6] Ironically, the alternative Grove Farm property was rejected because of a “perennial stream draining into a wildlife refuge,” DEIS at 1-19, wholly ignoring that the proposed Māhā‘ulepū location also has Waiopili Stream draining directly through the middle of the Dairy to the nearshore environment, a pupping and haul out location for endangered monk seals, and an area used for recreation (fishing and swimming) by the public. *See* Appendix E and U.S. National Park Service Reconnaissance Survey, attached to Ex. 8 at 24.

unavoidable, adverse impacts to insignificant levels, and the basis for considering those levels acceptable shall be included.”). The mitigation presented in HDF’s DEIS represents little more than a “plan to have a plan.” By way of example only, the DEIS vaguely promises “Best Management Practices” and “Integrated Pest Management,”[7] but does not provide those practices or plans for review. The DEIS also describes best management practices to control water runoff (DEIS at 1-15), but does not describe those practices in any level of detail. HDF also states that it will rely on “effluent management” to ensure environmental health and safety (DEIS at 2-9), but does not describe those practices in any level of detail. Moreover, HDF refers to the Nutrient Management Plan as containing significant information on its nutrient management practices (DEIS at 3-28), but does not include that plan in its DEIS.

2. HDF Relies Heavily on Mitigation Measures in its Natural Resources Conservation Service (NRCS) Conservation Plan But has Failed to Make that Document Available for Public Review as part of the DEIS Process

Kawailoa requested in its comments on HDF’s EIS Preparation Notice, that HDF’s Conservation Plan be attached to the DEIS, HDF has neither made the Conservation Plan available nor has it been attached to the DEIS. The West Kaua‘i Soil and Water Conservation District has also refused to disclose this document. Ex. 6. HDF’s Conservation Plan is the purported basis upon which HDF obtained the approvals, permits and exemptions that it obtained prior to its publication of the DEIS and that it now apparently holds. It is the antithesis of any EIS that such core information should be withheld. The permits desired are of significant public interest. The basis for such permits, i.e., if it is to be the Conservation Plan, forms the record for public comments and for governmental agencies to make decisions relating to the project. Without it, the public (as well as the agencies issuing the applicable permits and approvals) are in the dark.

In particular, HDF relied on the NRCS Conservation Plan to obtain an agricultural exemption by the County of Kaua‘i Department of Public Works under Section 22.76 of the County of Kaua‘i Sediment and Erosion Control Ordinance. *See* DEIS, at 4-13 (stating that the County granted the exemption “***provided that conservation practices documented in the HDF Conservation Plan are employed***”) (emphasis added). HDF also relied upon the NRCS Conservation Plan in obtaining its building permit approvals from the County of Kaua‘i.

In addition, the DEIS relies heavily on the Conservation Plan as the proposed mitigation of potential long and short-term impacts that could result from the dairy development. Openness and forthrightness with the public is not achieved by asserting that impacts will be managed by

[7] DEIS at 1-14, 1-15, 2-9, 3-7, 3-28, 4-6, 4-7, 4-13, 4-37, 4-38, 4-41, 4-42, 4-43, 4-45, 4-65, 4-66, 4-76, 4-80, 4-84, 4-87, 4-90, 4-91, 4-97, 4-99, 4-101.

practices that are contained in a secret document. A supplemental draft EIS attaching this document must be published and made available for comment.

The measures to minimize or mitigate the potential impacts of the dairy that are referenced in the undisclosed and unavailable Conservation Plan are as follows:

- p. 4-7: Regarding the potential long-term impacts on and mitigation measures relating to the topography of the dairy site, the DEIS states that the design and installation of any roads, raceways, and swales "will be incompliance with the HDF Conservation Plan and utilize standards from applicable NRCS Practice Codes";

- p. 4-13: The DEIS submits that in regards to short-term impacts resulting from earthwork for the dairy facilities, raceways, roads, drainage systems, and installation of utility infrastructure and effluent ponds, "[w]ork to date at HDF has followed the Conservation Plan, which was been [sic] approved by the West Kaua'i Soil and Water Conservation District in December 2013";

- p. 4-35: In regard to short term impacts on the flora at the site, "vegetated buffer strips along drainage ways are part of the Conservation Plan to reduce erosion and stabilize slopes";

- p. 4-65 to 66: In order to mitigate short-term impacts to surface water resources and the marine environment resulting from site work for pasture establishment and dairy facilities development, the developments will "employ NRCS standards per the HDF Conservation Plan," and notes that the Conservation Plan includes setbacks to minimize impacts of surface water, including a 50-foot setback from drainage ways for effluent application;

- pp. 4-83 to 84: In order to minimize impact to surface waters crossing the dairy and the impacts on nearshore marine resources due to run off surface water at the committed herd size of 699 cows, "HDF will follow its NRCS reviewed Conservation Plan to minimize sediment, nutrient and pathogen inputs to the surface waters in these drainages." On page 4-99 the DEIS asserts the same reliance on the Conservation Plan at the contemplated herd size of 2,000 cows;

- p. 4-103: The DEIS states that "Short-term soil disturbance for construction of roadways and dairy facilities [for the committed herd size]will be minimized through the adherence to the Conservation Plan, best management practices, and controls per an NPDES Construction Stormwater General Permit";

- p. 4-107: In order to minimize impacts to surface water resources at the committed herd size, "adherence to the Conservation Plan" and best management practices establish setbacks that will minimize impacts to surface water resources in the long-term for the committed herd size;

- p. 4-108: To minimize impacts to surface water resources at the contemplated herd size of 2,000 cows, "[a]dherence to the Conservation Plan and NRCS Nutrient Management Practice Code requires monitoring and analysis of soil, manure, and tissue samples which can be used to amend the nutrient budget prepared for the site";

- p. 6-19: Short term soil disturbance during construction for the committed herd size will be minimized through adherence to the Conservation Plan, best management practices , and NPDES Construction Stormwater Permit.

The references to the Conservation Plan are not just limited to the body of the DEIS. The supporting documentation attached to the DEIS and to its appendices rely upon the NRCS Conservation Plan. For example, Appendix D, "Nutrient Balance Analysis for Hawai'i Dairy Farms," prepared by Group 70, states on page 54 that "[t]he farm is managed under a Conservation Plan developed with [NRCS] guidance, and approved by the West Kaua'i Soil and Water Conservation District. The Conservation Plan specifies a variety of agricultural best management practices (BMPs) to be installed and implemented, as appropriate, prior to farm population and operation of the dairy." Appendix D further states, on page 64, that because the proposed dairy farm is pasture-based with "no significant amount of annual tillage planned," soil loss will be "manageable in accordance with the NRCS Conservation Plan . . .."

Given that the Conservation Plan is the plan by HDF to minimize and mitigate the impacts from the project, and given that the Conservation Plan is neither attached to the DEIS nor available for review, the DEIS essentially makes no disclosure of information regarding HDF's mitigation plans. As the Dairy's mitigation plans are not reviewable, the accuracy or the reasonableness of the mitigation plans cannot be evaluated, and of course, they are also unenforceable.

3. HDF Fails to Offer Assurance that Mitigation Will be Implemented

HDF's discussion of mitigation measures does not include a discussion of provisions to assure that the mitigation measures will in fact be taken. HAR § 11-200-17(m) ("Included, where possible and appropriate, should be specific reference to the timing of each step proposed to be taken in the mitigation process, what performance bonds if any, may be posted, and what other provisions are proposed to assure that mitigation measures will in fact be taken"). HDF has failed to discuss any timing of its mitigation measures (let alone the timing of "each step"), nor has it offered any guarantees that its vague mitigation measures "will in fact be taken." The public has therefore been deprived of the opportunity to evaluate the efficacy of these measures and offer comments regarding them.

A further, and more substantial concern, is that HDF will be left to monitor and self-police its own mitigation. There is no commitment that mitigation will be enforceable by any agency or the public. Mitigation plans are monitored, usually by an agency, and often adaptive management is required by agencies to correct any mitigation deficiencies. However, there is no apparent agency here to monitor whether integrated pest management will adequately control flies and odor emanating from the Dairy. These mitigation measures will not be made conditions of any permits identified in the DEIS. Some permits and approvals have already been issued (the NRCS conservation plan, the grading permit, the Individual Wastewater System permit, the Waste Management Plan, the Section 404 Permit exemption, the building permit, and the monitoring well construction permits. DEIS at 1-20 and 3-37. There are no land use permits listed. There is no agency issuing a permit for proper agricultural operations that will oversee issues such as flies and odors, as HDF appears determined to avoid oversight by the United States Environmental Protection Agency. Having circumvented the permit and approval process, HDF fails to identify any agency that will ensure that mitigation measures identified in the DEIS are undertaken. The community will be left with little or no remedy if promised mitigation plans do not materialize and operate as expected.

In this respect, HDF's failure to offer a performance bond for its mitigation measures is significant. *See* HAR § 11-200-17(m) requiring "performance bonds" for mitigation. While Chapter 343 allows for a performance bond, HDF's failure to offer one is an admission that it cannot put a price on the potential damage to drinking water resources, surface water resources, natural resources, cultural resources, the visitor industry, displaced workers and the residents of Kaua'i.

Without making mitigation plans available for review, without an enforceable commitment to mitigation, without adaptive management for well-intentioned, but failed, mitigation measures, and in the face of the dairy self-policing its mitigation commitments, the DEIS is not a meaningful document. The community should be allowed to review and evaluate these plans in a supplemental draft EIS. Without concrete assurances that impacts will be monitored, and that plans will be enforced if they fail to achieve the promised results, any such assurances are empty.

H. The DEIS Is Insufficient Pursuant to HAR § 11-200-17

In addition to the insufficient discussion of alternatives and mitigation measures, the DEIS also fails to meet the requirements of HAR § 11-200-17 on multiple fronts:

- The DEIS does not include a "[s]pecial emphasis," "on environmental resources that are rare or unique to the region and the project site (including natural or human-made resources of historic, archaeological, or aesthetic

significance," as required by HAR § 11-200-17(g). The DEIS noticeably de-emphasizes the U.S. National Park Service's reconnaissance study, attached to Ex. 8, which discusses the natural and cultural significance of the area and its potential inclusion in the national park system.

- The DEIS does not include any discussion of indirect environmental consequences of all phases of its action, as required by HAR § 11-200-17(i).

- The DEIS does not include a description of all irreversible and irretrievable commitments of resources – including natural and cultural resources – that would be involved in the proposed action should it be implemented. HAR § 11-200-17(k). The DEIS states that its action "does not preclude future conservation use of the wider region," DEIS at 4-101, but does not address the resources ***at*** the site in its entirety.

I. HDF Fails to Properly Disclose Required Approvals

HDF has failed to disclose necessary approvals and permits needed for its project in violation of Chapter 343. *See* HAR § 11-200-16(h) ("The draft EIS shall also contain a list of necessary approvals, required for the action, from governmental agencies, boards or commissions or other similar groups having jurisdiction. The status of each identified approval shall also be described.").

1. HDF Fails to Disclose that a CAFO Permit is Required for its Initial Herd of 699 Milking Cows

At its eventual herd size of 2,000 cows, the Dairy is without question a Large CAFO. HDF knows the thresholds for the determination of CAFOs. It admits that an application for a National Pollutant Discharge Elimination System ("NPDES") permit is required for dairy operations with 700 or more mature dairy cows, (*see, e.g.*, DEIS Response Letter to Kawailoa at 2, DEIS at 3-37), the initial herd size of 699 being one cow short of the more extensive review process required of large CAFOs. DEIS at 3-32.

Even at its initial declared herd size of 699 dairy cows, however, the Dairy is a Large CAFO. It will not have 699 mature dairy cows. In reality, it will have many more. In addition to the 699 cows on the site, HDF admits that approximately 600 cows and calves will be managed offsite during the first two years of operation, and 1,100 cows and calves will be managed offsite thereafter. DEIS at 3-33. These cows will be shuttled between different sites, a musical chairs of cows. The number of cows in the entire operation, including the offsite locations, should be totaled for the purposes of determining the number of animals and the management of manure. The DEIS suggests that all of the cows will be under the ownership of HDF wherever they may be located. As the DEIS does not address what will happen with all the manure from the combined herd, the manure from all the cows could be used and/or disposed at the Dairy site and the total number of cows at all sites would add up to a Large CAFO.

Even assuming HDF is able to maintain no more than 699 mature dairy cows at all times, the Dairy's operations will constitute a Medium CAFO, and will require a NPDES permit. A Medium CAFO is any AFO with 200 to 699 mature dairy cows where pollutants are discharged into waters of the United States. *See* 40 CFR § 122.23(b)(6). Additionally, an AFO may be designated as a CAFO notwithstanding the herd count, if there is a significant contribution of pollutants to waters of the United States. *See* 40 CFR § 122.23(c).

The streams in Māhāʻulepū Valley are waters of the United States. Regardless of whether the Dairy is able to limit the size of its herd, there is no doubt that there will be significant discharge to waters of the United States. The level of discharges of nitrogen and phosphorus are too large to be ignored. HDF has failed to disclose that with its intended 699 herd size, it will be required to obtain a NPDES permit.

In addition, the ditches throughout the Dairy, which go through the middle of paddocks without setbacks, and then drain to Waiopili Stream, are also state waters. HDF also needs a NPDES permit for discharge to those ditches.

2. HDF Fails to Disclose that it Commenced Construction Without a Storm Water Permit

Although HDF discloses that a NPDES General Permit for Construction Activities is "in progress," (DEIS at 1-20 and 3-37), this permit is for future construction activities. The DEIS fails to disclose that construction of the proposed dairy has already commenced ***without*** a required storm water permit for such construction activities. HAR § 11-55-04 requires that before beginning construction activities that disturb one or more acres of land, a person shall submit a complete NPDES permit application and provide notice of intent at least 180 days before construction begins. HDF's construction activities have involved far in excess of one acre of property, and HDF failed to obtain a storm water permit was not obtained before those activities commenced. DEIS at 1-20, 3-37. The DEIS therefore fails to appropriately describe the "status" of this approval as required by HAR 11-200-17(h), namely that a required permit was not obtained before work commenced.

3. HDF Improperly Fails to Disclose that the Clean Water Act Requires a Section 404 Permit

Whether certain areas constitute wetlands is a process determined by the Army Corps of Engineers, through issuance of a "jurisdictional determination." HDF has failed to obtain a jurisdictional determination regarding the wetlands at its proposed location.

By ignoring that portions of the Dairy are wetlands protected by the federal Clean Water Act, HDF fails to disclose permits necessary for work in those wetlands. Wetlands are areas "where the water table is usually at or near the surface of the land is covered by shallow water." HAR § 11-54-1. Further, wetlands have one or more of the following attributes: (1) at least periodically the land supports predominantly hydrophytic vegetation; (2) the substratum is predominantly hydric soil; or (3) the substratum is nonsoil (gravel or rocks) and is at least periodically saturated with water or covered by shallow water. *Id*. Low wetlands, which include marshes, swamps, and associated ponds, *id*. at § 11-54-2(b)(1)(C), are Class 2 Inland waters, as described in the Section above. *Id*. at § 11-54-5.1(a)(3)(C).

Māhāʻulepū valley is a wetland and is subject to regulation under the Clean Water Act. That is has been a wetland is evidenced by historical literature and HDF's own Archaeological Inventory Survey ("AIS") included in the DEIS as Appendix G. Stratigraphic trench excavations near the cluster of Land Commission Awards ("LCA") located on the east side of the Main East Ditch were undertaken as part of the AIS. The AIS Report notes that this part of the area "is currently marshland and an excavator could not safely be brought in to excavate." DEIS Appendix G at 132. Additionally, with respect to at least one trench, "located in the center of the project area east of Māhāʻulepū Ditch and south of Māhāʻulepū Road," the water table was reached at only 0.9 m below the ground surface. *Id*. at 136. HDF's report of both the presence of marshland and the extremely shallow depth to groundwater indicates that portions of the site are wetlands.

Current observations are supported by historical literature which depicts the valley as a swamp and as requiring draining. The book *Koloa Plantation 1835 – 1935*, cited by HDF in its References, traces the history of Koloa Plantation.

> In 1878 Koloa Plantation began the cultivation of sugar cane in Mahaulepu Valley, a beautiful valley nestling at the foot of Mount Haupu, with level floor and steep ridges on three sides, containing about 875 acres of perfectly flat cane land. This land looks most promising for cane cultivation, level, sheltered, with a good underground supply of water, but until recent years there has been ***much difficulty in draining it and in handling the clay soil***.

Arthur C. Alexander, *Koloa Plantation, 1835 – 1935: a history of the oldest Hawaiian sugar plantation* 75 (Honolulu, T.H. 1937) (emphasis added). Indeed, "[a] low wooden house with windows was built over the Mahaulepu pump pit, but the first heavy rains softened the exposed clay-like soil above the retaining walls so that it slipped down covering and crushing the wooden house and filling the pit." *Id*. at 98.

Survey maps are consistent in describing the valley as a swamp. *See*, historical survey map dated August 8, 1896, designating Māhāʻulepū Valley as "Swamp." Ex. 31. Another undated territory survey by Walter E. Wall designates the same. Ex. 32.

While some agricultural operations might be exempt from federal regulations as a prior converted cropland ("PCC"), there is no indicia of cropland status that would allow such an exemption here. Nothing in the DEIS or Important Agricultural Lands ("IAL") petition indicates that there was a history of annual tillage and cropping or that the land has continued to be used for agricultural purposes consistently since 1985.[8] In addition, no evidence exists that might indicate that there have been five consecutive years of management or maintenance operations related to the use of the farmed wetland pasture. 7 CFR § 12.33(c).

Māhā'ulepū Valley is therefore subject to state and federal regulation as a wetland. This is significant because HDF claims to follow National Resources Conservation Service Practice Standard 313 regarding Waste Storage Facilities. Ex. 7 at Appendix A. Practice Standard 113 says that "Waste storage facilities shall not be located in wetlands."

Further, the DEIS is deficient in failing to include a Section 404 permit under the Clean Water Act for work in those portions of the proposed dairy farm that constitute wetlands. Section 404 establishes a program to regulate the discharge of dredged and fill material into waters of the United States, including wetlands. HDF's DEIS, however, fails to list a Section 404 permit as a required permit for this project.[9] DEIS at 1-20, 3-37.

J. HDF Fails to Properly Disclose and Discuss State Policies

The DEIS fails to discuss the policy in Hawai'i that water quality shall not be degraded, or that water classifications shall be maintained. *See* HAR § 11-200-17(h) ("The draft EIS shall include a statement of the relationship of the proposed action to land use plans, policies and controls for the affected area.").

1. HDF Fails to Discuss How Discharges from the Dairy Comply with Hawaii's Policy that Water Quality Shall not be Degraded

The DEIS refers to "ditches" flowing through the dairy (DEIS at 4-60 – 4-61), ignoring that it is the policy of the state to protect such waters. The DEIS mentions, but does not discuss

[8] http://www.nrcs.usda.gov/wps/portal/nrcs/detail/vt/programs/?cid=nrcs142p2_010517 (last accessed Jul. 11, 2016).

[9] The DEIS represents that a Section 404 permit exemption was "approved" by the U.S. Army Corps of Engineers ("USACE") in October 2014. USACE made clear, however, that exemption <u>only</u> applied to "proposed maintenance of existing drainage ditches," and not to additional activities that "may occur at the site which could affect the drainage ditches or other aquatic resources such as the construction of farm roads, animal walkways, stream crossings, etc." Ex. 34. Whether for wetlands or other waters subject to jurisdiction under the Clean Water Act, the DEIS fails to mention that additional approvals from the USACE will be necessary. DEIS at 1-20, 3-37.

its compliance with Hawaii's antidegradation policy regarding water quality. DEIS at 5-28. Mere mention of a policy without discussion is insufficient, especially where, as here, water quality will degrade significantly. HAR § 11-200-17(h) ("Discussion of how the proposed action may conform or conflict with objectives and specific terms of approved or proposed land use plans, policies, and controls, if any, for the area affected shall be included.").

> Hawaii's policy regarding water quality is that,
>
> (a) Existing uses and the level of water quality necessary to protect the existing uses shall be maintained and protected.
>
> (b) Where the quality of the waters exceed levels necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water, that quality shall be maintained and protected unless the director finds, after full satisfaction of the intergovernmental coordination and public participation provisions of the state's continuing planning process, that allowing lower water quality is necessary to accommodate important economic or social development in the area in which the waters are located. In allowing such degradation or lower water quality, the director shall assure water quality adequate to protect existing uses fully. Further, the director shall assure that there shall be achieved the highest statutory and regulatory requirements for all new and existing point sources and all cost-effective and reasonable best management practices for nonpoint source control.
>
> (c) Where existing high quality waters constitute an outstanding resource, such as waters of national and state parks and wildlife refuges and waters of exceptional recreational or ecological significance, that water quality shall be maintained and protected.
>
> (d) In those areas where potential water quality impairment associated with a thermal discharge is involved, the antidegradation policy and implementing method shall be consistent with section 316 of the Clean Water Act.

HAR § 11-54-1.1.

Pursuant to this policy, Hawai'i requires that existing uses and level of water quality necessary to protect the existing uses be maintained and protected. The waters of the Waiopili Stream and the nearshore ocean near the stream currently contain concentrations of indicator bacteria that exceed water quality standards. Appendix G at 41. Additionally, much of the coastline near the proposed dairy already receives high concentrations and loads of nutrients. *Id.* However, HDF has not evaluated the concentrations of pathogens, nutrients or sediment in discharges from the dairy site to the Waiopili Stream or the nearshore ocean, and has not compared the concentrations expected to occur in receiving waters against water quality standards for these constituents. *Id*. at 35. Because it is likely that water quality will degrade significantly and that the frequency and magnitude of exceedances of water quality criteria can be expected to increase due to the proposed dairy, HDF must evaluate these impacts.

The total absence of discussion regarding Hawaii's antidegration policy renders the DEIS deficient, especially where impacts to water quality will be significant.

2. HDF Fails to Disclose that the Ditches Flowing Through its Proposed Location Are, in Fact, Protected Waters of the United States

The ditches in Māhāʻulepū Valley are waters of the United States that are subject to federal regulation. Waters of the United States include tributaries that contribute flow, either directly or through another water to the ocean, and that have a bed and banks and an ordinary high water mark. 40 CFR § 230.3(o)(3)(iii).

HDF admits that the ditches running through its site flow to Waiopili Stream and then to the ocean,

> This second ditch originates in the vicinity of a pond in an area of water wells in the upper west side of the valley. We did not establish the source of the water in this ditch, but ***the ditch contains water and extends south***, passing beside an agricultural operation that includes *kalo lo'i* (taro fields), from which it receives additional flow. This ditch then joins a larger ditch known as Mill Ditch (USGS, 1996) ***carrying water flowing from west to east across the valley within the project area***. Mill Ditch turns southward near the center of the valley, passes under Māhāʻulepū Road, and some 460 meters south, joins the first ditch coming down the valley. ***The two become Waiopili Ditch, with an outlet at Māhāʻulepū Beach***. Mill Ditch is actually receiving water from a pipe located adjacent to the west side of Māhāʻulepū Road.

DEIS Appendix A at 19 (emphases added). HDF refers to the USFWS National Wetlands Inventory ("NWI"), which characterizes all of the streams on the property as R4SBCx, and which represents "intermittent (seasonally flooded) flowing water, in an excavated channel." *Id*. at 19.

Ditches with intermittent flow are considered waters of the United States when they drain wetlands, which is the case here. 40 CFR § 230.3(o)(2)(iii)(B) Additionally, one ditch, which directs stream flow off Kāmaulele, is coded R3RBH, which represents "an upper perennial stream with a rock bottom." *Id.*

Because the ditches in Māhāʻulepū Valley are waters of the United States, HDF must obtain a NPDES permit, as well as a Clean Water Act section 401 water quality certification from the U.S. Army Corps of Engineers. HAR §11-54-1; 33 U.S.C. § 1341 ("Any applicant for

a Federal license or permit to conduct any activity including, but not limited to, the construction or operation of facilities, which may result in any discharge into the navigable waters, shall provide the licensing or permitting agency a certification from the State in which the discharge originates or will originate . . . ."). HDF's list of permits and approvals fails to include a Section 401 Water Quality Certification. DEIS at 1-20 and 3-37.

In addition, HDF should have obtained a Clean Water Act Section 404 permit from the U.S. Army Corps of Engineers prior to the discharge of dredged or fill material into these ditches pursuant to 33 U.S.C. § 1344. The Dairy is not exempt from a Section 404 permit because its operations are not part of an ongoing operation as contemplated by 33 CFR § 323.4(a)(1) and because new construction work has been done around the ditches. *See* Ex. 15.

HDF claims to have a Section 404 exemption, (DEIS 1-20, 3-37), however this claim is misleading. As HDF stated to the U.S. Army Corps of Engineers, HDF sought an exemption for "ongoing farming operations," which included maintenance for ditches and ponds. Ex. 35. The subject line of the exemption letter clearly states: "Clean Water Act Exemption for Proposed ***Maintenance of Existing Drainage Ditches*** of the Hawaii Dairy Farm in Mahaulepu, Island of Kauai, Hawaii." Ex. 34 (emphasis added). Moreover, the U.S. Army Corps of Engineers stated that this work would be exempt from the Section 404 permitting requirements, but noted that at that time, HDF was ***not*** requesting a determination of whether HDF's additional activities "such as the construction of farm roads, animal walkways, stream crossings, etc." were also exempt. *Id.* Therefore, HDF's statement that it has a Section 404 exemption for all of its construction activities is misleading and should be corrected in the supplemental draft EIS.

3. HDF Fails to Disclose that Waiopili Stream, Which Flows Through the Proposed Dairy Location, is State Water Protected for Recreation and the Propagation of Fish and Wildlife

The ditches in Māhāʻulepū Valley, running through the proposed dairy site, are protected as Class 2 Inland Waters under classifications of the State of Hawaiʻi. *See* Ex. 8. Class 2 flowing waters are "perennial streams and rivers, intermittent streams, springs and seeps, and man-made ditches and flumes that discharge into any other waters of the State." HAR § 11-54-5.1(a)(1)(C).

It is state policy to protect class 2 waters for recreational use, and for the protection and propagation of fish and wildlife:

> The objective of class 2 waters is ***to protect their use for recreational purposes***, the support and propagation of aquatic life, agricultural and industrial water supplies, shipping, and navigation. ***The uses to be protected in this class of waters are all uses compatible with the protection and propagation of fish, shellfish, and wildlife, and with recreation in and on these waters***. These waters shall not act as receiving waters for any discharge which has not received the best

> degree of treatment or control compatible with the criteria established for this class.

HAR § 11-54-3(b)(2) (emphases added). HDF has failed to disclose that Waiopili Stream is a protected Class 2 water.[10]

Surface waters in the area of the proposed dairy are recreational resources and are used by the public. As recognized in the DEIS, Mahaulepu Farm allows public access to the beach. *Id*. at 4-68. Additionally, a 2008 reconnaissance survey of Māhāʻulepū conducted by the National Park Service highlights that the Māhāʻulepū shoreline has "long served as [a] secluded recreation place[] for local residents. Lately a growing tourist presence has added to the mix; over one-third of the petition-signers in a community initiative to protect the Māhāʻulepū shoreline resources identified themselves as visitors to the island (MM2007)." U.S. National Park Service Reconnaissance Survey, attached to Ex. 8 at 42. The U.S. National Park Service also notes that "Māhāʻulepū Beach is favored for windsurfing and kite surfing, and its long white stretch of sand appeals to sunbathers and walkers." *Id*.

Notwithstanding the protected status of these waters, HDF states that it will discharge into Waiopili stream, in clear violation of Hawaii's water quality rules.

> Suspended soil inputs from natural sources and offsite ranching and agricultural uses in the watershed will continue to enter the agricultural ditches, ***which drain downstream into Waiopili Ditch and the nearshore ocean waters***. Waiopili Ditch receives runoff from the larger 2,700-acre Māhāʻulepū sub-watershed, including the lands mauka and makai of the dairy facilities and pasture paddocks.

DEIS at 4-66 (emphasis added).

K. HDF's After-The-Fact EIS Violates Chapter 343

It is simply incorrect for HDF to continue to state that "none of the permits that have been obtained or the reviews that were completed triggered the requirements for an environmental assessment or an EIS."[11] *See* DEIS Response Letter to Kawailoa at 1-2.

[10] The only mention of Class 2 Waters in the text of the DEIS is in a table on page 5-29. Without any further discussion, the table indicates that the proposed project is "supportive" of Class 2 Waters. Discussion of how the proposed Dairy conforms with the state's policy of protecting Class 2 waters is required by HAR § 11-200-17(h). The DEIS fails to include any such discussion. If discussed, the only logical conclusion is that fish, wildlife and recreational uses would not be protected with the substantial amount of nutrients and pathogens that will be discharged from the Dairy. Appendix H at 15-53, D at 17-31.

Repeating the same incorrect statements without more does not make such statements correct. There have been environmental triggers. The actions taken by the agencies are "approvals" within the meaning of Chapter 343. "Approval" is a defined term, as follows:

> "Approval" means a discretionary consent required from an agency prior to actual implementation of an action. ***Discretionary consent means a consent, sanction, or recommendation from an agency for which judgment and free will may be exercised by the issuing agency, as distinguished from a ministerial consent***. Ministerial consent means a consent, sanction, or recommendation from an agency upon a given set of facts, as prescribed by law or rule without the use of judgment or discretion.

(Emphasis added). HDF has obtained discretionary consents and approvals including but not limited to its waste management plan, conservation plan, Individual Wastewater System permit and Section 404 exemption, which all required a decision using "judgment and free will" and which in turn, triggered the EIS process.

That HDF has already conducted site work that is part of and necessary to the construction of its Dairy shows that HDF makes no pretense of complying with Chapter 343. The DEIS is not in compliance with Chapter 343.

L. The DEIS Contains Misstatements That Must be Corrected

The DEIS makes a number of misstatements about Kawailoa.

First, contrary to assertions from HDF, it is not true that stream water is mixed with reclaimed water from the Poipu Bay Golf Course and water from the Waita Reservoir for irrigation. DEIS at 4-83. No stream water is used for irrigation at the Poipu Bay Golf Course.

Second, HDF falsely asserts that there is "a slight odor when the reclaimed water is sprayed, which is more noticeable at the first three holes because of the higher concentration of reclaimed water. The irrigation of effluent within the recreational area also creates an odor close to the resort." DEIS at 4-85, Appendix J at III-12. Putting aside the highly subjective nature of the assertion, the assertion is not correct. Kawailoa has not received any complaints from hotel guests or workers related to odors from irrigation. Moreover, there is no reason why the first three holes would smell any differently than the other holes. The underlying premise of the assertion is false since the first ten holes utilize the same water as the first three holes.

Third, HDF claims without any authority whatsoever, that the Poipu Bay Golf Course "uses fertilizer which contributes nitrogen and phosphorous to the marine environment." DEIS

[11] HDF's argument ignores that, as set forth in Section II.I.2 above, it was required to obtain a stormwater permit for its construction activities.

Appendix F at 12. While fertilizer is used at the golf course, fertilizer is carefully managed. Both for cost and environmental reasons, it is sparingly used.

HDF's mischaracterizations of actions supposedly conducted by Kawailoa are troubling. HDF took about a year and a half since it issued the EISPN to prepare the DEIS. It had no deadline. It had all the time needed to verify any assertion made. That HDF did not appear to attempt to verify statements made demonstrates carelessness at the very least and if it is intentional, an arrogance that the public can be manipulated through misinformation.[12] The DEIS is an important document. It is the basis for receiving the public input. Carelessness in the preparation of the document is a disregard for the community.

IV. CONCLUSION

The DEIS was not prepared in accordance with the letter or the spirit of the law. It did not take a hard look at the environmental impacts of the project or its alternatives. Supporting details were insufficient to understand the environmental consequences and reasonable choices as among alternatives were not discussed. A supplemental draft EIS must be prepared to address the serious deficiencies of the DEIS and allow for public review and comment.

Very truly yours,

Lisa A. Bail

LAB

cc: Toshiaki Shindo, Kawailoa Development LLP
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Jeff Overton, Group 70 International, Inc.

[12] An example of this misinformation is the March 2016 Waiopili Ditch Sanitary Survey published by the State of Hawai'i Department of Health ("Sanitary Survey"). The DEIS does not disclose the extent of HDF's role in this document. The data relied upon in a DEIS must be reliable and not self-serving. *See, e.g.*, HAR § 11-200-14 ("An EIS is meaningless without the conscientious application of the EIS process as a whole, and shall not be merely a self-serving recitation of benefits and a rationalization of the proposed action."). Anything else prevents meaningful review and comment, and the supplemental draft EIS should disclose the extent of HDF's involvement.

TECHNICAL APPENDICES

Appendix A

Assessment of Economic Impacts of the Proposed Hawai‘i Dairy Farms Facility

July 2016

Berkeley Research Group

Berkeley Research Group

Table of Contents

I. Executive Summary

Hawai‘i Dairy Farms, LLC (“HDF”) proposes to establish a dairy farm on Kaua‘i (“HDF” or “Dairy”) to increase current local milk production and reduce reliance on imported milk from the mainland United States. The proposed location of the HDF is less than 2 miles from the Grand Hyatt Kauai Resort (“GHK”). HDF prepared and submitted a Draft Environmental Impact Statement (“DEIS”) pursuant to Hawai‘i Revised Statutes, Chapter 343, Environmental Impact Statement Law and Chapter 200, Title 11 of the Hawai‘i Administrative Rules regarding the proposed facility.

Berkeley Research Group (“BRG”) was asked by Goodsill Anderson Quinn & Stifel LLP on behalf of its client, Kawailoa Development LLP, to review and evaluate the economic impacts reported in the DEIS. BRG was also asked to identify and address the major deficiencies, if any, in the existing economic impact analysis in the DEIS. BRG finds that the DEIS largely ignores the potential economic impacts of the proposed Dairy on tourism in Kaua‘i generally and the impacts to the GHK specifically. This memorandum presents the BRG assessment of those potential impacts. BRG considered the analyses submitted by HDF, other publicly available materials, a survey of guests at the GHK, and other business documents from GHK for the assessment.

Based on our analysis, BRG finds that:

Tourism is important to Kaua´i and to Po‘ipū in particular. Available studies document the substantial potential impacts from noxious odors and pests on the selection of tourist destinations and accommodation choices. Tourist destinations and accommodation choices are particularly sensitive to negative on-line or word of mouth reviews. The current DEIS fails to address these impacts adequately even though HDF recognizes that nuisances from the facility might reach properties 3 miles away.[1]

- BRG compared the estimated economic impacts in the DEIS to the impacts to the GHK and, in some categories, to Kaua‘i and the state of Hawai‘i, that the DEIS fails to address. The comparison summarized in Exhibit 1 demonstrates that the potential negative impacts of the HDF exceed the benefits estimated in the DEIS by a wide margin.

- Regarding direct effects of operations, the HDF’s expenditure impact is approximately $8 million and employment impact is 5 farm jobs which BRG assumes are full-time equivalent (“FTE”) positions. Using even the low impact scenario for comparison, BRG estimates that the potential direct loss of expenditures and jobs at the GHK due to odor and pest problems from HDF’s operations is approximately $23 million and 146 FTEs. The potential cost of the likely nuisances

[1] Appendix J of DEIS, at p. III-8.

created by the HDF increases by another approximately $8 million and 49 FTEs when the state-wide indirect sales and employment driven by the visitor expenditures at the GHK are considered.

- There are also substantial potential tax implications of the likely odor and pest impacts of the HDF. Recognition of the tax credit for HDF implies a negative state tax revenue position if it operates. Adding to this burden on state tax revenues, the visitor expenditures threatened by the HDF operations result in a potential further loss of state taxes of approximately $1.6 million under the low scenario.

Exhibit 1. Table Summary of the Potential Economic Impacts from HDF

Direct Expenditures/Sales

HDF Development Activities (1 year)			
Construction Expenditures	$ 3,750,000		
Equipment Expenditures	1,000,000		
Consumption Expenditures	944,548		
Total	$ 5,694,548		
HDF Full Operations (Annual)		**GHK (Annual) [1]**	
Sales [2]	$ 8,132,887	Low Impact [4]	$ (22,992,407)
		High Impact [5]	$ (41,598,104)
		Survey Impact [6]	$ (53,012,624)

Employment

HDF Development Activities (1 year)			
Construction Jobs	12		
Indirect Employment Generated by Construction	24		
HDF Full Operations (Annual)		**GHK (Annual)**	
Dairy	5	Low Impact	(146)
Indirect Jobs	9	High Impact	(265)
		Survey Impact	(337)
		Indirect Statewide (Annual)	
		Low Impact	(49)
		High Impact	(89)
		Survey Impact	(113)

Statewide Indirect Expenditures [3]

HDF Development Activities (1 year) [7]			
Indirect Sales Related	$4,387,500		
Less Consumption	(944,548)		
Total	$3,442,952		
HDF Full Operations (Annual)		**GHK (Annual)**	
Oahu Indirect Sales	$1,988,828	Low Impact	$ (8,047,342)
		High Impact	$ (14,559,336)
		Survey Impact	$ (18,554,418)

Statewide Taxes

HDF		**GHK and Indirect (Annual)**	
HDF County Property Taxes on Dairy	$ 50,625	Low Impact	$ (1,611,768)
HDF State Tax Revenues	650,593	High Impact	$ (2,916,027)
Tax Credits	(1,000,000)	Survey Impact	$ (3,716,185)
Net Tax Impact	$ (298,782)		

***NOTES**

[1] BRG's calculations of the revenue, employment, and tax impacts are comparable to the HDF equivalent economic impacts during full operations.
[2] This figure includes both direct sales from HDF and indirect sales in Kaua'i.
[3] This analysis does not account for induced economic effects.
[4] Low impact values are derived from figures presented in Section V, Subsection A.
[5] High impact values are derived from figures presented in Section V, Subsection B.
[6] Survey impact values are derived from figures presented in Section V, Subsection C.
[7] The HDF values are derived from figures presented in Tables III-2, III-3, III-4, and III-5 of Appendix J of the DEIS. BRG could not locate the indirect impact assumptions used in Appendix J from the cited source materials. As a result, BRG could not replicate the HDF analysis.

Source:
Appendix J of DEIS, at p. 79, 81-84.
BRG Analysis

II. Tourism Is Important To Kaua'i

The DEIS acknowledges the importance of tourism for the economy of the region and for Po'ipū in particular which hosts approximately 36 percent of the visitor units on Kaua'i.[2] Tourism accounted for nearly 70 percent of jobs in Kōloa-Po'ipū.[3]

The DEIS also indicates that:

- Kaua'i hosted over 1.11 million visitors in 2014, and visitor expenditures totaled approximately $1.47 billion, making tourism the dominant industry in the County.[4]
- There were 29,400 jobs in Kaua'i County in 2014…The leisure and hospitality industry represents the largest proportion of jobs in the County, accounting for 9,300 jobs or 31.6 percent of countywide jobs.[5]
- The largest share of visitor units on Kaua'i is located in the Po'ipū/Kukui'ula area… Hotels in the area include the Grand Hyatt Kauai Resort & Spa, Koa Kea Hotel & Resort, and the Sheraton Kauai Resort. The Grand Hyatt Kauai Resort & Spa is the closest hotel to the proposed Dairy—about 2.4 miles from the Dairy facilities.[6] This resort provides 602 visitor units, and is the largest private employer on Kaua'i—in 2014, it employed 941 workers."[7]

In 2015, the 602 visitor units of the GHK represented 54 percent of the hotel plant inventory in Po'ipū/Kukui'ula.[8] Exhibit 2 reproduces the 2015 visitor plant inventory reported in the DEIS.

[2] Appendix J of DEIS, at p. ES-2.
[3] Appendix J of DEIS, at p. II-9.
[4] Appendix J of DEIS, at p. II-2.
[5] Appendix J of DEIS, at p. II-5.
[6] Appendix J of DEIS, at p. III-13.
[7] Appendix J of DEIS, at p. II-8. Note: "The Grand Hyatt Kaua`i is the closest resort to the dairy site, with 1.6 miles between the property boundaries." DEIS at p. 3-2.
[8] Appendix J of DEIS, at p. II-8.

Exhibit 2. Visitor Plant Inventory, Kauai: 2015

Item	Kauai		Popiu-Kukuiula	
	Properties	Units	Properties	Units
Apartment Hotel	-	-	-	-
Bed & Breakfast	12	56	2	24
Condominium Hotel	22	1,387	11	608
Hostel	-	-	-	-
Hotel	15	2,667	4	1,124
Vacation Rentals*	265	1,800	110	677
Other	4	40	-	-
Timeshare	21	2,632	3	625
Total	**339**	**8,582**	**130**	**3,058**
Island Share				36%

Source:
Appendix J of DEIS from Hawai'i Tourism Authority. "2015 Visitor Plant Inventory."

Economic analysis of Kaua'i indicates that its economy is more dependent on tourism than the other Hawaiian Islands.[9] Annual visitor arrivals divided by the resident population tends to be the highest in the state.[10] The ratio in Kaua'i is approximately three time as large as the ratio in Oahu.[11]

The dependence on visitor arrivals makes the Kaua'i economy highly sensitive to factors that reduce tourism. For example, during the 2008-2009 recession, total arrivals in Hawai'i declined by approximately 11 percent. The decline in Kaua'i exceeded all other Hawaiian Islands and was approximately 20 percent.[12] In addition, Kaua'i suffered greater impacts from the recession to employment than the other Hawaiian Islands with an estimated 3,500 jobs lost.[13]

III. CAFOs Have Known Impacts That Can Be Expected To Affect Tourism

The proposed Dairy is expected to have a significant economic impact on GHK. "HDF is committed to establishing a herd of up to 699 mature dairy cows, and demonstrating that rotational pasture-grazing is an economically and environmentally sustainable model for Hawai'i … [HDF] may expand the herd …

[9] First Hawaiian Bank, "Kauai's Outlook Buoyed By Strong Tourism," Economic Forecast, Kauai Edition 2015-2016, at p. 1.
[10] First Hawaiian Bank, "Kauai's Outlook Buoyed By Strong Tourism," Economic Forecast, Kauai Edition 2015-2016, at p. 1.
[11] First Hawaiian Bank, "Kauai's Recovery Will Strengthen in 2014," Economic Forecast, Kauai Edition 2013-2014, at p. 1.
[12] Laney, L. 2009. "Assessing Tourism's Contribution to the Hawaii Economy," *First Hawaiian Bank*, Economic Forecast Special Report, at p. 6.
[13] First Hawaiian Bank, "Kauai's Recovery Will Strengthen in 2014," Economic Forecast, Kauai Edition 2013-2014, at p. 1.

to 2,000 productive dairy cows. For dairy operations with 700 or more milking cows, additional regulatory review and permitting by the State Department of Health will be required for a CAFO.[14] For purposes of BRG's assessment, the proposed Dairy has potential impacts similar to those of a CAFO.

"The most pressing public health issue associated with CAFOs stems from the amount of manure they produce."[15] "Most CAFOs generate significant odors and other nuisance impacts (flies, dust, noise, runoff, etc.) that can extend beyond the CAFO property boundaries, thereby affecting nearby and downwind properties."[16] In addition to increased odor, "[r]esidences closest to the feeding operations experience a much higher fly population than average homes."[17]

The DEIS recognizes that "[m]ost CAFOs generate significant odors and other nuisance impacts (flies, dust, noise, runoff, etc.) that can extend beyond the CAFO property boundaries, thereby affecting nearby and downwind properties."[18] Nuisance impacts can threaten tourism.[19]

The DEIS states the "[p]otential sources of odor from the Dairy include (1) manure deposited by cows in the milking parlor and holding pens; (2) the two effluent ponds; (3) the irrigation system (which uses effluent); and (4) the manure deposited directly onto the pasture." [20] It further states "[t]he majority of manure (about 90 percent) will be deposited directly onto the pastures where – with the help of cattle egrets and dung beetles – it will break down quickly and provide nutrients to the pasture." [21]

The DEIS establishes that the Dairy is in close proximity to the resort properties. The DEIS reports that resort units are about 1.5 miles from HDF operations.[22] In addition, the DEIS states, "[t]he tradewinds blow across the Dairy property and toward Po'ipu…"[23] The DEIS assumes away the potential impacts by claiming that "[c]onsiderable distances will separate the Dairy from the resorts, commercial areas, homes and recreational areas. The nearest resort units are about 1.5 miles from a Dairy paddock and about 2.4 miles from the Dairy milking parlor. For the Kōloa town center, the distances from the closest paddock and dairy facilities are about 2.2 and 2.8 miles, respectively. For homes, the distances are about 1 and 2

[14] Appendix J of DEIS, at p. ES-1.
[15] Understanding Concentrated Animal Feeding Operations and Their Impact on Communities, by Carrie Hribar, National Association of Local Boards of Health, at p. 2.
[16] Appendix J of DEIS, at p. III-8.
[17] Understanding Concentrated Animal Feeding Operations and Their Impact on Communities, by Carrie Hribar, National Association of Local Boards of Health, at p. 8.
[18] Appendix J of DEIS, at p. III-8.
[19] 2014. "The Potential Economic Impact of the Salton Sea on the Greater Palm Springs Tourism Industry," *Tourism Economics*, December: 24, at p. 3.
[20] Appendix J of DEIS, at p. III-14.
[21] Appendix J of DEIS, at p. III-14.
[22] Appendix J of DEIS, at p. ES-4.
[23] Appendix J of DEIS, at p. III-13.

miles away, respectively. And for recreational activities, the distances are about 0.6 mile and 1.3 miles, respectively."[24]

Other experts do not agree with HDF that "[g]iven the plans for the Dairy and its location, environmental studies indicate that no noticeable noise, dust, odors, flies, runoff, or other nuisance impacts will extend to resort, commercial, residential or recreational areas.[25] These experts also do not agree that "noticeable nuisance impacts occurring outside the Dairy property will be limited to the abutting farm and ranch lands which are owned by Māhāʻulepū Farm, the lessor of the Dairy property."[26]

An odor impact assessment performed by Exponent, Inc. determined that "odorous conditions would often exist at the Kawailoa properties at levels its visitors would find offensive."[27] Another study found that biting flies known on Kauaʻi are strong fliers and can migrate long distances up to 4 miles, and possibly as far as 7.3 miles.[28] The report further noted that the DEIS "fails to evaluate the potential impacts of nuisance flies on nearby properties on Kauaʻi."[29]

The potential for odors of manure and increased flies are considered significant impacts for attractiveness to potential resort guests. Other studies have identified reductions in tourism due to odor problems at tourist destinations. For example, Tourism Economics has studied the decay of the Salton Sea and its threat to Greater Palm Spring's tourism. Substantially rising salinity levels of the Salton Sea, along with runoff from local agricultural operations, has led to a killing off of much of the resident fish population, resulting in a nuisance bad smell. The increasing occurrence of "bad-smell" events paired with wind storms have carried the malodorous stench to further regions in California. Harmful pesticides that have settled on the seabed from agricultural runoff have created bad smells and the potential for toxic dust storms.[30]

Exhibit 3 contains selected statements from studies of CAFO impacts and the DEIS regarding related nuisances and the economic impacts on communities.

[24] Appendix J of DEIS, at p. ES-4.
[25] Appendix J of DEIS, at p. III-13.
[26] Appendix J of DEIS, at p. III-13.
[27] Technical Memorandum, Hawaii Dairy Farm Odor Impact Assessment, Exponent, Inc., July 2016 at p. 28.
[28] A Review of the Arthropod-Related Sections of the Hawaiʻi Dairy Farms Draft Environmental Impact Statement, Pacific Analytics, LLC, July 2016 at p. 12,13.
[29] A Review of the Arthropod-Related Sections of the Hawaiʻi Dairy Farms Draft Environmental Impact Statement, Pacific Analytics, LLC, July 2016 at p. 2.
[30] 2014. "The Potential Economic Impact of the Salton Sea on the Greater Palm Springs Tourism Industry," *Tourism Economics*, December, at pp. 3 and 24.

Exhibit 3: Selected Statements Regarding CAFO Nuisances and Economic Impacts

Most CAFOs generate significant odors and other nuisance impacts (flies, dust, noise, runoff, etc.) that can extend beyond the CAFO property boundaries, thereby affecting nearby and downwind properties. Usually, but not always, property values of homes near CAFOs are lower than those of similar homes that are not affected by nuisance impacts of CAFOs [1, at p. III-8].
If nuisance impacts were to occur— which is not expected—it could result in reduced tourism, sales, employment, salaries and wages, property values, personal wealth, State and County tax revenues, enjoyment of homes and recreational activities, etc. As mentioned previously, 36% of the island's visitor units are in Po'ipū and Kukui'ula, including the Grand Hyatt Kaua'i Resort & Spa which is the largest employer in the County [1, at p. III-8].
The odors that CAFOs emit are a complex mixture of ammonia, hydrogen sulfide, and carbon dioxide, as well as volatile and semi volatile organic compounds (Heederik et al., 2007)...Odors from waste are carried away from farm areas on dust and other air particles. Depending on things like weather conditions and farming techniques, CAFO odors can be smelled from as much as 5 or 6 miles away, although 3 miles is a more common distance (State Environmental Resource Center, 2004) [2].
CAFO odors can cause severe lifestyle changes for individuals in the surrounding communities and can alter many daily activities. When odors are severe, people may choose to keep their windows closed, even in high temperatures when there is no air conditioning. People also may choose to not let their children play outside and may even keep them home from school. Mental health deterioration and an increased sensitization to smells can also result from living in close proximity to odors from CAFOs. Odor can cause negative mood states, such as tension, depression, or anger, and possibly neurophysciatric abnormalities, such as impaired balance or memory. People who live close to factory farms can develop CAFO-related post traumatic stress disorder, including anxiety about declining quality of life (Donham et al., 2007) [2].
CAFOs generate a number of harmful gases. These gases include ammonia, hydrogen sulfide, methane, and many others...Other dangerous gases include, but are not limited to, volatile organic compounds (VOCs), methanol (wood alcohol), and particulate matter. CAFOs release large amounts of particulates, aiding in dispersion of gases, odors and microbes [3].
Concentrated animal feeding operations (CAFOs) have the potential to release a variety and large quantity of emissions including gases, particulate matter and odors. These emissions are mainly generated from the microbial decomposition of the substantial amount of feces and urine from the animals, with a smaller contribution due to wastewater from other processes...The list of potential gases generated and emitted from a CAFO operation...is very extensive [4].
CAFO waste pollutes the air. Liquefied animal waste emits 160 known toxic gases, including hydrogen sulfide, a deadly gas with the characteristic stench of rotten eggs [5].

Sources:

[1] Appendix J of DEIS
[2] Hribar, C. 2010. "Understanding Concentrated Animal Feeding Operations and Their Impact on Communities," National Association of Local Boards of Health, p. 30.
[3] 2013. "Protecting Your Community From Existing and Proposed Concentrated Animal Feeding Operations (CAFOs)," Midwest Environmental Advocates, November: p. 60.
[4] 2011. "Rock Prairie Dairy Rapid Health Impact Assessment," Rock County Health Department, May: p. 42.
[5] Socially Responsible Agricultural Project. "Environmental Impact of Factory Farms," available at http://www.sraproject.org/environmental-impact-of-factory-farms/ (last visited August 13, 2016).

IV. The Analysis In the DEIS Is Insufficient To Capture the Nuisance Impacts on Tourism

The high importance of tourism in Kaua'i and the demonstrated sensitivity of its economy to changes in visitor arrivals necessitates a proper analysis of the potential impact of the Dairy on tourism-related expenditures.

HDF fails to conduct a proper analysis of the potential economic impacts on tourism-related expenditures. Instead, HDF largely assumed that no such impacts will occur from its operations. BRG reviewed information regarding nuisances and tourism and information from the GHK to assess the potential effects on GHK revenues, employment, and tax revenue due to the HDF.

V. BRG Assessment of Nuisance Impacts on Tourism

Using past data for the resort and other publicly available materials, BRG developed three scenarios to capture the range of uncertainty regarding the economic impacts of the proposed Dairy on the GHK and Kaua'i.

BRG reviewed a number of case studies and comparable environmental events which had an impact on a local or regional tourism industry. These events include disasters such as oil spills, harmful algal blooms ("HABs") and red tide events, hurricanes and tsunamis, as well as an economic impact study for the Greater Palm Springs tourism industry as a result of the degradation of the Salton Sea in the Coachella and Imperial valleys of California.

An important caveat in assessing these events and their resulting impacts, is that these events are predominantly temporary or short-term, and assume a duration of impact beginning with the start of the event, through the time it takes for the local tourism industry to recover to pre-event levels. The proposed HDF will have a more permanent or long-term effect on GHK and Kaua'i, thus the impact of the HDF could likely be more significant than the ranges of business impacts identified in the case studies and literature that BRG reviewed. However, BRG took a conservative approach, and used reasonable estimates within the identified range of revenue loss to each tourism economy, as opposed to increasing the potential effects due to the long-term nature of the proposed HDF.

The Salton Sea study estimated tourism losses in the first year of impact (2015), between a low-impact range of 5 percent of loss in tourist spending and a high-impact scenario to be 25 percent loss in tourist spending. Other events assessed included red tide events in Ft. Walton Beach & Destin, FL (between 1995 and 1999), in which the combined effects lasted 20 months and resulted in a 32.3 percent loss of tourism

related revenue; red tide events in Lee County, FL (2005) which caused a 25 percent loss of gross revenue; and a red tide event in Galveston, TX (2000) which caused an average loss of 16.5 percent, with revenue losses as high as 29.5 percent.

In addition to the published case studies which BRG reviewed, BRG examined historical performance figures of GHK reported to Smith Travel Research, in the form of monthly STAR Reports, as well as other financial information made available.

From the aforementioned sources, BRG developed three reasonable scenarios of impact due to the proposed HDF, including a low-impact scenario, a high-impact scenario, and an impact scenario based upon the results of the Market Trends Pacific, Inc. GHK Guest Survey. The only revenue drivers which BRG estimated to fluctuate based on potential nuisances, were Occupancy and Average Daily Rate ("ADR"), as these are the two key revenue drivers of a hotel and the factors which are most directly impacted by any set of economical or environmental factors. These factors reflect a conservative estimate of the potential loss of visitor expenditures which likely would also include gifts and non-resort expenditures.

BRG also considered the impact of guest perception of a hotel, as "perceptions dramatically effect traveler behavior as leisure travel is highly discretionary and alternative destinations are readily available. The slightest misperception of risk or the effects of a disaster can fundamentally shift travel patterns."[31]

A 2015 report reviewed and discussed numerous literature sources published on the impact of guest perception to a hotel's sales, ADR, and traffic to a property's site.[32] Other analyses developed a mathematical model to explain the impact of user generated comments on hotel sales and profitability, and discovered that a 10 percent improvement in reviews led to a 4.4 percent increase in sales.[33] A separate report finds that "a one-point increase in a review score equates to a 9 percent increase in ADR."[34]

Separately, a 2015 study reports that 95 percent of travelers report using travel reviews regularly to make booking decisions.[35] "For instance, a Cornell study found that a one-point increase in reputation (based

[31] 2014. "The Potential Economic Impact of the Salton Sea on the Greater Palm Springs Tourism Industry," *Tourism Economics*, December: 24, at p. 6.
[32] Singh, D., Torres, E., (2015, January). Hotel online reviews and their impact on booking transaction value. *XVI Annual Conference Proceedings January, 2015. ISBN no. 978-81-923211-7-2*. Retrieved July 7, 2016 from http://www.internationalconference.in/XVI_AIC/INDEX.HTM
[33] Ye, Q., Law, R., & Gu, B. (2009). The impact of online user reviews on hotel room sales, *International Journal of Hospitality Management*, 28, 180-182.
[34] Editor eHotelier. (2012, January 16). Online review reputation management trends for hotels in 2012. Sabre Hospitality Solutions *available at* http://ehotelier.com/news/2012/01/16/online-review-and-reputation-management-trends-for-hotels-in-2012/
[35] Ady, M., (2015, September 30). TrustYou Study with AccorHotels shows effect of TripAdvisor reviews on bookings.

on a five-point scale) may result in a hotel's ability to raise room rates up to 11.2 percent. A TrustYou heat mapping study found that given equal prices travelers are 3.9 times more likely to choose a hotel with a higher review score. And, even when hotel prices are increased for hotels with better review scores, travelers are more likely to book the hotel with the higher score despite the higher rate. In fact, 76 percent of travelers said they were willing to pay more for a hotel with higher review scores."[36]

A. LOW IMPACT SCENARIO

In the low-impact scenario, BRG assumed a 10 percent loss in Occupancy, or Occupied Rooms, and a 10 percent reduction in ADR. This assumption is in line with the methodology discussed in the aforementioned literature with respect to guest perception and effect on ADR, a one-point decrease in review rating (due to negative reviews from the effects of proposed HDF) could reasonably equate to a 10 percent reduction in ADR at GHK, or the room rates that GHK would be able to charge guests and remain somewhat competitive. Further, Occupancy is the well-recognized revenue driver which is most subject to the impact of guest perception and booking decisions.

The previously mentioned case studies on the impact of nuisance bad smell from red tide events, cite a range of revenue loss between 15 percent and 32 percent, over various time durations. Thus, as occupied rooms are the primary revenue driver at a hotel, estimated 10 percent declines in occupied rooms and the ADR under a low-impact scenario are reasonable and conservative assumptions.

B. HIGH IMPACT SCENARIO

In the high-impact scenario, BRG also uses a combination of published case studies and literature, but primarily considers the actual effects of the 2008 recession, and the resulting impact on GHK's performance. Between 2008 and 2009, GHK saw Occupancy levels drop from 80.3 percent to 69.6 percent (a 13.3 percent decline), and from 69.6 percent to 52.4 percent between 2009 and 2010 (a 24.7 percent Year-over-Year decline and 34.7 percent for the two-year period 2008 to 2010).

During the years of the 2008 recession, ADR rates at GHK declined to $332.5 in 2009 and remained at that level through 2011, until slightly rising to $338.6 in 2012 and finally beginning to recover in 2013 to

TrustYou. Retrieved on July 7, 2016 from http://www.trustyou.com/press/trustyou-study-accorhotels-shows-effect-tripadvisor-reviews-bookings-2
[36] Ady, M., (2015, September 30). TrustYou Study with AccorHotels shows effect of TripAdvisor reviews on bookings. TrustYou. Retrieved on July 7, 2016 from http://www.trustyou.com/press/trustyou-study-accorhotels-shows-effect-tripadvisor-reviews-bookings-2

$357.9. Therefore, in the high-impact scenario, BRG used ADR of the $332 range, the rate earned during the 2008 recession period.

C. SURVEY RESPONSE SCENARIO

In a third scenario, BRG focused on the results of the Market Trends Pacific, Inc. GHK Guest Survey,37 which was conducted between May and June 2015. The survey, which covered 362 guests, revealed that the proposed HDF could have substantial effects on the Grand Hyatt Kauai. When provided with a description of the proposed HDF, 46 percent of respondents would not or were not sure they would return to the hotel. The primary reason for guests stating they would not return to the GHK was odors and flies from cow manure.

The survey results provided additional insights that are useful in the formation of the third impact scenario, or "survey scenario." Responses indicated that 73 percent were first-time guests of GHK, and 27 percent were repeat guests. Of the first-time guests, 64 percent reported using either a travel consultant or travel agent, an online travel or review site, or a word-of-mouth recommendation, while planning and making their booking decision, thus negative reviews would strongly impact future bookings.

After analyzing the information provided by the survey, under the survey scenario, BRG estimated a 35.8 percent drop in hotel occupancy; (27 percent repeat guests x 46 percent won't return) + (73 percent first-time guests x 64 percent used some sort of online review or outside input to influence their booking decision x 50 percent). Note that although 64 percent of first-time guests were influenced by one of the aforementioned factors in making their booking decision, BRG decided to apply a 50 percent curtailment on the application of this metric, as it is conservative to estimate that all of these respondents may not avoid staying at the GHK due to the reviews.

With respect to ADR, BRG uses the assumptions under the high-impact scenario adjusting rates to the $332 range during the 2008 recession period. This is a conservative estimate, since the survey indicated that when asked "Suppose at the Grand Hyatt Kauai during your stay you experienced strong odors, flies or other issues such as ocean contamination related to the dairy farm, what would you do?",[38] percent of respondents said they would ask for a discount on their room rate.

[37] See Appendix: Summary of Grand Hyatt Kauai Guest Survey, Market Trends Pacific, Inc.

D. OUTPUT, EMPLOYMENT, AND STATE TAX EFFECTS

To understand the broader implications of a loss of visitor expenditures at the GHK, BRG uses information from the Department of Business, Economic Development, and Tourism ("DBEDT") in Hawai'i to investigate the indirect output, employment, and state tax impacts. DBEDT maintains input-output models for the state and counties that contain a comprehensive set of accounts of sales and purchases of goods and services among the producing industries, final consumers (households, visitors, exports, and government), and resource owners (labor, capital, and land). Input-output models can be used to investigate the related and subsequent impacts on all industries in an economy following a change in expenditures in a given industry or sector category such as visitor expenditures ("VE"). Impacts include changes to business sales, employment, and state tax revenue. Impacts are direct, indirect through the change in sales in related industries, and induced through the effects on household spending that results from employment and earnings effects. The indirect and induced impacts are often referred to as "ripple" effects of the direct change in economic activity. Multipliers are values that capture the combined implications of the direct, indirect, and induced effects.

Information from the state's inter-county input-output model is used to simulate the output, employment, and state tax consequences from the change in economic activity at the GHK under the three scenarios described above. The state model provides multiplier values that can be used to estimate the indirect and induced effects for all Hawaiian Islands when there is a change in economic activity on any one of the islands. The inter-county input-output model provides multipliers for changes in visitor expenditures in Kaua'i. Exhibit 4 shows the multiplier values used in the BRG simulations. Output and state tax multipliers for VE do not vary by year. BRG, however, conservatively uses the VE employment multiplier for 2020 as it reflects the mid-point for the 5-year operations period of the HDF following its development activities.

Exhibit 4: Multipliers

Revenue Factors:		
Direct Revenue	1.000	
Indirect Revenue	0.350	
Induced Revenue	0.490	
Employment Factors:		
Direct Count of Job Loss	6.360	Employees per $1 million (2013-2015 GHK average)
Direct	1.000	
Indirect	0.340	
Induced	0.440	
Taxes:		
State-level		
Direct and Indirect Revenue State	0.070	
Induced Revenue	0.022	

Sources:
2016. "The 2012 Hawaii State Inter-County Input-Output Study," State of Hawaii, May: 33, 35; and 2012-County-I-O-Detailed.xlsx available from
http://dbedt.hawaii.gov/economic/reports_studies/2012-inter-county-io/ ; and BRG analysis.

VI. Results of the BRG Assessment

A. RESULTS

First Year of Impact:

Under the low-impact scenario, the minimum impact estimated to the GHK in the first year is an impact to hotel revenue of $23.0 million, which equates to a 19.0 percent decline from projected revenue in the baseline year. The total economic impact on revenues, including indirect and induced revenue, could total $42.3 million in the first year of impact. As a result, the employment impact at GHK is estimated to be

146 jobs, with the total employment impact potentially reaching 260 jobs in the first year of impact. The total impact on state and local taxes is estimated to equal $2.1 million.

In the high-impact scenario, the impact on revenues to GHK in the first year of impact could be as great as $41.6 million, or a 34.4 percent decline, with the total economic impact of revenues reaching $76.5 million. The employment impact could be 265 jobs directly to GHK, and 470 jobs in total to the local and state economy. The total impact on taxes to the state could be $3.8 million.

Finally, in the survey impact scenario, the direct impact on hotel revenue at GHK could exceed $53.0 million, a decline in projected property revenue of 43.8 percent. The total economic impact on revenues could expand to $97.5 million, when considering the indirect and induced effect. Under the survey scenario, the employment impact to GHK directly is estimated at 337 jobs due to the potential decline in operational revenue, and a total employment impact to the economy could reach 599 jobs. The impact on local and state tax revenues could be $4.9 million in the first year of impact.

The following table illustrates the first-year impact calculated by BRG, in each of the low-impact, high-impact, and survey scenarios.

First Year Impact							
	Baseline	Low Impact Scenario	Low Impact Difference	High Impact Scenario	High Impact Difference	Survey Impact Scenario	Survey Impact Difference
Total GHK Revenue Impact	**$ 121,012,666**	**$98,020,259**	**$(22,992,407)**	**$79,414,562**	**$(41,598,104)**	**$68,000,042**	**(53,012,624)**
Indirect Revenue			$ (8,047,342)		$(14,559,336)		$ (18,554,418)
Induced Revenue			$(11,266,279)		$(20,383,071)		$ (25,976,186)
Total Revenue Impact			**$(42,306,028)**		**$(76,540,511)**		**$ (97,543,227)**
Employment Impact:							
Direct	770	623	(146)	505	(265)	432	(337)
Indirect	259	210	(49)	170	(89)	146	(113)
Induced	339	274	(64)	222	(116)	190	(148)
Total Employment Impact	**1,367**	**1,108**	**(260)**	**897**	**(470)**	**768**	**(599)**
State Taxes:							
Direct & Indirect - Hotel Revenue			$ (1,611,768)		$ (2,916,027)		$ (3,716,185)
Induced			$ (494,337)		$ (894,359)		$ (1,139,771)
Total State Taxes			**$ (2,106,104)**		**$ (3,810,386)**		**$ (4,855,956)**

Five-Year Cumulative Impact:

In the low-impact scenario, the cumulative five-year impact on direct hotel revenues at GHK could reach $116.2 million, with the total economic impact exceeding $213.9 million. 148 jobs could be directly impacted at GHK, with a total employment impact to the local and state economy of 264 jobs. The total impact on state and local taxes could surpass $10.6 million.

If the effects of the proposed HDF resulted in conditions under the high-impact scenario, the cumulative five-year impact on direct hotel revenues to GHK could be $210.3 million, resulting in a total economic impact of $386.9 million, including indirect and induced revenues. The direct employment impact could be 269 jobs, with a total of 477 jobs impacted in the local and state economy. The total impact on tax revenues to the state could exceed $19.3 million over five years.

In the survey impact scenario, based upon actual GHK guest feedback, the cumulative five-year impact to GHK could result in an impact of $268.0 million to direct hotel revenues. The total economic impact on revenues could rise to $493.1 million. The five-year cumulative direct employment impact on GHK is estimated to be 342 jobs, while the total employment impact could be 608 jobs. The cumulative five-year impact on local and state tax revenues could be in excess of $24.5 million. The below table shows a summary of the cumulative five-year impact of the proposed HDF.

Cumulative Five-Year Impact							
	Baseline	Low Impact Scenario	Low Impact Difference	High Impact Scenario	High Impact Difference	Survey Impact Scenario	Survey Impact Difference
Total GHK Revenue Impact	**$ 611,751,616**	**$ 495,518,809**	**$ (116,232,807)**	**$ 401,461,998**	**$ (210,289,618)**	**$ 343,758,527**	**$ (267,993,089)**
Indirect Revenue			$ (40,681,482)		$ (73,601,366)		$ (93,797,581)
Induced Revenue			$ (56,954,075)		$ (103,041,913)		$ (131,316,614)
Total Revenue Impact			**$ (213,868,365)**		**$ (386,932,897)**		**$ (493,107,284)**
Employment Impact:							
Direct	781	633	(148)	513	(269)	439	(342)
Indirect	263	213	(50)	173	(90)	148	(115)
Induced	344	279	(65)	226	(118)	193	(151)
Total Employment Impact	**1,388**	**1,124**	**(264)**	**911**	**(477)**	**780**	**(608)**
State Taxes:							
Direct & Indirect - Hotel Revenue			$ (8,147,920)		$ (14,741,302)		$ (18,786,316)
Induced			$ (2,499,005)		$ (4,521,227)		$ (5,761,851)
Total State Taxes			**$ (10,646,925)**		**$ (19,262,529)**		**$ (24,548,167)**

B. ASSUMPTIONS OF THE MODEL

Developing 2016 Annual Projection:

BRG was provided with the STAR Report through May 2016, which was the most recent available at the time of engagement. In order to develop a reasonable projection of 2016 full-year results, BRG analyzed the monthly Occupancy and ADR historical five-year trends. BRG analyzed the ratio between the May YTD Occupancy and ADR, and the complete year Occupancy and ADR, in each year 2011 through 2015, which accounts for seasonal fluctuations in Occupancy and ADR. Using the average of the annual ratios for the five year period, BRG extrapolated the results through May to the end of 2016.

Developing Five-Year Baseline Projection:

In developing the five-year baseline business projection for GHK, under normal and un-interrupted business circumstances, BRG considered historical data provided in the STAR Reports (Smith Travel Research) on GHK, the market tract of all hotel properties in Kaua‘i, and the direct competitors identified by GHK as the “Comp Set.” Specifically, BRG took the average Occupancy growth during the stabilized business period of 2013 through 2015 (1.0 percent) and applied this growth to our first baseline projection year, 2017. In 2018 we slowed the growth rate to 0.5 percent, then to 0.25 percent in 2019, and leveling off with no growth in 2020 and beyond. BRG used a conservative approach of only growing GHK’s ADR in the first baseline projection year, 2017, by 1.0 percent, by 0.5 percent in 2018, 0.25 percent in 2019, and stagnant with no growth in 2020 and beyond. A comparable ADR growth rate for luxury class hotels tracked in the STAR Reports in the 2012 to 2015 period is approximately 5 percent.

Caveats:

An important caveat in our assessment was that GHK does not keep track of rooms out of inventory or closed during renovations or for seasonality purposes, thus the available room universe is treated as the number of physical rooms (602) multiplied by 365 days in the year. Occupied rooms calculated in BRG’s assessment are therefore based on the Occupancy and ADR statistics that are reported by GHK to Smith Travel Research. Because full and actual financial statements were not available to BRG, we developed a reasonable expectation of Room Revenue based on the information provided through STAR Reports (Occupancy, ADR, and RevPAR) and our understanding of the available room inventory methodology employed at the property.

Any room closures during the significant renovations in 2010, nor any other year, should in theory have no impact on the number of occupied rooms used in BRG calculations, and further, no impact on the Room Revenues calculated, since the assumption is that the available room inventory remains constant at

219,730 room nights annually. Occupancy reported to STR is believed to be assumed over a full 602 room universe and not a lesser available room inventory at any point in time.

BRG uses the scenario descriptions to reflect uncertainly regarding the potential loss of visitor expenditures to Kaua‘i and Hawai‘i due to odor and pest nuisances from the HDF. Implicit in the analysis is the assumption that the lost expenditures at the GHK are not gained at other tourist destinations in Kaua‘i or elsewhere in the state.

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VIII. Appendices

A. FIRST-YEAR AND FIVE-YEAR FORECASTS

The following exhibits show the baseline five-year projections for the GHK, developed by BRG based on the methodology described in Section 6.B, and the resulting potential impacts of the proposed HDF, annually, in each of the three respective impact scenarios.

Five-Year Forecast Baseline:

Five-Year Forecast Table - Baseline	2015	2016	2017	2018	2019	2020	2021
Total Hotel Revenue	**$ 108,342,399**	**$ 116,902,969**	**$ 121,012,666**	**$ 122,225,818**	**$ 122,837,711**	**$ 122,837,711**	**$ 122,837,711**
Employment Impact							
Direct			770	777	781	781	781
Indirect			259	262	263	263	263
Induced			339	342	344	344	344
Total Employment Impact			**1,367**	**1,381**	**1,388**	**1,388**	**1,388**

Five-Year Forecast – Low Impact:

Five-Year Forecast Table - Low Impact	2015	2016	2017	2018	2019	2020	2021
Total Hotel Revenue	**$ 116,902,969**	**$ 118,628,238**	**$ 98,020,259**	**$ 99,002,912**	**$ 99,498,546**	**$ 99,498,546**	**$ 99,498,546**
Baseline Hotel Revenue			$ 121,012,666	$ 122,225,818	$ 122,837,711	$ 122,837,711	$ 122,837,711
Impact on Hotel Revenue			**$ (22,992,407)**	**$ (23,222,905)**	**$ (23,339,165)**	**$ (23,339,165)**	**$ (23,339,165)**
Indirect Revenue			$ (8,047,342)	$ (8,128,017)	$ (8,168,708)	$ (8,168,708)	$ (8,168,708)
Induced Revenue			$ (11,266,279)	$ (11,379,224)	$ (11,436,191)	$ (11,436,191)	$ (11,436,191)
Total Revenue Impact			**$ (42,306,028)**	**$ (42,730,146)**	**$ (42,944,064)**	**$ (42,944,064)**	**$ (42,944,064)**
Employment Impact:							
Direct			(146)	(148)	(148)	(148)	(148)
Indirect			(49)	(50)	(50)	(50)	(50)
Induced			(64)	(65)	(65)	(65)	(65)
Total Employment Impact			**(260)**	**(262)**	**(264)**	**(264)**	**(264)**
State Taxes:							
Direct & Indirect - Hotel Revenue			$ (1,611,768)	$ (1,627,926)	$ (1,636,075)	$ (1,636,075)	$ (1,636,075)
Induced			$ (494,337)	$ (499,292)	$ (501,792)	$ (501,792)	$ (501,792)
Total State Taxes			**$ (2,106,104)**	**$ (2,127,218)**	**$ (2,137,868)**	**$ (2,137,868)**	**$ (2,137,868)**

Five-Year Forecast – High Impact:

Five-Year Forecast Table - High Impact	2015	2016	2017	2018	2019	2020	2021
Total Hotel Revenue	**$ 116,902,969**	**$ 118,628,238**	**$ 79,414,562**	**$ 80,210,693**	**$ 80,612,248**	**$ 80,612,248**	**$ 80,612,248**
Baseline Hotel Revenue			$ 121,012,666	$ 122,225,818	$ 122,837,711	$ 122,837,711	$ 122,837,711
Impact on Hotel Revenue			**$ (41,598,104)**	**$ (42,015,125)**	**$ (42,225,463)**	**$ (42,225,463)**	**$ (42,225,463)**
Indirect Revenue			$ (14,559,336)	$ (14,705,294)	$ (14,778,912)	$ (14,778,912)	$ (14,778,912)
Induced Revenue			$ (20,383,071)	$ (20,587,411)	$ (20,690,477)	$ (20,690,477)	$ (20,690,477)
Total Revenue Impact			**$ (76,540,511)**	**$ (77,307,830)**	**$ (77,694,852)**	**$ (77,694,852)**	**$ (77,694,852)**
Employment Impact:							
Direct			(265)	(267)	(269)	(269)	(269)
Indirect			(89)	(90)	(90)	(90)	(90)
Induced			(116)	(118)	(118)	(118)	(118)
Total Employment Impact			**(470)**	**(475)**	**(477)**	**(477)**	**(477)**
State Taxes:							
Direct & Indirect - Hotel Revenue			$ (2,916,027)	$ (2,945,260)	$ (2,960,005)	$ (2,960,005)	$ (2,960,005)
Induced			$ (894,359)	$ (903,325)	$ (907,847)	$ (907,847)	$ (907,847)
Total State Taxes			**$ (3,810,386)**	**$ (3,848,585)**	**$ (3,867,852)**	**$ (3,867,852)**	**$ (3,867,852)**

Five-Year Forecast – Survey Impact:

Five-Year Forecast Table - Survey Impact	2015	2016	2017	2018	2019	2020	2021
Total Hotel Revenue	**$ 116,902,969**	**$ 118,628,238**	**$ 68,000,042**	**$ 68,681,743**	**$ 69,025,581**	**$ 69,025,581**	**$ 69,025,581**
Baseline Hotel Revenue			$ 121,012,666	$ 122,225,818	$ 122,837,711	$ 122,837,711	$ 122,837,711
Impact on Hotel Revenue			**$ (53,012,624)**	**$ (53,544,075)**	**$ (53,812,130)**	**$ (53,812,130)**	**$ (53,812,130)**
Indirect Revenue			$ (18,554,418)	$ (18,740,426)	$ (18,834,246)	$ (18,834,246)	$ (18,834,246)
Induced Revenue			$ (25,976,186)	$ (26,236,597)	$ (26,367,944)	$ (26,367,944)	$ (26,367,944)
Total Revenue Impact			**$ (97,543,227)**	**$ (98,521,098)**	**$ (99,014,319)**	**$ (99,014,319)**	**$ (99,014,319)**
Employment Impact:							
Direct			(337)	(341)	(342)	(342)	(342)
Indirect			(113)	(115)	(115)	(115)	(115)
Induced			(148)	(150)	(151)	(151)	(151)
Total Employment Impact			**(599)**	**(605)**	**(608)**	**(608)**	**(608)**
State Taxes:							
Direct & Indirect - Hotel Revenue			$ (3,716,185)	$ (3,753,440)	$ (3,772,230)	$ (3,772,230)	$ (3,772,230)
Induced			$ (1,139,771)	$ (1,151,198)	$ (1,156,961)	$ (1,156,961)	$ (1,156,961)
Total State Taxes			**$ (4,855,956)**	**$ (4,904,637)**	**$ (4,929,191)**	**$ (4,929,191)**	**$ (4,929,191)**

B. SUMMARY OF GRAND HYATT KAUAI GUEST SURVEY, MARKET TRENDS PACIFIC, INC.

In May and June 2015, Market Trends Pacific, Inc.[38] conducted a survey of guests at the Grand Hyatt Kauai. The survey demonstrated two things. First, the hotel is a significant contributor to tourism, and second, hotel guests would not return if the dairy farm were to be built. The survey covered 362 guests.

Of those surveyed, over half identified the Grand Hyatt Kauai as a primary or very important reason to be in the Poipu area. The majority of guests surveyed – 73 percent – were first-time visitors to the Grand Hyatt Kauai, and 56 percent identified the hotel as a primary reason for choosing to stay in Poipu. Indeed, if the Grand Hyatt Kauai was not available during desired travel dates, 28 percent of respondents would not or were not sure they would stay in Poipu during their next visit to Kauai. Being outdoors is also important to the guests. The majority – 81 percent – spend time at the Grand Hyatt Kauai's outdoor facilities at least once per day. Additionally, 83 percent stated that they would patronize the on-site restaurants, 54 percent would use the spa and fitness center, and 60 percent would utilize other outdoor activities, such as the hotel bars.

Guest satisfaction at the hotel is high, with 92 percent stating they are likely or somewhat likely to select the Grand Hyatt Kauai for their next visit to Kauai, and 98 percent stating they are very likely or somewhat likely to recommend the hotel.

In contrast, when provided with a description of Hawai'i Dairy Farms' proposed dairy, 46% would not or were not sure they would return to the hotel, and 48% would not or were not sure they would return to the Poipu area. The primary reason for guests stating they would not return to the Grand Hyatt Kauai or to Poipu was odors and flies from cow manure.

If strong odors, flies or ocean contamination issues were mentioned in news articles or online reviews, 65 percent of the guests would choose another hotel or were not sure where they would spend their vacation. Further, when asked, "Suppose at the Grand Hyatt Kauai during your stay you experienced strong odors, flies, or other issues such as ocean contamination related to the dairy farm, what would you do?," 38 percent of respondents said they would ask for a discount on their room rate. Since 64 percent of first-time guests reported using either a travel consultant or travel agent, an online travel or review site, or a word-of-mouth recommendation, while planning and making their booking decision, negative reviews would strongly impact future bookings. In addition, the effects go beyond the Grand Hyatt Kauai as 28 percent would choose a different hotel outside of Poipu and 13 percent would stay on a different island. The harm would therefore not be limited just to the Grand Hyatt Kauai, but would extend to all of Kauai.

[38] Market Trends Pacific, Inc. is market research provider. It designs and conduct consumer attitude studies based upon a variety of data collection techniques, including survey interviews.

Appendix B

Atmospheric Sciences

Exponent®

Exponent 2016
Odor Impact Assessment,
Hawai‘i Dairy Farms

Exponent®

Exponent 2016
Odor Impact Assessment,
Hawai‘i Dairy Farms

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July 2016

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Acronyms and Abbreviations

CAFO	Concentrated animal feeding operation
DEIS	Draft Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ESRL	Earth System Research Laboratory
g/s	grams/second
HDF	Hawai‘i Dairy Farm
ISD	Integrated Surface Database
K	degrees Kelvin
km	kilometer
LIH	Lihue Airport
m	meter
m/s	meters per second
µg/m^3	micrograms per cubic meter
NLCD 2001	National Land Cover 2001 Database
NCEI	National Centers for Environmental Information
NED	National Elevation Dataset
NOAA	National Oceanic and Atmospheric Administration
OFFSET	Odor from Feedlots – Setback Estimation Tool
OU	odor unit
POIH1	Poipu meteorological tower
TPY	tons per year
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator

1 Introduction

The Hawai‘i Dairy Farm (HDF) submitted a Draft Environmental Impact Statement (DEIS) that, among other issues, addressed the potential odor impacts at off-site locations. Air quality modeling described in Appendix I of the DEIS (Arcadis, 2016) concluded that the odor from the dairy farm would not exceed what they identified as applicable thresholds outside of the facility boundary.

Exponent, Inc. (“Exponent”) has been retained by Goodsill Anderson Quinn & Stifel LLP on behalf of Kawailoa Development LLP (“Kawailoa”) to conduct air quality dispersion modeling to predict the odor impacts of the proposed HDF. The Grand Hyatt Kauai and the Poipu Bay Golf Course are located on property owned by Kawailoa. As part of this study, the basis for the odor threshold used by the DEIS as well as the emission sources and their odor strengths were reviewed. Based on this review, the odor modeling performed in the DEIS was updated. The purpose of the odor modeling was to determine

(1) the odor impacts on the Kawailoa property using the same emission sources and strengths as the DEIS, but evaluated with an appropriate odor threshold for a tourist population in a resort area, and

(2) the odor impacts on the Kawailoa property using more appropriate odor emission sources than what was evaluated in the DEIS.

2 Summary of Findings

- The odor threshold of 6.5 OU/m^3 averaged over one hour used in the DEIS to evaluate impacts is not appropriate for a sensitive population such as hotel guests at a resort area. The DEIS odor threshold being used has not been adopted by any governmental authority or agency. Odors are perceived over much shorter time periods than one hour. A threshold odor concentration used by a number of government agencies for sensitive locations, 2 OU/m^3 averaged over 15 minutes, was adopted for our analyses.
- The odor emissions for some sources that were used in the DEIS were significantly underestimated. For example, HDF failed to include the odor emissions from fields that had received effluent irrigation or slurry in the hours before the one being modeled and grossly underestimated the odor strengths from several sources.
- Air quality dispersion modeling which used the same odor emissions as in the DEIS indicated that objectionable odors would reach the Kawailoa property. For a herd size of 699 cows, odor 15-minute averaged concentrations up to 25 OU/m^3 were predicted on the Kawailoa property. These predicted concentrations are much larger than the odor threshold of 2 OU/m^3 averaged over 15-minutes.
- Air quality dispersion modeling that we conducted with more appropriate odor emissions from the dairy indicate much larger maximum odor concentrations on the Kawailoa property. For a herd size of 699 cows, 15-minute averaged odor concentrations up to 150 OU/m^3 were predicted on the Kawailoa property using our estimated worst-case odor emissions.
- The lowest odor emissions from HDF would occur on hours when there is no fresh application of slurry or irrigation with effluent. We estimate that even during these low emission periods the maximum 15-minute averaged concentrations at the Kawailoa property with a herd size of 699 cows would be as high as 30 OU/m^3. These would still be in excess of the 2 OU/m^3 odor threshold.
- Our modeling results with our worst-case and lowest-case odor emissions estimates suggest that during at least 450 hours each year HDF odor impacts at the Kawailoa property could exceed the 2 OU/m^3 odor threshold. Values could possibly be as high as

150 OU/m^3 during hours with worst-case emissions. These impacts could result in conditions that visitors at the Kawailoa properties would likely find offensive.

3 Odor Sources from Dairy

3.1 HDF odor source emissions

The nature of odor emissions makes them a quantity that is subject to significant uncertainties. Odors can be related to a number of different chemicals present in the air. Manure produces dozens to hundreds of odor producing chemicals with some chemicals being more detectable in combination than alone. As a result, no individual measurement of chemical concentrations can universally be applied to calculate odor impacts. Typically, odors are quantified using olfactometry, where a trained panel of testers is used to determine how many dilutions are necessary before an odor becomes imperceptible. A value of 1 odor unit (OU) is assigned to the dilution level when 50% of the trained panelists first detect the odor. Literature references commonly will include values of emissions for different dairy activities in terms of $OU/m^2/s$.

Odor emissions from dairy manure can be affected by factors including animal diet and climate as well as the manure storage or application method being used. Since the operation of the HDF would differ from many large dairy facilities, care must be taken to ensure the emissions factors used are from activities as similar as possible to what is proposed for the HDF.

3.1.1 Dairy Barn Facility

The emission factors used in the DEIS to represent the milking barn and calf sheds are based on values for free stall dairy buildings (Jacobson et al, 2001) which are used in the Odor from Feedlots – Setback Estimation Tool (OFFSET) developed at the University of Minnesota. The OFFSET model is a well-recognized reference for odor emissions from animal housing facilities. Other odor emission rates for dairy barns available in the literature are generally similar in magnitude to the cited value from the OFFSET model (Sheffield 2004, Wood 2001). The milking barn proposed at HDF will not be used as the primary housing facility for the dairy cattle. Although emission factors for free-stall barns assume that cows will spend more hours per day within the barn than would be the case at the HDF facility, it is assumed that the milking barn has been sized appropriately for the number of cows to be housed within it at any given time. Therefore, the emission factors which are provided on an odor unit per square meter basis

should be a reasonable and appropriate reference for estimating odor emissions from the HDF milking barn and calf sheds.

3.1.2 Settling and Storage Ponds

Emissions from effluent ponds are highly dependent on the proper design, maintenance and sizing of the pond system. The emission factors used in the DEIS to represent the settling pond and storage pond ($8.1\ OU/m^2/s$) were referenced to come from Feitz 2002 as documented in Dairy Australia (2008). The Feitz 2002 reference listed in the Dairy Australia document is cited as "per. corr., UNSW" which is understood to mean "personal correspondence". This personal correspondence reference does not allow for any evaluation of its applicability to the facility being modeled.

There are large uncertainties in the emissions from storage lagoons. Odors have been reported to vary spatially across a pond by as much as a factor of ten (Dairy Australia 2008) and emissions from lagoons that are not properly sized or maintained can be higher (Iowa 2006). The value of $8.1\ OU/m^2/s$ used in the HDF DEIS modeling is within the range of values cited by others including the values used in the OFFSET model (Jacobson, 2005; Idaho 2004). Given the currently available literature for effluent pond emission rates, the values used in the DEIS model appear reasonable and appropriate if the settling pond and storage pond have been appropriately sized and properly maintained.

3.1.3 Irrigation

At HDF, it is proposed that irrigation water sprayed from two center pivots would include effluent from the storage pond and would spread the liquid effluent across a large portion of the pasture land. Given the large land areas to be irrigated, effluent application represents a very significant source of potential odor emissions. Concerns have been raised recently about the practice of using dairy farm effluent in sprayed irrigation water. For example, Wisconsin established a working group to provide guidance on the use of manure irrigation (Genskow 2016). Other reports have cited the potential for significant odor and pathogenic emissions from this practice both during and after applications (Krantz 2007, Casey 2006).

The odor emission rates used in the DEIS modeling are not based on emission factors for effluent applied to fields. Instead, the DEIS used the storage pond emissions rates reduced by a factor of 12 to represent dilution with non-effluent water, resulting in an odor emission rate of 0.675 $OU/m^2/s$. This emission rate was applied only over the area covered by the pivot in a single hour, suggesting in effect that sectors watered in prior hours would have zero odor emissions. No justification is given for this assumption in the representativeness of their odor emission rate.

The irrigation process uses water from the storage ponds, but the physical processes of odor releases from quiescent storage ponds are dramatically different than those involved in spray irrigation. One would not reasonably expect identical or even similar odor emission rates. Spraying will expose a much larger liquid surface to evaporation, both while the droplets are in the air and when they fall on vegetated grass surfaces which have large available surface areas (Pape 2009). The turbulent aeration process caused by spraying also has the potential to release more odors than would emit from the surface of a still pond. Furthermore, the water used in irrigation would not be drawn from the top surface of the pond, but rather from a subsurface layer where odorous compounds would likely exist at higher concentrations. The DEIS offers no explanation or plausible justification for adopting published odor emission factors developed explicitly for quiescent storage pond surfaces for its calculation of odor emissions from proposed spraying effluent for irrigation.

Tests of odors from land application of slurry have been performed by the Institute for Grassland and Animal Production in Berkshire UK (Pain 1988). These tests specifically measured odor emissions from dairy cow slurries applied to grasslands; a situation directly relatable to the practice proposed at HDF. Measurements were made both for whole and separated slurries. Separated slurries were passed through a roller press mechanical separator which retained the liquid fraction. The liquid was then applied to plots using a watering can and emissions were collected using a wind tunnel. Measured odor emissions for separated dairy cow slurry were approximately 19 $OU/m^2/s$ for the first three hours after application, and then dropped to about half that rate for times out to 48 hours. Dilution by a factor of 12 is possibly justified if fresh water is mixed at a 12:1 ratio with the effluent water as proposed at the HDF. This would yield an emission rate factor of 1.64 $OU/m^2/s$. However, it should be noted that the HDF Waste Management Plan (Group 70, 2014) also mentions that "the irrigators can run in November, December and January (if no dry spells occur) to distribute only effluent water." In

those cases when no fresh water is used to dilute the effluent, odor emissions would be much higher.

As discussed above, the tests performed by Pain (1988) demonstrate that emissions are not limited to just the first hour after application and can extend for at least 48 hours. Therefore, modeling must include emissions from the full pivot area, with sectors older than three hours having emission reduced by one-half. It is important to note that Pain's measurements did not quantify the emissions during the physical spraying process. The turbulence and aeration during that process could result in additional higher short-term odor emissions.

We did not model odor impacts associated with irrigation of the pasture beyond the range of the two irrigation pivots. The DEIS stipulates that drip irrigation would be used for these areas. We assumed that drip irrigation would produce no significant odor emissions.

3.1.4 Spraying of Sludge Slurry (Nutrient Application)

The greatest odors from dairy farm operations are associated with land application of manure (e.g. via a slurry) (Center for Agricultural Science and Technology, 2011). For the proposed HDF, a manure waste sludge slurry will be applied with a gun system to specified areas outside of the regions irrigated by the two center pivots.[1] Based on the description provided in the DEIS, slurry will be applied to a 65 foot radius area for a period of between 2 and 3 hours before the gun is moved to a new location. The total time spent applying slurry will be approximately 40 to 50 hours. As a result, approximately 15 different areas, each 65 feet in radius, will receive slurry during one application process.

The methodology used in the DEIS to calculate emissions from slurry calculates a weighted average of storage pond emissions and manure emissions in order to determine emissions from the slurry. As has been described before, the emissions from a still storage pond have no direct relationship with emissions from sprayed slurry. Further, there is no documentation provided in the DEIS to support the methodology used. Similarly, there is no justification given for the

[1] The Hawaii Department of Health (HDOH) sent a letter to Mr. Paul T. Matsuda at Group 70 International on 15 June 2016 (HDOH, 2016) stating that wastewater effluent from the proposed storage pond should not be distributed via irrigation gun. Presumably, HDOH would also object to distributing manure slurry from the settling pond via irrigation. Thus, it is not clear that the proposed slurry distribution methodology is feasible from a regulatory perspective.

assumption that the solid portion of the slurry will have emissions similar to manure. Estimation of slurry emissions should use established emission factors developed for the application of slurry in a field. Per the Waste Management Plan, the solids within the settling ponds will be thoroughly mixed before application of the slurry. This results in a material with odor emissions much higher than what would emit from the surface of the settling pond under normal quiescent settling conditions. Additionally, the emissions were applied to a single 65 foot radius area representing only the current period of slurry application. Slurry applied during prior hours will continue to emit odors and should properly be included in any odor modeling.

Tests of slurry land applications were conducted by the Institute for Grassland and Animal Production in Berkshire UK (Pain 1988). The tests performed included the application of both whole and separated slurry to grass surfaces. The application of whole dairy cow slurry to grassland resulted in odor emissions of approximately 22 $OU/m^2/s$ during the first three hours and 11 $OU/m^2/s$ for hours after. These odor emissions are direct measurements of slurry application and are a more reliable estimate of odor emissions.

3.1.5 Pastures

HDF dairy cattle will spend a majority of their day in the pasture paddocks instead of housed in barns. As a result, a significant majority of the manure produced will be deposited outdoors within the paddocks. Thus, the paddocks represent a significant source of potential odor emissions.

The DEIS relies on a single study conducted by Topper (2008) to quantify pasture manure emissions. The stated purpose of the Topper study was to evaluate statistical correlations between high/low forage quality and high/low concentrate level nutrient-balanced diets and simultaneous odor and gas emissions from the manure. The Topper study methodology was clearly not intended to reproduce manure production conditions in pastures; for example:

- Topper's heifers were housed 24 hours per day confined in stalls within an environmentally controlled barn rather than living and grazing freely outdoors in pastures;
- Topper's manure samples were taken at only one time of the day just before indoor feedings;

- Topper took small 200 gram samples directly from the test animals;
- His samples were separated, refrigerated, then later reconstituted and tested under a hood; and
- Topper's reported emission rate units were OU/s per square meter of manure, not OU/s per square meter of pasture land.

Yet, the DEIS attempted to extrapolate Topper's results to large volumes of manure deposited outside in the pasture. Arbitrary assumptions were made about manure thickness and distribution while no evaluation was made for how odor is released from manure droppings in an outdoor environment. The DEIS emission factors are not applicable to odor emissions from dairy cow manure in outdoor paddocks. We judge these emission factors and the methodology used to develop them to be unreliable.

More appropriate pasture odor emissions factors were published by Jacobson (University of Minnesota, 2009) within his OFFSET model. The Jacobson OFFSET model includes a value of 4.3 $OU/m^2/s$ for open feedlots for dairy or beef. This value was intended to represent emissions from manure deposited by animals living in an outdoor environment, and are more closely related to the manure that would be deposited in the paddocks at the HDF facility. The herd density represented in the OFFSET model is stated to be 250 to 300 square feet per head, which is denser than what is expected at the HDF facility. Therefore, Jacobson's odor emission factor should properly be reduced by a factor to account for the lower animal densities proposed for HDF grazing operations.

3.2 Conclusions about DEIS Odor Emissions Estimates

In the prior section, we summarized our review of the DEIS odor emissions calculations in the context of published literature on the subject of odor emissions from dairy farms. In this section, we summarize our opinions and conclusions about the representativeness of the DEIS odor emissions estimates.

3.2.1 Dairy Barn Facility

The DEIS used odor emissions factors that are representative of the range of emissions factors published for dairy barn facilities. Their odor emissions total calculations also appear to be correct. Thus, in our opinion the Dairy Barn Facility odor emissions presented in the DEIS appear to be reasonable estimates.

3.2.2 Settling and Storage Ponds

The DEIS used odor emissions factors that are representative of the range of emissions factors published for dairy waste settling and storage ponds. Their odor emissions total calculations also appear to be correct. Thus, in our opinion the Settling and Storage pond odor emissions presented in the DEIS appear to be reasonable estimates.

3.2.3 Irrigation

The DEIS used storage pond odor emissions factors divided by a factor of 12 (to account for a 12:1 dilution with fresh water) for only one hour of spray irrigation. Their approach completely fails to account for the dramatic differences between the physical processes of odor releases from quiescent storage ponds and those from spray irrigation. Odors from effluent spraying are enhanced compared to the DEIS estimates because:

- They did not account for the much larger liquid surface areas exposed to evaporation, both while the droplets are in the air and when they fall on vegetated grass surfaces;
- They did not account for the turbulent aeration process which occurs during spraying;
- They did not account for the expected higher concentrations of odorous compounds that likely exist at the depths from which the effluent is drawn; and
- They did not account for the documented tendency of pasture surfaces receiving the sprayed effluent to continue to emit odors for many hours after the spraying operation.

Thus, in our opinion, the odor emissions related to Irrigation presented in the DEIS are grossly underestimated.

3.2.4 Spraying of Sludge Slurry (Nutrient Application)

The DEIS used settling pond odor emissions factors plus a small amount for mixed solid manure for a single hour of spraying. Their approach completely fails to account for the dramatic differences between the physical processes of odor releases from quiescent settling ponds rather than those occurring during their proposed spraying of waste sludge slurry. Odors from slurry spraying operations are much larger than the DEIS estimates because:

- They did not account for the fact that the sludge in the settling pond is to be completely mixed during slurry spraying operations;
- They did not account for the much larger liquid surface areas exposed to evaporation, both while the droplets are in the air and when they fall on vegetated grass surfaces;
- They did not account for the turbulent aeration process which occurs during spraying; and
- They failed to account for the documented tendency of pasture surfaces receiving the sprayed sludge slurry to continue to emit odors for many hours after the spraying operation.

Thus, in our opinion, the odor emissions related to Spraying of Sludge Slurry presented in the DEIS are grossly underestimated.

3.2.5 Pastures

To quantify pasture odor emissions, the DEIS incorrectly extrapolated odor emissions factors from a single paper by Topper (2008). However, as discussed in section 3.1, the Topper study methodology was clearly not intended to reproduce manure production conditions in pastures because:

- Topper's heifers were confined indoors 24 hours per day;
- Topper took small 200 gram samples directly from the test animals at the same time each day; and
- Topper's samples were separated, refrigerated, then later reconstituted and tested under a hood.

Furthermore, unsupported assumptions about manure thickness were made in extrapolating the Topper results for the DEIS.

Thus, in our opinion, the odor emissions emanating from manure in pastures presented in the DEIS are significantly underestimated.

3.3 Recommended Odor Emissions Estimates

In section 3.2, we summarized our opinions and conclusions about the odor emissions presented in the DEIS. We noted that the odor emissions estimates for the Dairy Barn, Settling and Storage ponds appear to us to be reasonable and acceptable. However, we explained that it is our opinion that the odor emissions estimates presented in the DEIS for Irrigation, Sludge Slurry Spraying (Nutrient Application) and Pastures were significantly underestimated. In this section, we present our estimates of the worst-case HDF odor estimates for these three latter categories.

3.3.1 Irrigation

It is our opinion that the odor emissions from the irrigation process described in the Waste Management Plan cannot be reliably estimated using the storage pond odor emissions factors. As discussed above, this is due to a number of physical processes associated with effluent spraying that are not addressed using these pond factors. Instead, we chose to use odor emission factors published in peer-reviewed and oft-cited literature sources. In particular, we found the estimates published by Pain (1988) most relevant to this problem.

Tests of odors from land application of slurry and separated effluent were performed by the Institute for Grassland and Animal Production in Berkshire UK (Pain 1988). These tests specifically measured odor emissions from dairy cow slurries applied to grasslands; a situation directly relatable to the practice proposed at HDF. Specifically, we used Pain's published factors for separated liquid effluent. His measured odor emissions for separated liquid dairy cow effluent were approximately 19 $OU/m^2/s$ for the first three hours after application, and then dropped to about half that rate for times out to 48 hours. Dilution by a factor of 12 is possibly justified (if fresh water is mixed at a 12:1 ratio with the effluent water as proposed at the HDF) which yields an emission rate factor of 1.64 $OU/m^2/s$. Thus, for our modeling, we used 1.64 $OU/m^2/s$ as the odor emission factor for irrigation operations.

As discussed above, the tests performed by Pain (1988) demonstrate that emissions are not limited to just the first hour after application and can extend for at least 48 hours. Therefore, for our modeling, we included emissions from the full pivot area with sectors older than three hours having emission reduced by one-half.

It is important to note that Pain's measurements did not quantify the emissions during the physical spraying process. The turbulence and aeration during that process could result in additional higher short-term odor emissions. Also, the HDF Waste Management Plan also mentions that "the irrigators can run in November, December and January (if no dry spells occur) to distribute only effluent water." In those cases when no fresh water is used to dilute the effluent, odor emissions would be much higher.

We did not model odor impacts associated with irrigation of the pasture beyond the range of the two irrigation pivots. The DEIS stipulates that drip irrigation would be used for these areas. We assumed that drip irrigation would produce no significant odor emissions.

3.3.2 Spraying of Sludge Slurry (Nutrient Application)

It is our opinion that the odor emissions from the slurry spraying process cannot be reliably estimated using the settling pond odor emissions factors as a starting point as was assumed in the DEIS. As discussed above, this is due to a number of physical processes associated with slurry spraying that are not addressed using these pond factors. For example, as per the Waste Management Plan, the solids within the settling ponds will be thoroughly mixed before application of the slurry. Instead, we chose to use odor emission factors published in peer-reviewed and oft-cited literature sources. Again, we found the estimates published by Pain (1988) most relevant to the slurry spraying odor issue. Pain reported the application of whole dairy cow slurry to grassland resulted in odor emissions of approximately 22 $OU/m^2/s$ during the first three hours and 11 $OU/m^2/s$ for hours after.

As per the DEIS, slurry would be applied to a 65 foot radius area for a period of between 2 and 3 hours before the gun is moved to a new location. The total time spent applying slurry will be approximately 40 to 50 hours. As a result, approximately 15 different areas, each 65 feet in radius, will receive slurry during one application process. As was the case for irrigation with effluent irrigation, slurry applied during prior hours will continue to emit odors for many hours, and should therefore be included in our odor modeling. We applied the factor of 22 $OU/m^2/s$ during the first slurry spray circle (i.e., the most recent three hours), and 11 $OU/m^2/s$ for the earlier 14 spray circles.

3.3.3 Pastures

DEIS incorrectly extrapolated odor emissions factors from a single paper by Topper (2008). As discussed above, the Topper study methodology was clearly not intended to reproduce manure production conditions. Instead, we chose to use odor emission factors published in peer-reviewed and oft-cited literature sources. More appropriate pasture odor emissions factors were published by Jacobson (University of Minnesota, 2009) within his OFFSET model. The Jacobson OFFSET model includes a value of 4.3 $OU/m^2/s$ for open feedlots for dairy or beef. This value was intended to represent emissions from manure deposited by animals living in an outdoor environment, and are more closely related to the manure that would be deposited in the paddocks at the HDF facility. The herd density represented in the OFFSET model is stated to be 250 to 300 square feet per head, which is denser than what is expected at the HDF facility. Therefore, we reduced Jacobson's odor emission number of 4.3 $OU/m^2/s$ to account for the lower animal densities proposed for HDF grazing operations.

For the 699 herd size, the Pasture odor emissions factor we used was 0.74 $OU/m^2/s$. For the 2,000 herd size, the factor we used was 2.12 $OU/m^2/s$.

3.3.4 Total HDR Odor Emissions Estimates

We summarize our worst-case odor HDR emissions estimates in Table 1. Lowest-case emissions were derived by subtracting the pivot irrigation and slurry spraying emission. These would represent emissions during periods when there was neither irrigation nor slurry spraying during the prior three days.

For comparison, we also show the DEIS odor emissions estimates in Table 2.

Table 1 Our Estimated Worst-Case Odor Emissions Parameters (as modeled)

Source Description	Odor Emissions Factors ($OU/m^2/s$)	Surface Areas (m^2)	Odor Emissions Rates (OU/s)
Herd Size 699			
Pasture/Paddock	0.740E+00	98,410	72,823
Pivot Irrigation with Effluent (current + prior hours 2&3)	1.600E+00	64,433	101,491
Pivot Irrigation with Effluent (prior hours 4-40)	8.000E-01	571,012	456,710
Settling Pond	8.100E+00	707	5,727
Storage Pond	8.100E+00	1,925	15,593
Calf Shed 1	1.840E+00	198	364
Calf Shed 2	1.840E+00	198	364
Milking Parlor	1.840E+00	2,121	3,903
Slurry Spraying (current hour + prior hours 2&3))	2.200E+01	1,233	27,128
Slurry Spraying (prior hours 4-45)	1.100E+01	17,264	189,898
TOTAL			874,001
Herd Size 2000			
Pasture/Paddock	2.120E+00	98,410	208,629
Pivot Irrigation with Effluent (current + prior hours 2&3)	1.600E+00	64,433	101,491
Pivot Irrigation with Effluent (prior hours 4-40)	8.000E-01	571,012	456,710
Settling Pond	8.100E+00	707	5,727
Storage Pond	8.100E+00	1,925	15,593
Calf Shed 1	1.840E+00	198	364
Calf Shed 2	1.840E+00	198	364
Milking Parlor	1.840E+00	2,121	3,903
Slurry Spraying (current hour + prior hours 2&3))	2.200E+01	2,466	54,256
Slurry Spraying (prior hours 4-45)	1.100E+01	34,527	379,795
TOTAL			1,226,832

Table 2 DEIS Odor Emissions Parameters (as modeled)

Source Description	Odor Emissions Factors ($OU/m^2/s$)	Surface Areas (m^2)	Odor Emissions Rates (OU/s)
Herd Size 699			
Pasture/Paddock	0.13E+00	113,312	14,731
Pivot Irrigation with Effluent	0.675E+00	20,701	13,973
Settling Pond	8.10E+00	703	5,697
Storage Pond	8.10E+00	1,906	15,442
Calf Shed 1	1.84E+00	196	360
Calf Shed 2	1.84E+00	196	360
Milking Parlor	1.84E+00	2,105	3,873
Slurry Spraying	8.02E+00	1,233	9,889
TOTAL			64,325
Herd Size 2000			
Pasture/Paddock	0.370E+00	113,312	41,925
Pivot Irrigation with Effluent	1.600E+00	20,701	13,973
Settling Pond	8.100E+00	703	5,697
Storage Pond	8.100E+00	1,906	15,442
Calf Shed 1	1.840E+00	196	360
Calf Shed 2	1.840E+00	196	360
Milking Parlor	1.840E+00	2,105	3,873
Slurry Spraying	8.020E+00	2,460	19,778
TOTAL			101,408

4 Odor Threshold

The DEIS cites an Australian study by Wang and Feitz (2004) as justification for adopting an odor threshold of 6.5 OU/m^3 (1-hour averaging and 99.5th percentile) as an appropriate threshold for assessment of the HDF odors. However, in a document published by the Australian Dairy Industry (2008), it is suggested that Wang and Feitz's 6.5 OU/m^3 threshold was based on arbitrary assumptions and was not verified by community surveys or field panel assessments. It is also important to recognize that the DEIS relied on a suggestion contained in a single technical paper, not an odor standard adopted by any governmental agency or authority.

Galvin et.al. (2007) listed odor threshold criteria (99.5th percentile) for sensitive receptors which were adopted by states in Australia. These ranged from 0.5 to 2.5 OU/m^3. Averaging times ranged between 1 second and 1 hour. Sheffield and Thompson (2004) and Mahin (2003) summarized odor standards/thresholds that have been adopted in the United States. For residential receptors, the ranges cited were between 0 and 8 OU/m^3 and representative averaging times were between 1 and 15 minutes. These values are noted to be based on measurements with a scentometer, indicating that they are averaging times much shorter than 1 hour. For some standards, the threshold value must be met at the property line. Ten of the twenty listed states/jurisdictions have adopted odor thresholds for sensitive receptors of between 0 and 2 OU/m^3.

Kaua'i should be considered among the most odor sensitive locations in the United States. This would be especially true for visitors at its premium eco-tourism destinations. Thus, based on our consideration of the above, we conclude that:

- The DEIS odor threshold of 6.5 OU/m^3 is inappropriately high for the area; and
- The use of a 1-hour average concentration greatly understates impacts because odors are perceived on much shorter time periods.

An appropriate odor threshold range is 0-2.0 OU/m^3. We selected 2.0 OU/m^3 for our assessment calculated as 15-minute averaged concentrations.

5 Odor Modeling

5.1 Description of Our Modeling Approach

5.1.1 Model Selection

Consistent with the modeling performed in the DEIS, the AERMOD model developed by the U.S. Environmental Protection Agency (EPA) was used to predict the odor concentrations in the vicinity of the Kawailoa property. AERMOD is a steady-state plume model that incorporates air dispersion based on boundary layer turbulence scaling. The most recent version of AERMOD (v15181) was used with default options, as well as the most recent versions of AERMET (v15181) and AERMAP (v11103).

5.1.2 Averaging Time

Human perception of odors is related to the frequency at which an established threshold concentration for an odorous compound is exceeded at a particular location. Less frequent, short-term high odor concentrations are more critical in causing nuisance than the majority of hours when concentrations are relatively low or zero. Typically odor threshold concentration standards are determined by various government agencies using olfactometric measurement data with representative averaging times of a few seconds to several minutes (Mahin, 2003). This suggests that it is necessary to estimate the frequency distribution of concentrations with short averaging periods to properly quantify odor impacts.

In view of the difficulty with applying models that estimate short averaging time concentrations, regulatory air dispersion models are commonly used to estimate odor impacts (Engel et al. 1997; Scire et al. 2000) by multiplying the time averaged model estimate, C_m, by a factor, f:

$$f = (T/T_s)^p$$

where T_s is the averaging time for odor impacts (on the order of seconds or minutes), and T is averaging time of the model estimate (usually 1 hour). This expression is often called the "Turner Power Law." Multiplication of the modeled concentration, C_m, by the factor f results in a "peak" concentration, C_s, corresponding to T_s, which can then be compared to an established odor threshold concentration.

The DEIS reported one-hour average concentrations predicted by AERMOD. In our modeling, we applied the Turner Power Law with p=0.2 (Turner 1970) to our AERMOD results, and we present 15-minute average odor concentrations values.

5.2 Odor emission sources and fluxes

Our analysis includes an initial run using the same odor sources and odor emission fluxes (strengths) that were specified in the DEIS. This allows a comparison to be made of the odors predicted in the DEIS, but with an appropriate odor threshold for a resort area. The DEIS specified source parameters and emission rates are summarized in Table 2 and shown in Figure 1.

A second analysis was conducted using the more appropriate odor emission sources described in section 3 for both a worst-case emissions scenario and a lowest-case emission scenario. Our more appropriate source parameters and emission rates are summarized in Table 1. Our lowest-case emissions do not include the slurry application or the pivot irrigation which occur only at specified hours. Figure 2 shows our worst-case emission sources and Figure 3 shows our lowest-case emission sources. The predicted odor concentrations for these simulations were also judged against the more appropriate odor threshold of 2 OU/m^3 for a 15-minute averaged period.

Our odor analysis treated only stationary sources associated with the HDF. There are also expected to be mobile odor sources from the HDF. For example, animals will be transported to and from the HDF to maintain the number of animals below the concentrated animal feeding operation (CAFO) threshold of 699 cows. The road adjacent to the hotel and golf course (Poipu Road) may be used as secondary access for these transport activities. However, we did not model the odor impacts of these mobile activities due to the insufficiency of information about these sources (numbers and types of trailers, frequency of events, numbers of heifers involved, leakage rates from the trailers, etc.). However, due to potentially very close proximity to sensitive areas, these mobile sources will likely have additional odor impacts.

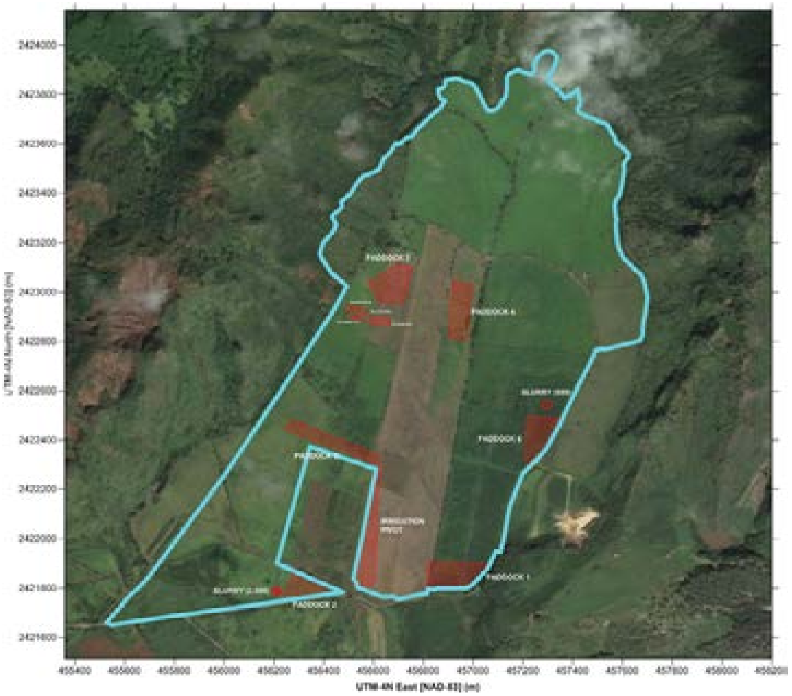

Figure 1 Odor emission sources used in the DEIS odor modeling

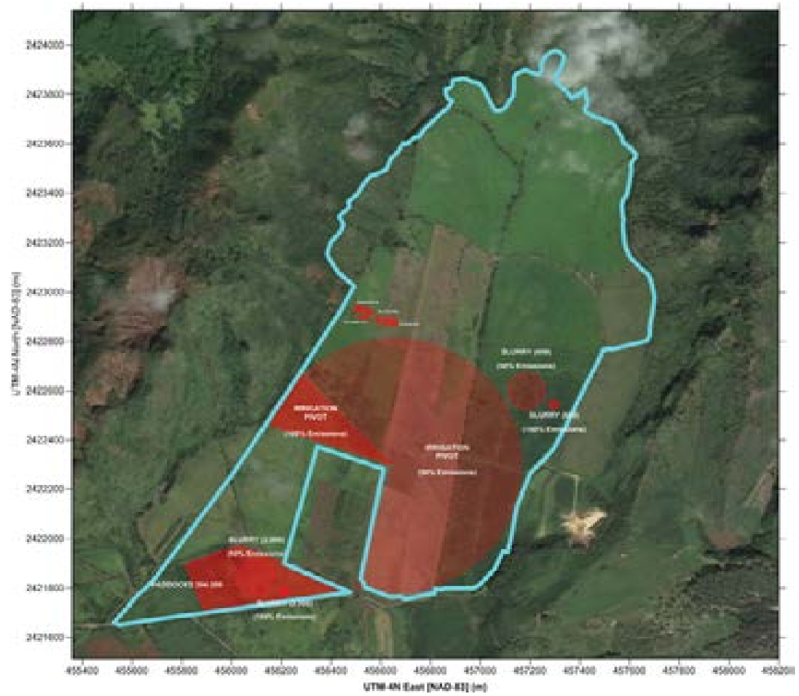

Figure 2 Our worst-case odor emission sources for the proposed dairy farm

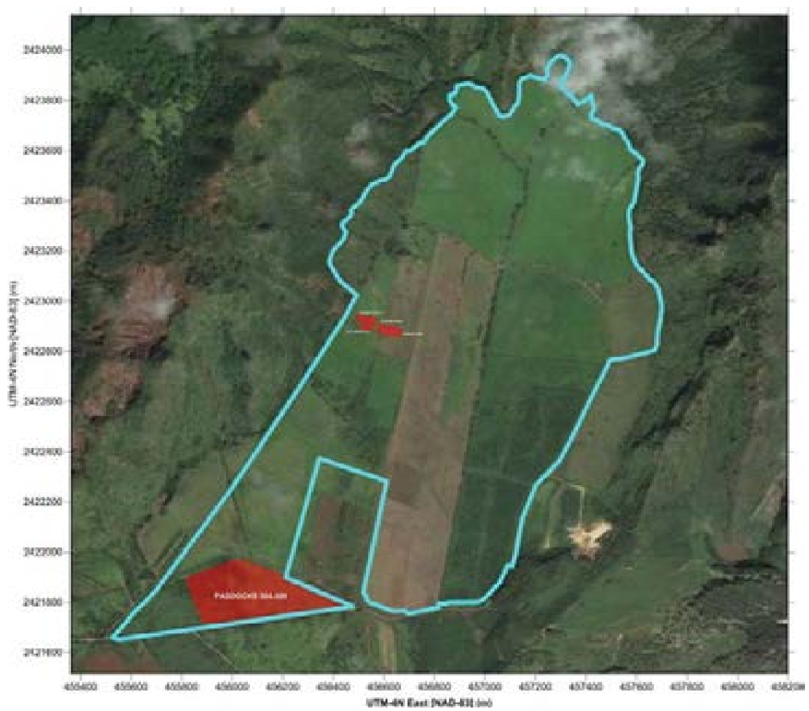

Figure 3 Our lowest-case odor emission sources for the proposed dairy farm

5.3 Meteorological data

Hourly wind speed, wind direction, temperature and pressure values were obtained from data collected at the Poipu meteorological tower (POIH1). The data collection platform, which is owned and operated by the National Weather Service Pacific Region, is located on the Poipu Bay Golf Course. The data are available through the Iowa Environmental Mesonet. Because the topography between the odor sources of the dairy farm and the Kawailoa property is relatively flat and open, the Poipu tower is the most representative source of wind data for these model simulations. For the relatively few hours with missing surface observations, supplemental data were obtained from the Lihue Airport (LIH) from the National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (NCEI) Integrated Surface Database (ISD). Twice-daily radiosonde soundings from LIH were used to supply the upper air data for the modeling. These were obtained from the NOAA/Earth System Research Laboratory (ESRL) Radiosonde Database.

5.4 Land use classification

Land use classification data were obtained from the 30-meter resolution United States Geological Survey (USGS) National Land Cover 2001 Database (NLCD 2001). The surface parameters, Bowen ratio, albedo and surface roughness length, were calculated following EPA procedures outlined in the AERSURFACE Users Guide (2013). The land use classifications used in the calculation of Bowen ratio, albedo and surface roughness are shown in Figure 4 for the Poipu tower.

The AERMET model, using the meteorological data from Poʻipū and Lihue and the surface parameters described above, was used to produce the hourly meteorological data for the AERMOD model. The 3-year wind rose of the meteorological data used in the odor modeling is shown in Figure 5.

5.5 Topography and model receptors

Terrain elevation data were obtained from the 30-meter resolution USGS National Elevation Dataset (NED). Model receptors, which are the locations where the odor concentrations are predicted by the AERMOD model, were based on a Cartesian grid with a spacing of 100 meters that covered the Kawailoa property and dairy farm. The AERMAP model was used to determine the terrain elevations and hill heights associated with each receptor. A total of 5,824 receptors were used for the odor modeling. A plot of the approximately 2,000 receptor locations in the vicinity of the dairy farm and resort is shown in Figure 6.

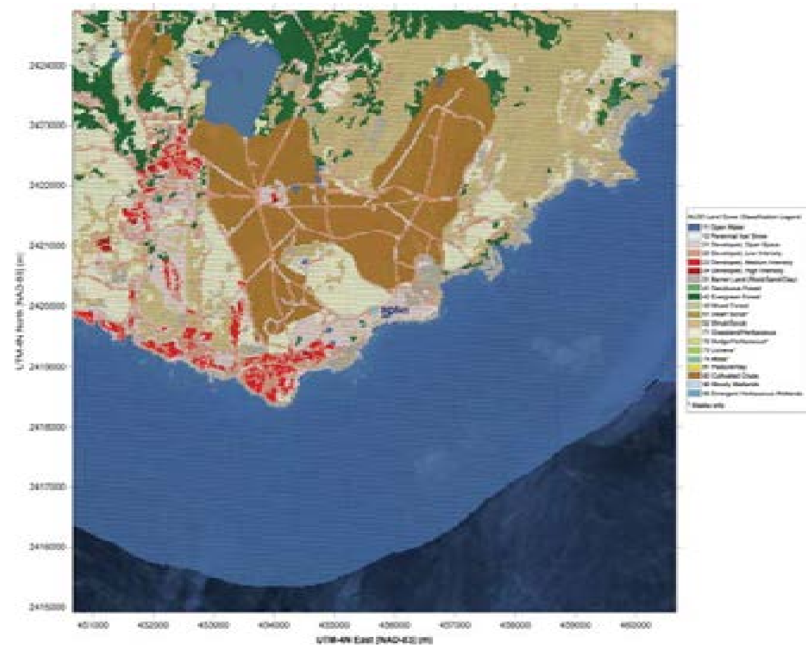

Figure 4 Plot of NLCD 2001 land use used in the calculation of Bowen ratio, albedo and surface roughness.

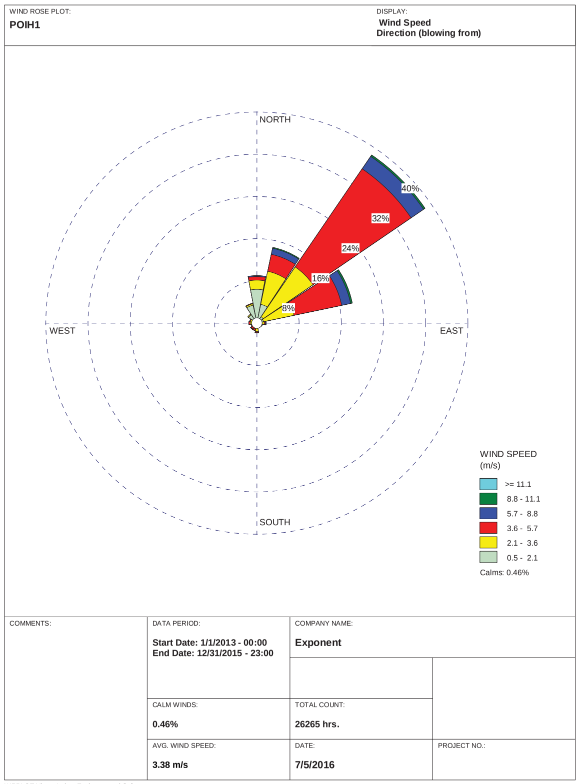

Figure 5 Wind rose for Poipu meteorological tower for 2013–2015

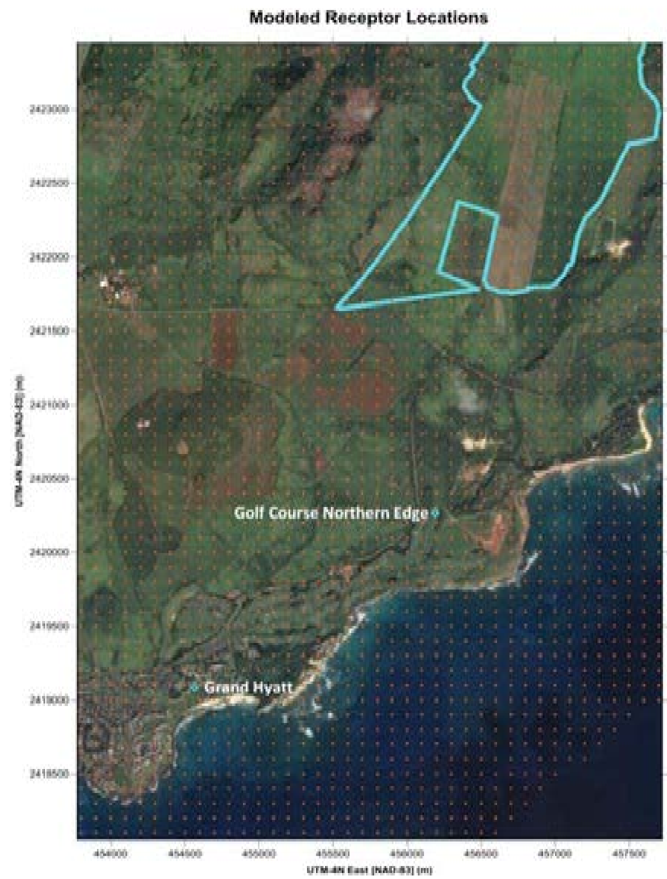

Figure 6 Model receptors in the vicinity of the dairy farm and the Kawailoa property

5.6 Predicted odor impacts

5.6.1 DEIS odor sources and emissions

The odor sources and odor emission fluxes (strengths) that were listed in the DEIS were used in an initial odor modeling simulation. A spot check showed that our model results, if compared with the odor threshold listed in the DEIS, were consistent with the DEIS results. The modeled impacts based on the unrealistically low emissions specified in the DEIS were then compared with an appropriate odor standard of 2 OU/m^3 for a 15-minute averaged period. This analysis was done for a herd size of 699 cows. The AERMOD model was run for the 3-year period from 2013-2015 using the approximate DEIS specified emissions listed in Table 2. AERMOD produces hourly averaged values of odor concentrations. The concentrations produced by AERMOD were scaled from the 1-hour average to a 15-minute average using a Turner Power Law exponent of 0.2 (Turner, 1970).

Plots showing contours of predicted 15-minute maximum odor impacts for the DEIS specified source emissions for a herd size of 699 cows are shown in Figure 7 with a zoomed view shown in Figure 8. Maximum 15-minute averaged odor concentrations of up to 25 OU/m^3 are predicted on the Kawailoa property. Even using the unrealistically low emissions listed in the DEIS, the modeled odor impacts are in excess of what would be considered an appropriate odor threshold.

5.6.2 More appropriate odor sources and emissions

More appropriate odor emissions were described in section 3 and presented in Table 1. AERMOD modeling of odor concentrations was conducted using these emissions for the two herd sizes of 699 cows and 2,000 cows. The same 15-minute average odor concentration of 2 OU/m^3 was used as a threshold for evaluating the predicted concentrations.

Plots showing contours of the predicted 15-minute maximum odor impacts for the more appropriate odor emissions for a herd size of 699 are shown in Figure 9 with a zoomed view shown in Figure 10. Maximum odor concentrations of up to 150 OU/m^3 are predicted on the resort property.

Plots showing contours of predicted 15-minute maximum odor impacts for our worst-case sources and emissions for a herd size of 2,000 are shown in Figure 11 with a zoomed view shown in Figure 12. Odor concentrations of up to 350 OU/m^3 are predicted on the Kawailoa property.

We also performed model runs with our lowest-case emissions estimates for the 699 herd size. The lowest-case odor emissions from HDF would occur during hours when there is no fresh application of slurry or irrigation with effluent. Results of these lowest-case emission runs are depicted in Figure 13 and Figure 14. These figures show that even during these low emission periods, the maximum 15-minute averaged concentrations at the Kawailoa property with a herd size of 699 cows would reach up to 30 OU/m^3. Figure 15 and Figure 16 show the number of hours that predicted 15-minute average OU concentrations exceed 2 OU/m^3. These would exceed the 2 OU/m^3 threshold for up to 450 hours per year.

Combining the results of our modeling with our worst-case and lowest-case odor emissions estimates for a herd size of 699 cows suggests that during at least 450 hours each year HDF odor impacts at the Kawailoa property could exceed the 2 OU/m^3 odor threshold. Moreover values could possibly be as high as 150 OU/m^3 during these hours with worst-case emissions. These odor impact predictions indicate that odorous conditions would often exist at the Kawailoa properties at levels its visitors would find offensive. For a herd size of 2,000 cows, the maximum odor concentrations would be as large as 350 OU/m^3 and the number of hours with odor impacts exceeding the 2 OU/m^3 odor threshold would be higher.

Figure 7 through Figure 16 were focused on the areas in and around the boundary of the Grand Hyatt Kauai and the Poipu Bay Golf Course. Our modeling of HDF odors included receptors in areas further from the proposed HDF, including residential areas in the vicinity of Poʻipū. Odors above the 2 OU/m^3 threshold levels are predicted to occur frequently in these residential areas as well. (See Figure A-1 and A-2 in Appendix A).

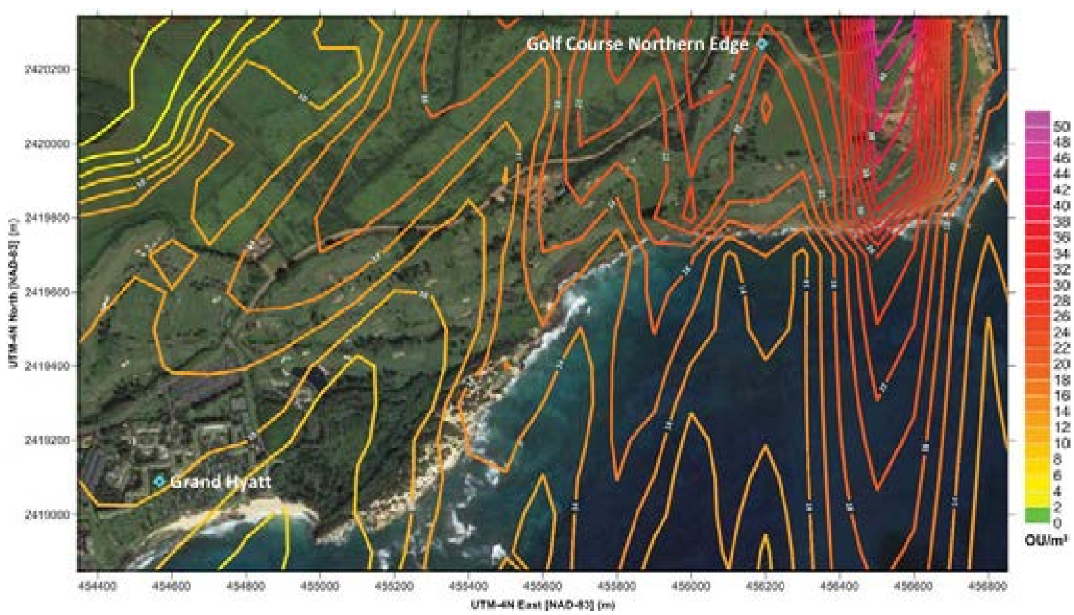

Figure 8 Zoomed view of contours of predicted 15-minute maximum odor impacts using DEIS worst-case odor sources and emissions rates for a herd size of 699

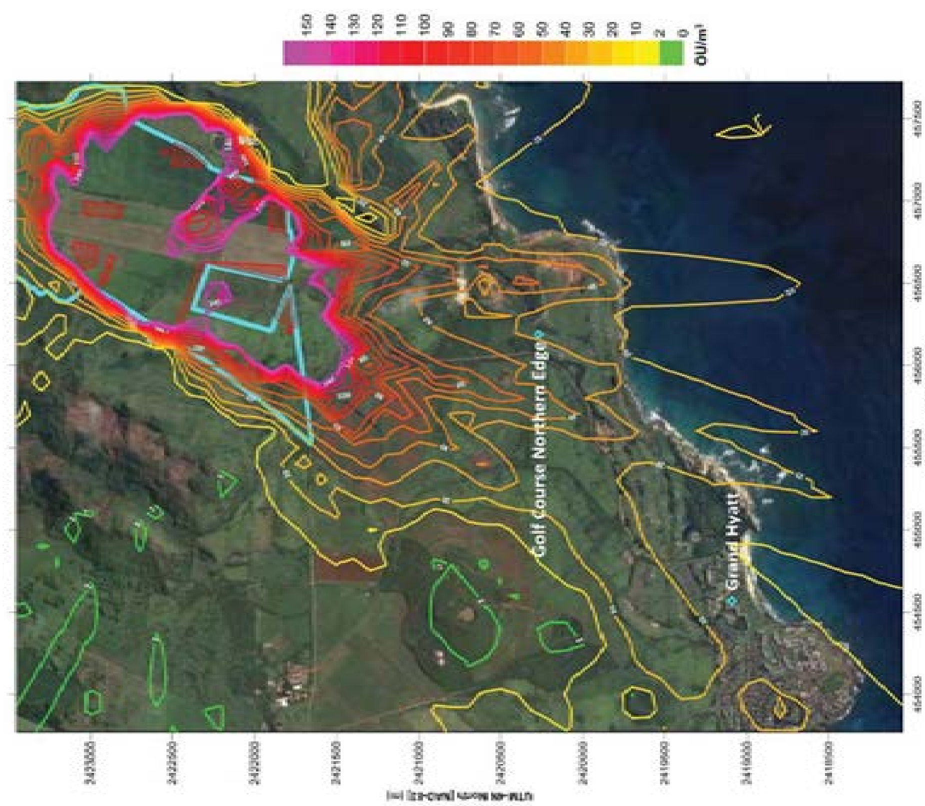

Figure 7 Contours of predicted 15-minute maximum odor impacts using DEIS odor sources and emissions rates for a herd size of 699

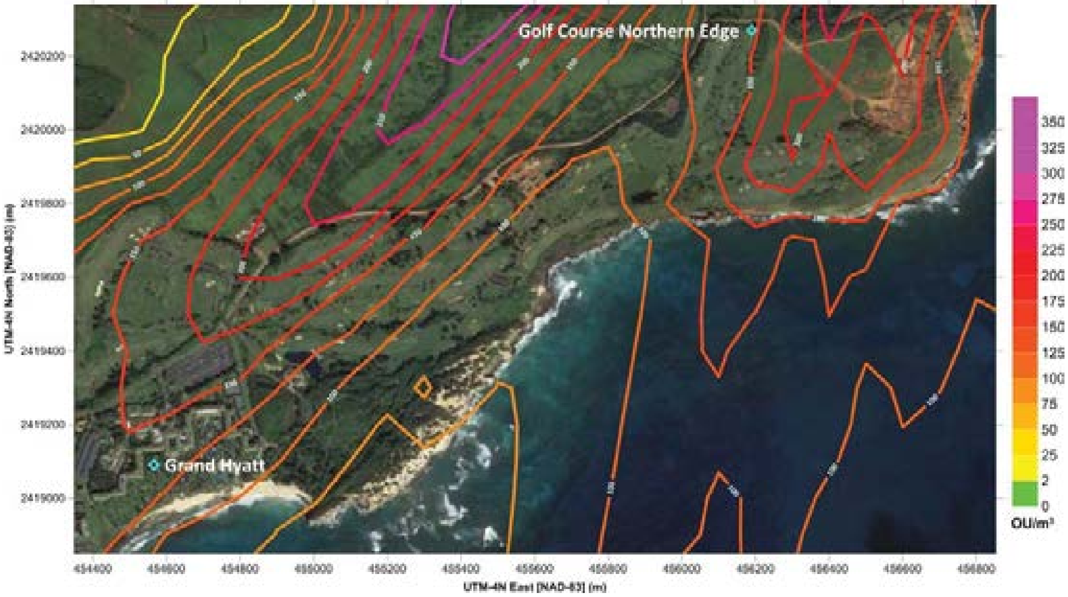

Figure 10 Zoomed view of contours of predicted 15-minute maximum odor impacts using our worst-case odor sources and emissions rates for a herd size of 699

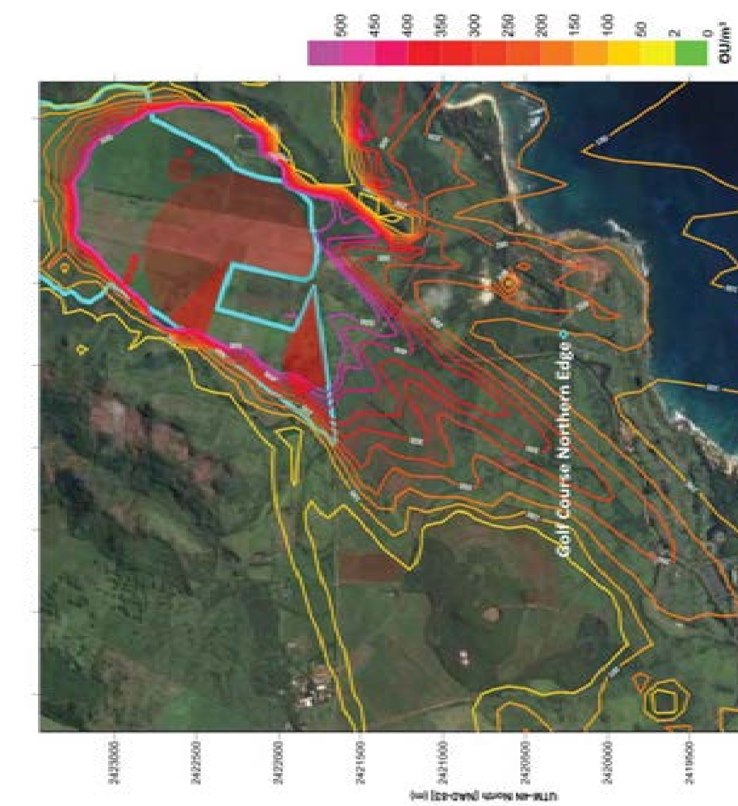

Figure 9 Contours of predicted 15-minute maximum odor impacts using our worst-case odor sources and emissions rates for a herd size of 699

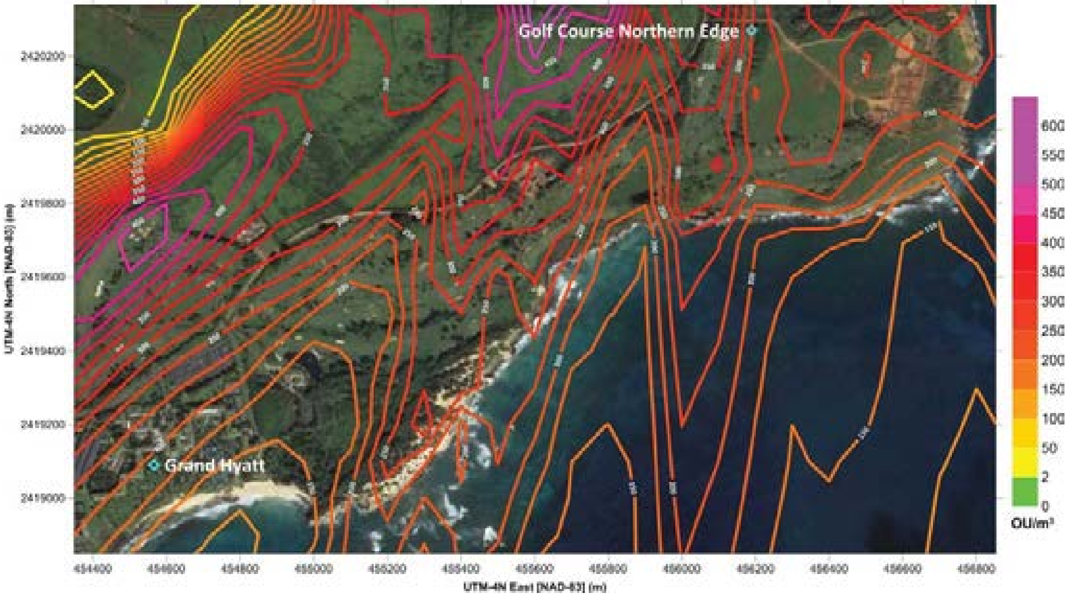

Figure 12 Zoomed view of contours of predicted 15-minute maximum odor impacts for our worst-case odor sources and emissions rates for a herd size of 2,000

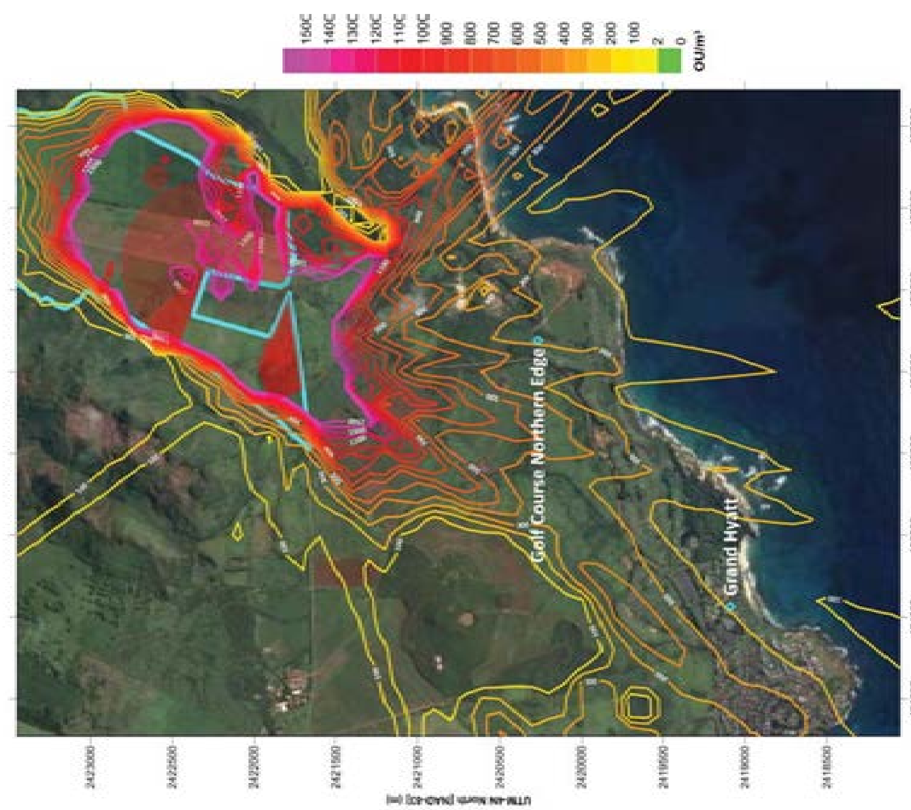

Figure 11 Contours of predicted 15-minute maximum odor impacts using our worst-case odor sources and emissions rates for a herd size of 2,000

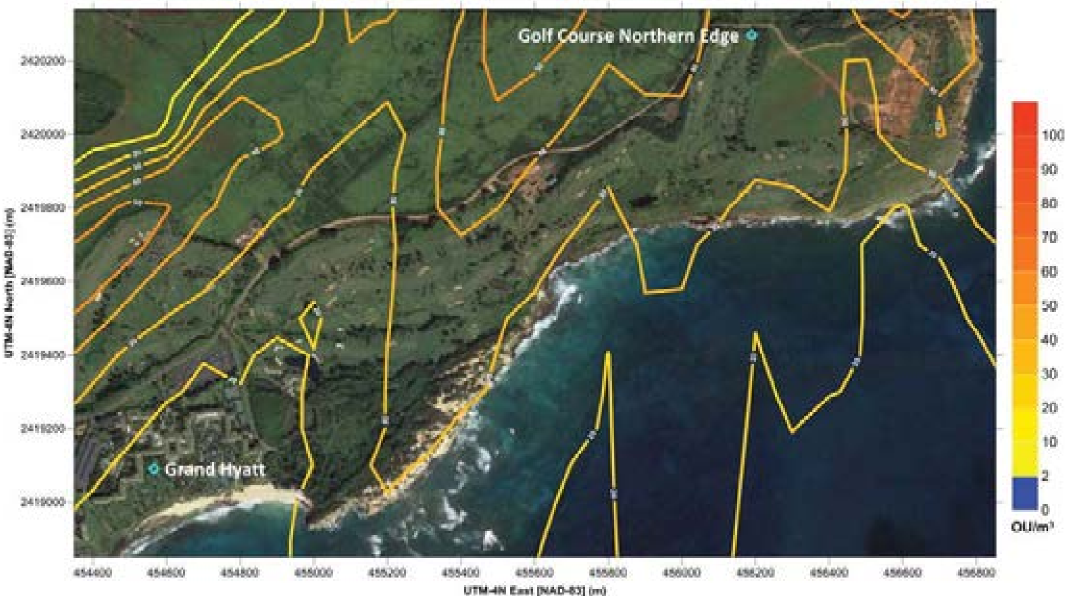

Figure 14 Zoomed view of contours of predicted 15-minute maximum odor impacts for our lowest-case odor sources and emissions rates for a herd size of 699

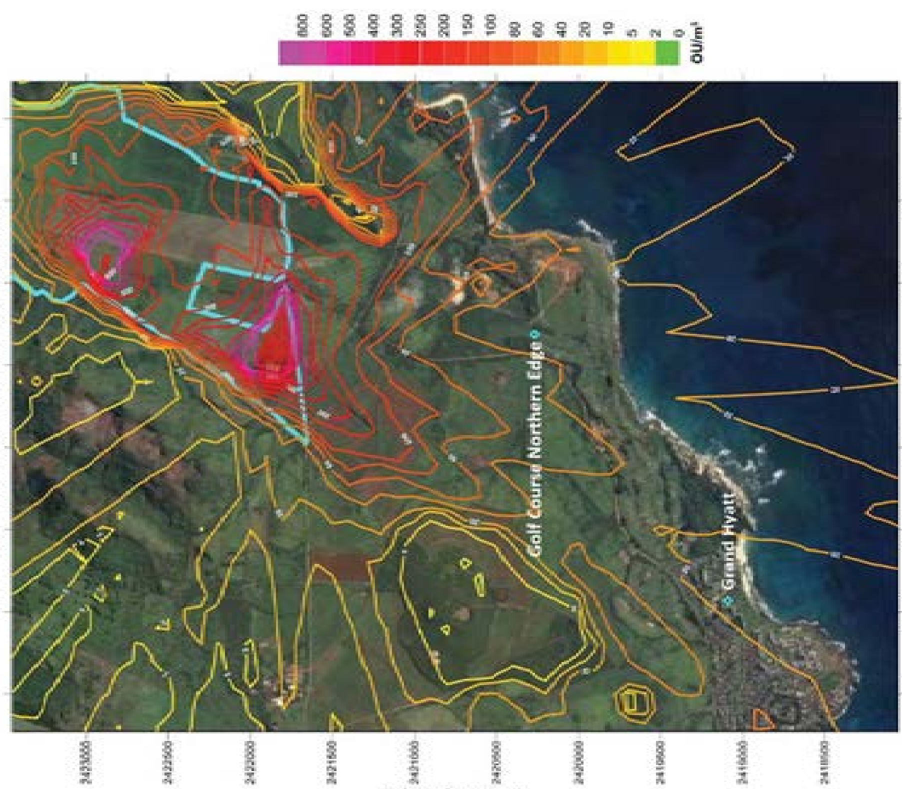

Figure 13 Contours of predicted 15-minute maximum odor impacts using our lowest-case odor sources and emissions rates for a herd size of 699

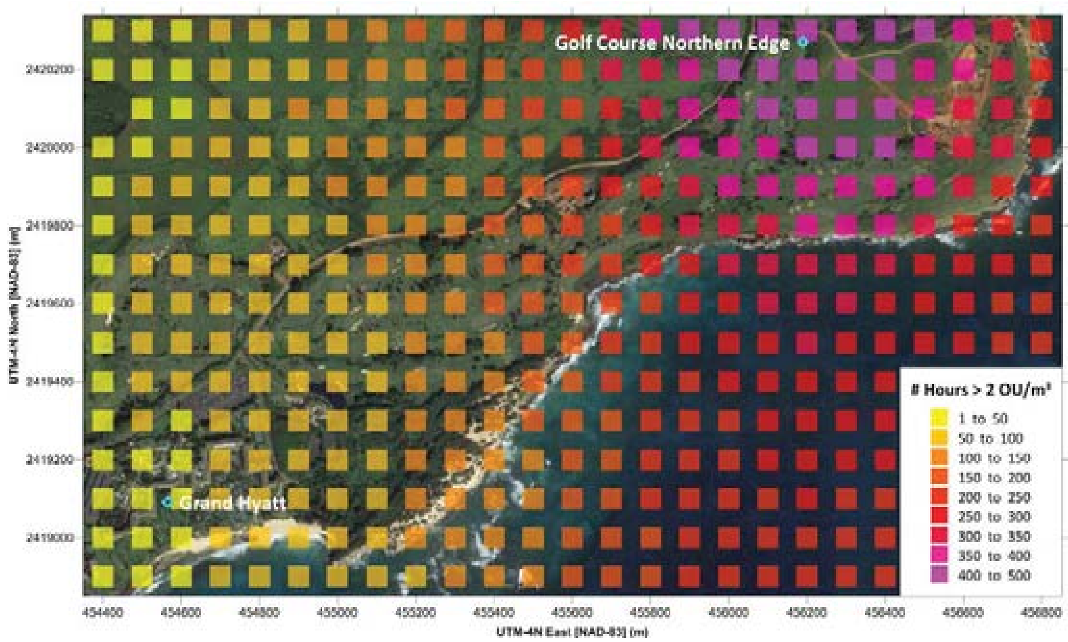

Figure 16 Zoomed view of contours of predicted 15-minute maximum odor impacts for our lowest-case odor sources and emissions rates for a herd size of 699

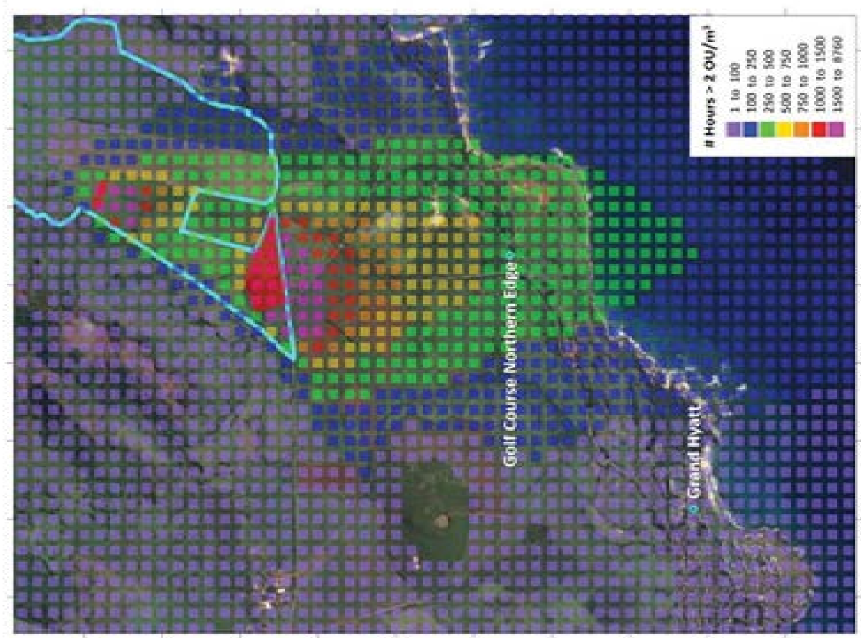

Figure 15 Number of hours when 15-minute maximum odor impacts exceed 2 OU/m^3 using our lowest-case odor sources and emissions rates for a herd size of 699

6 Limitations

The information upon which we rely in preparing this report is from the HDF DEIS and from publicly available information. We have generally not verified these data independently, and unless otherwise stated, assume that they are accurate. In addition, some of the data and information generated or reported by the HDF is unclear, and we have interpreted that information to the best of our ability. This report summarizes work performed to-date and presents the findings resulting from that work. We reserve the right to supplement this report and to expand or modify opinions based on review of additional material as it becomes available.

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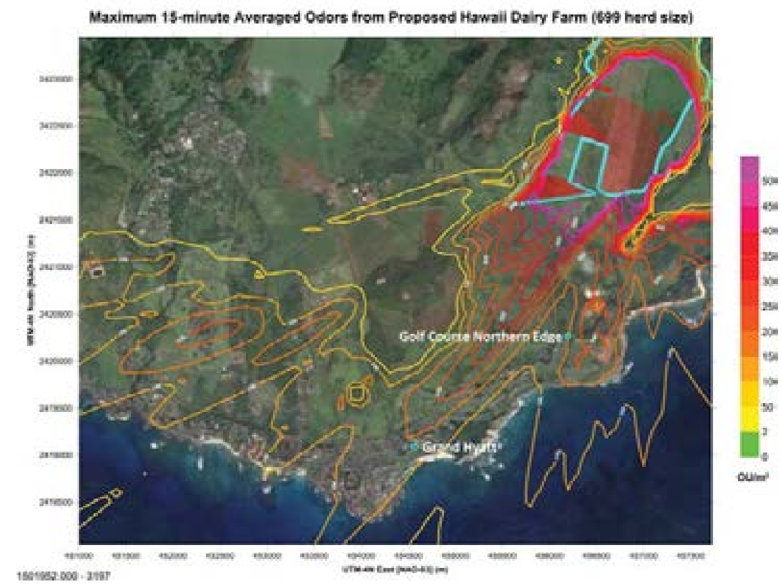
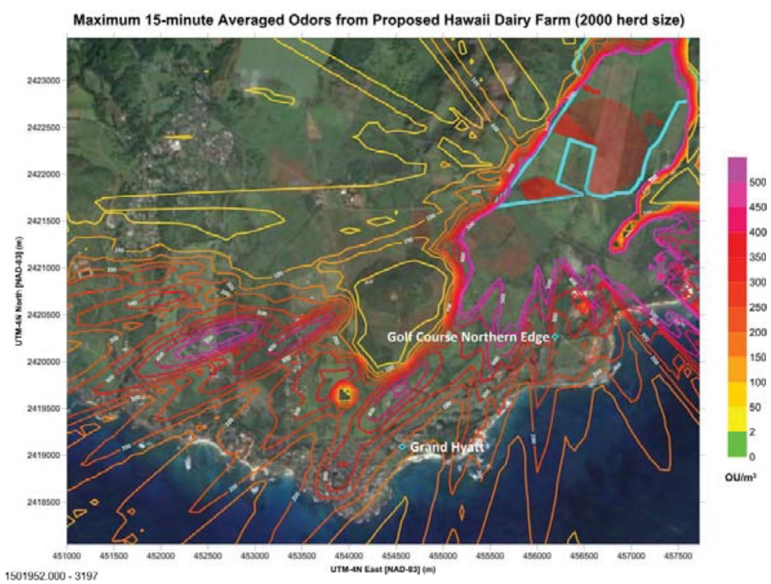
Appendix A

Predicted odor contours of the greater Po‘ipū area



A-1 Broader view of contours of predicted 15-minute maximum odor impacts using our worst-case odor sources and emissions rates for a herd size of 699



A-2 Broader view of contours of predicted 15-minute maximum odor impacts using our worst-case odor sources and emissions rates for a herd size of 2000

Appendix C

A Review of the Arthropod-Related Sections of the Hawai'i Dairy Farms Draft Environmental Impact Statement

July 2016

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A Review of the Arthropod-Related Sections of the Hawai‘i Dairy Farms Draft Environmental Impact Statement

TABLE OF CONTENTS

I. EXECUTIVE SUMMARY

Hawai‘i Dairy Farms (HDF) proposes to establish a dairy farm on 557 acres of agricultural land in Māhā‘ulepū Valley on the island of Kaua‘i. HDF would initially establish a herd of 699 mature dairy cows, and contemplates increasing the herd size to 2,000 dairy cows at a later date. A draft environmental impact statement (DEIS) was prepared to analyze the potential impacts and mitigation measures associated with dairy operations at HDF.

Pacific Analytics, LLC performed a review of the arthropod-related sections of the DEIS. The purpose of this review is to identify shortcomings of the DEIS, point out information that was not included in the DEIS, find sections where insufficient analysis was performed, show potential problems, and identify missing information.

The review is arranged in four chapter dealing with major arthropod-related topics, Pest Flies, Pest Control, Dung Beetles, and Hawaiian Native, Threatened and Endangered Species.

Pest Flies

Fly Species from Dairies Identified in *An Evaluation of Fly Breeding and Fly Parasites at Animal Farms on Leeward and Central O‘ahu*[2]

Stomoxys calcitrans (Linnaeus) – Stable Fly
Haematobia irritans Linnaeus – Horn Fly
Musca sorbens Wiedemann – Dog Dung Fly
Musca domestica Linnaeus – House Fly
Hydrotaea chalcogaster (Wiedemann) – Small Blue Fly
Tricharea occidua (Fab.) – Flesh Fly
Ravinia anxia Walker – Flesh Fly
Ornidia obesa (Fabricius) – Green Hover Fly
Eristalis arvorum (Fabricius) – Hover Fly
Hermetia illucens (Linnaeus) – Black Soldier Fly

- ✯ The DEIS states that there will be no impact due to 699 cows, but fails to address the impacts of significant amounts of manure and the number of pest flies that will breed in that manure.

- ✯ The DEIS states that qualitative or quantitative analyses were conducted for pest species, but fails to include those analyses for public comment.

➢ **Biting Flies**

There are two species of biting flies associated with dairies, the stable fly and the horn fly.

- ✯ The DEIS fails to discuss the dispersal capability of biting flies to other properties on Kaua'i.

➢ **Nuisance Flies**

There are at least six species of nuisance flies on Kaua'i.

- ✯ The DEIS fails to evaluate the potential impacts of nuisance flies on nearby properties on Kaua'i.

➢ **Mosquitoes**

Mosquitoes are not dung-dwelling flies, but the proposed dairy could potentially generate large populations of these pests in standing water, ponds, ditches, and pasture divots.

- ✯ The DEIS does not mention mosquitoes, and includes no analysis of the potential impacts by mosquitoes on HDF neighbors or native Hawaiian endangered birds.

Pest Control

➢ **Integrated Pest Management (IPM)**

- ✯ The DEIS states in several places that HDF will use Integrated Pest Management (IPM) measures and an IPM program to control pest flies at the dairy, however, the DEIS does not provide an actual IPM plan or details of how various control measures would be integrated.

- ✯ While the DEIS mentions some measures HDF would take to control pests, it does not describe how those measures would be integrated into an effective program.

- ✯ The DEIS also states HDF would use Best Management Practices to control pests, but fails provide a Best Management Practices plan.

➢ **Chemical Controls**

- ✯ The DEIS states that HDF will use chemical methods to prevent any spike in pest populations, but fails to mention:

  - Which chemicals will be used
  - What the thresholds are for chemical application decision-making
  - What quantities of chemicals will be applied
  - Where the chemicals will be applied
  - Against which pests the chemicals will be used

- ✯ The DEIS neglects to address the effectiveness of chemical controls on target species.

- ✯ The DEIS fails to consider impacts of chemical control on dung beetles and other non-target arthropods.

- ✯ The DEIS fails to provide any information about chemical control of mosquitoes.

- **Mechanical Control**

  - ✯ The DEIS provides no details about:
    - The types of mechanical devices to be deployed
    - The number of mechanical devices to be deployed
    - Where mechanical devices will be deployed
    - How long mechanical devices will be deployed
    - The effectiveness of the mechanical devices
    - What constitutes a "spike" in pest populations and how they would be detected

  - ✯ The DEIS neglects to discuss the effectiveness of mechanical devices HDF would deploy.

- **Parasites and Predators**

  - ✯ The DEIS states that HDF proposes to release insect parasites and predators to control fly populations, but fails to provide information about:

    - What fly parasite and predator species will be used at HDF
    - What is the source of parasites and predators
    - How many parasites and predators HDF will release
    - How HDF will prevent the accidental release of Invasive Species
    - What is the effectiveness of the parasites and predators
    - What pests will the parasites and predators target
    - What are the impacts on non-target species

  - ✯ The DEIS fails to describe how fly parasites will be integrated into HDF pest control.

  - ✯ The DEIS fails to provide an analysis of the amount of pest fly control HDF expects to achieve with predators, and does not provide sufficient information about the source of pest fly predators, when they will be released, and how HDF will prevent the accidental release of Invasive Species.

  - ✯ The DEIS fails to provide enough information about the HDF biological control methods that would be part of an IPM plan, monitoring plan, or Best Management Practices plan.

Dung Beetles

HDF is relying on dung beetles to reduce pest flies and accumulated manure.

Dung-Dwelling Beetles known from Kaua‘i

Aphodius lividus (Olivier)
Copris incertus Say
Oniticellus militaris (Castelnau)
Onthophagus gazella (Fabricius)
Sphaeridium scarabaeoides (Linnaeus)

- **Effectiveness**

  - ✯ The DEIS proposes that HDF will use dung beetles to hasten the breakdown of manure, and to minimize pest fly populations, but provides no analysis of the amount of manure a dung beetle consumes.

  - ✯ The DEIS states that a healthy population of dung beetles can bury a dung pat in one to three days. The DEIS provides no references or evidence to support this claim.

Soil Types and Conditions

  - ✯ The DEIS fails consider how HDF clay soils will impact dung beetle dung-burying capacity.

  - ✯ The DEIS does not analyze the effects of excessive soil moisture on dung beetle dung-burying capacity.

  - ✯ The DEIS neglects to consider what impacts the paddock rotation schedule could have on dung beetles.

Competition for Food and Nesting Sites

- ✯ The DEIS does not take into account how competition for both food and nesting space in adult and larval dung beetles may impact dung beetle manure burying capacity.

Dung Beetle predators

- ✯ The DEIS did not consider the potential impacts predators may have on dung beetle establishment and effectiveness at controlling pest flies or the massive amount of manure that would be generated by HDF dairy cows.

Controlling Pest Flies

- ✯ The DEIS claims that dung beetles will reduce pest fly populations by 95%. This claim is contradicted by their own manure-related arthropod survey. Both dung beetles (*Onthophagus gazella*), and the biting stable fly were found to be abundant during the survey.

- ✯ It is unlikely that HDF will achieve significant pest fly control with dung beetles. The DEIS does not provide an IPM plan that fully describes how pest flies would be controlled.

➢ **Translocation of Dung Beetles**

- ✯ The DEIS states that deploying a night collection light and white sheet can collect many adult dung beetles to quickly boost the population at HDF. The DEIS fails quantify the number of dung beetles that would be collected with these traps, and fails to describe the collection locations.

- ✯ Up to 8 million actively feeding adult dung beetles could be required on any given day to effectively suppress fly development. The DEIS neglects to provide sufficient information about how many dung beetles would be translocated and how they intend to capture the large numbers of dung beetles necessary to control pest flies and process manure pats.

- ✯ The DEIS fails to consider the accidental release of pest species collected with the dung beetles.

- ✯ The DEIS does not address:

  - The possibility of translocating invasive species
  - Who will collect the dung beetles to be translocated
  - How will insect species other than dung beetles be removed from the collections before transport
  - What methods will HDF employ to ensure survival of the translocated species during transport

- ✯ The DEIS fails to consider that dung beetles may become a nuisance pest on nearby properties.

Hawaiian Native, Threatened, and Endangered Species

➢ **Endangered Arthropod Species**

- ✯ The DEIS states there are no native, protected, or endangered insect species within the HDF site, however, HDF failed to perform a complete arthropod survey and assessment, and did not provide complete information about potential impacts on Kauai’s endangered cave arthropods.

- ✯ The DEIS did not fully consider potential impacts to Kauai’s endangered cave arthropods.

➢ **Kaua‘i Forest Birds**

There is a potential for mosquito populations to increase at HDF.

- ✯ The DEIS fails to discuss potential impacts to endangered Hawaiian forest birds by mosquitoes.

- **Native Insects**

Only sixteen arthropod species were identified in the manure-related arthropod survey. A study of a similar landscape less than 15 miles from HDF identified 238 insect species, about 10% of which were native Hawaiian species.

- The DEIS did not conduct a standard arthropod survey and assessment.
- The manure-related arthropod study was not sufficient to inform the public about all potential arthropod species that occur at the HDF site.

II. INTRODUCTION

Hawaiʻi Dairy Farms (HDF) proposes to establish a dairy farm on 557 acres of agricultural land in Māhāʻulepū Valley on the island of Kauaʻi. HDF would initially establish a herd of 699 mature dairy cows, and 150 calves with additional cows located on other existing Kauaʻi ranches. The average dairy cow produces up to 2.3 cu. ft. of manure per day (HDF Waste Management Plan), thus the 699 dairy cows at HDF could produce up to 1,608 cu. ft. of manure per day. That is equivalent to six large dump truck loads of manure per day, not including the manure from the 150 calves. This large amount of manure would be breeding habitat for pest flies which are capable of migrating from HDF to surrounding properties on Kauaʻi.

A draft environmental impact statement (DEIS) was prepared by HDF to analyze the potential environmental impacts and mitigation measures associated with dairy operations. The DEIS was released on June 8, 2016 and is undergoing a 45-day agency and public review. Pacific Analytics, LLC performed a review of the arthropod-related sections of the DEIS. The information provided in the DEIS was evaluated for completeness and the analyses were assessed for potential flaws.

This evaluation consists of four major sections

- Pest Flies
- Pest Control
- Dung Beetles
- Hawaiian Native, Threatened and Endangered Species.

III. DISCUSSION

Pest Flies

The DEIS mentions six species of pest flies (DEIS page 4-39), but fails to mention four other species of pest flies that occur on Kaua‘i[1, 2]. All of these species breed in manure[2] and are very likely to breed at HDF. The DEIS states that there will be no impact due to 699 cows (DEIS page 4-101), but fails to address the impacts of significant amounts of manure and the number of pest flies that will breed in that manure. The DEIS states that qualitative or quantitative analyses were conducted for pest species (DEIS pages 4-79 and 4-97), but fails to include those analyses for public comment.

Fly Species from Dairies Identified in *An Evaluation of Fly Breeding and Fly Parasites at Animal Farms on Leeward and Central O‘ahu*[2]

- *Stomoxys calcitrans* (Linnaeus) – Stable Fly
- *Haematobia irritans* Linnaeus – Horn Fly
- *Musca sorbens* Wiedemann – Dog Dung Fly
- *Musca domestica* Linnaeus – House Fly
- *Hydrotaea chalcogaster* (Wiedemann) – Small Blue Fly
- *Tricharea occidua* (Fab.) – Flesh Fly
- *Ravinia anxia* Walker – Flesh Fly
- *Ornidia obesa* (Fabricius) – Green Hover Fly
- *Eristalis arvorum* (Fabricius) – Hover Fly
- *Hermetia illucens* (Linnaeus) – Black Soldier Fly

- **Biting Flies**

There are two species of biting flies associated with dairies, the stable fly and the horn fly[2].

The Stable Fly - *Stomoxys calcitrans* (Linnaeus)

Stable Fly - *Stomoxys calcitrans*

- Stable flies are active year-round in warm latitudes
- Their highest fecundity is during warm, wet summers[5, 6, 7]
- Stable flies oviposit an average of 500 eggs over their two week life span.
- Eggs hatch in 15–24 hours under favorable conditions, and hatching rates are greatest between 25°C and 35°C
- Larvae develop in manure and moist, decaying vegetation
- Larvae also live in substrates with active microbial communities including wet grass and thatch[8]
- The larvae burrow into the dung as the surface layers dry out and larvae growth is usually completed in 4–5 days
- Pupation takes place in or under the dung pats, and adults emerge in 3–5 days under ideal conditions
- Both sexes require blood meal for mating[9]
- Can disperse regularly up to 6.5 km (4 miles)[10, 11, 12, 13]
- Known to disperse up to 225 km (140 miles) when wind blown[3]

The Horn Fly - *Haematobia irritans* Linnaeus

Horn Fly - *Haematobia irritans*

- A serious pest of cattle in Hawai‘i[2, 14]
- Numerous natural enemies and competitors have been imported to Hawai‘i for its control[2, 14]
- The primary breeding medium is wet manure[2]
- Females lay up to 500 eggs
- Both sexes require blood meal up to 30 times a day
- Can disperse up to 11 km (~7 miles)[4]

❖ Biting Fly Dispersal

The DEIS fails to discuss the dispersal capability of biting flies to other properties on Kaua'i. Both species of biting flies known on Kaua'i are strong fliers and can migrate long distances driven by wind[3, 4]. In Florida, large swarms of stable flies are driven by winds to coastal beaches from dairies up to 225 km (140 miles) away[3]. Stable flies have been shown to disperse 6.5 km (4 miles) along a beach in 30 minutes, pushed by a 5- to 8-kph wind[10]. Figure 1 illustrates these distances superimposed on a map of Po'ipū on Kaua'i. The map does not account for overland contours, but instead provides an illustration of the dispersal capabilities of the stable fly.

Figure 1. Map of Po'ipū, Kaua'i showing dispersal capability of the stable fly. With no wind, 80% of the biting stable flies would disperse at least 0.8 km from the milking parlor, and 50% would disperse at least 1.6 km. With a 5 to 8-kph wind, biting stable flies can disperse up to 6.5 km[10].

Horn flies emerging from manure would disperse 1.7 km (1 mile) from a paddock without a change in density[4]. Researchers found while monitoring a herd of dairy cows, that horn flies flew 11 km (7.3 miles) or more in less than 10 hours[4]. Figure 2 illustrates these distances superimposed on a map of Po'ipū on Kaua'i. The map does not account for overland contours, but instead provides an illustration of the dispersal capabilities of the horn fly.

Figure 2. Map of Po'ipū, Kaua'i showing dispersal capability of the horn fly. With no wind, horn flies will move up to 1.7 km with the same density as found in a paddock. With the prevailing wind, horn flies can disperse up to 11 km in ten hours[4].

- **Nuisance Flies**

There are at least six species of nuisance flies on Kaua'i[1, 2]. The species originating from dairies which cause the most complaints from properties near dairies are the dog dung fly and house fly[2]. The DEIS fails to evaluate the potential impacts of nuisance flies on nearby properties on Kaua'i.

The Dog Dung Fly - *Musca sorbens* Wiedemann

- Larvae feed on all sorts of dung
- Adults feed on food, garbage, and filth
- Adults are particularly aggressive and can be extremely unpleasant when they occur in large numbers[16].
- Attracted to eyes, open sores, and wounds

Dog Dung Fly - *Musca sorbens*

The House Fly – *Musca domestica* Linnaeus

- Closely associated with humans
- One of the fastest breeding insects in Hawai'i. Adult house flies can lay up to 900 eggs in 4 to 12 days[16]
- Larvae feed on excrement and garbage, and mature in as little as 6 days
- Will disperse up to 10 km (6.2 miles) in 24 hr[17]

House Fly - *Musca domestica*

Other flies can become a nuisance when they aggregate near human habitations. These pests include the small blue fly, flesh flies, and hover flies. Annoying in small numbers, nuisance flies become irritating or can spread diseases as their numbers increase. The DEIS fails to assess nuisance flies and their impacts on nearby properties.

Small Blue Fly - *Hydrotaea chalcogaster* (Wiedemann)

- Also known as garbage flies
- Larvae develop in manure, garbage, and decaying vegetation
- Adults often hover in shafts of light
- Attracted to various substances including sugar, sweat, and blood

Small Blue Fly – *Hydrotaea chalcogaster*

Flesh Flies - *Tricharea occidua* (Fabricius) and *Ravinia anxia* Walker

- Attracted to open wounds
- Larvae develop in manure and decaying vegetation
- Females are viviparous, they deposit live larvae instead of eggs
- Nuisance pest around humans

Flesh Fly - *Tricharea occidua*

Flesh Fly - *Ravinia anxia*

Green Hover Fly - *Ornidia obesa* (Fabricius)

- Breeds in decomposing vegetation, semi-liquid manure and urine polluted areas
- Carry bacteria of health importance
- Larvae reach their full development in 25 days

Green Hover Fly - *Ornidia obesa*

- **Mosquitoes**

Yellow Fever mosquito - *Aedes aegypti*

Mosquitoes are not dung-dwelling flies, but the proposed dairy could potentially generate large populations of these pests in standing water, ponds, ditches, and pasture divots. Mosquitoes would be blown by the prevailing winds from HDF and descend on nearby properties. There are four species of mosquitoes on Kaua‘i capable of breeding at HDF[1].

The Hawai‘i Department of Health[18] warns that two of the species on Kaua‘i, The Yellow Fever mosquito (*Aedes aegypti*) and the Asian tiger mosquito (*A. albopictus*) can transmit viruses that cause dengue fever and Zika virus disease. The Southern House mosquito, (*Culex quinquefasciatus*) is a nuisance to humans, but is a vector for avian malaria and avian pox. These mosquito-borne diseases have already devastated Hawaiian honeycreepers, leading some species to extinction[23, 24, 25]. The DEIS does not mention mosquitoes, and includes no analysis of the potential impacts by mosquitoes on HDF neighbors or native Hawaiian endangered birds.

Pest Control

- **Integrated Pest Management (IPM)**

The DEIS states in several places that HDF will use Integrated Pest Management (IPM) measures and an IPM program to control pest flies at the dairy (DEIS pages 1-14, 1-15, 4-41, 4-42, 4-44, 4-45, 4-80, 4-97, 4-101, 4-105, 6-20), however, the DEIS does not provide an actual IPM plan or details of how various control measures would be integrated.

An Integrated Pest Management Plan has several components, including:

- Clearly stated goals and objectives that would be achieved by implementing the plan
- A Monitoring Plan for pest populations and other relevant factors
- A determination of the thresholds for various pest populations that trigger treatments
- A detailed description of each control method that would be used
- A explanation of how treatments would be selected for deployment, which would be used, and when they would be used, including details about timing treatments for maximum effectiveness
- How the effectiveness of treatments would be evaluated
- An account of how biological controls would be conserved and enhanced

While the DEIS mentions some measures HDF would take to control pests, it does not describe how those measures would be integrated into an effective program.

The DEIS also states HDF would use Best Management Practices to control pests, but fails to provide a Best Management Practices plan.

- **Chemical Controls**

The DEIS states that HDF will use chemical methods to prevent any spike in pest populations (DEIS page 4-41), but fails to mention:

- Which chemicals will be used
- What the thresholds are for chemical application decision-making
- What quantities chemicals will be applied
- Where the chemicals will be applied
- Which pests the chemicals will target

This information would be found in an IPM plan. The DEIS does not provide an IPM plan.

The DEIS neglects to address the effectiveness of chemical controls on target species. Chemical control of some pest species, such as stable flies, has been unsuccessful[5], and other pest species, such as horn flies and house flies, have developed resistance to chemical controls[22, 23, 24, 25, 26, 27].

The DEIS fails to consider impacts of chemical control on dung beetles and other non-target arthropods. Pest fly insecticides are toxic to exotic dung beetles and native arthropod species[28, 29]. Veterinary pharmaceuticals have also been found to have adverse impacts to dung beetles[30, 31, 32, 33, 34, 35, 36]. Chemicals applied for pest fly control destroy dung beetles and parasite control measures, and can lead to outbreaks of pest flies. The DEIS fails to describe how non-target impacts of chemical control will be avoided.

The DEIS fails to provide any information about chemical control of mosquitoes.

- **Mechanical Control**

The DEIS states that mechanical methods, such as sticky tapes or ribbons and traps, will be used to prevent spikes in pest populations (DEIS page 4-41). The DEIS provides no details about:

- The types of mechanical devices to be deployed
- The number of mechanical devices to be deployed
- Where mechanical devices will be deployed
- How long mechanical devices will be deployed
- The effectiveness of the mechanical devices
- What constitutes a "spike" in pest populations and how they would be detected

The DEIS neglects to discuss the effectiveness of mechanical devices HDF will deploy. Walk-through horn fly traps have been shown to be only 57% effective[37] leaving a significant quantity of flies free to multiply. Sticky-traps are only 5.6% to 14% effective[38] and baited traps are only slightly better, capturing only 4.4% to 20% of released flies in controlled experiments[39]. The effectiveness of traps depends on several factors, including temperature, season and position[40]. The DEIS does not provide sufficient information about deployment of traps to determine if their use will be effective. The DEIS provides no information about mechanical control of mosquitoes.

- **Parasites and Predators**

The DEIS states that HDF proposes to release insect parasites and predators to control fly populations (DEIS pages 4-39, 4-45, 4-80), but fails to provide information about:

- What fly parasite and predator species will be used at HDF
- What is the source of parasites and predators
- How many parasites and predators will HDF release
- How HDF will prevent the accidental release of Invasive Species
- What is the effectiveness of the parasites and predators
- What pests will the parasites and predators target
- What are the impacts on non-target species

There have been eight parasites of horn fly purposely released for biocontrol in Hawai'i[41] and only one established on Kaua'i[1]. Nine parasites have been purposely released in Hawai'i to control house flies[41] and only one established a population on Kaua'i[1]. The reference cited by DEIS regarding stable fly control effectiveness (DEIS page 4-39) contains no evidence that parasites control flies. The DEIS fails to describe how fly parasites will be integrated into HDF pest control.

Twelve predators have been purposely released for biological control of the horn fly in Hawai'i, only three of which established on Kaua'i [1, 41]. Researchers studying predators associated with flies in animal dung on O'ahu [2] discovered that fly predators have difficulty locating their fly prey and are not effective horn fly biological control. Other studies have also demonstrated the inefficiency of fly predators in finding their prey[42, 43]. The DEIS fails to provide an analysis of the amount of pest fly control HDF expects to achieve with predators, and does not provide sufficient information about the source of pest fly predators, when they will be released, and how HDF will prevent the accidental release of Invasive Species.

Studies have demonstrated that when pesticides are applied to fly larvae at their breeding sites, almost 100% of the natural enemies, both parasites and predators, are destroyed[39, 44]. The DEIS fails to provide enough information about the HDF biological control methods that would be part of an IPM plan, monitoring plan, or Best Management Practices plan.

Dung Beetles

HDF is relying on dung beetles to reduce pest flies and accumulated manure (DEIS pages 1-15, 3-23, 4-39, 4-41, 4-42, 4-45, 4-80, 4-97, 4-105, 6-20). During the manure-related arthropod survey (DEIS Appendix B), there were two dung beetle species found near the HDF site. Despite the purposeful release of twenty-nine dung beetles in Hawai'i[39, 45], only five are found on Kaua'i[1].

Dung-Dwelling Beetles known from Kaua'i

Aphodius lividus (Olivier)
Copris incertus Say
Oniticellus militaris (Castelnau)
Onthophagus gazella (Fabricius)
Sphaeridium scarabaeoides (Linnaeus)

Aphodius lividus (Olivier)

- 3 to 6 mm (less than ¼ inch)
- Females produce up to 100 eggs in their adult lifetime of 1 to 2 months[46]
- Females lay eggs singly or in small clutches[46]
- Dung Dweller, Adults and larvae live in dung[46]
- Larvae take up to six weeks to develop[45]
- Consume a small fraction of material in dung pat[47]
- Known to inhabit and destroy other dung beetle brood chambers[48]
- Accidental introduction to Hawai'i[1]

Aphodius lividus

Copris incertus Say – **Mexican Dung Beetle**

- 15 to 17 mm (a little more than ½ inch)
- Feed on microbes in liquid manure
- 6 weeks to completely breakdown dung pat[49]
- Not efficient at controlling pest flies[49]
- Dung Burrower, adults live in manure and form brood chambers in the soil where larvae develop[50]
- A purposeful introduction to Hawai'i (1922)[1, 39]

Copris incertus

Oniticellus militaris (Castelnau)

- 7 to 11 mm (¼ to ½ inch)
- Feed on microbes in liquid manure
- Tunneler 0-15 cm (0-6 inches) deep[51]
- Active during warm, wet weather
- A purposeful introduction to Hawai'i (1957)[1, 39]

Oniticellus militaris

Onthophagus gazella (Fabricius)

- 10 to 13 mm (½ inch)
- Feed on microbes in moist manure
- Prefers firm to semi-liquid dung pats
- Prefers moist, loose soil[52]
- Burrows 20 to 25 cm (8-10 inches) deep[52]
- 6 to 8 weeks egg to adult
- A purposeful introduction to Hawai'i (1957 and 1973)[1, 39]

Onthophagus gazella

Sphaeridium scarabaeoides (Linnaeus) - **Water Scavenger Beetle**

- 5.0 to 7.0 mm (< ¼ inch)
- Adults and larvae feed in cow manure
- Larvae eat fly eggs and larvae, and beetle larvae in manure[53]
- An accidental introduction to Hawai'i[1]

Sphaeridium scarabaeoides

- **Effectiveness**

The DEIS proposes that HDF will use dung beetles to hasten the breakdown of manure, and to minimize pest fly populations (DEIS pages 1-15, 3-24, 4-41, 4-42, 4-80, 4-97, 4-105, 6-20, Appendix B pages 1, 2, 22, 29, 30, 31), but provides no analysis of the amount of manure a dung beetle consumes.

The DEIS states that a healthy population of dung beetles can bury a dung pat in one to three days (DEIS pages 3-24, 4-41, 4-42). The DEIS provides no references or evidence to support this claim. In an extensive field study up to 80% of the dung remained unburied after seven days[58].

Removing Manure from the Soil Surface

There are several reasons why dung beetles may not fully bury manure pats, including:

- Dung Beetle nesting biology
- Soil types and conditions
- Competition for food and nesting sites
- Fluctuations in dung beetle populations
- Dung Beetle predators
- The large quantity of manure generated by 699 dairy cows
- The even larger quantity of manure generated by 2,000 dairy cows

❖ Dung Beetle Nesting Biology

Dung beetles do not feed their entire adult life. After an initial feeding period, adults (males and females) remain inside the nesting galleries made under the soil surface[59]. Adult dung beetles stay in the nest taking care of the brood balls throughout embryonic, larval and pupal development, leaving shortly before or when progeny emerge[60, 61]. This reduces the feeding efficiency of adult dung beetles, and increases the number of dung beetles required to consume large quantities of manure.

❖ Soil Types and Conditions

The DEIS fails to consider how HDF clay soils will impact dung beetle dung-burying capacity. The most abundant soil types occurring throughout the HDF site are Kalihi Clay and Kaʻena Clay Brown Variant, accounting for more than 60% of the area (DEIS page 4-8). The rest of the soils at HDF are other types of clay (about 30% of the area) and clay loam (about 10% of the area). Dung beetles are less efficient burying dung pats on clay soils than on sandy soils[62, 63, 64, 65, 66] and more dung beetle species prefer sandy soil habitats to clay soil habitats[62]. *Onthophagus gazella,* the most abundant dung beetle at the proposed HDF location, usually buries pats on sand or sandy soils rather than on heavier soil types[55].

The DEIS does not analyze the effects of excessive soil moisture on dung beetle dung-burying capacity. Soil moisture contributes to dung beetle breeding success as well. Soils that are too wet will support fewer dung beetles than drier soils[67, 68]. Excess moisture results in higher mortality of dung beetle eggs and larvae in the top 10 cm of the soil beneath dung pads[69, 70, 71]. HDF clay soils will likely be saturated or nearly saturated most of the year, due to rainfall patterns and irrigation that spreads liquid manure from wash-down in the HDF milking parlors[72]. This water could flood dung beetle nesting burrows, drowning the larvae and adults guarding the nesting burrows. Poorly drained clay soil promotes larvae-killing mold and fungi that could cause dung beetles to fail to establish at HDF[75].

Cattle easily damage moist clay soil, creating divots and ruts. A herd of 100 dairy cows or more grazing a three acre paddock could trample dung beetle brood nests. Dung beetle larvae take several weeks to months to develop, and pupae often diapause underground until conditions are right for their emergence, subjecting the immature dung beetles to disturbance every 18 days by rotational-grazing cattle. The DEIS neglects to consider what impacts the paddock rotation schedule could have on dung beetles.

❖ Competition for Food and Nesting Sites

The DEIS does not take into account how competition for both food and nesting space in adult and larval dung beetles may impact dung beetle manure burying capacity. For tunnelers, like *O. gazella*, there is competition between adults for food in the dung pat and for nesting space below the dung pat[49]. And at higher dung beetle densities there is usually a lower degree of burial than would be expected, due to mutual interferences[56, 58, 74, 76].

❖ Dung Beetle predators

The potential for dung beetles to bury significant quantities of manure may be limited by dung beetle predators. The faunal report attached to the DEIS (Appendix A) lists several species of birds, many of which are insectivores, including the cattle egrets (*Bubulcus ibis*), Plovers (*Pluvialis filva*), the Myna (*Acridotheres tristis*), and barn owls (*Tyto alba*). These birds or similar species have been observed eating dung beetles in pastures[68, 75, 77] and may be responsible for large amounts manure being left above ground[56].

Cane toads at the proposed HDF site eat dung beetles. Studies have found as many as 80 dung beetles in a single cane toad preying next to cow manure[78, 79]. Predation on dung beetles by cane toads around dung pats reduces the number of dung beetles enough to substantially influence dung pat breakdown[75]. The DEIS did not consider the potential impacts predators may have on dung beetle establishment and effectiveness at controlling pest flies or the massive amount of manure that would be generated by dairy cows.

❖ Controlling Pest Flies

The DEIS claims that dung beetles will reduce pest fly populations by 95% (DEIS page 4-39, Appendix B page 30). This claim is contradicted by their own manure-related arthropod survey. Dung beetles (*Onthophagus gazella*), and biting stable flies were both found to be abundant during the survey. The claim of “95% control” is from a laboratory experiment[55] and does not represent what could occur under actual field conditions. A field study investigating the control of horn flies by dung beetles found the carrying capacity of each day’s excreta was about 20,000 horn flies per cow[80]. That amounts to almost 14 million horn fly larvae per day for the 699 initial herd size daily. The study found that the presence of 50 pairs of the dung beetle *O. gazella* per kg of manure would result in a 50% mortality to horn fly larvae, leaving about 10,000 viable larvae per cow per day, (6,990,000 viable horn fly larvae per day), and would have little effect on adult horn fly populations. They concluded that the effect of dung beetles in removing pest fly larval habitat would be relatively small[80].

Of these numerous biocontrol species introduced to control horn flies in Hawai'i[16, 39] only eight are found on Kaua'i [44]. Even with the release of these beneficial insects, the horn fly continues to be a serious pest in Hawai'i[81].

There are two reasons why dung beetles have not effectively controlled horn flies on Kaua'i First, the dung beetle *Oniticellus militaris* does not dispose of manure swiftly enough to have an appreciable impact on horn fly survival. Horn fly eggs hatch quickly, and larvae pupate under the manure, avoiding disturbance by beetles[82]. Secondly, horn flies oviposit whenever suitable manure is present, whereas most dung beetles fly at night to find a suitable dung pat to exploit [82]. This gives the flies a competitive advantage. Horn fly eggs hatch within hours and larvae start developing, but control is effective when only eggs are present[81].

It is unlikely that HDF will achieve significant pest fly control with dung beetles. The DEIS does not provide an IPM plan that fully describes how pest flies would be controlled.

➢ **Translocation of Dung Beetles**

HDF intends to translocate dung beetles from elsewhere on Kaua'i or, working with State Department of Agriculture to translocate beetles from other Hawaiian islands (DEIS pages 1-15, 4-42, 4-81, Appendix B pages 2, 29, 30, 31). The DEIS neglects to analyze the impacts of depleting dung beetle populations on or near the collection properties.

The DEIS states that deploying a night collection light and white sheet can collect many adult dung beetles to quickly boost the population at HDF (DEIS page 4-40, Appendix B page 29). The DEIS fails quantify the number of dung beetles that would be collected with these traps. It is unlikely that translocation of dung beetles from other areas on Kaua'i will provide a sufficient number of dung beetles capable of immediately controlling manure-related flies. Biological control experience with dung beetles found that beetle populations did not increase rapidly and disperse until up to 10 years after mass release[28, 54].

A dairy cow produces up to 2.3 cu. ft. (~28 l) of manure per day (HDF Waste Management Plan), thus six hundred and ninety-nine dairy cows can produce about 1,608 cu. ft. (19,572 l) of manure per day. Under laboratory conditions it requires 840 pairs of dung beetles (*Onthophagus gazella*) per cu. ft. to effectively suppress the development of horn flies for the volume of manure from 699 dairy cows[55]. It is estimated that it would require about 2.7 million actively feeding adult dung beetles on any given day to effectively suppress horn

fly development under laboratory conditions. Under field conditions on Kaua'i, even more dung beetles could be required to effectively suppress development of fly larvae. Even when a large number of dung beetles are present, soil type and mutual interference can lower the manure-burying capacity of dung beetles and thereby reduce the effectiveness of fly control[56]. It is not reasonable to expect HDF to be able to capture and translocate 2.7 million dung beetles on Kaua'i. If 2,000 cows are at HDF, then 8 million actively feeding adult dung beetles could be required on any given day to effectively suppress fly development under laboratory conditions[56]. The DEIS neglects to provide sufficient information about how many dung beetles would be translocated and how they intend to capture the large numbers of dung beetles necessary to control pest flies and process manure pats.

The DEIS fails to consider the accidental release of pest species collected with the dung beetles. Many species of insects are attracted to lights at night, and will gather on the collecting sheets. Dung beetles are less than 10 mm (½ inch) long and some pest species in the same family (Scarabaeidae) look similar to dung beetles on the collecting sheets at night. For example, the Chinese Rose beetle (*Adoretus sinicus* Burmeister), a serious pest of over 500 native and landscape plants in Hawai'i, is about the same size as dung beetles found on Kaua'i. The accidental collection and relocation of pest beetle species to HDF could result in migration to nearby golf courses and landscaping. Adult dung beetles are potential carriers of rhabditic and helminthic worms and other organisms (including phoretic mites), and scientists recommend that only dung beetle eggs can be translocated in order to prevent worm contamination[57]. The DEIS does not address:

- The possibility of translocating invasive species
- Who will collect the dung beetles to be translocated
- How will insect species other than dung beetles be removed from the collections before transport
- What methods will HDF employ to ensure survival of the translocated species during transport

The DEIS fails to consider that dung beetles may become a nuisance pest on nearby properties. Dung beetles are attracted to lights and even if a portion of the millions of dung beetles HDF hopes to have at the dairy are attracted to lights at resorts and homes near the dairy the beetles could be bothersome.

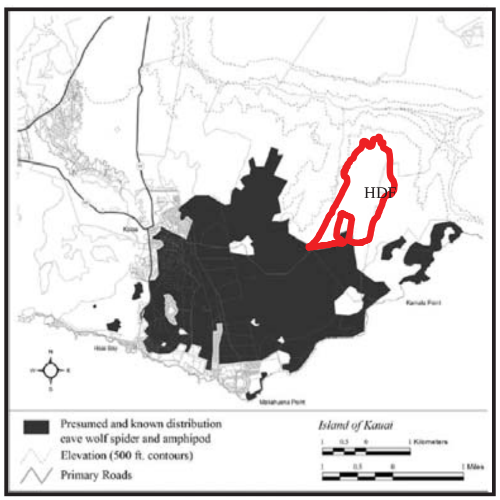
Hawaiian Native, Threatened, and Endangered Species

- **Endangered Species**

The DEIS states there are no native, protected, or endangered insect species within the proposed HDF site (DEIS page 4-40, Appendix B page 12-13), however, HDF failed to perform a complete arthropod survey and assessment, and did not consider impacts information about Kauai's endangered cave arthropods.

- Cave Arthropods

The DEIS fails to analyze potential impacts to endangered arthropod species. There are two species of endangered cave arthropods on Kaua'i, the Kaua'i Cave Wolf Spider (*Adelocosa anops* Gertsch) and the Kaua'i Cave Amphipod (*Spelaeorchestia koloana*). These unusual animals are known only from caves, subterranean cracks, and microcaverns (voids and inaccessible passages) in Koloa District on Kaua'i[83].



Presumed and known distribution of the Kaua'i cave wolf spider and amphipod.[83]

Potential threats to Kauai's Endangered Cave Arthropods[82]

- Pesticides
- Non-Native Invasive Species
- Habitat disturbance
- Altered humidity levels
- Insufficient food source
- Contaminants in ground water

The cave wolf spider is an opportunistic predator, feeding on whatever prey it can find. The cave amphipod is a detritivore, feeding on roots and decaying vegetation. Its food source can be disturbed by altering the vegetation above the habitat[83].

The DEIS states there is no evidence of lava tubes or caves at the HDF site and that no such features have been reported nearby (DEIS page 4-42, Appendix B pages 2 and 20), yet it acknowledged that there are caves within 0.75 miles of the proposed dairy (DEIS page 4-40). One of these is within the Makauwahi Cave Reserve, where Kauai's endangered cave arthropods have been observed[82].

Habitat for these cave arthropods is not exclusively large caves that can be detected by wandering haphazard transects across proposed HDF pastures. Interstitial spaces and cracks form in lava as it cools, resulting in an interconnected system of voids up to 20 km long[84]. The small spaces are known as microcavernous habitat.

Hawaiian troglobitic arthropods live in suitable spaces in both the microcavernous habitats and in the larger cave habitats[84]. While the principal habitat for most cave-dwelling species is in spaces 0.5 to 10 cm, cave species can disperse through microcavernous spaces[85, 86, 87, 88].

It is likely the lava tube system below HDF is connected to the cave habitat of these two endangered species[89]. Herbicides and pesticides and other ground-water contaminants that will be applied at HDF may migrate to microcavernous habitat and impact the endangered species there. These cave animals are particularly vulnerable to pesticides and contaminants because of their affinity for moisture[85] and because the exoskeleton of the Hawaiian cave organisms is permeable to water[90]. Even when pesticides are not used directly above a lava tube, pesticides can leach into the microcavernous habitat, exposing the species to additional risk via absorption of contaminants through their exoskeleton[91].

Even if not killed outright, sublethal effects of pesticides on the cave animals could reduce fecundity and life span, slow development, and impair mobility and feeding efficiency[92].

The DEIS also failed to disclose the impacts to Kauai's endangered cave arthropods from pharmaceuticals typically used by dairies, including antibiotics, anthelmintics, and parasiticides. HDF failed to reveal the half-life of these chemicals, and the persistent impacts they may cause, especially to Kauai's endangered cave arthropods. These pharmaceuticals may leach into ground-water and find their way to underground cave arthropod habitats.

- **Kaua'i Forest Birds**

The DEIS fails to discuss potential impacts to endangered Hawaiian forest birds by mosquitoes. There is a potential for mosquito populations to increase at HDF. Moist ground around troughs and in paddocks often become roughened by cattle hooves, producing myriad small pockets of water where mosquitoes can multiply[93]. Dairy waste water in ponds and slow moving waterways can be havens for mosquitoes[94]. The DEIS neglects to address control measures for mosquitoes at HDF.

Mosquitoes are not only a problem for humans, annoying us while they seek to extract a blood meal, they are also a serious problem for Hawaii's famous forest birds. Mosquitoes carry avian malaria that has caused a number of extinctions, population declines, and range contractions of native birds in Hawai'i[95]. Uncontrolled at HDF, mosquitoes can multiply rapidly and migrate to bird nearby upland habitats where they can infect these threatened and endangered species.

Partial List of Hawaiian Native Forest Birds on Kaua'i[95]

Common Name	Scientific Name
Puaiohi	*Myadestes palmeri*
'Akeke'e	*Loxops caeruleirostris*
'Akikiki	*Oreomystis bairdi*
'Anianiau	*Hemignathus parvus*
'Apapane	*Himatione sanguinea*
'Elepaio	*Chasiempis sandwichensis sclateri*
'I'iwi	*Vestiaria coccinea*
Kaua'i 'Amakihi	*Hemignathus Kauaiensis*

- **Native Insects**

The DEIS did not conduct a standard arthropod survey and assessment. The manure-related arthropod study was not sufficient to inform the public about all potential arthropod species that occur at the HDF site. According to the report (DEIS Appendix B):

- The primary purpose of the survey was to determine the presence or absence of species associated with the manure of cattle and of the parasites and predators that control them.
- The major focus of the survey was on the fresh and dry manure generated by beef cattle at the adjacent pasture for Māhā'ulepū Cattle Co.
- No attempt was made to document endemic and indigenous Hawaiian invertebrate species, although they were reported when seen.

Only sixteen arthropod species were identified in the manure-related arthropod survey. A study of a similar landscape less than 15 miles from HDF identified 238 insect species, about 10% of which were native Hawaiian species[96]. A complete and thorough arthropod survey is required to fully assess the impacts of the project on the existing arthropod fauna.

V. CONCLUSIONS

The Hawai‘i Dairy Farms Draft Environmental Impact Statement did not fully analyze the arthropod-related impacts of dairy operations on nearby properties. It failed to discuss all the pest flies and the potential impacts of the increase in their populations that will result from manure generated by dairy cows.

The DEIS neglected to provide sufficient information about the control of the biting and nuisance flies, and failed to provide an Integrated Pest Management plan, depriving the public of the opportunity to properly evaluate the impacts of the dairy's operation. Insufficient information was provided in the DEIS regarding chemicals that would be applied at HDF, the kinds of mechanical devices that would be deployed for pest fly control, and the species and source of parasites or predators that may be released. HDF failed to consider the accidental release of landscape and turf pests when translocating dung beetles, and other associated concerns with invasive species.

The DEIS did not fully consider the difficulties associated with dung beetle biological control of manure and manure-related arthropod pests. Dung beetle species are unevenly distributed throughout their ranges. Their occurrence, activity, and abundance is influenced by soil and vegetation type, and by seasonal variations in temperature and rainfall. The current distribution of dung beetles on Kaua‘i is not known and there are no published data on their population densities and little on the effect that any of these insects has on dung decomposition or pest fly species in Hawai‘i. The limitations of beetle nesting biology, soil type, excessive moisture, competition for nesting, predators and the effectiveness of dung beetle control of pest flies were not analyzed in the DEIS.

The DEIS overlooked potential impacts to Hawaiian native, threatened, and endangered species on Kaua‘i. Changes to above-ground vegetation and the impacts that may have on microcavernous habitats of Kauai's endangered cave arthropods was not provided in the DEIS endangered species analysis. The potential impacts to cave-dwelling arthropods from veterinary pharmaceuticals, herbicides, and pesticides that would be used at HDF was not analyzed or discussed in the DEIS.

The DEIS failed to consider potential impacts to Kauai's forest birds by avian malaria carrying mosquitoes that would breed on HDF pastures, ponds, and waterways.

HDF did not conduct a standard arthropod survey and assessment for native, threatened, or endangered species. The manure-related arthropod study was not sufficient to analyze all potential impacts to Hawaiian native species.

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Appendix D

Pathogen Impacts, Hawai‘i Dairy Farms Draft Environmental Impact Statement, May 2016 Māhā‘ulepū, Kaua‘i

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July 2016

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Acronyms and Abbreviations

BMPs	Best Management Practices
CAFO	Concentrated animal feeding operation
CFU	Colony forming units
DEIS	Draft Environmental Impact Statement
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
FIB	Fecal indicator bacteria
g	gram
geomean	geometric mean concentrations
h	hour
HDF	Hawai‘i Dairy Farms
HDOH	Hawaii Department of Health
mL	milliliters
MPN	Most probable number
MRC	Marine Research Consultants, Inc.
NPDES	National Pollutant Discharge Elimination System
ppt	parts per thousand
TMDL	Total Maximum Daily Load
USDA	US Department of Agriculture

Executive Summary

Under the scenarios presented in the Draft Environmental Impact Statement (DEIS; Hawaiʻi Dairy Farms 2016), manure from dairy cows will be stored and handled onsite at the proposed Hawaiʻi Dairy Farms (HDF) before being used as agricultural fertilizer; however, dairy wastes, and more specifically cattle manure, contain a diverse range of microorganisms at high concentrations, including human pathogens and fecal indicator bacteria (FIB) and are widely recognized as a potential source of FIB and pathogens to local watersheds (Haack et al. 2015; Collins et al. 2007). Due to conditions at the proposed HDF site, pathogens in manure may impact surface and groundwater quality and pose risks to human and ecological health.

In the DEIS, HDF relied on two studies to characterize the baseline pathogen concentrations in and around the proposed dairy site, as indicated by the presence of FIB; however, information provided in the DEIS was incomplete with regard to describing pathogen/FIB baseline conditions and did not show an understanding of pathogen risks in the Hawaii environment. Despite dairy cows being a known source of fecal pathogens to stream and ground waters, and the environment of the proposed HDF location being specifically suited to pathogen survival and transport, an analysis of the potential impact of pathogens and FIB produced by the proposed HDF facility was not included in the DEIS submitted by HDF. The DEIS does not propose any method for the HDF operators or others to determine whether impacts are occurring, as no monitoring program is proposed for pathogens. As the potential impacts of pathogens and FIB were not specifically assessed in the DEIS, no mitigation measures were proposed to address any impacts.

The DEIS as written has failed to acknowledge the potential impact of microbial pathogens and FIB and has failed to adequately characterize the human health or ecological impacts of microbial pathogens discharged from the proposed HDF.

Introduction

Under the scenarios presented in the Draft Environmental Impact Statement (DEIS; Hawaiʻi Dairy Farms 2016), manure from dairy cows will be stored and handled onsite at the Hawaiʻi Dairy Farms (HDF) before being used as agricultural fertilizer; however, in addition to providing nutrients for grass growth, manure may impact surface and groundwater quality, both by increasing concentrations of nutrients and also as a source of pathogens that may pose risks to human health. The issue of microbial pathogen impact has previously been raised by several community groups (e.g., comments provided by Surfrider and Friends of **Māhāʻulepū** on HDF's January 2015 Environmental Impact Statement Preparation Notice), and the 2016 DEIS released by HDF cites a recent Hawaii Department of Health (HDOH) study showing that fecal indicator bacteria are elevated in the Waiopili Stream, the surface water flowing through the middle of the HDF;. however, the DEIS's treatment of pathogens and the associated risks to human health is cursory, and the document does not address Probable Impacts or Mitigation Measures associated with fecal pathogens from operations on the proposed dairy farm.

Human pathogens in cow manure can include *E. coli* O:157, *Listeria*, *Salmonella*, *Campylobacter*, *Cryptosporidium*, and viruses (U.S. Environmental Protection Agency [EPA] 2010). As it is impractical to test for all of these organisms in water samples, several fecal indicator bacteria (FIB) are used to identify the presence of human sewage or animal waste in recreational and drinking waters for regulatory purposes. The FIB species are chosen because they are abundant in sewage and waste and are less likely than other species to grow and replicate in the environment, although growth in Hawaii's tropical climate does occur. The presence of these organisms is used to indicate the likely presence of actual human pathogens. Dairy farms have been implicated in several outbreaks of disease due to pathogens in the United States and elsewhere and have resulted in many fresh and salt water recreational water closures due to the presence of FIB above regulated levels.

The DEIS as written has failed to acknowledge the potential impact of microbial pathogens and FIB and has failed to adequately characterize the human health or ecological impacts of microbial pathogens discharged from the HDF. The objectives of this report are to identify important information lacking in the DEIS related to the potential impact of FIB and pathogens from the proposed facility and to request additional information from the preparers of the DEIS.

Comments

1. Information provided in the DEIS was incomplete with regard to describing pathogen/FIB baseline conditions and did not show an understanding of pathogen risks in the Hawaii environment.

The Waiopili Stream is a seasonal freshwater stream which drains the surrounding subwatershed and runs through the HDF property. Within the immediate area of the HDF, the stream has been channelized during previous agricultural uses. The stream continues makai of the proposed dairy for approximately a mile before discharging directly to the ocean. Waters of the Waiopili Stream are considered “Class 2” waters under the Clean Water Act, and, as such, they must be protected for recreational use and the support and propagation of aquatic life as well as other purposes (DEIS Table 505 and Haw Admin. R. 11-54-3). Groundwater is shallow throughout much of the site, occurring at only 24 inches below ground surface in some areas, and, under some conditions, shallow groundwater may be expected to discharge to the surface streams (HDF 2016, Appendix K and pp. 4–54).

Because of the difficulty of directly measuring the many pathogens which might be present in fecal matter, FIB are used to estimate of the amount of feces and the likely presence of fecal pathogens in the water. Hawaii uses *Enterococcus* to determine impairment of recreational waters and *Clostridium* perfringens as a secondary indicator. Hawaii’s bacteria water quality criteria for enterococci in recreational waters is a geometric mean of less than 35 colony forming units (CFU) per 100 milliliters (mL) over 30 days with no single sample exceeding 130 CFU per 100 mL. *C. perfringens* is another FIB that can be used as a secondary indicator, but does not have an enforceable regulatory level. The 2006 State of Hawaii Water Quality Monitoring and Assessment Report lists 50 CFU/100mL as the guideline concentration at which C. *perfringens* may indicate fecal contamination.

In the DEIS, the HDF relied on two studies to characterize the baseline pathogen concentrations in and around the proposed dairy site, as indicated by the presence of FIB. The first is a report generated by the Hawaii Department of Health (HDOH 2016) which characterized FIB indicator bacteria in the Waiopili Stream, prompted by studies performed by citizen groups which alleged elevated concentrations of FIB where the stream meets the beach. The second was a study of Surface Water Quality and Marine Assessment (Marine Research Consultants, Inc [MRC] 2016) which was included as Appendix F to the DEIS. Each of these studies was completed prior to the presence of dairy cows on the proposed HDF facility and represents the pre-dairy condition. Each only focused on concentrations of FIB present in surface waters and did not consider rainfall conditions. Baseline concentrations of pathogens or FIB were not measured in groundwater for this DEIS.

1.1. FIB baseline studies did not account for seasonal (rainfall, temperature) variability.

The HDOH study was precipitated by citizen-group efforts to document the microbial condition in/near the Waiopili Stream. This study was not intended to characterize the baseline pathogen conditions on the HDF property, but it provides information on existing conditions (i.e., prior to HDF operation). HDOH collected five sets of samples from 12 sites along the Waiopili Stream during a four month period (from November 2014 through March 2015) and analyzed for the FIB *Enterococcus* and *C. perfringens*. *Enterococcus* concentrations ranged from 42 to greater than 2,005 most probable number (MPN)/100 mL and generally (but not consistently) increased in the downstream direction. *C. perfringens* concentrations did not follow the same trend, although they were elevated above the 50 MPN/100mL guideline at most downstream locations. The geometric mean concentrations (geomean) reported in the HDOH report include samples taken over approximately four months (November 6, 2014 through March 3, 2015) a time period that is longer than the 30 days used to calculate the geomean for regulatory purposes.

MRC collected samples to analyze for FIB on three days to characterize baseline conditions in the Waiopili Stream as well as at the beach and in nearshore marine water. Samples collected on March 4, 2015 were analyzed only for *Enterococcus*. Samples collected on May 8, 2015 and July 9, 2015 were analyzed for both *Enterococcus* and *C. perfringens*; however, no samples were collected during the winter, which is the wettest season in Kaua'i and the one most likely to generate flow from the Waiopili Stream to the marine environment (Figure 1, further details

in Exponent 2016b). Specific rainfall conditions prior to and during sampling were not reported. Additionally, the collection of "beach" and "ocean" samples was not described, and it was not clear how they related to the location of the freshwater input from the Waiopili Stream. Based on these studies, in the DEIS, HDF concluded "Counts of indicator bacteria (*Enterococcus* and *C. perfringens*) in surface water samples and nearshore marine samples showed no repetitive pattern" (HDF 2016, pp. 4–63). Given the limited number of samples and the failure to sample during the full range of anticipated conditions, existing sampling is not adequate to determine spatial or temporal trends.

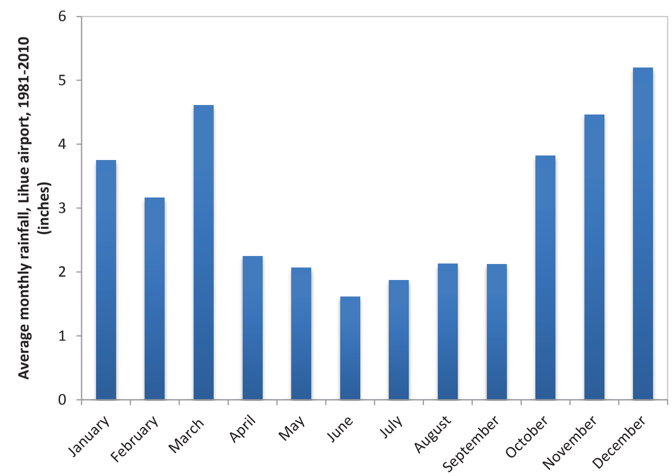

Figure 1. Average monthly rainfall at Lihue airport from 1981 to 2010.

1.1. FIB baseline studies did not provide any replication to understand the variability associated with the measured values.

Another factor which may make baseline trends difficult to interpret is the lack of replication in the FIB studies. Neither the HDOH nor MRC analyzed duplicate samples, which might provide information on heterogeneity in this environment; however, the HDOH collected samples on

March 3, 2015, and MRC sampled the same locations on the following day (March 4, 2015). Comparing the *Enterococcus* concentrations (Figure 2) showed differences which varied largely between the two sampling dates. There is not enough information available to understand whether this variability is due to temporal differences on the scale of a day, slight differences in sampling location, or differences in sampling or analysis protocols between the two studies. *C. perfringens* was not measured on 3/4/16 by MRC, so it is not possible to compare whether the secondary tracer, which is less likely to grow and reproduce in the Hawaiian environment, would be more consistent. Without an understanding of the variability, any future monitoring efforts or changes from baseline will be difficult to interpret.

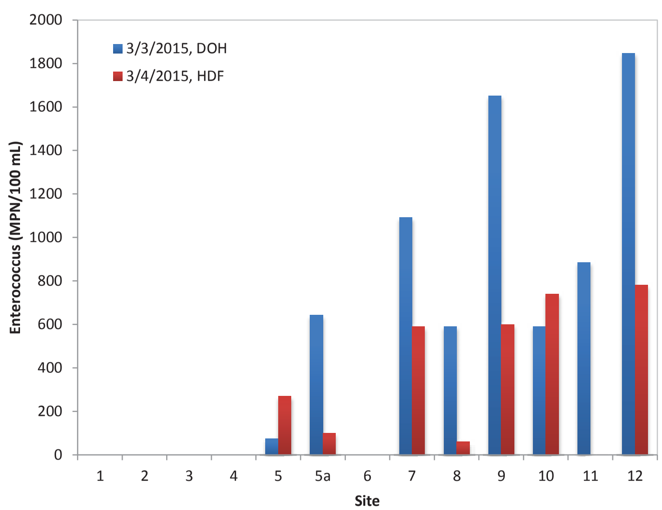

Figure 2. Concentrations of enterococcus (MPN/100 mL) in the Waiopili Stream on consecutive days.

1.2. The presence of FIB in the Waiopili Stream above acceptable levels prior to dairy operation does not mean that FIB and pathogens from operations from the dairy do not need to be considered during the EIS.

Based on the two cited studies (HDOH 2016 and MRC 2016), the DEIS stresses that the Waiopili Stream is already impaired on and downstream of the proposed HDF property. The DEIS does not discuss any potential changes in pathogen concentrations or loading which may occur once large numbers of dairy cows are grazing this land, and with the application of both liquid and solid manure to select paddocks at the HDF site. Once it begins to operate, the HDF is expected to exacerbate the existing problem and/or to cause exceedances in areas which currently do not exceed water quality standards. In addition, transport of FIB and pathogens is expected to be enhanced during wet weather events. In the DEIS, these risks are not considered.

Pathogens are the most commonly listed cause of impairment for 303(d) listed waters and are the second most frequent subject of a Total Maximum Daily Load (TMDL), behind only mercury.[1] The presence of FIB prior to dairy operation suggests that the receiving waters adjacent to the HDF may provide habitat favorable to the survival and growth of FIB and pathogens, suggesting that any increase in pathogen loadings from the dairy farm will only increase the human health risk in the Waiopili Stream and in the ocean downstream of the HDF. This is supported by the HDOH conclusion that sediments in this area may act as a reservoir for FIB (HDOH 2016).

1.3. Assertions that concentrations of pathogens will decay rapidly in marine waters receiving input from the Waiopili Stream due to "toxicity" are not supported by data.

The DEIS states that concentrations of pathogens were significantly lower in the ocean than in the Waiopili Stream due in part to "toxicity from saline water" (HDF 2016, p. 155); however, data presented in the MRC report do not substantiate this claim, and external studies appear to refute it. *Cryptosporidium* and *Clostridium* form cysts and spores, respectively, enhancing survival in sub-optimal conditions for long periods of time, including in marine environments

[1] https://iaspub.epa.gov/waters10/attains_nation_cy.control?p_report_type=T#causes_303d

(Grimes et al. 1986) and viruses may survive even longer in marine environments than typical bacteria and protozoa. For example, Fayer and others studied the survival of *Cryptosporidium parvum* oocysts in artificial seawater at various salinities and temperatures and reported a 4-week survival time in water with a salinity of 30 ppt at 20 °C (Fayer et al. 1998). An evaluation of biotic and abiotic factors that affect survival of enteric bacteria in marine environments found that light (radiation) is the most challenging factor and that salinity does not significantly impact the growth of *E. coli* as long as sufficient organic nutrients are supplied such that *E. coli* may out-compete naturally-occurring marine bacterial strains (Rozen and Belkin 2001) Microcosm experiments have demonstrated persistence and growth of *Enterococcus casseliflavus* and *Enterococcus faecalis* at 30 °C for 28 days in the presence of plankton, which suggests that enterococci may be able to multiply in marine environments (Mote et al. 2012). Clearly, evidence in the scientific literature suggests that pathogens can and do survive in marine environments. Thus, the DEIS's assertion that toxicity from saline water will rapidly reduce pathogen concentrations is unsupported and likely incorrect.

The claim that saline water is toxic to pathogens and will thus render them harmless is contradicted by state and federal standards, including US EPA Recreational Water Quality Criteria (EPA 2012), under which ocean beaches can be declared "impaired" due to the presence of FIB. As of 2014, eleven marine locations on the island of Kaua'i were listed as impaired based on *Enterococcus* levels for recreational waters (HDOH 2014). Based on current standards, the presence of FIB in marine environments has potential human-health consequences and possibly ecological consequences as well.[2]

Compounding the issues surrounding poorly-supported assertions of toxicity caused by the marine environment, the field measurements and samples collected by MRC and described in the DEIS are not sufficient to fully characterize potential impacts. Sampling was limited in scope, with only three sampling dates for samples collected from the "beach" and "ocean," none of which occurred during the rainy season (winter). The sampling events did not account for antecedent rainfall, which may have altered the transport and dilution of microbes in the

[2] See Ecological impacts report for additional details (Exponent. 2016a).

Waiopili Stream. Furthermore, the lack of description of the "beach" and "ocean" sample locations makes evaluation of the data impossible. The report contains no discussion of the source of the "beach" and "ocean" samples, such as criteria applied to select sample locations or the water depth from which the samples were collected.

The exact locations and depths of the samples are not presented, though the MRC report plainly shows that location and depth are critical in capturing the plume of discharging water from the stream. For example, Figure 7 from the MRC (2016) report shows that samples collected from two of four transects were characterized by low salinity in the "shallow" samples, but the other two transect locations were not impacted by discharging fresh water (Figure 3). The data in Figure 3 indicate that a plume of stream-impacted water extends from the discharge point, but that the effects are localized. Thus, knowing the locations of ocean and beach samples (i.e., inside or outside of the plume) collected for pathogen analysis are essential to understand the implications of the results, and these locations are not shown or described in the report. The lack of information about field sampling extends to collection protocols. The public cannot properly evaluate the validity of samples without a comprehensive description of protocol followed during sample collection and analysis.

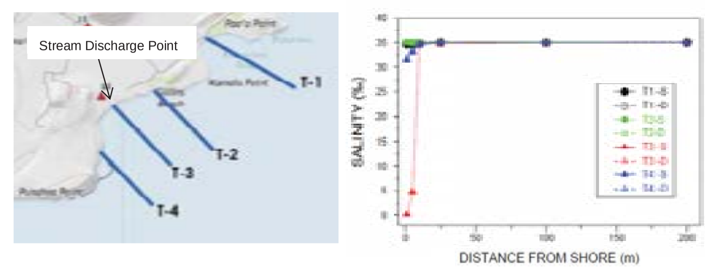

Figure 3. Four transects shown relative to stream discharge point and the associated salinity data. Adapted from MRC (2016) Figures 1 and 7.

The MRC (2016) report does not establish that the "ocean" samples were collected from areas impacted by the stream. High variability in measurements taken on a single sampling date suggests that mixing was not instantaneous, a conclusion supported by the data shown in Figure

3.[3] Variability is most evident when comparing *Enterococcus* and salinity; a range of both salinity and *Enterococcus* concentrations were measured within "ocean" samples (Figure 4). Salinity can be used as a conservative tracer to determine the magnitude of freshwater impact on ocean water. Samples with a salinity of approximately 35 parts per thousand (ppt) are dominated by ocean water while freshwater samples have a salinity of less than 1 ppt. Salinities between those values are indicative of mixing. Dilution alone can account for both the observed reduction of salinity and *Enterococcus* concentrations, and MRC (2016) presents no evidence to support the conclusion that reductions in pathogen concentrations are caused by toxicity in the marine environment.

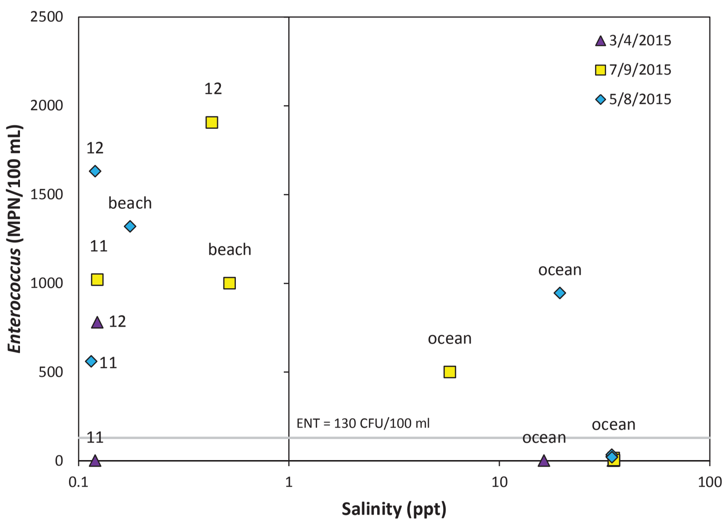

Figure 4. *Enterococcus* concentration decreases generally with salinity, suggesting that mixing is not instantaneous and that dilution alone may account for reductions in pathogen concentration.

[3] See also the analysis of Water Impacts in the DEIS, Exponent 2016b.

Two of the three "ocean" samples which contain measurable freshwater (salinity < 34 ppt) have *Enterococcus* levels above the regulatory guidelines of 130 MPN/100 mL for a single sample, indicating that freshwater-impacted ocean water was also impacted by *Enterococcus* at unacceptable levels. The exception was the sample collected on March 4, 2015, which has salinity about half that of ocean water and no detected *Enterococcus*, but which is consistent with the absence of *Enterococcus* in the freshwater sample collected from station 11 on the same day. The MRC report states that the area of elevated FIB in the "ocean" samples "only extends several meters from the shoreline," but because recreational use in this area is likely to be highest on the beach and in the water immediately adjacent, the presence of FIB exceeding water quality guidelines in this area presents the greatest human health risk compared to farther from shore.

2. Probable Impacts of FIB/Pathogens were not included in the DEIS despite being a known impact of dairy farming.

The proposed HDF project has the potential to contribute to an increase in pathogens via runoff to surface waters, groundwater infiltration, overland transport, and transport via organisms present on the site (including insects). While the presence of FIB as an indicator of pathogens is discussed in the baseline studies, the DEIS includes no discussion of potential impacts due to pathogens resulting from the HDF.

These impacts may include:

- Human health impacts from pathogens in the Waiopili Stream and the adjacent marine waters which receive water from the stream;
- Ecological health impacts due to pathogens in surface or groundwater, including in both freshwater and marine systems;
- Human health impacts associated with transport of pathogens to the adjacent taro fields via airborne contamination or runoff; and
- Economic impacts of potential beach closures from FIB exceedances related to discharges from the HDF.

In the DEIS, the HDF justifies the discharge of manure particles into the reaches of the Waiopili Stream by describing them as insignificant because of the presence of other particles in the stream: “The relative contribution of manure particles in the stormwater flows within the agricultural ditches will be a small fraction of the total from the watershed” (HDF 2016, pp. 4–67). This is misleading at best since the composition of the manure particles is different from those expected to be washed into the stream from elsewhere, and the manure particles represent a pathogen risk which is elevated compared to other runoff debris.

2.1. Dairy wastes are known sources of pathogens with the potential to negatively impact surface and groundwater, especially under conditions found at the proposed HDF.

Dairy wastes, and more specifically cattle manure, contain a diverse range of microorganisms at high concentrations, including human pathogens and FIB. The primary pathogens of concern in livestock waste, based on their abundance in manure, occurrence in water, and persistence and ability to multiply in the environment, are *Cryptosporidium*, *Giardia, E.coli, Salmonella* and *Campylobacter* (EPA 2010; Haack et al. 2015). Table 1 below summarizes the concentrations of these pathogens, four additional pathogens commonly found in manure, and FIB in cattle manure.

Table 1. Zoonotic microbial pathogens associated with adverse human health outcomes and FIB identified in cattle manure

Organism	Role	Concentrations in cattle manure (as wet weight unless specified)	Source
Enterococcus	pathogen/FIB	5-7.9 x 10^4 colony forming units per gram (CFU/g), median: 4.5 x 10^2	Moriarty et al. 2008;
Clostridium perfringens	FIB	1.27 x 10^4 CFU/g	Thurston-Enriquez et al. 2005
E. coli	pathogen/FIB	5.9 × 10^6 to 4.8 x 10^7 CFU/g	Moriarty et al. 2008; Sinton et al. 2007
Salmonella	pathogen	1.6 × 10^3 to 3.2 × 10^7 CFU/g (dry weight)	Sinton et al. 2007
Campylobacter	pathogen	15 – 1.8 x 10^7 CFU/g, median: 4.3 × 10^2 CFU/g	Moriarty et al. 2008
Cryptosporidium	pathogen	1–25 oocysts per gram up to 447 oocysts /g per gram on a California dairy farm; 1,778 oocysts /g per gram with a highest observed density of 280,000 oocysts /g per gram, 21,090 oocysts /g per gram at a dairy farm in New York.	Moriarty et al. 2008; Atwill et al. 2006; Sturdee et al. 2003; Wade et al. 2000
fecal streptococci	pathogen	6.9 × 10^5 to 7.2 × 10^6 CFU/g (dry weight)	Sinton et al. 2007
Giardia	pathogen	1–17 cysts /g, 1.9 to 29.9 cysts /g at a dairy farm in Canada a mean of 3,039 cysts /g from 212 dairy farms in New York .	Moriarty et al. 2008; Heitman et al. 2002; Wade et al. 2000
Mycobacterium paratuberculosis	pathogen	Up to 1 x 10^6 /g at peak shedding	John Kirk, U of Tulare

The loading of FIB and pathogens from cattle at the HDF to the pasture and potentially the watershed could be significant. On average, according to calculations in the DEIS (HDF 2016) and in comments by Meyer (2016) each head of cattle excretes approximately 90.8 to 128 pounds of feces per day. Assuming a herd of 699 cattle, which is conservative as it only accounts for lactating cows present, and *Enterococcus* concentrations in cattle feces of 450 *Enterococcus* CFU/g (median estimate based on Table 1), the total number of *Enterococcus* produced at the HDF per day could be up to 18 billion *Enterococcus*. Concentrations of microbial pathogens listed in Table 1 are typically between one and three orders of magnitude less than *Enterococcus* and could range from 28 million *Giardia* up to 17 billion *Campylobacter* produced per day by the dairy herd. HDF indicates that untreated cattle manure, containing high concentrations of both FIB and pathogens, will be sprayed on to the pasture to act as fertilizer, resulting in FIB and pathogens spread widely across the HDF pasture.

Dairy farms are widely recognized as a potential source of FIB and pathogens to the local watershed (Byappanahalli et al. 2012).When pathogens are present in fecal material at high-enough numbers they can contaminate runoff and be carried into local watersheds (EPA 2010). Transport mechanisms to local watersheds include (Haack et al. 2015; Collins et al. 2007):

1. Direct runoff in storm water during rain events;
2. Direct discharge through over-spraying, equipment failure, storage overflow;
3. Percolation to shallow ground water; and
4. Direct discharge from cattle into watersheds.

According to the EPA *Quantitative Microbial Risk Assessment to Estimate Illness in Freshwater Impacted by Agricultural Animal Sources of Fecal Contamination* (EPA 2010), runoff from land of fresh or treated manure during and immediately after rainfall events is considered the primary mechanism for livestock-derived pathogens to reach surface waters. Livestock operations have been shown to contribute significant pathogen loads to the environment (Atwill et al. 2006). Identified risk factors include the application of manure to agricultural fields (Siscko et al. 2000) and surface runoff from dairy and beef cattle operations (Miller et al. 2007).

Given the absence of any pathogen reduction treatment on the cattle manure, the high numbers of FIB and pathogens associated with cattle manure, and the documented cases of impacts to surface water and ground water from other livestock operations, dairy wastes at the HDF have the potential to significantly impact surface and groundwater in the vicinity of the HDF. Depending on transport factors and hydrology (Exponent 2016b), HDF is expected to degrade recreational water quality in the Waiopili Stream and in the ocean downstream of the HDF.

2.2. Pathogens are able to survive days to months within cow patties and in effluent ponds which will allow time for transport offsite.

Microbial survival outside of a host environment for FIB and pathogens can be highly variable and affected by a variety of environmental factors including temperature, moisture content of soils, humidity, solar radiation, salinity (if present in water), and the extent of grazing by other microorganisms (Byappanhalli et al. 2012). Furthermore, different microbial species can adopt differing survival strategies in harsh environments. Microorganisms able to form spores (e.g., *C. perfringens*), oocysts, and cysts (*Cryptosporidium* and *Giardia*) increase survival times over vegetative non-sporulating bacteria (e.g., *E. coli* and *Enterococcus*) that may be more susceptible to environmental conditions. Warm and damp conditions promote the survival of microorganisms in the environment (Sinton et al. 2007), and as a result *Enterococcus* and *E. coli* have been shown to grow in Hawaii soils and waters (Hardina and Fujioka 1991; Byappanahalli et al. 2012). Weather on the eastern shores of Kaua‘i is typically temperate to warm and damp, and as a result soil in the HDF pasture would be expected to favor the growth or survival of FIB and pathogens. Concentrations of *Enterococcus* in cattle manure have been demonstrated to initially grow by up to three-fold after deposition, to survive up to 60 days or longer under appropriate conditions, and to regrow when wetted (Sinton et al. 2007). Environmental persistence of FIB and pathogens associated with cattle feces are indicated in Table 2 below.

Table 2. Environmental Persistence of FIB and Pathogens in Hawaii

Organism	Environmental persistence in soil sediment or waters	Source
Enterococcus	> 56 days	Sinton et al. 2007
Clostridium perfringens	Up to years	Mueller Spitz et al., 2010
E. coli	47 days, > 150 days, 1–14 weeks, up to 13 months	Kudav et al. 1998; Sinton et al. 2007; Fukushima et al. 1999; Muirhead et al. 2006
Salmonella	> 150 days	Sinton et al. 2007
Campylobacter	up to 76 days	Sinton et al. 2007
Cryptosporidium	4 to 12 weeks and greater in saline conditions of up to 30 ppt	Fayer et al. 1998
fecal streptococci	> 150 days	Sinton et al. 2007

As discussed in Section 2.1, runoff from land of manure after rainfall events is considered the primary mechanism for livestock-derived pathogens to reach surface waters. Rainfall events in in the vicinity of HDF occur frequently (Exponent 2016b), and, as such, FIB and pathogens would be expected to survive or possibly grow during the intervening periods between rainfall events to facilitate transport off the HDF pasture in the next rainfall event.

2.3. Pathogens related to livestock manure have been implicated in multiple outbreaks of human illness.

Disease outbreaks from pathogens present in livestock manure can occur through two main mechanisms: direct contact with contaminated recreational waters and food-borne disease outbreaks. Establishing an epidemiological causation link with illness associated with recreational waters is challenging due to a number of factors including the variable duration of exposure, different types of recreation, time of day and other weather conditions, broad and non-specific symptoms (nausea, vomiting, stomachache, diarrhea, headache, and fever), and more strongly associated causes. As a consequence, illness caused by recreational exposure will not always be identified; however, EPA considers the risk of illness from recreational exposure within a cattle impacted waterbody to be equivalent to the risk levels specified in the

recreational water quality criteria (Dufour 1986). By comparison, the risk of illness from exposure to bacteria originating from swine or other livestock animals is considered to be lower (EPA 2010).

In contrast, food-borne disease outbreaks can often be readily traced back to a source, and irrigation water contaminated with livestock manure or direct deposition of livestock manure onto produce is a common cause of outbreaks. Lambertini et al. (2015) demonstrated direct contact with dairy farms and their environments was linked to numerous *E. coli* outbreaks; over 400,000 individuals in Milwaukee were sickened with *Cryptosporidiosis in* 1993, potentially associated with agricultural runoff although the exact source was never identified; and 206 cases of *E. coli* 0157:H7 were linked to cattle wastes contaminating spinach fields (Jay et al. 2007).

2.4. Much of the soil at the HDF is described as “anaerobic” and poorly drained, which may affect the potential for pathogens to survive and be transported offsite (as well as the transport of nutrients and other chemicals).

The majority of the area enclosed by the paddocks of the proposed HDF facility (> 70%) contains soils which are considered “poorly drained” (Table 1, Figure 5; Appendix K HDF 2016). These poorly drained soils are likely to promote survival and transport of pathogens due to their saturated conditions. The water table in this area may be as shallow as 24 inches (Table 1, Appendix K, HDF 2016), increasing the likelihood that water (i.e., from rain or irrigation effluent) which has come in contact with cow manure will reach the groundwater. The Archaeology Inventory Survey Report describes some areas as “marshland” (Appendix G, HDF 2016). The potential impact of pathogen transport to groundwater will be increased as a result of proposed irrigation practices at the HDF, which will increase the moisture content of soils and result in saturated or near-saturated conditions across much of the site much of the time (Exponent 2016b).

The DEIS did not consider the impact of preferential flow paths in soils on the potential transport of pathogens to groundwater. Generally, seasonal variation in wetness of soils will promote the development of preferential flow paths, which will facilitate transport of surface material to deep soils and groundwater. The development of preferential flow paths in Hawaii soils have been documented to be important in moving dissolved and particulate nutrients from surface soils into deep subsurface soils and groundwater (Marin-Spiotta et al. 2011). Depending on the conditions of the soils and season, pathogens and FIB from cattle manure on the HDF may be transported via preferential flow paths into groundwater. Because the ground water at the HDF site is so shallow across much of the site (Exponent 2016b), simple percolation of water through the surface soil would also likely introduce pathogens and FIB into groundwater.

Warm, anaerobic soil conditions are conducive to the growth and survival of pathogens and FIB as they are not unlike the conditions found inside the digestive system of cattle and other animals, where they originate (Bergeim 1924). The warm, wet conditions that exist in the soils and manure at the HDF will likely harbor and promote pathogen and FIB growth (Gagliardi and Karns 2000), especially when considering the long environmental persistence of pathogens and FIB in Hawaii soils (see Table 2 in Section 2.2).

The addition of nutrients may further increase the ability of the soil to harbor pathogens and FIB. Pathogens present at low concentration may grow substantially in suitable conditions and/or with the addition of nutrients (Gagliardi and Karns 2000). An increase in soil water content correlates with a decrease in pathogen die-off rate (Pachepsky et al. 2006), further increasing the pathogen survival risk in poorly drained soils.

Pathogens and FIB from dairy operations can then pass through soils to impact groundwater. The addition of manure to poorly drained and/or saturated soils may enhance the survival and growth of pathogens and FIB by approximating the enteric environment in which they thrive. In a discussion of Best Management Practices (BMPs) for dairy farms, Collins et al. (2007) recommend against the use of poorly drained soils for grazing of dairy cows: "Poorly drained soils with a low infiltration rate have been shown to be a relatively strong predictor of streamwater faecal contamination."

2.5. Unlike nutrients, which the DEIS asserts will remain constant with the proposed change from a 699-head up to a 2,000-head farming operation (assuming the appropriate adjustments in

fertilizer applications), pathogens would be expected to scale proportionally with the change in manure input. This is not addressed in the DEIS.

The DEIS discusses the potential for a 2,000-cow "contemplated herd size" which would result in a nearly three-fold increase in manure input to the proposed HDF facility. In the discussion of this change in herd size, the DEIS focuses on the change in nutrient balance and asserts that the impacts from the increased herd size can be balanced by changes in fertilizer application; however, unlike nitrogen and phosphorus, the pathogens deposited with the manure from a 2,000 cow herd do not have a beneficial use (will not be used by the grass at the site) and will not be offset by changes in fertilizer application. As a result, the chances of impairment of recreational waters or human health impacts are increased.

In addition to the larger overall pathogen input, several other impacts of the larger herd size may affect the risk from pathogens at the HDF. Paddocks would be more frequently grazed, minimizing operational flexibility to avoid allowing cattle to graze in water-adjacent paddocks in times of heavy rainfall. Additional grazing on the land increases the likelihood that soils would be compacted due to compression from the cattle. This can decrease infiltration and increase runoff, which would also increase the likelihood that pathogens and FIB would enter surface waters on or adjacent to the HDF site. Presumably, biosolids would be applied to land more frequently with the 2,000 cow herd size, decreasing the amount of time available for die-off of pathogens prior to land application, and a larger area would receive the biosolids. On page 3-30, the DEIS states "At 2,000 mature dairy cows, slurry can be applied to non-irrigated areas, which are outside of the liquid effluent application area from the center pivot, as well as areas under the gun irrigation system."[4] The actual location is not specified, including the distance from water bodies and wells. Much of the area under the gun irrigation system (Figure 2.5-4, HDF 2016) is adjacent to the taro farm, which represents a specific risk for pathogen contamination. These potential impacts should be explicitly considered as part of the EIS process.

[4] A recent letter from the Hawaii Department of Health (HDOH) states that "wastewater effluent from the storage pond should not be used to irrigate…if gun irrigation is proposed" (HDOH, 2016). It is not clear how irrigation and slurry application processes will change in response to this letter, which was issued after the DEIS. HDF should clarify the proposed methods for disposing of or reusing liquid and solid manure at the facility.

2.6. The taro farm which is nearly enclosed by the HDF property has fields with standing water and represents another potential source and/or receptor for pathogens which was not considered by the HDF in the EIS.

On the south end of the proposed HDF facility, there is a working taro farm which is nearly enclosed by the proposed dairy farm location. According to the Grove Farm IAL Petition (Grove Farm 2011), this land is part of a 20-year lease to W.T. Haraguchi that began in 2007. In a news article describing funding for the company's operations, W.T. Haraguchi was described as a "leader in the production of wetland taro on Kaua'i for generations,"[5] referring to the growing of taro in flooded fields, similar to rice paddies. The DEIS shows gun irrigation being used to spray both effluent and biosolids on the fields in these locations (Figure 3.5-4; HDF 2016). The use of animal waste products in the vicinity of this farm is of concern, as taro is being grown for human consumption and presents a risk of food-borne disease outbreaks.

The use of overhead pivots and gun irrigators present a mechanism by which pathogens may be transported via aerosols to the adjacent taro farm. Because the taro farm is nearly enclosed by the HDF, bio-aerosol could reach the taro farm under nearly all wind directions (Exponent 2016c). The distance between the proposed irrigated area and the taro farm is only 20 feet, according to the DEIS (HDF 2016), which is less than the protective zones for other surface water features (50 feet).

The US Department of Agriculture (USDA) (Borchardt and Burch 2016) studied the presence of fecal bacteria (both FIB and pathogens) downwind of application of dairy manure with a spray gun and center pivot irrigation in Wisconsin and found that concentrations decreased approximately 30% for every 100 foot distance downwind. Microbes were measured up to 700 feet downwind of application. Thus, the airborne transit of pathogens to the crops, standing water, and workers of the taro farm should be considered. Several management practices are suggested to decrease the risk, including but not limited to only irrigating under low wind speed

[5] http://thegardenisland.com/news/w-t-haraguchi-farm-gets-federal-grant/article_3cbc5a05-b782-57cf-8bf7-42f63a3a9406.html

conditions and storing manure for at least three months to deactivate pathogens prior to application. The HDF waste management plan does not incorporate either of these practices.

Wetland taro in this location is grown in standing water, which results in saturated soils in this area, presenting a second possible mechanism of transport of pathogens from the HDF to the taro farm. Any runoff from over-irrigation or rainfall could result in direct contamination of the standing water of the taro farm. These shallow, warm waters which may be shaded by the growing crops, can act as a reservoir for both FIB and pathogens, in addition to being a route of exposure to workers on the taro farm. Taro farming has been associated with outbreaks of leptospirosis, which is caused by bacteria of the genus *Leptospira* (Katz et al. 2011). Although these documented outbreaks at taro farms have not been associated with adjacent dairy farming, *Leptospira* are present in cattle urine, and the presence of the cattle could represent another source of *Leptospira* to local small animal vectors and the farm.

These potential impacts should be considered as part of the EIS process.

2.7. The use of burial pits for deceased cattle described in the Animal Mortality Management Plan included in the HDF Waste Management Plan and referenced in the DEIS presents an additional risk for pathogen transport to ground or surface waters.

The HDF's plan to dispose of cattle in unlined burial pits (HDF 2014) is inadequate to protect groundwater from pathogens and other contaminants. In the Waste Management plan, the HDF states that deceased cattle will be disposed of in burial pits dug in an Animal Cemetery, which is shown located within paddock 159 (Figure 8, HDF 2014). According to the Animal Mortality Management Plan provided, these pits would only be lined if the soil had a permeability of more than 2 inches/hr. As there are no soils on the HDF site with a permeability within this range (Table 1, Appendix K, HDF 2016), it is assumed that the HDF plans for these pits to be unlined (HDF 2014). Without a liner, any water from precipitation flowing through the preferential flowpaths created by the digging of pits can leach pathogens from the decaying cow carcass and transport them to downstream receptors. This practice has been banned in many places, including the European Union (Gwyther et al. 2011). In the Risk Assessment Table for

Livestock Operations (Robotham et al. 2000) published by the Hawaii Cooperative Extension Service, dead animals disposed of on property without composting is considered a “high risk” operation, due to the fact that “decomposing animals can be a concentrated source of pollutants including nutrients and microorganisms.”

The location of the cemetery is in an area of Kaʻena Clay, Brown Variant soil (Table 5 and Figure 6, HDF 2014) in which the depth to the water table is only 24 to 60” below the ground surface. Given that each carcass will be covered with a minimum of 24” of soil and pits may be up to 8 feet deep (HDF 2014), all buried cows will likely come in direct contact with the groundwater, which is known to discharge into surface water downstream of this location. The practice of burying cows where the water table is elevated above the depth of the hole (“water in hole”) is not recommended due to the risk to groundwater (Stanford and Sexton 2006).

The human health risks associated with onsite burial are increased if the cause of animal mortality was a microorganism which is also pathogenic to humans, as the initial loading of pathogenic microorganisms would be higher. The use of paddock 159 by grazing cattle after burial of cattle in this area would increase the risk of pathogen transfer to living cattle and increase the overall levels of pathogens within the dairy property. If live cattle are excluded from that paddock once deceased cattle are buried there, the overall area available for cattle grazing would be decreased and estimates of nutrient loading, etc., for the remainder of the land would need to be altered.

Because the EIS did not account for the high water table when developing the plans for onsite disposal of deceased cattle, the plan is not adequately protective of ground or surface waters.

3. Mitigation Measures to control the risks of pathogen transport to surface and ground waters were not included in the DEIS, as no impact of the dairy farm was considered.

As the potential impacts of pathogens and FIB were not specifically assessed in the DEIS, no mitigation measures were proposed to address any impacts. Many of the BMPs which mitigate the impacts of pathogens from dairy farms are similar to those which are used to limit the

transport of nutrients to groundwater and surface waters. In some cases, such as the exclusion of cattle from waterways and the use of vegetative buffer strips, the HDF proposes such measures for nutrient management as part of the DEIS; however, the design of these BMPs is not described, and no modeling or analysis is conducted to evaluate the residence time of water in these BMPs or their effectiveness (Exponent 2016b). Despite a claim that cattle will be excluded from waterways via fencing of paddocks, paddocks 105–111 show a surface water ditch running through the middle of the paddocks (Figure 3.5-3; HDF 2016). This represents a high pathogen risk to surface waters, as cattle have been found to preferentially defecate directly into water sources (Collins et al. 2007). The HDF plans to use computerized controls on the center pivot irrigation to enforce the 50 foot buffer along surface water on the site (HDF 2014), but does not describe the anticipated failure rate or performance monitoring of this system. The deposition of effluent directly into the Waiopili Stream would represent a high pathogen risk, and specific measures to prevent this occurrence should be discussed.

4. Given that there is the potential for pathogen transport to surface and ground water as well as taro farm crops, the HDF should have a monitoring program to determine the extent of any impact from the HDF, and response measures should be described if an impact is observed.

Not only does the DEIS fail to present any consideration of impacts from pathogens on the proposed HDF site, but it does not propose any method for the HDF operators or others to determine whether impacts are occurring. While some BMPs for pathogen control are proposed to be implemented as part of the plan to limit runoff of nutrients (fencing of paddocks away from surface waters, riparian buffers, etc.), there is currently no way to determine whether such measures are adequate for protection of waters from pathogens. Literature shows that riparian buffers and other mitigation measures are not 100% effective for this purpose (Collins et al. 2004). Additionally, other BMPs, such as avoidance of grazing on poorly drained soils will not be in practice at the HDF, increasing the risk of pathogen input to streams.

In their study of pathogens in the Waiopili Stream, HDOH notes that “The proposed dairy has a draft monitoring program that may be revised in their Voluntary EIS” (p. 84); however, no monitoring program for pathogens was proposed in the DEIS for the committed herd size, so there is currently no mechanism for the HDF, the public, or the government to know if surface water or groundwater is being impacted. Additionally, there is currently no mechanism to monitor for leaks from underground pipes which transport manure effluent and manure slurry around the HDF property for application to fields. The only references to monitoring describe "monitoring and analysis of nutrient and chemical constituent levels" in groundwater (HDF 2016, pp. 4–60), surface water, and marine water (HDF 2016, pp. 4–68). There is no mention of monitoring of FIB or pathogens in any of these media for a herd of 699 dairy cows. In the section for the contemplated herd size, it is noted that pathogens will be measured, presumably as part of the National Pollutant Discharge Elimination System (NPDES) permit required for a concentrated animal feeding operation (CAFO), but details are not given.

No details of the nutrient and chemical monitoring program for the committed herd size are presented in the DEIS, which means that the public is unable to properly evaluate the acceptability of this plan. The baseline stream and marine water studies done by MRC for the DEIS (HDF 2016) did not provide adequate sampling details, did not include any replication, and did not sample during times of heavy rainfall, so a monitoring plan based on this study format would be unacceptable. Only one apparent proposed monitoring well (monitoring well 3) is downgradient of the poorly drained soils which represent the largest area of risk of pathogen transport to groundwater, and it may be inadequate to characterize the offsite shallow ground water transport of pathogens and/or other contaminants even if FIB were measured (Figure 4.16-1, pp. 4–55, HDF 2016). Details of the monitoring plan are necessary for the public and the government to properly consider the impacts in the DEIS.

In addition, HDF should conduct additional baseline sampling to characterize the full range of existing conditions (e.g., during wet weather). HDF should also specify the details of their sampling design, including sample locations, sample handling and analysis methods, and chain of custody protocols. HDF should also indicate how and when sample results will be made available to regulatory agencies and the public, the process for determining if impacts are significant, and the relevant thresholds to be used for determining significance. Finally, HDF needs to specify in detail the actions that will be taken, up to and including the removal of dairy

cows or cessation of the land application of liquid and/or solid manure at the site, if subsequent monitoring determines that impacts are occurring.

Summary

The DEIS as written has failed to adequately characterize the potential human health, economic, or ecological impacts of microbial pathogens discharged from the HDF.

- Baseline sampling was inadequate to characterize the current pathogen conditions. Samples should be collected over a variety of seasonal (flow) conditions, and results and study parameters should have been provided in enough detail for the public and the government to properly review the implications of the work.
- Despite dairy cows being a known source of fecal pathogens to streams and ground waters, and despite the fact that the environment of the proposed HDF location is specifically suited to pathogen survival and transport, the potential impact of pathogens and FIB produced by the proposed HDF facility was not included in the DEIS submitted by HDF. Without these details, it is impossible for the DEIS to evaluate potential impacts to human and ecological health.
- As no impact from pathogens was considered, no mitigation measures were proposed. Information on management practices was unclear and contradictory. For example, the DEIS stated that waterways would be fenced to exclude access by grazing cattle, but figures show streams crossing through the middle of several paddocks. As direct access to surface water is one of the greatest risks for pathogen contamination by cattle, this needs to be corrected.
- No monitoring for pathogens is proposed during dairy operations at the committed herd size. Given the potential risk factors, pathogen monitoring should be required for both the 699-cow and 2,000-cow scenarios. This plan should be available for public review and comment.
- Finally, HDF needs to specify in detail the actions that will be taken, up to and including the removal of dairy cows or cessation of the land application of liquid and/or solid manure at the site, if subsequent monitoring determines that pathogen impacts are occurring.

Limitations

The information upon which we rely in preparing this report is from the HDF DEIS and from publicly available information. We have generally not verified these data independently and, unless otherwise stated, assume that they are accurate. In addition, some of the data and information generated or reported by the HDF is unclear, and we have interpreted that information to the best of our ability. This report summarizes work performed to-date and presents the findings resulting from that work. We reserve the right to supplement this report and to expand or modify opinions based on review of additional material as it becomes available.

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Appendix E

Exponent®

Ecological and Biological Science Practice

Comments on Ecological Assessment in Hawai‘i Dairy Farms Draft Environmental Impact Statement, May 2016

Exponent®

Comments on Ecological Assessment in Hawai‘i Dairy Farms Draft Environmental Impact Statement, May 2016

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July 21, 2016

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Executive Summary

Exponent was retained by Goodsill Anderson Quinn & Stifel LLP on behalf of Kawailoa Development LLP (Kawailoa) to review information related to a proposal by Hawai‘i Dairy Farms (HDF) to construct and operate a dairy farm on the island of Kaua‘i, Hawaii. Specifically, Exponent was asked to evaluate impacts of the proposed dairy farm on the flora and fauna in the area and evaluate the adequacy of the ecological analysis performed as part of the Draft Environmental Impact Statement, which is the subject of this report. Exponent was also retained to prepare separate reports to evaluate impacts related to odor and air quality, water and water quality impacts, and pathogens.

In May 2016, HDF submitted a Draft Environmental Impact Statement (DEIS) for the dairy farm project at Māhā‘ulepū. The DEIS included a main body as Volume 1 and a series of Appendices presenting supporting information and impacts of the project. These documents, together with documents provided by Kawailoa or obtained from public sources, form the basis of the evaluations presented in this report.

HDF proposes a 557-acre dairy farm in the Māhā‘ulepū Valley on the southeast portion of the island of Kaua‘i, near Po‘ipū. The dairy farm would support 699 mature dairy cows at first (the proposed project), with the possibility of expanding to support 2,000 cows in the future (the "contemplated" project). The overall project area is 557 acres. The farm would mostly consist of open paddock areas (469.9 acres). Kikuyu grass would be grown in the paddocks for cattle grazing. The farm would include several new structures on a 9.7-acre "headquarters" parcel near the western boundary of the site, including a milking parlor, a calving shed, and an implement shed.

The comments that were developed in preparing this report were generated following review and analysis of the HDF DEIS and from publicly available information. In addition, some of data and information generated or reported by the HDF is unclear, and we have interpreted that information to the best of our ability.

The comments on the DEIS are organized in the following subsections including:

- Botanical Survey
- Avian Survey
- Mammalian Survey
- Other Terrestrial Fauna
- Aquatic Resource Surveys
- Harmful Algae Blooms
- Introduction of Exotic Species
- US Fish and Wildlife Service Recommendation letter and Group 70's response to the USFW recommendation

The comments in each subsection address specific questions on the reporting of the surveys and other information relevant to the ecological assessment of the proposed HDF project as well as our analysis as to the suitability of the assessment or other concerns regarding potential impacts.

In summary, many of the analyses performed and presented in the DEIS are insufficient and the presented methodology and other information is often lacking to determine the impacts from the proposed HDF to important ecological resources. In addition the DEIS does not propose management plans for addressing many of the concerns expressed by the US Fish and Wildlife Service (USFW).

Comments on Ecological Assessment in Hawai‘i Dairy Farms Draft Environmental Impact Statement, May 2016

1.0 Introduction

1.1 Proposed Project

Exponent was retained by Goodsill Anderson Quinn & Stifel LLP on behalf of Kawailoa Development LLP (Kawailoa) to review information related to a proposal by Hawai‘i Dairy Farms (HDF) to construct and operate a dairy farm on the island of Kaua‘i, Hawaii. Specifically, Exponent was asked to evaluate impacts of the proposed dairy farm on the flora and fauna in the area and evaluate the adequacy of the ecological analysis performed as part of the Draft Environmental Impact Statement, which is the subject of this report. Exponent was also retained to prepare separate reports to evaluate impacts related to odor and air quality:[1] water and water quality impacts;[2] and pathogens.[3]

In May 2016, HDF submitted a Draft Environmental Impact Statement (DEIS) for the dairy farm project at Māhā‘ulepū.[4] The DEIS included a main body as Volume 1 and a series of Appendices presenting supporting information and impacts of the project. These documents, together with documents provided by Kawailoa or obtained from public sources, form the basis of the evaluations presented in this report.

HDF proposes a 557-acre dairy farm in the Māhā‘ulepū Valley on the southeast portion of the island of Kaua‘i, near Po‘ipū.[4] The dairy farm would support 699 mature dairy cows at first (the proposed project), with the possibility of expanding to support 2,000 cows in the future (the

[1] Exponent 2016a. Hawai‘i Dairy Farms Odor Impact Assessment. July

[2] Exponent 2016b. Water and Water Quality Impacts, Hawai‘i Dairy Farms DEIS, Mahaulepu, Kaua‘i. July

[3] Exponent 2016c. Expert Report on Pathogens Hawai‘i Dairy Farms Draft Environmental Impact Statement, May 2016. July

[4] Group 70 International, 2016. Hawai‘i Dairy Farms, Volume 1 Draft Environmental Impact Statement. Submitted by Hawai‘i Dairy Farms, Māhā‘ulepū, Kaua‘i. May.

"contemplated" project). The overall project area is 557 acres. The farm would mostly consist of open paddock areas (469.9 acres). Kikuyu grass would be grown in the paddocks for cattle grazing. The farm would include several new structures on a 9.7-acre "headquarters" parcel near the western boundary of the site, including a milking parlor, a calving shed, and an implement shed.[5]

1.2 Purpose and Overview of Report

The purpose of this report is twofold:

1. To summarize key aspects of the ecological surveys and subsequent analysis in the DEIS, and to identify deficiencies in HDF's analysis of ecological impacts.
2. To summarize Exponent's analysis of the anticipated impacts of the project on flora and fauna.

This report contains two main sections following the Introduction. Section 2 presents Exponent's evaluation of the specific surveys including the botanical survey, avian survey, mammalian survey, other terrestrial fauna and aquatic resource surveys in the DEIS, including additional concerns such as harmful algae blooms and introduction of exotic species as a result of the proposed project. Section 3 of this report summarizes the US Fish and Wildlife Service (USFW) recommendations and HDF's response to the proposed recommendations.

2.0 The Draft Environmental Impact Statement, May 2016

The Draft Environmental Impact Statement (DEIS) is presented in a main body of the document (Volume 1) and a series of Appendices[5]. For evaluating and assessing the completeness of the ecological assessment as part of the DEIS and developing the comments on the Ecological Assessment in Hawai'i Dairy Farms, Section 4.0 (Environmental Setting, Potential Impacts, and Mitigation Measures), specifically Section 4.9 (Flora), Section 4.10 (Fauna), Section 4.11 (Invertebrate Species and Pest Impacts) and Appendix A (Flora and Fauna Surveys) of the DEIS

[5] Group 70 International, 2016. Hawai'i Dairy Farms, Volume 1 Draft Environmental Impact Statement. Submitted by Hawai'i Dairy Farms, Māhā'ulepū, Kaua'i. May.

were reviewed. These comments include questions with regards to the DEIS assessment including but not limited to missing and/or inadequate evaluations of the impacts from the proposed project.

2.1 Botanical Survey

The botanical survey assessing the proposed project area is insufficient to predict the potential impacts to both exotic plants and threatened native plants.

- Sampling was only conducted in the dry season, so wet season annual plants were likely missed or under-represented.
- Plants flowering or seeding in the wet season were also likely missed or under-represented. Plants can be difficult or impossible to identify without flowers or seeds.[6]
- The methodology presented in the DEIS used a "wandering pedestrian transect method." This method produces a qualitative plant list, not quantitative population measures.
- The "wandering pedestrian transect method" is likely to miss very small plants as the assessor is walking around instead of kneeling and looking under other plants as they would using a quadrat method. Adequate assessment would be to use both methods as part of the survey during important seasons to fully assess the flora.
- It is unclear how much of the area was sampled. The GPS trajectory of the botanical survey was recorded, according to the DEIS, but is not included in the DEIS. A map showing the recorded transects would be necessary and should be provided to verify sufficient sampling coverage.
- Five of 115 species were native but not endemic; the rest were exotic naturalized species. The high number of invasive species highlights that Hawaii is already highly invaded. It is critical to develop sound management strategies to ensure that the proposed project does not increase the introductions or populations of invasive species. This was one of the points made by USFW in their letter to Jeffrey Overton.[7]

[6] H. D. Harrington. 1957. How to Identify Plants. Swallow Press Books. Athens, Ohio

[7] US Fish and Wildlife (USFW). 2015. Comment letter from Aaron Nadig, Island Team Manager to Jeffrey Overton concerning USFW concerns of the Proposed Hawai'i Dairy Farm project, dated 23 February 2015.

2.2 Avian Survey

The avian surveys assessing the bird populations and long-term planned habitat changes were insufficient to predict the potential impacts to threatened and endangered endemic birds and to predict whether exotic bird populations would increase.

2.2.1 Survey methods and sampling effort

- Only <u>one</u> (1) six-minute point count observation was made at each of the 28 census stations distributed throughout the study area. This resulted in a total of <u>*only*</u> 168 minutes (2.8 hours) of census time to support the DEIS.
- An avian census that only takes samples once fails to address temporal and temporospatial variation in bird presence and distribution. If there were a change in the avian community due to the breeding season, migration patterns, or foraging behavior, this limited census would be insufficient in assessing the baseline of the area prior to proposed project being implemented. The lack of consideration of temporal and temorospatial variation does not support the statements made in the DEIS regarding the potential impacts from the proposed project on important, threatened or endangered avian species in the proposed area.
- More clarity is necessary in the methods. It is unclear if the avian survey took place on one day or over many days, and the date(s) of the survey is/are not recorded; however, based on the arrangement of the information provided in the DEIS, it appears that the survey occurred on one day.
- The DEIS fails to provide references for statements regarding comparison of survey data (e.g., "*An average of 38 individuals birds was recorded per station count; a number that is relatively high for a lowland site on Kaua'i.*")
- The DEIS should have included a map of point count stations. The U.S. Department of Agriculture (USDA) suggests that point count stations be at least 150 meters apart. These stations described in the DEIS are 300 meters apart, which may not provide adequate coverage based on regulatory guidance.

July 21, 2016

2.2.2 Endemic endangered waterbirds

- Four endemic waterbirds were found on the property: the Hawaiian Duck (*Anas wyvilliana*), the Hawaiian sub-species of the Common Gallinule (*Gallinula galeata sandvicensis*), Black-necked Stilt (*Himantopus mexicanus knudseni*), and the Hawaiian Coot (*Fulica alai*).
- While the paddocks are proposed to be fenced, cattle can often breach fencing barriers and enter streams and subsequently destroy streambanks. In addition, it appears that a water feature or ditch may pass through several of the paddocks (paddocks 105–111). Even with the proposed buffer areas between water features and grazing areas, cattle disturbance will likely reduce nesting habitat for endemic birds that nest or feed near the water features on the property and may cause failed nests or mortality of young prior to fledging.
- Page 6-20 of the DEIS states that native endangered waterbirds may use the paddock area. The table does not address this use by seabirds or shorebirds, however. It states in the next sentence that lights will be shielded to prevent attraction to overflying seabirds. Seabirds are not waterbirds in most scientific uses of the word, so the DEIS is not clear on this issue. When speaking about "waterbirds," scientists usually refer to birds that use fresh water, such as ducks.
- The reports seems to use "waterbirds" and "shorebirds" interchangeably at times, thus creating some confusion over what birds are actually being affected by their proposed mitigation actions.
- It is not clear what cleaning products and medicines will be used at the dairy, and if endemic waterbirds will be exposed to them through the direct use as part of the dairy operations or from the use of the effluent settling or storage ponds. It is similarly unclear what the projected health effects of such an exposure may be.

2.2.3 Nēnē – Endemic and endangered

- The DEIS states that the endangered Nēnē "probably" nests on the project site.

- Cattle are known to lower nesting success of ground nesting birds[8] such as the Nēnē. HDF will need to implement weekly surveys by certified biologists during Nēnē nesting season. This was also highly recommended by the USFW.[9] Pastures identified as hosting nests should not be used by cattle, or a 10 x 10 m fence should be erected around individual nests to protect them from trampling. Actually, the USFW highly recommended a 100-ft. exclusion zone for identified nests and the required reporting within 48 h of nest identification to the USFW.
- Additionally the USFW highly recommended that electric fencing not be used as part of the proposed project due to concerns that it might impact native avian populations, the Nēnē in particular. The DEIS has failed to consider this recommendation and does not provide justification for disregarding a federal agency's recommendation.
- The dairy will provide ideal conditions for supporting additional numbers of Cattle Egrets (*Bubulcus ibis*), which have the potential to result in increased predation on Nēnē eggs and chicks. Predation on birds by cattle egrets has been well-documented.[10] The Cattle Egret is well known for associating with grazing animals and they had adapted to following animals such as cattle, eating arthropods that are disturbed by or attracted by livestock (including threatened and endangered arthropods and the proposed introduced dung beetle).
- Since the dairy operations will likely lead to an increase in rats and feral cats, it is very likely that increased predation on Nēnē adults, juveniles, chicks, and/or eggs will result, even though the DEIS recommends trapping of cats and rats. The DEIS provides no documentation as to the management plan for controlling the potential predation other than trapping. Cattle Egrets, as well as feral cats and rats will be highly attracted to the land use activities of the dairy operations.
- Infection of Nēnē by the protozoan parasite *Toxoplasma gondii* has been documented. *T. gondii* is transmitted by domestic cats and has historically caused mortality in native

[8] Moore, P. 2005. Stock fencing and electric fence enclosures to prevent trampling of Chatham Island oystercatcher *Haematopus chathamensis* eggs, Chatham Island, New Zealand. *Conservation Evidence* 2:76–77.

[9] US Fish and Wildlife (USFW). 2015. Comment letter from Aaron Nadig, Island Team Manager to Jeffrey Overton concerning USFW concerns of the Proposed Hawai'i Dairy Farm project, dated 23 February 2015.

[10] https://www.fws.gov/policy/library/2013/2013-26071.html

Hawaiian birds.[11] *T. gondii* has been identified as a potential concern in Kaui'i; however, currently the infection rate appears to be lower on Kaui'i than other populations such as those on Mau'i or Molokai.[11] The DEIS does not evaluate this potential impact or concern.

2.2.4 Effect of increasing populations of invasive species

- The DEIS survey found that exotic species comprised 52% of individual birds noted. The percent of birds that are exotic will likely increase after the dairy is implemented due to habitat alterations that will favor invasive species, such as changes to pasture land for the cattle and new structures within the dairy operations.
- The dairy will provide ideal conditions for supporting additional numbers of Cattle Egrets (*Bubulcus ibis*) on the island. This invasive species has been the target of eradication efforts by the USFW, and this species preys on Nēnē eggs and nestlings.
- Operations will likely provide conditions for supporting additional numbers of Barn Owls (*Tyto alba*) on the island. This invasive species has been the target of eradication efforts by the USFW.
- The potential increase in Barn Owls as a result of the dairy operations could lead to increased predation on seabirds nesting in the nearby highlands. Predation on Hawaiian seabirds by Barn Owls has also been well-documented.[12]
- It is also possible that the dairy operations could lead to an increase in the Common Myna on the island by providing ideal foraging conditions where they did not exist previously. The Common Myna is an invasive species, and they out-compete native species for food and nesting areas.[13] They are known to be associated with cattle and forage on the arthropods that are attracted to large concentrations of these livestock and may impact the threatened and endangered species in the area as well as the dung beetles which are proposed to be introduced as part of HDF. This issue has not been addressed in the DEIS.

[11] Work TM, Verma SK, Su C, Medeiros J, Kaiakapu T, Kwok OC, Dubey JP. 2016. *Toxoplasma gondii* antibody prevalence and two new genotypes of the parasite in endangered Hawaiian Geese (Nene: *Branta sandvicensis*). *Journal of Wildlife Diseases* 52:253–257.

[12] http://usfwspacific.tumblr.com/post/70400439380/under-attack-protecting-hawaiis-birds-from-an

[13] Pell and Tidemann. 1997. *Biological Conservation* 79:145–153

- Any increase in rats or cats population has the potential to lead to increased predation on Nēnē and seabirds nesting in the nearby highlands.

2.3 Mammalian Survey

The mammalian survey assessing the mammal populations and long-term planned habitat changes was insufficient to predict the potential impacts to the endangered Hoary bat and to predict the effects of increased pest mammal species.

2.3.1 Survey methods and sampling effort

- No formal survey or assessment of impacts to or from mammals in the proposed project area was provided in the DEIS.
- The DEIS did report the presence of domesticated animals and mice within the footprint of the proposed project, but no survey information or document was presented.

2.3.2 Hawaiian Hoary bats – Endemic and endangered

- HDF does not include collision risk from structures, electric fences, or barbed wire fences[14] as a risk for long-term losses. This was a great concern as presented in the USFW recommendation letter. USFW were quite concerned that the Hoary bats would be impacted by the use of barbed wire fencing and specifically requested that it not be used in proposed project.[15]
- The DEIS does not include a mitigation plan to put warning devices on fences and to reduce exterior lighting at night to reduce collision risk with structures. A mitigation plan for public review and comment should have been part of the DEIS.

[14] https://hawaii.conferences-services.net/reports/template/onetextabstract.xml?xsl=template/onetextabstract.xsl&conferenceID=2069&abstractID=410279

[15] US Fish and Wildlife (USFW). 2015. Comment letter from Aaron Nadig, Island Team Manager to Jeffrey Overton concerning USFW concerns of the Proposed Hawai‘i Dairy Farm project, dated 23 February 2015.

2.4 Other Terrestrial Fauna

Other important terrestrial fauna, such as invertebrate, amphibian, and reptiles were not assessed as part of the DEIS for the proposed project area, and thus the DEIS is insufficient to predict the potential impacts to the fauna community from HDF activities.

2.4.1 Invertebrates

- There was no survey of invertebrates.
- An invertebrate survey should have been conducted to explore the feasibility of implementing the “inter-dependent web in nature” as a means to “naturally control” exotic species using integrated pest management (IPM).
- The DEIS discusses many invertebrates that would control pest flies, such as dung beetles and predatory wasps. It also discusses their presence on Kaua‘i and on other islands but does not explore which species are already present in the proposed area and which would have to be introduced, because no survey was conducted.
- The DEIS does not detail the means of collecting the invertebrate species that would be needed for introduction or the source area where invertebrate species would be collected. This is a concern for bringing in other unwanted species, such as mites or accidentally trapped species which could subsequently spread.
- The DEIS does not explore or assess the suitability of the habitat for the invertebrates that it intends to bring to the site to ensure that they will be able to maintain populations without constant re-introductions and the corresponding risk of introducing new unwanted species.
- The Kaua‘i cave wolf spider (*Adelocosa anops*) and the Kaua‘i cave amphipod (*Spelaeorchestia koloana*) were listed as concerns by the USFW in their recommendation letter for the proposed project;[16] however, no assessment of potential mitigation measures for impacts to these species was presented in the DEIS. The

[16] US Fish and Wildlife (USFW). 2015. Comment letter from Aaron Nadig, Island Team Manager to Jeffrey Overton concerning USFW concerns of the Proposed Hawai‘i Dairy Farm project, dated 23 February 2015.

response letter from Jeffrey Overton to USFW[17] did discuss that the potential habitat was assessed within the proposed project area for these species, but insufficient documentation was provided in the DEIS to allow an independent evaluation. The impacts from the HDF proposed project to habitat adjacent to the project area, including the impacts of operations such as transportation, nutrient run-off, chemical releases, and pesticide use, were not evaluated as part of the DEIS and the overall impacts to these important species were not assessed.

2.4.2 Amphibians

- There was no survey of amphibians.
- There are no native terrestrial amphibians in Hawaii.
- Exotic populations of amphibians have the potential to increase with the addition and maintenance of treatment ponds and in water features.
- The cane toad (*Rhinella marina*) is already established on Kaua‘i. The settling and storage ponds that will be maintained on the proposed property will increase available habitat and potentially increase the population size of these invasive species. The toads are poisonous and may affect cattle through the consumption of poisonous eggs or by mouthing the toads accidentally. Additionally, the effect of the toads on the native species of Hawaii is unknown,[18]and thus the effect of an increased population cannot be predicted.

2.4.3 Reptiles

- There was no survey of reptiles.
- There are no native terrestrial reptiles in Hawaii.
- There are two invasive chameleon species that are not known to Kaua‘i that should be checked for when equipment and feed is moved between islands.

[17] Group 70 International. 2016. Response letter from Jeffrey Overton to Aaron Nadig, USFW Island Team Manager on USFW recommendations for the proposed Hawai‘i Dairy Farm Project.

[18] U.S. Geological Survey. [2016]. Nonindigenous Aquatic Species Database. Gainesville, Florida. Accessed [6/23/2016].

2.5 Aquatic Resource Surveys

The aquatic resources were not surveyed, and thus the assessment of the proposed project area was insufficient to predict the potential impacts to the freshwater and marine communities from HDF activities.

2.5.1 Freshwater Organisms

- No survey of the aquatic plants or biota in the freshwater features of the property was made because it was the dry season. Water flows through the property in the Waiopili Stream. While this stream was highly managed by straightening of the original alignment of the native stream, it is defined as a Class 2 waterway and does have a direct link to the ocean. Thus, this water feature should have been surveyed, and the impacts from the proposed HDF activities should have been assessed to ensure protection for recreational use and for the support and propagation of aquatic life, as well as other purposes.[19]
- There are native and endemic species of fish and mollusks on Kaua‘i, most with diadromous life cycles (they move between saltwater and freshwater). The aquatic features listed on in HDF’s report connect to the Waiopili Stream (USFW lists it as “Riverine” Class R4SBCx, which means that it is intermittent[20]) which runs to the ocean at Gillins Beach. This connection may allow native aquatic organisms seasonal access to the proposed HDF property. The water features should be surveyed for native organisms during the wet season when filled with water.

2.5.2 Marine Organisms

- No assessment of the marine system was performed in the DEIS.

2.5.2.1 Corals

- No evaluation was performed as to the potential impacts to corals from the direct connection of the proposed project to the marine system.

[19] Haw Admin. R. § 11-54-3

[20] https://www.fws.gov/wetlands/data/mapper.html

- Corals are sensitive to water quality changes.
  - Corals require clear waters for zooxanthellae photosynthesis.
  - Increased nutrients (from manure or fertilizer) stimulate phytoplankton and macroalgae growth that can effect corals. Increased phytoplankton abundance contributes to shading of corals, and increases in macroalgae can smother reef corals, killing them or limiting their growth.
  - Excessive phytoplankton abundance can affect corals, which leads to decreased dissolved oxygen concentrations in bottom sediments, where microbial degradation of dead phytoplankton consumes oxygen.
  - Nutrient enrichment has also been linked to coral decline and disease. Coral reefs are declining worldwide, and these trends are particularly severe. Changes in water quality, including water clarity, are considered to be contributing causes.
  - Ammonium (NH4+) in areas with "considerable" livestock farming can contribute to acidification of the aquatic environment. Acidification decreases calcification of coral skeletons.
  - Fecal bacteria can infect coral colonies and lead to disease and coral death.
- The DEIS fails to consider the cumulative impact to surface waters and the nearshore environment from all operations impacting the Waiopili Stream. Prior to dairy operations, a Sanitary Survey conducted by the Hawaii State Department of Health (DOH) revealed high concentrations of *Enterococcus* and *Clostridium perfringens* in the sediment of the Stream (referred to ditch in the survey), as well as degraded water quality parameters for nutrients (see the water[21] and pathogen[22] reports). The DEIS states that the "Sanitary Survey found no significant impact to the Waiopili [Stream] Ditch from any activity that can be attributed to the dairy"; however, since the dairy is not currently in operation, this assessment has no bearing on whether the dairy ***will*** impact the water quality of the Waiopili Stream and the receiving nearshore marine waters when the dairy ***is*** operational. The DEIS did not assess this issue, and thus is insufficient in determining the impacts from the HDF proposed project.

[21] Exponent 2016b. Water and Water Quality Impacts, Hawai‘i Dairy Farms DEIS, Mahaulepu, Kaua‘i. July

[22] Exponent 2016c. Expert Report on Pathogens Hawai‘i Dairy Farms Draft Environmental Impact Statement, May 2016. July

- Similarly, surface water samples collected in the nearshore water that show "substantially lower" concentrations of indicator bacteria in the marine waters compared to the stream do not include input from the dairy, which will increase concentrations of pathogens and nutrients in the stream (freshwater) and resulting connection with the marine waters.
- The DEIS fails to include a monitoring plan to assess the health of the fringing reefs near the discharge point of the Waiopili Stream. While water quality monitoring in the nearshore waters can be a useful approach to evaluate the impact of dairy operations on nearshore water quality, these data will not directly inform if/how dairy operations are affecting the composition of the fringing reef community, which can experience phase shifts from coral dominance to algae dominance with increased nutrient input. A baseline assessment of the fringing reefs should be conducted, and monitoring should be undertaken to identify any changes in reef community structure over time and distance from the Waiopili Stream.
- The MRCI (2016) report provided in the DEIS[23] Appendices examines a hypothetical release of 2% and 1% of the nitrogen and phosphorus, respectively, from the HDF facility. No explanation or scientific justification for these percentages is given. MRCI contrasts the hypothetical nitrogen and phosphorus load added to the nearshore marine environment as a result of HDF operations to production and disposal of domestic wastewater and landscape fertilizer in the Kōloa-Po‘ipū area. MRCI estimate that 15% of nitrogen and 2% of phosphorus from wastewater enter the marine environment from the Kōloa-Po‘ipū area, and they estimate that 8% of nitrogen and 2% of phosphorus applied as fertilizer in this area reach the marine environment. The percent of nutrients, particularly nitrogen, that reach the marine environment as a result of these operations in the Kōloa-Po‘ipū area is substantially higher than the "first-order approximation" of 2% of nitrogen and 1% of phosphorus used to simulate potential nutrient additions from the HDF. If 8% of nitrogen from the HDF is assumed to reach the marine environment instead of 2%, the total load of nitrogen to the receiving marine waters below the HDF is comparable to that in the Kōloa-Po‘ipū area, based on combined input from municipal

[23] Group 70 International, 2016. Hawai‘i Dairy Farms, Volume 1 Draft Environmental Impact Statement. Submitted by Hawai‘i Dairy Farms, Māhā‘ulepū, Kaua‘i. May.

wastewater and landscape fertilization. By failing to provide scientific justification for the percentages of nutrient impact to the marine environment and to consider a range of possible nutrient loads, and by failing to consider seasonal changes in the quantity of nutrients that will be released from the HDF, the DEIS for impacts to marine water quality from the HDF is insufficient to conclude that the project will not cause substantial effects to marine water quality beyond the immediate area where ocean water and surface water merge.

- The scenario used by MRCI to evaluate nutrient input from HDF to the nearshore marine waters also fails to consider additional area inputs of nutrients, such as wastewater and landscape fertilizer. Thus, the cumulative impact to marine waters could be substantially greater than considered by MRCI.
- MRCI assert that nutrient impacts from HDF would not be chronic; however, a pulsed release of highly concentrated pathogens and nutrients can have substantial negative environmental impacts and should be evaluated. In addition, elevated concentrations of nutrients in groundwater will reach the nearshore ocean in a long-term, chronic discharge plume, and impacts from discharges of nutrients in groundwater have not been evaluated.
- MRCI assume that physical mixing in the marine environment will rapidly dilute nutrient inputs from the HDF to surface waters, but they failed to conduct any modelling exercises to demonstrate this assumption, and the field measurements they use to support this assertion were conducted during dry weather conditions.
- MRCI contrast the area impacted from nutrient releases in the Po‘ipū area, which releases nutrients over a large area, to the point discharge of nutrients from the Waiopili Stream. They suggest that a chronic input spread over a large area has more impacts to marine water quality than a concentrated, sporadic release without providing any scientific rationale for this opinion. Release of a comparable (depending on the assumption of the percentage of nutrients released to the marine environment) nutrient load over a larger area over a longer time period results in greater dilution of the nutrients than the release of a concentrated nutrient load to a localized area in a pulse.
- MRCI erroneously assume that because the area offshore of the Waiopili Stream is not a safe area for marine activities and is not used for recreation that a substantial,

concentrated influx of nutrients is inconsequential. In reality, MRCI failed to evaluate how such concentrated releases would impact the coral reefs near the Waiopili Stream outlet.

2.5.2 Monk Seals

The DEIS did not evaluate HDF's impact to the marine environment, and in particular the impacts to monk seals or sea turtles. Thus, the DEIS failed to assess this important resource.

The DEIS did not address the endangered Hawaiian monk seal (*Neomonachus schauinslandi*) which is native to Hawaii, including the island of Kaua‘i. The Hawaiian monk seal is the most endangered marine mammal in the United States and is currently on the IUCN Red List of Threatened species[24]. Hawaiian monk seals are protected under the Endangered Species Act (ESA), Marine Mammal Protection Act (MMPA), and state law in Hawaii [25] and the National Oceanic and Atmospheric Administration (NOAA) reports population estimates at 1,112 and declining.

During the pupping season on Kaua‘i, daily reports of monk seal activity are provided on a public website.[26] Foraging and haul-out areas used by the monk seals include Gillin's Beach, and discharges from the Waiopili Stream during HDF operation will likely increase exposure of the monk seals to pathogen pollution from the outflow of HDF. Monk seals are known to haul out and pup on Po‘ipū Beach, less than 4 miles away from the outflow of the planned HDF farm.[27] Monk seals typically forage along a long area of Kaua‘i coast (Figure 1), thus monk seals from Po‘ipū will be foraging near the outflow from the proposed HDF site and may even be hauling up on the beach.

[24] Lowry, L. & Aguilar, A. 2008. Monachus schauinslandi. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1.

[25] National Marine Fisheries Service. May 2016. U.S. Pacific Marine Mammal Stock Assessments: 2015. NOAA-TM-NMFS-SWFSC-561. 399 pp. (NMFS Stock Assessment 2015)

[26] https://kauaiseals.wordpress.com/)

[27] http://www.parrishkauai.com/blog/hawaiian-monk-seals/

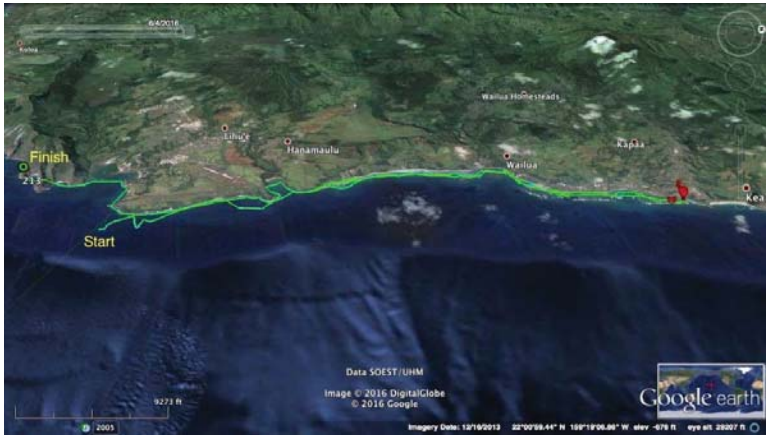


Figure 1. Foraging path of one male monk seal on Kauai's east coast. https://kauaiseals.wordpress.com/2016/06/page/3/

Monk seals primarily forage in the offshore and nearshore waters and pup on the beaches of the Northwest Hawaiian islands (NWHI), though a small but increasing portion of their population also hauls out and pups on Kaua'i and other Main Hawaiian Islands (MHI). NOAA highlights the risk of exposure to pathogens introduced from livestock, feral animals, pets, and other carrier wildlife could have a "catastrophic" effect to the immunologically naïve monk seal population.[28] In the early 2000s, six monk seals died from exposure to toxoplasma (*Toxoplasma gondii*), a protozoal parasite transmitted through feces of cats. This is the same protozoal parasite that has been known to be lethal to Hawaiian birds.[29] Two other mortality cases from the Big Island showed evidence of *Leptospira* bacteria exposure but the cause of death was not confirmed. Both of these pathogens are zoonotic, can originate in livestock, domestic, and feral animals, and can be transmitted though water.[30] Exposure to monk seals occurs during their time hauled out to rest, pup, and nurse onshore on beaches, rocky areas, and even nearby streams, all

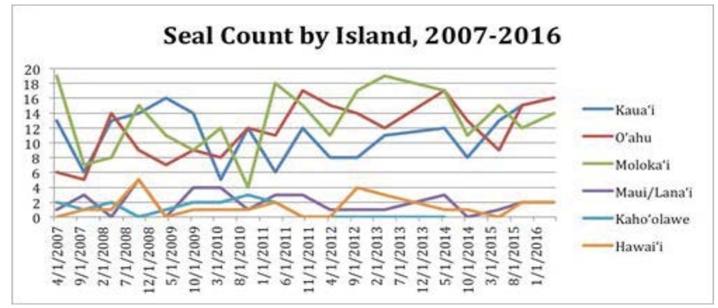
[28] http://www.fpir.noaa.gov/Library/PRD/Hawaiian%20monk%20seal/Fact%20Sheets/HMS-top_threats.MAY2010.pdf

[29] Work TM, Verma SK, Su C, Medeiros J, Kaiakapu T, Kwok OC, Dubey JP. 2016. *Toxoplasma gondii* antibody prevalence and two new genotypes of the parasite in endangered Hawaiian Geese (Nene: *Branta sandvicensis*). *Journal of Wildlife Diseases* 52:253–257.

[30] National Marine Fisheries Service. 2007. Recovery Plan for the Hawaiian Monk Seal (*Monachus schauinslandi*). Second Revision. National Marine Fisheries Service, Silver Spring, MD. 165 pp.

of which can be points of entry of polluted upland freshwater drainage. The MHI and lower islands of the NWHI (Nihoa and Necker islands) are experiencing a rise in monk seal populations with an estimated growth of 6.5% per year.

Figure 2. Seal Count by Island, 2007–2016. [31]



Recent 2013 estimates by NOAA reported 179 animals in the Nihoa, Necker, and MHI comprising 30% of the total monk seal population.[32]

The DEIS did not address any of these concerns listed above.

2.5.3 Sea Turtles

Six species of sea turtles occur in the Pacific but two regularly occur in Hawaii, the green sea turtle (*Chelonia mydas*) and hawksbill (*Eretmochelys imbrica*). Green sea turtles have been reported to haul out and nest on a few Hawaiian islands including the southern shore of Kaua'i.[33]

[31] NMFS Stock Assessment 2015

[32] NMFS Stock Assessment 2015

[33] https://koloalandingresort.com/when-and-where-is-the-place-to-view-sea-turtles-in-kauai/

The range of haul-out beaches includes areas near the Waiopili Stream, and thus dairy operations will increase the risk of sea turtle exposure to pathogen pollution. Threats to Green sea turtles in Hawaii include disease, incidental take in fisheries, ingestion of marine debris, and entanglement.[34] Disease is considered the primary threat and has been a cause of concern in Hawaii. These disease concerns include:

- Fibropapillomas occur on exposed soft tissue including flippers, head, and neck areas. While the tumors do not appear to be accompanied by any other symptoms or negative effects, their location could be detrimental to the survival of an individual. For example, if a tumor obstructs a turtle's mouth or eyes, it may starve due to inability to locate and/or ingest food. Tumors around the eyes may also impair vision so that a turtle's ability to avoid predators is reduced.[35]
- Researchers in Hawaii have recently reported an association between the incidence of fibropapillomas sea turtles and macroalgae high in tumor promoting amino acids, most notably arginine.[36] Green sea turtles forage on algae and sea grasses on rocks and reefs in the nearshore environment.
- There appeared to be clusters of green sea turtles with fibropapillomas in areas with high eutrophication and increased arginine content in macroalgae, which may metabolically promote latent herpesviruses and cause fibropapillomas in green turtles.[37]
- Outflow from the HDF could increase the likelihood of eutrophication in foraging areas of the green sea turtles and thus increase the potential for exposure to tumor promoting arginine and fibropapillomatosis.

The DEIS did not address any of these concerns listed above.

[34] http://www.fpir.noaa.gov/PRD/prd_green_sea_turtle.html
[35] http://www.fpir.noaa.gov/PRD/prd_green_sea_turtle.html
[36] Van Houtan KS, Hargrove SK, Balazs GH (2010) Land Use, Macroalgae, and a Tumor-Forming Disease in Marine Turtles. PLoS ONE 5(9): e12900. doi:10.1371/journal.pone.0012900
[37] Van Houtan et al. (2014), Eutrophication and the dietary promotion of sea turtle tumors. PeerJ 2:e602; DOI 10.7717/peerj.602

2.6 Harmful Algae Blooms

The DEIS did not address the potential for harmful algal blooms in water features on the property that could spread into the nearby marine system.

- The occurrence and intensity of cyanobacterial harmful blooms have become increasingly common over the last few decades. Cyanobacteria (blue green algae) are a worldwide concern in areas with eutrophic water conditions. Cyanotoxins generated from cyanobacteria are harmful ecologically, cause economic impact, and are a public health threat. The accurate detection of harmful cyanotoxins has become increasingly important in the protection of human and ecological health. The frequency and intensity of harmful algal blooms (HABs) is increasing for a variety of reasons, with implications for human/animal health and water use.
- Additional to cyanobacteria, another HAB comes from the marine golden algae, *Pyrmnesium parvum*. The golden algae has caused fish kills and harmed many aquatic resources, and golden algae have been documented in many states include Hawaii.[38]
- The poorly drained soils and high nutrients from the dairy will increase the likelihood of HAB occurring in the drainage ditches between pastures and the Waiopili Stream as well as potentially impacting the adjacent marine system (including marine mollusks, monk seals, turtles, and fishes).
- The DEIS did not discuss the impact from HAB to the aquatic resources nor to the cows themselves, and the DEIS did not propose a management strategy to minimize the occurrence of HABs.

2.7 Introduction of exotic species

The DEIS does not address the controls necessary to stop further invasive species from arriving to Kaua'i during transportation of equipment and feed, relocation of invertebrates such as dung beetles, and attraction of exotic species due to habitat changes (e.g., settling or storage ponds); thus the analysis of the DEIS is insufficient in its assessment of the impacts from the proposed project.

[38] New Mexico State University. Toxic Golden Algae (*Prymnesium parvum*), Circular 647. http://aces.nmsu.edu/pubs/_circulars/cr-647/welcome.html accessed 6/23/2016.

- Hawaii is a highly invaded system with many invasions restricted to only one or a few islands, which state and national agencies are trying to stop from spreading and becoming naturalized.
- The DEIS does not include any specific control measures for the introduction of exotic species to Kaua'i, nor does it contain information on the education that will be given to staff on how to recognize harmful species if they are introduced.
- On page 1-4, the DEIS states that the pasture system will grow 70% of the feed needs of the cattle. They do not clarify where they will obtain the feed for the remaining 30%. Feed shipments frequently carry exotic seeds[39] which are difficult to quantify.[40] Cattle can then spread the exotic seeds by transporting them through endozoochory.[41] A statement explaining where the additional feed is coming from and how it is being checked for exotic species is necessary. In addition, the development of a management plan and strategy for mitigation should have been part of the DEIS.
- Little fire ants (*Wasmannia auropunctata*) are an invasive pest on the Big Island that is being strictly controlled to reduce spread. When transporting equipment, feed or invertebrates such as dung beetles from the Big Island, what methods will be used to control ant introductions? The DEIS did not perform any analysis or propose any management options to mitigate the risk.
- Big-headed ants (*Pheidole megacephala*) are an aggressive pest species in Hawaii and were found on site. They can infest buildings and greatly increase their population, which will have deleterious effects on native populations of arthropods. The DEIS provides no information as the methods that will be employed to mitigate this population increase.
- The Coqui frogs *(Eutherodactylus coqui*) are only found in a few locations on Kaua'i but are an invasive species listed as a rapid response species[42] that can be transported on

[39] Thomas, A. G., A.M. Gill, P. H.R. Moore, and F. Forcella. 1984. Drought feeding and the dispersal of weeds. Journal of the Australian Institute of Agricultrual Science 50: 103–107.

[40] Weller S, Florentine S, Sillitoe J, Grech C, McLaren D, Chauhan BS. Detecting the Seeds of *Nassella neesiana* in Large Round Hay Bales, by Means of Non-Destructive Core Sampling. Li M, ed. *PLoS ONE*. 2015;10(9):e0137343. doi:10.1371/journal.pone.0137343.

[41] Vignolio O.R. and O.N. Fernández. 2010. Cattle dung as vector of spreading seeds of exotic species in the Flooding Pampa grasslands (Buenos Aires, Argentina). Annales Botanici Fennici 47: 12–22.

[42] http://dlnr.hawaii.gov/hisc/info/invasive-species-profiles/coqui/

vehicles or when moving plants. The Waiopili Stream and other water features proposed and insect populations that will be supported on the HDF land will support a large population of Coqui. The DEIS does not contain a management plan or proposed mitigation strategy for the staff to be trained to recognize this species (or other invasive species) and react if they are introduced.

- Jackson's chameleon (*Chamaeleo jacksonii*) has not yet been introduced to Kaua'i but is found on other islands. Depending on how materials, equipment, feed, etc. are moved from various islands to the proposed HDF facility, this species may be introduced by HDF construction or operations.

3.0 US Fish and Wildlife Service Recommendation letter and Response to Recommendations

In a six-page letter from Aaron Nadig, USFW Island Team Manager, to Jeffrey Overton,[43] the USFW listed concerns and recommendations for the proposed HDF project. Their concerns were for the potential impacts of many important, threatened or endangered species including:

- Hawaiian black-necked stilt (*Himantopus mexicanus knudseni*)
- Hawaiian moor hen (*Gallinula chloropus sandvicensis*)
- Hawaiian coot (*Fulica alai*)
- Hawaiian duck (*Anas wyvilliana*)
- Hawaiian goose (*Branta sandvicensis*)
- Hawaiian Hoary bat (*Lasiurus cinereus semotus*)
- Hawaiian petrel (*Pterodroma sandwichensis*)
- Newell's shearwater (*Puffinus auricularis newelli*)
- Band-rumped storm petrel (*Oceanodroma castro*)
- Kaua'i cave wolf spider (*Adelocosa anops*)
- Kaua'i cave amphipod (*Spelaeorchestia koloana*)
- Ohai (*Sesbania tomentosa*)

[43] US Fish and Wildlife (USFW). 2015. Comment letter from Aaron Nadig, Island Team Manager to Jeffrey Overton concerning USFW concerns of the Proposed Hawai'i Dairy Farm project, dated 23 February 2015.

In additional to their concerns over potential impacts from the proposed project to these species, the letter offered management recommendations and mitigation strategies to reduce or eliminate impacts[44]. Several of these management recommendations included:

- Covering the settling and storage ponds to reduce the attraction of waterbirds and geese to reduce or eliminate damage from collision, increased predation, and reduced reproductive success.
- Control of non-native predators such as feral cats and rats.
- Elimination of electric fencing in the paddocks to reduce or prevent adult and juvenile waterbirds from becoming entangled or colliding with the fencing.
- USFW had concerns about the increased impacts from *Clostridium botulinum*, a bacteria commonly occurring in nutrient-rich substrates, and the potential impact to waterbirds and geese by avian botulism. They recommended that a management plan be developed to address these concerns.
- USFW had concerns about impacts during construction and operation to nesting habitat of waterbirds and geese (in particular the Hawaiian goose). They recommended that a management plan be developed to address these concerns.
- Elimination of the use of barbed wire to reduce or eliminate the impacts to the Hawaiian Hoary bat that could impact the foraging of insects in the pastures by populations adjacent to the proposed project area.
- USFW had concerns about the attraction of seabirds by artificial lights, which would increase collision risks in utility lines, guy-wires, and communication towers. They recommended that artificial lighting be used with the installation of motion sensing equipment or shielding of the light when sensors cannot be in installed. Utility lines, guy-wires, and communication towers should not be used, or when necessary they should be carefully sited.
- USFW had concerns about the impacts to important, threatened and endangered animals from the toxic release of chemicals, nutrients, and pesticides from the HDF construction

[44] US Fish and Wildlife (USFW). 2015. Comment letter from Aaron Nadig, Island Team Manager to Jeffrey Overton concerning USFW concerns of the Proposed Hawai'i Dairy Farm project, dated 23 February 2015.

and operation. They recommended that a management plan be developed to address these concerns.

A response letter from Jeffrey Overton to Aaron Nadig[45] addressed some of the concerns raised by USFW; however, most of the items that were raised or recommended by USFW were ignored in the response letter and several of the items that were proposed by Jeffrey Overton in his letter as mitigation strategies were in direct conflict with the USFW concerns or recommendations. For example, the response letter proposed the use of electric fencing for the paddocks, which is in conflict with the USFW concern for the protection of waterbirds and geese (specifically the Hawaiian goose). Other responses provided minimal details and were insufficient as to USFW's concerns or recommendations.

While the recommendation letter and response letter are presented in the appendices of the DEIS, the main body of the DEIS failed to provide an assessment of the USFW concerns and recommendations. The DEIS is insufficient in providing necessary analysis to the potential impacts from the proposed project as well as inadequate in providing management options and mitigation strategies to reducing potential impacts that may occur from the proposed project.

4.0 Limitations

The information upon which we rely in preparing this report is from the HDF DEIS and from publicly available information. We have generally not verified these data independently and, unless otherwise stated, assume that they are accurate. In addition, some of the data and information generated or reported by the HDF is unclear, and we have interpreted that information to the best of our ability. This report summarizes work performed to-date and presents the findings resulting from that work. We reserve the right to supplement this report and to expand or modify opinions based on review of additional material as it becomes available.

[45] Group 70 International. 2016. Response letter from Jeffrey Overton to Aaron Nadig, USFW Island Team Manager on USFW recommendations for the proposed Hawai'i Dairy Farm Project.

Appendix F

Comments on Animal and Manure Management

in Hawaiʿi Dairy Farms Draft Environmental Impact Statement

July 2016

Prepared for

Goodsill Anderson Quinn & Stifel LLP

Prepared by

Deanne Meyer, Ph.D.

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TABLE OF TABLES

I. EXECUTIVE SUMMARY

This report addresses the completeness and correctness of animal and manure management information presented in the current Draft Environmental Impact Statement (DEIS) prepared for Hawaiʽi Dairy Farms (HDF) and their associated Waste Management Plan as referenced in the DEIS.

The DEIS does not provide sufficient detail to adequately evaluate potential direct and cumulative impacts from the proposed project. Insufficient or incorrect information was provided on animal numbers, animal productivity, estimates of feed intake, estimates of nutrient composition of feed intake, and pasture management to determine project impacts. This report therefore estimates manure and nutrient excretion quantities using ASABE Standard Values. This information is critical to assess increases in nutrients at the proposed dairy location, throughout Kauaʽi where animals are reared offsite, and the potential for nutrient runoff or infiltration.

Milk production drives dry matter intake (the amount of feed eaten after subtracting water). Higher producing cows eat more. As milk production increases, nutrient density of the diet increases. Kikuyu nutrient composition is unbalanced for dairy cattle as a sole feedstuff. Mineral concentrations of calcium and sodium are lower in this forage while nitrogen, potassium, phosphorus, chloride, and iron concentrations are typically fed in excess. HDF will be forced to rectify deficiencies in nutrient composition of forages through concentrate feeding and additional salt feeding. HDF has failed to provide information regarding, and evaluate impacts from supplementation with grain concentrates. These off-island feed sources will import nitrogen and salts. HDF failed to estimate nutrient imports. Pasture management practices (fertilization and topping) as well as rotation and grazing objectives are not provided in sufficient detail to determine pasture yields throughout the year to allow assessment of nutrient uptake abilities of kikuyu.

II. BY PROPOSING THIS PROJECT IN HAWAIʻI, HDF AVOIDS MORE STRINGENT REQUIREMENTS APPLIED BY OTHER JURISDICTIONS.

The DEIS provided by HDF fails to include detailed technical information required by regulators in California to assess nutrients and water cycling, animal and manure management and potential impact to existing water resources (quantity and quality) associated with the direct and cumulative impacts of the operation. Additionally, absent a regulatory permit foundation, there are no checks and balances established to mitigate predicted or unpredicted impacts from the facility once built.

California regulations are not applicable to HDF, which has chosen to propose this dairy in Mahaulepu. Hawaiʽi regulators, however, should consider that water quality and air district regulatory agencies in California have enacted extensive regulations to restrict, manage, and require mitigations of dairy impacts on natural resources. In evaluating approvals for HDF, Hawaiʽi governmental authorities should be mindful that because Hawaiʽi has not been subject to impacts from small or large scale dairy operations such as those in California, Hawaiʽi does not have the regulatory systems in place to ensure its communities are protected. With this knowledge in mind, additional careful scrutiny of the impacts from HDF's proposed dairy farm are required. For the benefit of Hawaiʽi regulators, and to provide an overview of regulatory requirements for dairies in other jurisdictions, some of the California regulatory requirements for new dairies are summarized below.

The DEIS prepared for HDF does not provide sufficient detail to adequately evaluate potential direct and cumulative impacts from the proposed project. If this new dairy (or an expansion of an existing dairy) was proposed in California, an Environmental Impact Report (EIR) to comply with the California Environmental Quality Act is a mandatory process regardless of the number of cows associated with the project, since a discretionary land use permit is associated with changing land use from one agricultural activity to a dairy operation. For a California project, the EIR would include all technical appendices necessary to evaluate the potential impacts (direct and cumulative) of the project and permit application documents with detailed calculations and assumptions would be available for review. Through the cumulative analysis, impacts of all animals associated with the project (including animals reared offsite) would be included in the analysis. Applicant information addressing hydrological setting for the project site includes flood control, runoff, drainage, and water quality and are required. This section includes a detailed analysis of salt loading (cations and anions) as a result of the project (imported feed and fertilizers as well as salts from groundwater, if present). Analyses of potential impacts due to construction and daily operation are necessary. Detailed information related to manure source generation and nutrient management (through the production facility and land application areas) is available from the permitting agency if not included in the document. Typically, all calculations necessary to determine impacts to air quality are provided or details are accessible through sources referenced. Stationary and mobile sources from building, agricultural and dairy operations are detailed for Particulate Matter of 10 microns in aerodynamic diameter (PM10) from fugitive dust, exhaust emissions from dairy and agricultural equipment, emissions from manure decomposition, emissions from cattle, and localized and regional emissions from motor vehicle use associated with the project. Additional components are required.

In each section of the EIR, an area is devoted to project consistency with existing plans or policies, a clear definition of criteria to determine significance, as well as impacts and mitigation measures.

Most grazing dairies in California are coastal dairies. Although there is an acknowledgement that the Federal Clean Water Act has specific requirements for dairy operations that meet the permitting threshold of 699 milking and dry cows, the State Water Resources Control Board and each of the Regional Water Quality Control Boards require that all dairy operations including pasture operations seek coverage through Waste Discharge Requirements or Conditional Waiver of Waste Discharge requirements. The minimum standards for compliance are compliance with existing State regulations found in California Code of Regulations Title 27.

The most recently adopted General Order by the San Francisco Bay Regional Water Quality Control Board, 2016 that will include milk cow, sheep and goat dairy operations in a grazing environment with low threat to water quality includes protection of manure storage areas from inundation during a 100 year flood, development and implementation of a surface water monitoring program (data submitted annually for review), conducting visual inspections, grazing operation monitoring and reporting, and groundwater well testing (data submitted in Annual Report). Compliance with Title 27 regulations is required. This Order includes commercial horse operations and other livestock and poultry operations. As per existing regulatory requirements, existing dairies with low threat to water quality must complete a Grazing Management Plan and Waste Management Plan during 2017 and a Nutrient Management Plan by 2019. Large facilities (>699 milking and dry cows) must submit Nutrient Management Plans prior to being enrolled. For existing facilities, any facility that is greater than a low threat to water quality must complete a detailed schedule for improvements and updates within each Annual Report. New facilities need to submit all necessary Plans for review prior to construction and comply with CEQA analysis. The entire record is available for public review and comment. If a proposed new facility does not meet the requirements of the General Order, then it may seek coverage under an Individual Order typically requiring a more intensive monitoring and reporting program as it is by definition a greater threat to water quality.

III. HDF HAS FAILED TO PROPERLY QUANTIFY MANURE PRODUCTION AND NUTRIENT EXCRETION

HDF failed to estimate excretion of animals utilizing Standard D384.2 Manure Production and Characteristics (ASABE, 2005). ASABE Standard values and equations are utilized by consulting engineers and the USDA Natural Resources Conservation Service staff when estimating excretion unless actual dietary and milk production information are provided for a herd. This Standard provides equations for N, P and K excretion from most production stages of dairy animals. The Standard assumes animals are fed within 113% of crude protein requirements (used to estimate Nitrogen). Milk production amounts for lactating cattle and body weight values for non-lactating cattle (dry cows and replacement heifers) are required inputs.

In the absence of an estimate from HDF, this report estimates nutrient excretions based on ASABE Standard equations (Table 1). Given the reported concentrations of N, P and K of kikuyu in the DEIS it is likely that N and K excretions will be much larger than those estimated in Table 1 and depending on total dietary P, it will be greater as well. This is likely due to concentrations of these nutrients being overfed beyond recommended amounts.

Table 1 Manure and nutrient excretion estimates from dairy animals.

		Pounds excreted per animal day			
		Manure	N	P	K
Lactating cow (42 lbs milk/day)		122[1]	0.80[1]	0.13[1]	0.14[1]
Dry cow		75.56[1]	0.66[1]	0.08[1]	0.25[2]
Replacement heifers/steers (400 to 1000 lbs)[3]		51.80[1]	0.39[1]	0.08[2]	0.19[2]
Replacement heifers/steers (150 to 400 lbs)[3]		18.70[1]	0.14[1]	0.04[2]	0.09[2]
Calf[3]		n/a	0.04[1]	0.01[2]	0.01[2]
		Pounds excreted per 699 milking cow herd per day			
699 milking cows	Number	Manure	N	P	K
Lactating cows (42 lbs milk/day)	699[4]	85,278	559	91	98
Dry cow	133	10,049	87	11	33
Replacement heifers/steers (400 to 1000 lbs)[3]	1,248	64,643	485	99	238
Replacement heifers/steers (150 to 400 lbs)[3]	208	3,890	29	9	19
Calf[3]	208		8	1	1
		Pounds excreted per 2000 milking cow herd per day			
2000 milking cows	Number	Manure	N	P	K
Lactating cows (42 lbs milk/day)	2,000	244,000	1,600	260	280
Dry cow	381	28,784	250	32	95
Replacement heifers/steers (400 to 1000 lbs)	3,571	184,991	1,388	282	680
Replacement heifer/steers (150 to 400 lbs)	595	11,131	83	26	55
Calf	595	n/a	22	4	4

n/a indicates no data available in ASABE Standard.
Sources: [1]ASABE Standard D384.2;
[2]Mass balance calculations based on Dairy NRC 1988 estimates for input;
[3] Category identification as replacement heifers. Bull calves included in this category as HDF has provided no information to understand feeding out of bulls or steers.
[4]Animal numbers in each category are based on live births.

Nutrient Requirements of Dairy Cattle (NRC, 1988) identifies recommendations for diet formulations and intake amounts for all classes of dairy cattle. When ASABE equations are insufficient for predicting excretion (either equations don't exist or dietary concentrations are excessive as will likely occur with kikuyu feeding) mass balance calculations of feed nutrient inputs minus milk and body weight nutrient outputs are used to estimate nutrient excretion.

Table 2 illustrates the impact of different daily milk production amounts on estimated nutrient excretion for sodium and chloride. These values were calculated by the difference of estimating intake of sodium and chloride with assumed quantity and concentration of consumed feed, and estimating secretion of nutrients in milk by assumed quantity of milk and estimates of its nutrient composition. Note that for the lower production values (20 or 30 lbs of milk a day) excretions are likely underestimated.

Table 2. Estimates of nutrient excretion (pounds per head per day) from lactating dairy cows based on milk production.

	Milk Production @4% Fat Corrected Milk			
	20	30	40	50
Constituent	Estimated excretion lb/hd/d			
Sodium	0.04	0.04	0.05	0.05
Chloride	0.04	0.05	0.06	0.06

Nutrient intake based on Dairy NRC 1988 estimates for inputs. Nutrient composition based on the average bulk tank composition from 32 herds (Robinson, et al., 2011).

IV. DEIS DEFICIENCIES

A. HDF does not quantify the total number of dairy animals associated with the project.

Dairy operations have milking and dry cows. The standard assumption is that each cow is milked for 305 days of each year, and is dry (not milked) 60 days a year. 699 cows will be milked daily. 305/365 days is 84% with the 60 days comprising 16% of the year. If 699 = 0.84 of total animals then, total animals = 832. Dry cows = 832 total cows - 699 milking cows = 133. The 133 animals will be dried and removed from/returned to the facility approximately every 60 days (average 15 cows per week).

HDF fails to provide the following information:

How many days before calving will animals be transported to the dairy? If more animals are transported to the dairy than removed, then fewer lactating animals will be present if the 699 number is followed. To maintain a milking herd size of 699, more than 832 cows will need to calve per year as some animals will die or produce insufficient amounts of milk and be sold.

- What is the assumed milking cow to dry cow population?
- What is the assumed mortality rate of milking animals (milking cows that die--involuntary cull)?
- What is the voluntary cull rate of lactating animals (how many live lactating cows will be sold annually)? To maintain 699 milking cows, additional replacement animals (must be reared or purchased to fill-in for those animals removed from the milking herd in the first two years (either due to death or reduced milk production).
- How many additional animals will be reared?
- What is the mortality rate of young stock in pre-weaning, post-weaning, and post-conception categories?
- What is the age at first calving?

These numbers are necessary to account for each animal through its growth and productive cycle as well as to identify the impact of mortality on resource management.

B. HDF's Waste Management Plan Underestimates the number of calves.

Given that more than 832 animals will need to calve each year to maintain a daily milking herd of 699 cows (some cows will die at calving or during their lactation or be sent to market), and that cows will need to calve year round to maintain milk production, the number of animals 90 days of age or younger is 90/365 x 832= 205 calves. However, the modification to the WMP (dated May 25, 2016) indicates only 150 calves will be on site if under 90 days of age or 150 lbs. If animals will only be maintained until they are 150 lbs, then moving them offsite at that body weight will require the grower of the calves to supplement with grain feed (not just grazing).

The consequence of underestimating the number of calves is that one cannot determine total nutrients excreted from these animals and include these nutrients in analyses of facility balances and potential threats to water quality impairment.

C. HDF does not provide sufficient information to precisely quantify manure production.

Beyond the nutrient excretions that can be calculated using the ASABE Standard, it is possible to precisely quantify manure production. HDF has failed not only to provide this quantification, it has also failed to provide the following information necessary to quantify manure production: How much milk is produced? What is the average milk production of cattle? This information is necessary because the amount of milk production drives feed intake and feed consumption is the precursor to manure production.

The DEIS is internally inconsistent by a magnitude of 50% in defining milk production. "More than 1,000,000 gallons of fresh milk" (DEIS 1-13) and Section 4.20.2 page 4-85 DEIS "When the dairy matures to full capacity with a committed herd size of 699 milking cows, it will produce approximately 1.5 million gallons of fresh, local milk each year for the residents of Hawaiʻi. "

If milk production is 1,000,000 gallons per year and the total number of cows producing that milk is 832 (as described in deficiency A), then the average production is 1,201 gallons (10,329 lbs/cow/305 day lactation) or about 28 lbs of milk a day (assuming 1 gallon of milk is 8.6 lbs).

If milk production is 1,500,000 gallons per year and the total number of cows producing that milk is 832, then the average production is 1,802 gallons (15,504 lbs/cow/305 day lactation) or 50.8 lbs of milk a day (assuming 1 gallon of milk is 8.6 lbs).

Since HDF has failed to provide the milk production information necessary to compute manure production, Table 1 assumes an average of 42 pounds of milk per lactating cow per day, which is a bit higher than the midpoint between 28 and 50.8 pounds of milk per head per day.

D. HDF calculates manure production incorrectly

HDF has underestimated manure production. (DEIS Appendix C). Weight of daily manure production is the weight of the feces plus the weight of the urine. ASABE Standard D384.2 has equations to estimate manure production and nutrients excreted. The DEIS erroneously discounts manure production from cows during hours of resting. The Updated Waste Management Plan (May 25, 2016) indicated average cow weight of 1,200 lbs and manure production of 90.8 lbs per day. This value is located in Table 19A of DEIS Appendix C. The base assumption used in this calculation is 0.68 gallons of manure produced per hour and only 16 hours per day when manure is produced (2 during milking and 14 on pasture when not resting). When 2.2 pounds (1 kg) of milk are inserted into the ASABE equation, the daily estimate of manure production is 96 lbs/hd. This value is greater than the DEIS quantity. Assuming a 24 hr period and using the .68 gal of manure per hour, the estimate of manure excretion would be 16.32 gallons (assuming 8 lbs/gallon then 130.5 lbs/hd/d). The data used to develop the ASABE equations were collected from animals where feces and urine were collected over multiple 24 hr periods. This is important because equations estimate excretion amounts per day (24 hr period) not per non-resting hr.

The value provided for manure production in the DEIS (Appendix C) is below manure excretion estimates from the animals in the data set used to develop the ASABE equations. The DEIS fails to identify assumptions used to calculate such low manure production numbers. The DEIS also fails to provide its calculations. Table 3 provides a comparison of estimates of manure and nutrient excretion from milking cows as calculated from ASABE equations for the low and high range of estimated milk production assuming the 823 cows lactating during the year and the 1,000,000 or 1,500,000 gallons of milk production. Given the elevated concentrations of potassium in kikuyu, it is assumed the excretion estimate for potassium using the ASABE equations is an underestimate. This may hold true for nitrogen (N) and phosphorus (P) as well depending on the daily quantity and their concentrations in supplemental feeds.

Table 3. Comparison of estimates of manure and nutrient excretions by using the ASABE equations and to information presented in the HDF DEIS.

ASABE equations for milking cows assuming 22.9 kg milk production per day (value for 15.5 kg /hd/d)	**Table 18A or 19A page 57 Nutrient Balance Analysis**
Manure production Kg/hd/d=(milk x .647) + 43.212 128 lbs/hd/day (117 lbs/hd/day)	Table 19A page 57 Nutrient Balance Analysis 90.8 lbs/hd/day
Nitrogen (N) excretion [1] g/hd/day= (Milk x 4.204) + 283.3 0.83 lb N/hd/day (.77 lbs N/hd/day)	**Table 18A page 57 Nutrient Balance Analysis** 0.546 lbs-N/cow/day

Phosphorus (P) excretion [1] g/hd/day= (milk x .773) + 46.015 0.14 lbs P/hd/day (.125 lbs P/hd/day)	**Table 18A page 57 Nutrient Balance Analysis** .11 lbs-P/cow/day
Potassium (K) excretion [1] g/hd/day= (milk x 1.8) + 31.154 0.16 lbs K/hd/day (.13 lbs K/hd/day**)**	**No data provided.**

[1]Based on the N and K concentrations of kikuyu grass (DEIS Appendix C Kikuyu is 3.2% N, .57% P, and 4.5%K), these will likely be excreted in higher amounts as they will likely be consumed in higher amounts.

E. HDF underestimates nutrient output from the proposed dairy project.

Mass balance of nutrients available for use:

HDF has underestimated nutrient output from the proposed dairy project by ignoring excretions from replacement animals, dry cows and heifers. As indicated in Table 1, the nutrients excreted from dry cows and heifers associated with this project are a significant contribution to the overall nutrient load from this project. The replacement animals and dry cows would not exist on other farms absent the dairy. Why were these excretions ignored? Comparison of estimates of N and P excreted from lactating cows (Table 3) from estimated values from ASABE tables or from the DEIS indicates the DEIS underestimated N and P excretions for these animals. The nutrient composition identified for kikuyu grass suggests that the ASABE values would likely underestimate N, P and K excretion further.

F. HDF has not provided sufficient information to assess nutrient mass balance at paddock scale.

HDF has failed to provide sufficient information to assess nutrient mass balance at the paddock scale. In order to calculate the mass balance of nutrients applied to and removed from paddocks, the following information is necessary: Number of irrigated acres by irrigation type, nutrient applications (rate, timing, and nutrient composition) for all sources applied to or deposited on (manure, fertilizer, water), must be known to estimate nutrients applied. Additionally, productivity of each paddock type and nutrient composition of forage harvested by cattle must be known to estimate nutrients consumed.

Land management---

One great challenge of pasture systems is the non-uniform application of manure. Feces and urine are deposited as excreted. These locations have higher amounts of nutrients than areas where no feces or urine are deposited. Non-uniform nutrient applications combined with periods of excess water applications (rain events) can exacerbate nutrient leaching beneath plant root zone to underlying groundwater.

The DEIS Appendix C page 40 identifies that each mob will rotate through a group of 18 paddocks on a one paddock per day rotation with 105 to 115 animals per paddock. If 6 mobs are utilized, then 108 paddocks will be used for forage consumption by the lactating cows. Which of the 119 paddocks will be used for lactating cows? What yields are expected from the non-irrigated paddocks? How will manure management and nutrient incorporation occur on the non-irrigated paddocks? Paddocks 209-211 are

not irrigated; Parts of 231, 214, 133, 134, 238, 237, 149, 118, 122, 161, 160 and most or all of 135, 136, 137, 138, 239, 145, 146, 147, 148, 162, 120, 121, 119 are not irrigated. What yield differences are anticipated between pivot, gun and non-irrigated paddocks? How will nutrient applications be modified to account for more manure application if some paddocks are used more frequently than others? This information is necessary to adequately evaluate mass balance of nutrients (applied and removed) from each paddock in order to quantify the mass of nutrients available for potential infiltration or runoff during rain events.

A recent review of kikuyu-based dairy systems (Garcia et al., 2014) clearly indicated that pasture growth rate changes during the course of a year. Kikuyu growth rate should drive grazing management and not the cows' requirement or the farmers' preference. When pasture is not managed well then more grain will be brought in (increase nutrients imported to the Island, decrease resiliency of pasture after storm events, etc.) potentially contributing to adverse impacts to water quality.

What is the difference in yield and nutrient/nutritional value of the forage grown in an 18 day period throughout the year? Nutrient and chemical composition of the forage will vary during different parts of the growing season (Garcia et al., 2014). What are these variations? How will they impact forage intake, the need for supplemental nutrients and manure production/nutrient cycling? It is important to know this forage information because overly mature forages will not be consumed as readily by cattle. They may be trampled or mowed with associated nutrients cycling back into soil or leaving through runoff. Additionally, plots analyzed through mechanical harvest (clipping or mowing) traditionally have higher yields that those harvested by animals. Also, changes in forage composition during the growing season will likely alter the ability of animals to consume the forage thereby requiring additional supplementation and the need to manage residual material not consumed.

If the 108 paddocks are sufficient to support milk production for 105 to 115 cows per mob, then how will the same forage production support milk production for 300 to 330 cows per mob? How much additional feed will need to be imported from off Island? If there is sufficient forage for 300 to 330 cows per paddock, how will the unconsumed forage be managed to maintain forage quality and productivity when only 105 to 115 cows per mob are used? No information is provided to identify how unconsumed forage will be handled. Will it be mowed? If so, how will these nutrients be incorporated into the nutrient management plan? If not, how will grass productivity be maintained over time? How will pasture productivity be maintained to minimize offsite discharge of manure nutrients during rain events? Which paddocks will be used by calves and what is the nutrient cycle estimate from manure and other nutrient sources on these paddocks? This information is necessary to enable assessment of nutrient cycling on paddocks and potential quantity of nutrients leached to groundwater or contained in storm water runoff.

G. Animal Cemetery

Detailed representation of animal mortality and estimates of nutrient load in the designated animal cemetery are needed to define the amount of nutrients that will likely contaminate groundwater as these mortality are being inserted into the ground and no growing crop is consuming the nutrients. What is the anticipated animal mortality at the location? Why is no information provided on the animal cemetery's potential contributions to water quality degradation given the high precipitation amounts?

How will mortality be handled during rain events that prohibit insertion into the cemetery to minimize impact to surface water? What mitigation measures will be in place to protect nutrients from leaching from the cemetery into underlying water? How many animals will be buried? Will individual or common plots be used? Note: the recently adopted regulatory process by the San Francisco Bay Board (2016) prohibits the disposal of dead animals at a facility. In Michigan, where burial is an acceptable practice, restrictions exist specific to burial: time from death to internment unless refrigerated; depth of soil overlay; maximum number of individual graves per acre and a restriction of maximum tons per acre; separation width between plots; detailed restrictions if common burial plot is used.

H. HDF has failed to describe or quantify offsite impacts.

Manure and nutrients excreted from dry cows, replacement animals and bulls and steers associated with the dairy are ignored. What is the cumulative manure/nutrient excretion on Island of the dairy? What is the manure/nutrient excretion of dry cows, and most replacement heifers, as well as bull calves or steers reared elsewhere on the Island? For 699 milking cows, approximately 133 dry cows are housed offsite on any given day. What is their nutrient excretion?

Detailed information is needed to estimate additional animals on Island associated with the proposed dairy. One needs to know the annual calving rate, mortality rate of cows, and mortality rate of young stock to determine number of replacement heifers and bulls/steers relocated throughout the Island. Although castrated males (steers) can be grown for beef, they will not yield a similar sized carcass as other beef animals on the Island as the animals have been genetically selected to produce milk and not muscle (beef). If 832 cows calve a year and all survive, and the distribution is one-half male, one-half female, then 416 or 416 animals will be male and female. Females (heifers) will be reared until they are bred, and return as animals ready to calve. What age are heifers due to calve? Assuming 24 months, then for every cow milking or dry, there are an equal number of heifers growing up (832). Although the DEIS (3-18) indicates “cows tend to be healthier and live longer productive lives with access to fresh air, high quality feed, and exercise while they forage” the reality is that if female offspring are incorporated into the herd, then cows need to be culled (either voluntary or involuntary) to maintain a given herd size. If lactating cows live longer, then heifers will enter the beef supply chain to maintain a cap on lactating cow numbers. Heifers are slower than steers at becoming market ready. What age is the anticipated finishing time for the steers? If it’s 18 months, then some 624 steers are present. If it takes 24 months to finish cattle then 8323 steers are present after the second year of the dairy operating. Will supplemental grain be needed to finish market animals? What is the additional nutrient load to the Island associated with supplemental feed brought in to finish market animals? How much manure will be produced by these animals? How much nutrient excretion will be contributed to each watershed by these animals (nitrogen, phosphorus, potassium, salts)? How and what will calves under 6 months of age be fed when housed away from the dairy? What is the manure production from these animals? What additional nutrients will be imported to the Island to provide feed before these animals are able to consume all their nutrients from pasture (typically near 6 months of age).

I. HDF failed to establish management measures for stream buffers.

HDF’s DEIS inconsistently defines stream setback distances. Is the intended setback distance for vegetated buffers 35’ or 50’? The DEIS 3-29 identifies 50’ from top of bank of the water resource on both sides (irrigation ditch, agricultural water, natural water resource). Other locations within the document identify 35’ setback of paddock fencing from top bank of the water resources on both sides (e.g. DEIS Appendix 3 page 21). How will these vegetated buffers be managed? Will they be irrigated?

Will they be mowed? If vegetative buffers are mowed, will the plant matter be left to decompose and potentially infiltrate to groundwater or runoff to surface water or will it be removed?

J. HDF has inconsistencies in representing and underestimates vehicle trips that will enter or leave the dairy daily.

Why are there inconsistencies in vehicle trips? Why is there no detailed list of vehicle trips to provide sufficient information for the public to review? DEIS 4.18.1 indicates the projected increase in vehicle movements related to HDF operations includes daily employees accessing the site, milk tanker and supply trucks every two days, and truck with stock trailer, for a total of 12 additional vehicle trips per day. The DEIS indicates these additional trips would have a minimal effect on traffic conditions at County roadways in the surrounding area. However, weight loads and driving speeds of vehicles with livestock need to differ from the standard rental car to accommodate road safety. Why was time of day of livestock movement and local traffic patterns and potential nuisance to adjacent land operations not evaluated?

HDF’s DEIS states at page 4-85 “Offsite Transportation. Employees working at HDF will create five offsite vehicle trips each day. Transport of cows for herd management will involve one or two truck trips per day between HDF and the offsite ranches. Fluid milk will be trucked offsite once every two days. Sand and feed delivery would generate three truck trips per week. Fertilizer would be delivered once every other month. Milk transport from Kaua‘i would be once or twice each week via regularly scheduled ocean barges departing from Nawiliwili Harbor. Offsite transportation associated with HDF operations is not anticipated to generate significant secondary effects.”

If five employees have offsite vehicle trips, they must first come to the site. Five people arriving at work and departing to home equals 10 vehicle trips. High labor needs will be associated with moving cattle to and from the milking parlor and milking animals. The DEIS indicates the milking parlor will hold 60 cows and take 8 to 10 minutes per rotation, so the 699 cows would require 12 rotations (up to 2 hours). Add time to set up and clean up at the end of a shift, and shift time is between 2.5 and 3 hrs, twice daily. Why is there no detailed list of employee categories and estimated work hours to determine if the individuals who move or milk cattle have complete shifts or split shifts where they leave the farm and return (increasing vehicle trips)?

Transportation of cattle offsite will likely involve 1 trailer (coming to and leaving the farm each day) for dry cows or dried cows near calving, resulting in 2 vehicle trips per day. In actuality, depending on management, dry cows may be removed daily from the dairy and animals ready to calve may return daily or less frequently. Estimated animal removal and return processes are important to determine vehicle emissions. HDF will likely use 1 trailer or pickup with racks at less frequent intervals retrieving calves (perhaps every other day) and a truck with trailer returning heifers ready to calve.

Additional service professionals who will logically visit the facility at prescribed intervals include: veterinary services, equipment dealer services (milking equipment in the parlor and the equipment area), inspectors and other services needed to operate a dairy (refuse removal, delivery of supplies, laundry, etc.). HDF has failed to account for this transportation.

K. HDF has failed to quantify solid waste impacts

Other

Milk and managing dairy cattle is intensive. Solid wastes will be generated and end up in landfills, recycled, or composted. What are the impacts of solid waste to landfill capacity? How many feed/supplement bags, chemical containers (herbicides, pesticides, sanitizers for milk equipment, teat dip), paper towels (or clothes that are washed) will be generated? What other solid waste will be generated? How will expired pharmaceutical waste be disposed? HDF has failed to consider these issues.

L. HDF Failed to Consider Reasonable Alternatives

The list of alternatives for the project focused solely on alternative activities for the specific location. Why were no alternative locations for the project identified on Island? Why didn't HDF consider installation of more dairies with fewer animals per location? The amount of run-on water that will need to be managed to flow around animal paddocks is sizeable at the proposed location. Locations in the western side of Kaua'i topographically lend themselves to dairy grazing operation due to the flatter topography.

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Appendix G

Environmental & Earth Sciences

Water and Water Quality Impacts, Hawai‘i Dairy Farms DEIS, Māhā‘ulepū, Kaua‘i

Water and Water Quality Impacts, Hawai‘i Dairy Farm DEIS, Māhā‘ulepū, Kaua‘i

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Acronyms and Abbreviations

cfs	cubic feet per second
BMP	Best Management Practice
DEIS	Draft Environmental Impact Statement
DEM	Digital elevation model
gpd	gallons per day
GIS	Geographic Information System
GPS	Global Positioning System
HDF	Hawai'i Dairy Farm
HDOH	Hawaii Department of Health
Kawailoa	Kawailoa Development LLP
MG	Million gallons
mgd	million gallons per day
NRCS	Natural Resources Conservation Service
NPDES	National Pollutant Discharge Elimination System
SCS	Soil Conservation Society
SWMM	Storm Water Management Model
WMP	HDF Waste Management Plan

Executive Summary

Exponent was retained to evaluate the anticipated impacts of the proposed Hawai‘i Dairy Farms (HDF) facility on water resources and water quality. Exponent relied upon information from the Draft Environmental Impact Statement (DEIS) (Group 70 International, 2016a) and information obtained from public sources as the basis for hydrologic modeling to simulate the water balance at the site; to analyze the expected impacts of the project on groundwater and surface water resources; and to evaluate the proposed management practices of the HDF.

Exponent found that the DEIS evaluated runoff and water quality impacts to groundwater and surface water, including to the Waiopili Stream and the ocean, using overly broad, general assumptions, and without considering important hydrologic processes and data. The HDF DEIS makes significant and unfounded assumptions regarding the quantity of nutrients (nitrogen and phosphorus) that are expected to leave the site by surface and groundwater flows, and does not adequately consider impacts due to pathogens from manure at the facility. The DEIS fails to evaluate impacts related to erosion and the transport of sediment and other potential contaminants to the nearshore ocean.

Although the DEIS asserts that the best management practices (BMPs) proposed to address water quality impacts will minimize water quality impacts, BMPs are not described in detail, and their effectiveness is not modeled or quantified. It is not clear that the wastewater management practices proposed for the ponds at the facility are adequately designed or how they will be operated, and it is likely that the effluent ponds onsite will exhibit poor water quality and produce noxious odors. It is also not clear that the proposed on-site effluent handling measures, which involve the distribution of both liquid and solid manure at the site via the site irrigation systems, are feasible or that they could be implemented without exacerbating water quality impacts.

Although baseline water quality sampling is reported in the DEIS, water quality data for existing conditions are not adequate to describe the full range of conditions; notably, the limited sampling that was conducted did not include wet weather events. The DEIS does not describe

how baseline monitoring will be used, the monitoring and sampling regime proposed to evaluate project impacts, whether sampling data gathered after the project is implemented will be shared with agencies or the public, or the actions that will be taken if water quality impacts are observed.

The proposed irrigation practices at the site will cause a significant increase in the amount of water applied to the site. We found that the poorly drained soils over much of the site are expected to be saturated, or nearly saturated, much of the time, including in the area of the site where manure solids are proposed to be applied as a slurry via gun irrigation. As a result of the soil types and irrigation practices proposed for the facility, the amount of water leaving the site as surface water runoff will increase. Our analysis also identified the likelihood of significant water quality impacts due to nitrogen, phosphorus, pathogens, and sediment. These water quality impacts may, in turn, result in impacts to coral, marine life, and human health (see also Exponent, 2016a and Exponent, 2016c). The HDF can be expected to cause exceedances of water quality standards that would not have occurred without the project and to result in degradation of the Waiopili Stream and the ocean.

Introduction

Project Background

Exponent was retained by Goodsill Anderson Quinn & Stifel LLP on behalf of Kawailoa Development LLP (Kawailoa) to review information related to a proposal by Hawai‘i Dairy Farms (HDF) to construct and operate a dairy farm on the island of Kaua‘i, Hawaii. Specifically, Exponent was asked to evaluate impacts of the proposed dairy farm on water resources and water quality, which is the subject of this report. Exponent was also retained to prepare separate reports to evaluate impacts related to odor and air quality, ecological impacts, and pathogens (Exponent, 2016a, 2016b, 2016c).

In May 2016, HDF submitted a Draft Environmental Impact Statement (DEIS) for the dairy farm project at Māhā‘ulepū (Group 70 International, 2016a). The DEIS included sections and supplementary reports on groundwater and surface water impacts of the project (TNWRE, 2016; MRC, 2016; Group 70 International, 2016b). These documents, together with documents provided by Kawailoa or obtained from public sources, form the basis of the evaluations presented in this report.

HDF proposes a 557-acre dairy farm in the Māhā‘ulepū Valley on the southeast portion of the island of Kaua‘i, near Po‘ipū (Figure 1) (Group 70 International, 2016a). The site receives rainfall-runoff from surrounding steep hillsides, and it is drained by an existing network of agricultural ditches that ultimately convey runoff to the ocean by way of the Waiopili Stream. The dairy farm would support 699 mature dairy cows at first (the proposed project) with the possibility of expanding to support 2000 cows in the future (the contemplated project).

The farm would mostly consist of open paddock areas (469.9 acres). Kikuyu grass would be grown in the paddocks for cattle grazing. The farm would also include several new structures on a 9.7-acre “headquarters” parcel near the western boundary of the site, including a milking parlor, a calving shed, and an implement shed (Figure 2).

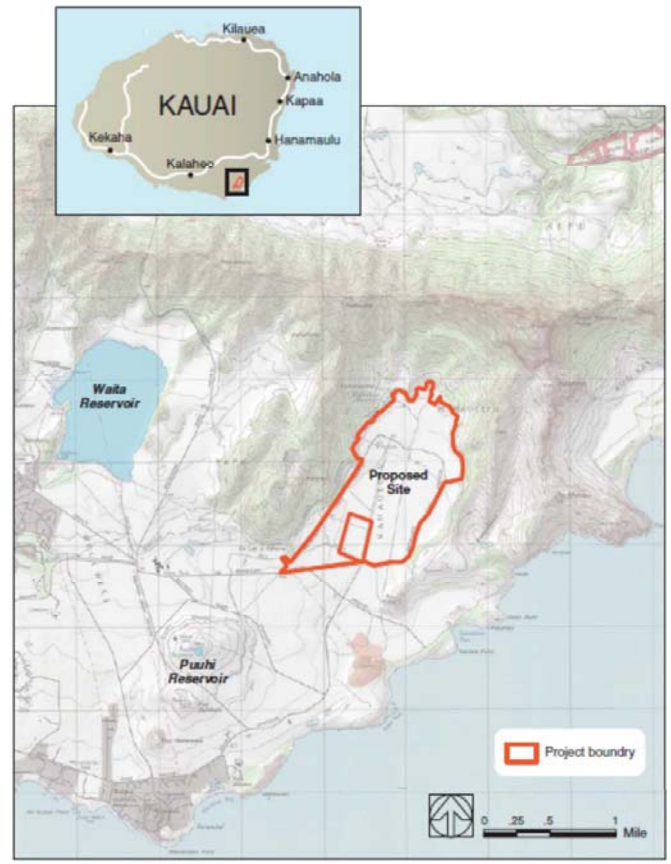

Figure 1. Location of proposed dairy farm at Mahaulepu

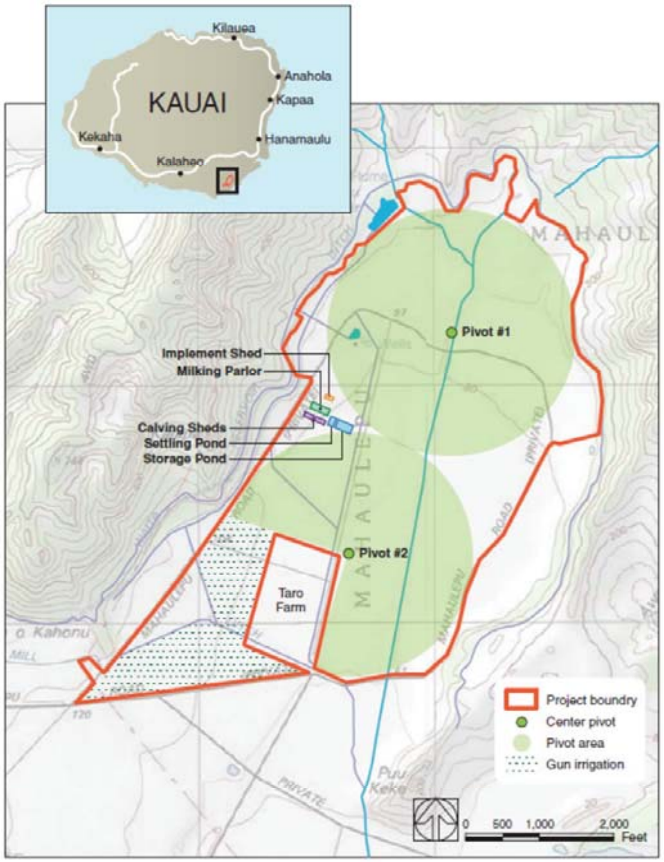

Figure 2. Irrigation areas and proposed structures – dairy farm at Mahaulepu

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Potable water from several existing groundwater wells would be used to wash down the cattle waste generated in the milking and calving facilities. Wash water would flow to a settling pond and storage pond to be reused onsite.

An irrigation system would be implemented to irrigate most of the site (346.5 acres), using water conveyed from the nearby Waita Reservoir and water collected in the two ponds (Figure 1, Figure 2). The irrigation system would include "two central pivots that feed water to an overhead, rotating sprayer supported by trusses mounted on wheeled towers that rotate in a 1,000-foot diameter. Nozzles are suspended several feet from the ground to direct water directly onto the pasture grass" (Group 70 International, 2016a, pp. 3–25). Pivot #1 would rotate 360 degrees while Pivot #2 would rotate roughly 270 degrees (Figure 2). The pivot irrigation system would be controlled by software that employs a Global Positioning System (GPS) and that is intended to apply irrigation water in pasture areas and not in drainage ditches or ditch buffer areas. In addition to the two central irrigation pivots, reel gun irrigation would be used to irrigate an area in the southwest corner of the site (Figure 2), and a gun irrigation system is proposed to apply a slurry of manure solids from the settling pond (see Figure 3, Figure 4, and additional description below).

As noted above, the cattle waste and wash-water generated in the 9.7-acre headquarters area (estimated to be 13,225.8 gallons per day [gpd] for the proposed project and 37,894.7 gpd for the contemplated project), along with any rainfall runoff from the 1.76 acres surrounding the structures, would flow into the settling pond where the solids in the wastewater would settle out. A stirrer pump operating two hours each day is planned to break up the solids in the settling pond. Solids are proposed to be removed from the pond roughly every 45 days and distributed as a slurry on select paddocks (Figures 3 and 4) using an irrigation gun (Group 70 International, 2014, pp. 43, 54).[1]

[1] The Hawaii Department of Health (HDOH) sent a letter to Mr. Paul T. Matsuda at Group 70 International on 15 June 2016 (HDOH, 2016) stating that wastewater effluent from the proposed storage pond should not be distributed via irrigation gun. Presumably, HDOH would also object to distributing manure slurry from the settling pond via irrigation. Thus, it is not clear that the proposed slurry distribution methodology is feasible from a regulatory perspective.

Figure 3. Manure solids slurry application areas indicated in brown, proposed HDF project (699 cows). Source: Group 70 International and Red Barn Consulting, 2016a, Figure 19A.

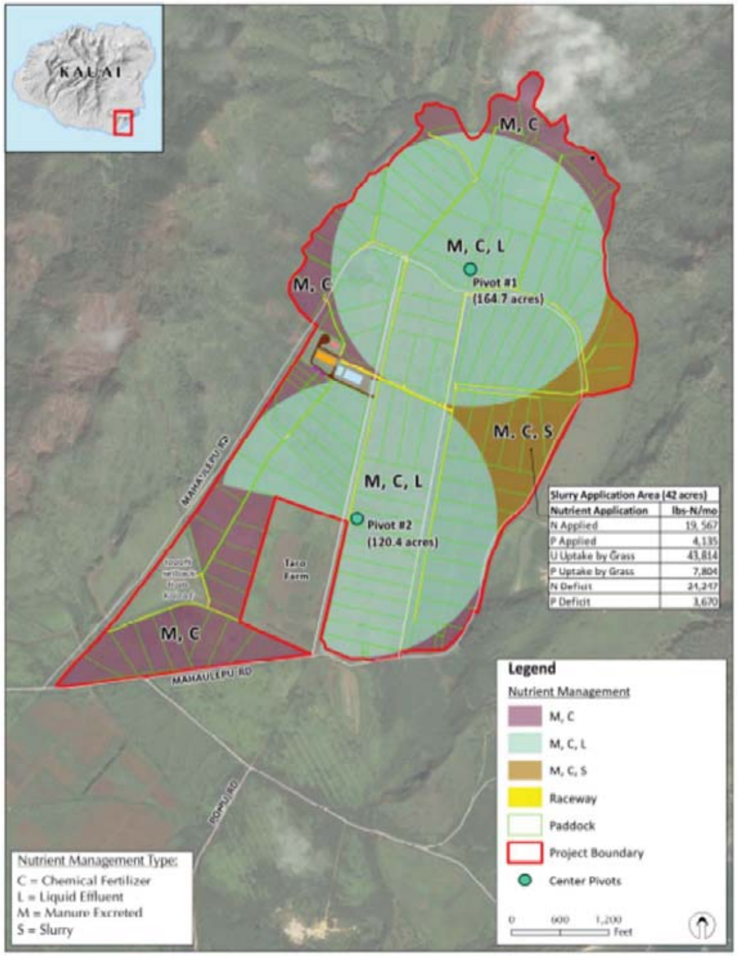
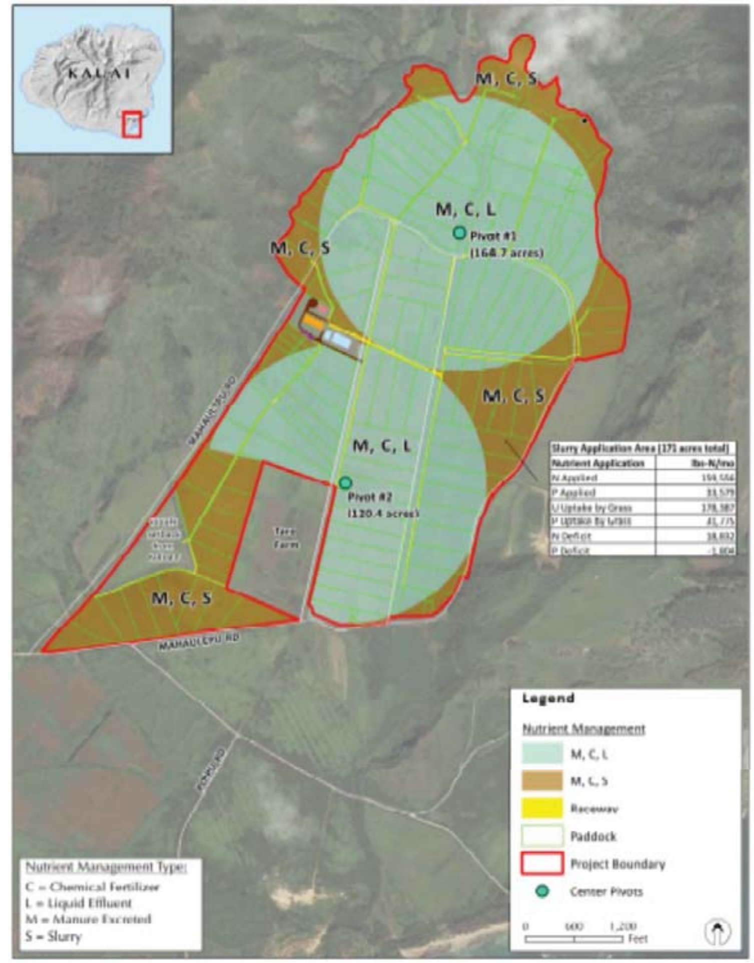


Figure 4. Manure solids slurry application areas indicated in brown, contemplated HDF project (2000 cows). Source: Group 70 International and Red Barn Consulting, 2016a, Figure 19B.



After settling of solids, wastewater in the settling pond would overflow into a storage pond at the same rates noted above for waste and wash-water inflow to the settling pond. According to the DEIS, the storage pond would be built to accommodate 30 days of effluent inflow from the settling pond (under contemplated project conditions), average monthly rainfall runoff from the 1.76-acre surrounding area (six inches of rainfall), 25-year, 24-hour storm runoff, and one foot of freeboard (Group 70 International and Red Barn Consulting, 2016a, Figure 15B, p. 49). Wastewater from the storage pond would be distributed to select paddock areas via Pivot #1 and Pivot #2 of the irrigation system (see Figure 2) supplemented by irrigation water from Waita Reservoir. Using wastewater for irrigation is intended to help to fertilize grass in the paddock areas. Since nutrients in the wastewater and cattle waste at the site would not be sufficient to fertilize the site—even for the 2000-cow contemplated project—commercial fertilizer would also be applied at the site.

Purpose and Overview of Report

The purpose of this report is twofold:

1. To summarize key aspects of the water balance and water quality analysis in the DEIS and identify deficiencies in HDF's analysis of groundwater and surface water impacts.
2. To summarize Exponent's analysis of the anticipated impacts of the project on groundwater and surface water.

This report contains four main sections following the Introduction. The first section presents Exponent's evaluation of the hydrologic and water balance analysis in the DEIS, including Exponent's hydrologic analysis of the site using EPA's Storm Water Management Model (SWMM). The second section presents Exponent's evaluation of the drainage design analysis presented in Appendix K of the DEIS (Group 70 International, 2016b). The third section presents Exponent's evaluation of surface water and groundwater quality impacts presented in Appendices E and F of the DEIS (TNWRE, 2016; MRC, 2106). The fourth section presents additional considerations pertaining to water quality at the site with regard to regulations concerning stormwater management for concentrated animal feeding operations (CAFOs) in Hawaii, anti-degradation requirements, and applicable water quality standards.

Water Balance

A water balance for a geographic area is an accounting of the water flowing into and out of the area. Exponent expects the water balance at the HDF site would change significantly as a result of the proposed and contemplated projects, primarily as a result of extensive additional irrigation proposed for the site and the presence of poorly drained soils underlying the site. Proposed irrigation rates would cause soils at the site to be saturated or nearly saturated most of the time, diminishing the soils' capacity to absorb water (see also CH2M, 2016). As a result, surface water-runoff from the site would likely increase.

Hydrologic Modeling with SWMM

Methodology

To evaluate project-driven changes to the water balance for the site of the proposed dairy farm, Exponent formulated a hydrologic model of the site using the Storm Water Management Model (SWMM) (Version 5.1). SWMM is an EPA-approved hydrologic modeling system that is able to simulate continuous long-term records of precipitation, irrigation, rainfall runoff, evapotranspiration, soil wetting and drying, infiltration to groundwater, and other aspects of the hydrologic cycle (U.S. EPA, 2015; U.S. EPA, 2016). The system includes algorithms for routing runoff through open channels (e.g., streams and ditches).

Exponent modeled two scenarios using SWMM: existing conditions and proposed project conditions (699 cows). The existing condition was simulated to provide a baseline for evaluating changes to the site water balance that would result from the project. The contemplated condition (2,000 cows) was not modeled explicitly since the primary factors affecting the water balance at the site—irrigation and soil type—are identical for proposed and contemplated project conditions; thus the water balance was not expected to be significantly different for the proposed and contemplated project conditions.[2]

The one-year period from 1 June 1996 through 31 May 1997 was simulated for both scenarios. This period exhibited significant rainfall (approximately 69 inches) and some storm events, though rainfall was fairly evenly distributed over the period relative to other wet years (e.g., 2006, which exhibited several long periods of intense rainfall). The modeled period was selected instead of an average rainfall year since it would yield hydrologic and water quality impacts expected to be observed at the site as a result of the project during wet hydrologic conditions.

The HDF site and the watershed area draining to it were modeled in order to assess runoff rates in the Waiopili Stream within and downstream of the HDF site. U.S. Geological Survey digital elevation data (USGS, 2016) and Geographic Information System (GIS) tools were used to delineate the modeled watershed and to divide it into sub-basins. Sub-basins were distinguished for several reasons. First, they were distinguished in order to account for junctions in the open channel network and to calculate runoff rates at selected other points. Second, sub-basins were defined in order to separate the HDF site from surrounding watershed areas. Third, sub-basins were delineated to correspond to soil and land-use types, and to separate areas that would be subject to irrigation under project conditions from unirrigated areas. GIS tools were used to calculate sub-basin areas and other watershed geometry parameters required by SWMM (e.g., sub-basin width, sub-basin slope, and open channel length).

Soil data were obtained from the U.S. Department of Agriculture's SSURGO database (NRCS Soil Survey Staff). Existing condition land-use data were obtained from the National Land Cover Database (Homer et al., 2015). Project condition land-use data were estimated from the

[2] The main hydrologic difference between the scenarios would be increased wastewater generated in the headquarters area and increased manure slurry applied to non-irrigated areas of the site, under contemplated project conditions. Increased wastewater generated in the headquarters area would not affect irrigation volumes, and so it would not influence the site water balance. The increased manure slurry would affect the site water balance, but slurry volumes are anticipated to be small relative to irrigation volumes, and so their effect on the water balance would not be significant.

HDF DEIS. Data included the proportion of each sub-basin that is impervious to infiltration (e.g., rock outcrops and paved areas).

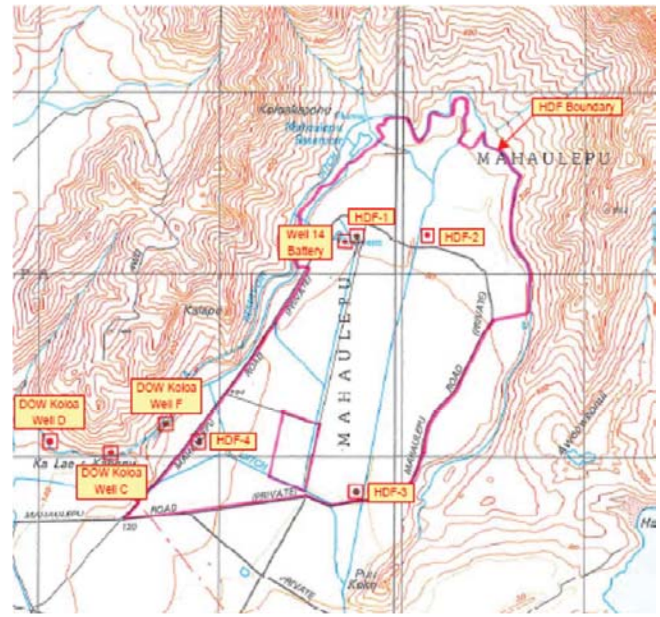
Two methods were used to model soil infiltration. First, to maintain consistency with the hydrologic methods used in Appendix K of the DEIS (Group 70 International, 2016b), the Soil Conservation Society (SCS) Curve Number method was used for one set of SWMM runs. SCS curve number data were obtained from the U.S. Department of Agriculture National Engineering Handbook (USDA, 2004) and were checked against data in the SWMM Hydrology Reference Manual (U.S. EPA, 2016, Table 4-9). Since the Curve Number method does not allow for further infiltration once soils are saturated, it yields low estimates of infiltration when water application rates are high; thus SWMM runs using the Curve Number method were treated as low-end estimates of project condition infiltration.

Infiltration rates calculated using the Curve Number method represent a condition in which groundwater is at or close to the ground surface. Under these conditions, very little water applied to the ground surface as rainfall or irrigation would infiltrate. Groundwater is reported to be at or near the ground surface in some areas of the site during wet periods. For example, the groundwater level in monitoring well HDF-1 was reported as five feet below ground surface in July 2015 (see Figure 5; SHCWRM, 2015; and TNWRE, 2016, pp. 3–4); thus the inverts of the approximately five-to-ten-foot deep channels at the site are reported to intersect with groundwater near this well (and HDF-2) in the northern area of the site (Figure 5; TNWRE, 2016, p. 26). In addition, the area including paddocks 135 to 137 (i.e., within the approximate area proposed for slurry (solid manure) application as shown on Figure 3) has been reported as "currently marshland" that could not be excavated (SCS, 2016, p. 132), and the depth to groundwater in some portions of the site has been reported to be as shallow as 0.9 m (SCS, 2016, p. 136). Thus, the Curve Number method may well produce an accurate representation of infiltration over certain parts of the site, under some conditions.

To bracket soil infiltration rates under project conditions, a second set of SWMM runs was conducted using Horton's method for infiltration. Horton's method continues to allow soil infiltration even when soils are saturated (representing the loss of percolating water to deeper groundwater), so SWMM runs using Horton's method provide for greater infiltration than

SWMM runs using the Curve Number method. Since no local hydrologic data were available to calibrate the SWMM model, two model runs were used to represent infiltration that is believed to cover the range of expected rates.

Figure 5. Location of groundwater wells at the HDF site. Source: TNWRE, 2016, Figure 1.



The network of open channels and other drainage features at the site was implemented in the model according to current and historical U.S. Geological Survey maps, digital elevation model (DEM) data, and information in the HDF DEIS (Figure 6). The channel network used in the modeling includes channels that drain the interior of the HDF site to the coast downstream of the site, such as the Waiopili Stream and natural drainages and ditches within the HDF site and around the perimeter of the HDF site below the steep slopes within the watershed (Figure 6). The Māhā‘ulepū Reservoir, located near the northwest corner of the site (Figure 6), was also included in the simulation.

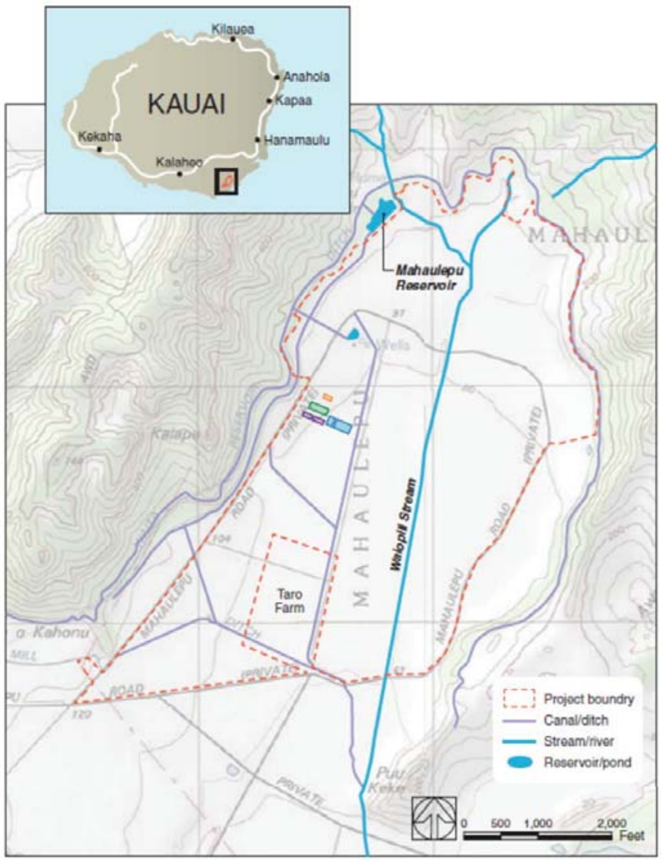


Figure 6. Drainage features at the HDF site

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The proposed headquarters area was simulated as part of the project condition. As noted above, the headquarters is proposed to include 9.7 acres of developed area in the northwest portion of the site, including a milking parlor, a calving shed, an implement shed, and two ponds designed to contain wash water and animal waste from the milking parlor and calving shed (Figure 2). According to the most recent version of the HDF Waste Management Plan (WMP) (Group 70 International, 2014; Group 70 International and Red Barn Consulting, 2016b), potable water from existing groundwater wells at the site would be used to wash down yard areas and equipment in the headquarters area, resulting in a daily flow of 13,225.8 gpd of wastewater to the settling pond for the proposed project condition and 37,894.7 gpd for the contemplated project condition. The settling pond would also receive storm water runoff from 1.76 acres of the headquarters area, though rain falling directly on the roofs of headquarters buildings would be drained to surrounding pasture areas. Liquid effluent would accumulate at a rate of 13,226 gpd in the storage pond and is proposed to be used for irrigation and fertilizer. Exponent assumed in SWMM modeling that the irrigation extraction rate from the storage pond was identical to the inflow rate to the pond. An emergency overflow spillway in the storage pond was also modeled, and flow over the spillway was simulated to occur when the volume of water in the storage pond exceeded 2.12 million gallons (MG). Overflow from the storage pond was assumed to drain to the ditch network, since the WMP did not provide sufficient detail to allow the overflow containment to be simulated (e.g., see Group 70 International, 2014, p. 49).

Hourly rainfall was simulated in the model since rainfall-runoff processes in a small watershed like the Māhā‘ulepū Valley occur on short (sub-daily) timescales. Rainfall data from the Lihue Weather Service Office Airport Station[3] were used since hourly rainfall data were not available at the more local M Māhā‘ulepū gauge,[4] and since even the daily rainfall record at the Māhā‘ulepū gauge had large gaps. For the purposes of this analysis, because hourly data within the Māhā‘ulepū watershed were not available, rainfall at the Lihue Airport gauge was used as a

[3] Station 1020.1, maintained as part of the National Weather Service (NWS) U.S. Cooperative Observer Program (Station COOP ID: 515580). The gauge is located on the ground at an elevation of 30.5 meters (100 ft) above sea level and at 21.983 N and 159.340 E. Precipitation data from this gauge were obtained online from NOAA’s National Climatic Data Center (NCDC).

[4] Mahaulepu Station 941.1. The gauge is maintained as part of the NWS COOP program (Station COOP ID: 515710). It is located on the ground at an elevation of 24.4 meters (80 ft) above sea level and at 21.8999 N and 159.4211 E.

reasonable surrogate for rainfall at the HDF site since it is located nearby and at a similar elevation. In addition, total annual rainfall amounts at the Lihue and Māhā‘ulepū gauges are similar, and the timing and magnitude of storms at the two gauges roughly correspond (though with a small time lag). Rainfall was assumed to be uniform throughout the Māhā‘ulepū watershed, even though available data indicate that rainfall is greater at higher elevations than at lower elevations within the watershed (Giambelluca et al., 2014).

Monthly grass reference evapotranspiration rates for the site were obtained from data compiled by the Geography Department at the University of Hawai‘i at Manoa (Giambelluca et al., 2014). Total annual grass reference evapotranspiration at the site was reported as 100.47 inches with a peak of 9.86 inches in July and a low of 6.89 inches in February. For the existing condition SWMM run, monthly reference evapotranspiration rates were multiplied by a crop factor of 0.85 to account for the difference between the grass reference and Guinea grass, which was assumed to be the predominant vegetative cover at the site before Kikuyu grass was planted. A crop factor of 0.85 was also used for Kikuyu grass, the crop proposed for the HDF.

In the sub-basins subject to irrigation, irrigation water was modeled as additional precipitation. Under existing conditions, the sub-basins within the proposed HDF site were assumed to be subject to furrow irrigation whereby five inches of water were applied over the first three days of each two-week period in the months of June, July, and August unless there was significant rain. If there was rainfall greater than 0.357 inches per day (equivalent to five inches per 14 days) within the two-week period, then irrigation was postponed until two weeks after the rainfall.

Under project conditions, irrigation was modeled according to the rates identified in the DEIS and WMP (Group 70 International and Red Barn Consulting, 2016b, p. 11). The following irrigation rates were applied: 1.07 mgd over the 164.7 acres irrigated by Pivot #1; 0.79 mgd over the 120.4 acres irrigated by Pivot #2; and 0.40 mgd over the 61.4 acres irrigated by reel gun. Total project condition irrigation rates were 2.26 mgd. Project condition irrigation rates were applied at the site for each hour in the simulation period except during hours when there was precipitation of any amount, in which case the site was not irrigated. Note that the moisture content of cow urination and defecation in the paddock areas was not accounted for in the

SWMM modeling. Although the WMP and DEIS Appendix D Nutrient Balance Analysis (Group 70 International and Red Barn Consulting, 2016a and 2016b) suggest irrigation may occur according to a more complicated schedule with reduced volumes, the exact nature of the irrigation plan is not clear (e.g., see Group 70 International, 2014, pp. 37–40, 44). Given available information, the irrigation schedule and volumes applied in the project condition SWMM model is believed to be a reasonable estimate of the highest wet-year irrigation rates that would be observed at the site under project conditions. In turn, these irrigation rates would produce the largest hydrologic and water quality impacts likely to be observed, consistent with the goal of this analysis to identify the magnitude of potential impacts.

Note that Exponent’s approach to modeling irrigation in the project condition SWMM model differed from the approach used by CH2M to evaluate nutrient impacts of project conditions (CH2M, 2016). Exponent’s SWMM model analysis was intended to identify hydrologic and water quality impacts that could result under project conditions during a wet period and using irrigation rates specified in the DEIS, since the DEIS did not specify irrigation rates for wet-year conditions. In contrast, CH2M’s analysis was intended to identify impacts that could result under wet-year conditions if optimal irrigation was assumed. These two approaches to evaluating the project condition are complementary and are intended to identify the range of impacts that might be expected to result from the HDF.

It is important to note that the SWMM modeling has several limitations. The SWMM modeling was based on rainfall data that were not measured at the site itself and that did not account for rainfall variations with elevation, since local rainfall data were not available on an hourly basis. The model was not calibrated to local conditions since the data needed for calibration were not available (e.g., streamflow and ditch runoff measurements, local soil infiltration measurements, data describing the flow rate and fate of shallow groundwater, detailed cross-sectional data for the network of open channels at the site). The application of manure slurry to select paddocks was not accounted for in the model since application flow rates and water content were not specified in the DEIS documents. Finally, Exponent has not visited the site and observations could not be used to guide the SWMM modeling exercise. Given these limitations, our modeling was intended to show that a detailed hydrologic analysis of the site is both possible and important and also to present a range of possible hydrologic outcomes at the site.

SWMM Model Results

SWMM model results for the Horton's method infiltration case are illustrated in Figures 7 and 8, which show the annual water balance at the site under both existing and project conditions. Tables 1 and 2 summarize the monthly water balance at the site under the two modeled conditions for the Horton's method case. SWMM model results for the Curve Number infiltration method are provided in Figures A-1 and A-2 and Tables A-1 and A2 of Appendix A.

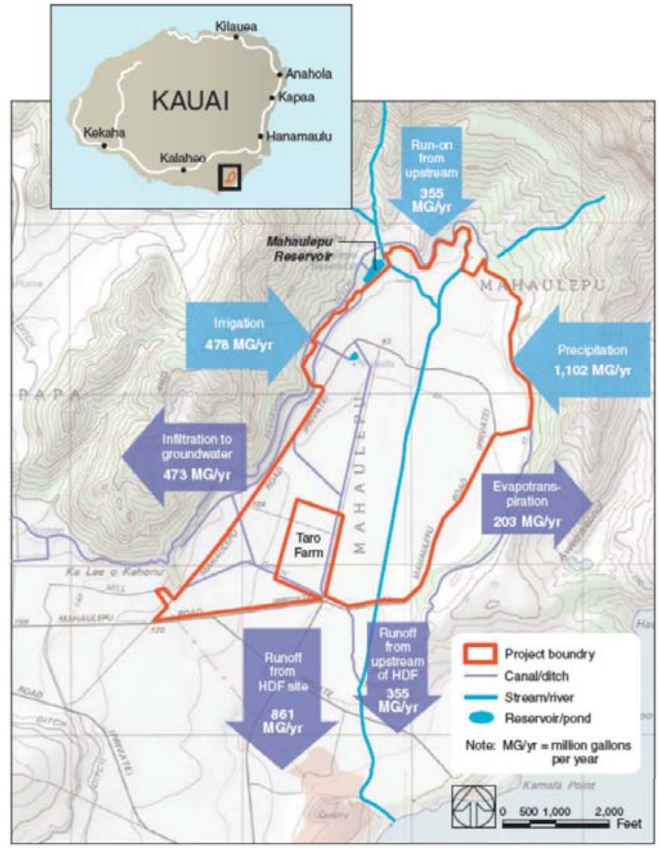

Figure 7. Annual water balance at the HDF site, existing conditions, Horton's method for infiltration

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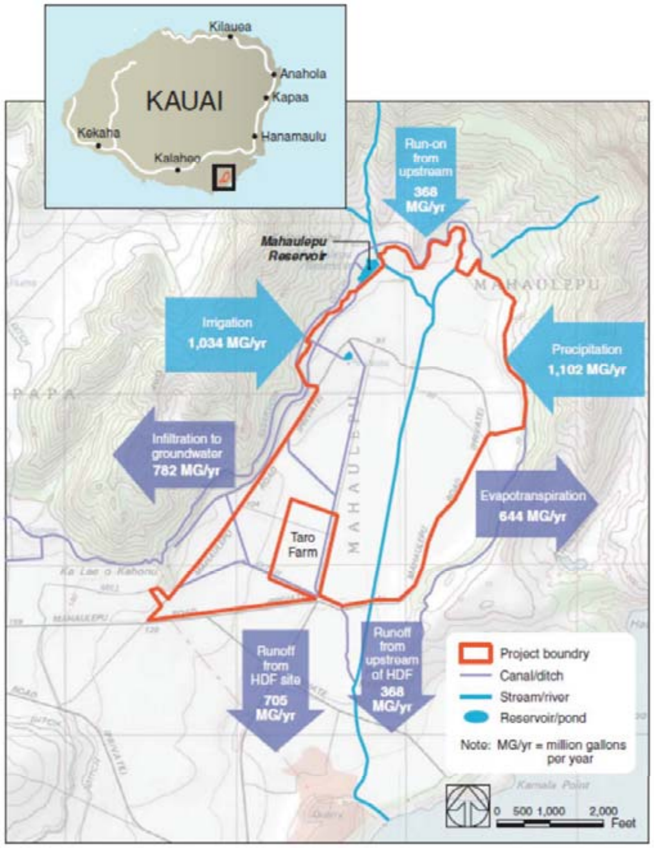

Figure 8. Annual water balance at the HDF site, project conditions, Horton's method for infiltration

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Table 1. Monthly water balance in millions of gallons (MG) for existing conditions at the proposed HDF site (Horton's method for infiltration). Source: Exponent SWMM modeling (2016).

Month	Inflows			Outflows			
	Precipitation (MG)	Irrigation (MG)	Stream flow from upstream (MG)	Evapotran-spiration (MG)	Runoff from HDF site (MG)	Stream flow from upstream (MG)	Infiltration to groundwater (MG)
Jun-96	70	159	8	35	119	8	72
Jul-96	27	159	0	27	93	0	61
Aug-96	13	159	0	22	93	0	55
Sep-96	124	0	89	8	86	89	27
Oct-96	112	0	22	18	52	22	36
Nov-96	191	0	84	22	124	84	40
Dec-96	88	0	45	7	51	45	29
Jan-97	90	0	15	9	48	15	31
Feb-97	32	0	0	5	5	0	19
Mar-97	140	0	26	19	76	26	40
Apr-97	56	0	2	10	20	2	23
May-97	159	0	64	22	95	64	40
Total	1102	478	355	203	861	355	473

Table 2. Monthly water balance in millions of gallons (MG) for project conditions at the proposed HDF site (Horton's method for infiltration). Source: Exponent SWMM modeling (2016).

Month	Inflows			Outflows			
	Precipitation (MG)	Irrigation (MG)	Stream flow from upstream (MG)	Evapotran-spiration (MG)	Runoff from HDF site (MG)	Stream flow from upstream (MG)	Infiltration to groundwater (MG)
Jun-96	70	84	8	55	35	8	63
Jul-96	27	92	0	54	3	0	61
Aug-96	13	94	0	47	2	0	57
Sep-96	124	88	95	53	93	95	64
Oct-96	112	88	22	62	66	22	70
Nov-96	191	83	82	58	142	82	73
Dec-96	88	89	45	49	62	45	64
Jan-97	90	88	15	50	61	15	67
Feb-97	32	81	1	44	12	1	55
Mar-97	140	84	29	59	94	29	72
Apr-97	56	84	3	51	27	3	62
May-97	159	82	68	61	107	68	73
Total	1102	1034	368	644	705	368	782

Irrigation volumes are considerably higher under project conditions (1,034 MG) than under existing conditions (478 MG) due to the increased irrigation regime proposed for the site. Similarly, evapotranspiration (ET) volumes are higher under project conditions than under existing conditions (644 MG versus 203 MG for the Horton's method SWMM runs). Under project conditions, daily application of water (either as irrigation or as rainfall) makes more water available for ET, and thus ET volumes are closer to the full ET capacity of 1,362 MG per year.

For the SWMM runs that apply Horton's method, the volume of water infiltrated during the one-year simulation period is higher under project conditions (782 MG) than under existing conditions (473 MG) since water is applied to the site (as rainfall and irrigation) nearly continuously under project conditions and since Horton's method allows infiltration even when soils are saturated. As a result of the higher infiltration volume under project conditions, the simulated project conditions runoff volume from the HDF site (705 MG) is slightly lower than existing conditions runoff volume (861 MG) for the Horton's method runs (though project condition peak flow rates do increase slightly from existing conditions; see below).

For the SWMM runs that apply the Curve Number method, infiltration is low under project conditions (116 MG) relative to existing conditions (860 MG). Infiltration volumes are lower using the Curve Number method, since this method reduces infiltration when soils are saturated, and the site is almost constantly saturated under project conditions due to irrigation. The Curve Number method predicts runoff volumes during the simulation period under project conditions (915 MG) will be greater than under existing conditions (474 MG), which would occur when groundwater is at or near the ground surface.

As noted in the "Methodology" section, infiltration and runoff volumes computed using the two different infiltration methods in SWMM (Horton's method and the Curve Number method) bracket the expected range of outcomes at the site in the absence of calibration data.

The SWMM model was used to simulate flow rates in the Waiopili Stream that will occur as a result of rain events. Table 3 summarizes existing and project condition peak runoff rates downstream of the proposed HDF site for the six most significant rainfall events in the modeled

period. Results are presented for runs using both Horton's method and the Curve Number method for infiltration in order to show the potential range of flow rates. As shown in Table 3, peak runoff rates would increase as a result of the project by as much as 175 %. The continuous application of water under the proposed project would cause nearly continuous soil saturation, reducing the capacity of soils to absorb rainfall during storm events; thus the site would likely exhibit greater runoff volumes and higher peak flow rates during storms under project conditions than under existing conditions.

Table 3. Simulated peak runoff rates downstream of the proposed HDF site, June 1996–May 1997, existing and project conditions. Source: Exponent SWMM modeling (2016).

Date of maximum storm precipitation	Total storm precipita-tion (in.)	Storm duration (hours)	Curve Number method for infiltration			Horton's method for infiltration		
			Existing condition, peak downstream runoff rate (cfs)	Project condition, peak downstream runoff rate (cfs)	Increase (%)	Existing condition, peak downstream runoff rate (cfs)	Project condition, peak downstream runoff rate (cfs)	Increase
9/7/1996	6.01	12	363	458	26 %	490	507	4 %
10/20/1996	2.93	22	104	286	175 %	298	322	8 %
11/12/1996	4.67	18	205	290	41 %	319	331	4 %
11/16/1996	2.6	16	160	213	33 %	200	220	10 %
12/21/1996	3.59	10	247	355	44 %	407	427	5 %
5/5/1997	2.85	30	165	256	55 %	261	272	4 %

Comments on DEIS Hydrologic Calculations in Appendix E

Comment 1: Appendix E of the DEIS employed flawed rainfall data.

It appears that the HDF DEIS evaluation of surface water impacts (Appendix E) utilized the record of daily rainfall as measured at the Māhā‘ulepū gauge (TNWRE, 2016, p. 43). As noted above, the rainfall record at the Māhā‘ulepū gauge has significant data gaps, and Appendix E did not describe how these data gaps were addressed. Because an incomplete rainfall record may have been used, it appears that the DEIS may have underestimated rainfall amounts and the frequency of rainfall events at the HDF site.

Comment 2: Appendix E of the DEIS failed to use a calibrated hydrology model to evaluate site hydrology.

Hydrologic impacts of the project should have been evaluated using a calibrated hydrology model applied on an hourly or sub-hourly basis over a long time period and covering a range of hydrologic conditions (i.e., both wet and dry time periods). Calibration data should include local hourly rainfall data (see Comment 1), streamflow data at key points in the open channel network on and around the site, more comprehensive seasonal measurements of shallow groundwater levels, soil infiltration measurements, and comprehensive geometry data describing the hydraulic features of the site, including stream channels (e.g., the Waiopili Stream), drainage ditches, and Māhā‘ulepū Reservoir.

Comment 3: Appendix E of the DEIS incorrectly assumes that 15% of rainfall on flat areas and 30% of rainfall on steeper areas will end up as runoff.

At page 39, Appendix E makes the “first order approximation” that surface water runoff will amount to 15% of rainfall on flat areas and 30% of rainfall on surrounding steeper areas. This assumption is unfounded. Surface water runoff is not strictly proportional to rainfall. The amount and timing of runoff caused by a rainfall event depends on the amount of rainfall, the rainfall intensity (e.g., rain amount in inches per hour), antecedent soil moisture conditions, and other factors.

Exponent’s hydrologic analysis indicates that under existing conditions, runoff from flat areas was frequently less than 15% of rainfall for events in the relatively dry months of June and July of 1996. Runoff from the steeper watershed areas surrounding the HDF site during June and July 1996 was frequently less than 30% of rainfall, due at least in part to the attenuating effect of Māhā‘ulepū Reservoir. In contrast, runoff rates under existing conditions frequently exceeded 30% during the wetter months of November 1996 and May 1997, as soils were wetter or saturated when rain occurred.

Runoff rates for the proposed project were higher than for the existing condition, since irrigation kept soils near saturation for most of the year. As shown in Table 1, for the one-year simulation

period of June 1996 through May 1997 and under existing conditions, runoff from the flat agricultural areas amounted to 78% of total precipitation (861 MG / 1102 MG), considerably more than the 15% assumed in TNWRE (2016). Under project conditions, Table 2 shows that runoff from the flat agricultural areas amounted to 64% of total precipitation (705 MG / 1102 MG). The DEIS Appendix E assumption that runoff would be 30% of rainfall on steeper slopes and 15% of rainfall on flat areas is an oversimplification, and it is incorrect for the June 1996 through May 1997 period, as the analysis in DEIS Appendix E did not account for the effects of antecedent soil moisture, irrigation, and the off-site ditches and reservoir.

Comment 4: Appendix E of the DEIS incorrectly assumes that runoff would occur only on days when rainfall exceeds 0.8 inches.

At page 43, Appendix E assumes that runoff would occur only on days when the rainfall exceeds 0.8 inches (TNWRE, 2016). SWMM modeling performed by Exponent showed that under both existing and project conditions runoff is generated by rainfall amounts as low as 0.02 inches. SWMM modeling indicated the runoff occurred in response to low rainfall amounts when soils were near saturation prior to the rainfall (e.g., during periods of irrigation or during closely spaced rainfall events).

Comment 5: Appendix E of the DEIS failed to consider important hydrologic processes.

The analysis in DEIS Appendix E evaluated hydrologic processes on an annual average basis. The inter-annual and intra-annual variations in processes that determine runoff were not examined, though these are essential considerations for evaluating runoff and water quality impacts (which are discussed in greater detail below). Exponent’s SWMM analysis demonstrates the importance of the sequence and intensity of rainfall events in generating runoff.

Comment 6: The DEIS hydrologic analysis did not analyze the drainage network at the HDF site.

The DEIS Appendix E hydrologic analysis failed to consider the drainage geometry of the site, which is important in evaluating runoff rates in the Waiopili Stream downstream of the site.

Exponent's SWMM analysis demonstrates the role of the perimeter ditch network and Māhā'ulepū Reservoir in attenuating runoff volumes and rates from the surrounding watershed areas to the site. A comprehensive analysis of the drainage network should have been part of a calibrated hydrology model used to evaluate hydrologic and water quality impacts of the project (see Comment 2).

Comment 7: Site soils are expected to be saturated, or nearly saturated, much of the time.

The DEIS and available data indicate that soils at the HDF site are, in many areas, poorly drained, consisting in large part of clay soils (see DEIS Appendix D at p. 14–15). Under existing conditions, groundwater is within several feet of the ground surface over much of the site, and groundwater discharges to agricultural ditches during wet conditions near the upper end of the site (DEIS at pp. 4–53 and 4–54). In addition, the area including paddocks 135 to 137 (i.e., within the approximate area proposed for slurry (solid manure) application as shown on Figure 3) has been reported as "currently marshland" that could not be excavated (SCS, 2016, p. 132), and the depth to groundwater in some portions of the site has been reported to be as shallow as 0.9 m (SCS, 2016, p. 136). In a section describing poorly drained soils on the site, the DEIS also states that "[d]rains may also be installed and used to remove non-nutrient laden water from the surface of these areas [areas with poorly drained soils] to reduce soil dry time and restore grazing" (see DEIS Appendix D at pp. 94-95); the location, extent, and design of these drains is not described. After HDF operations commence, water will be applied over much of the site nearly continuously, and groundwater elevations are expected to rise compared to the existing condition. SWMM modeling confirms that much of the site, particularly the areas with poorly drained soils, will be saturated or nearly saturated most of the time.

Site Drainage Design Calculations

Appendix K of the HDF DEIS presents hydrologic calculations performed using the methods of the County Hydrology Manual to size drainage improvements at the facility (Group 70 International, 2016b). It appears that two sets of calculations may have been performed: (1) drainage calculations for the 9.7-acre HDF headquarters area that includes the milking parlor and the effluent settling and storage ponds, likely performed using the rational method, and (2) drainage calculations for the watershed as a whole, performed using the TR-55 model.

Comments on DEIS Hydrologic Calculations in Appendix K

Comment 8: Appendix K provides insufficient details on hydrologic drainage design calculations.

Little detail is provided to support the hydrologic analyses conducted for existing and proposed conditions in DEIS Appendix K. Specifically, the following details are lacking:

1. Design calculations performed for the 9.7-acre HDF headquarters area were not provided. Indeed, page 6 of DEIS Appendix K states that "local drainage flows *will* be analyzed…" (emphasis added) and as such it is not clear whether calculations for the 9.7-acre area were performed. Details and results of drainage calculations for the 9.7-acre area should be provided.
2. Input and output files were not provided for the TR-55 hydrologic model of the larger watershed surrounding and including the HDF site.
3. DEIS Appendix K describes modeling conducted to determine flow rates draining to two main ditches through the site; however, topographic data used to delineate the two modeled areas draining to "Mahaulepu Ditch West" (which is actually the Waiopili Stream) and Māhā'ulepū Ditch East were not included or described in the DEIS.
4. It is not clear which drainage features were included in the model (e.g., drainage channels, perimeter cut-off ditches, reservoirs, waste ponds), how the time of concentration was calculated, or how runoff flow was routed through ditches.

Comment 9: Appendix K seems to employ an incorrect SCS curve number for areas draining to "Mahaulepu Ditch East."

Weighted runoff curve numbers used in the hydrologic analysis in DEIS Appendix K were identical (i.e., 68) for areas draining to the Māhā'ulepū Ditch East under both existing and proposed conditions; however, pasture conditions are characterized as "fair" under existing conditions and "good" under proposed conditions. As indicated in Table 2-2c of the TR-55 manual (USDA, 1986, pp.2–7), the different characterization ("fair" versus "good") should have yielded different weighted curve numbers for the two different model runs.

Comment 10: It does not appear that calculated peak design flow rates were used to evaluate existing drainage structures at the HDF site.

Although a main purpose of DEIS Appendix K was to provide hydrologic information to be utilized in the design of drainage infrastructure at the HDF site, it does not appear that the calculated peak design flow rates were used to determine whether existing drainage channels and structures at the site are adequate. Since it has not been established that the existing drainage structures are adequate to address existing flows, and since the DEIS proposes to leave much of the existing drainage infrastructure in place under project conditions (Group 70 International, 2016b, p. 18), it is important to evaluate the existing infrastructure against calculated design flow rates. Because peak flow rates may increase under project conditions (see Table 3 of SWMM results), any problems with the existing drainage infrastructure may be exacerbated once the project is constructed.

Comment 11: It appears that important watershed features were not considered in the evaluations contained in DEIS Appendix K.

DEIS Appendix K presents calculated peak runoff rates for a point downstream of the proposed HDF project site. These runoff rates are summarized in Table 4 for convenience. There is no indication that the hydrology calculations contained in DEIS Appendix K considered important drainage features, such as the routing of flow in the ditches below the steep slopes surrounding the HDF site or in the Māhā'ulepū Reservoir, all of which attenuate runoff hydrographs from the watershed. The failure to consider these features may account for the significant differences between the flow rates in DEIS Appendix K and flow rates obtained using SWMM modeling.

Table 4. Peak runoff rates downstream of the proposed HDF project site, as presented in Appendix K of the HDF DEIS. Source: Group 70 International (2016b), Tables 3 and 5.

Rainfall Frequency and Duration	Rainfall Amount (inches)	Existing Condition Peak Runoff Rate (cfs)	Project Condition Peak Runoff Rate (cfs)
2-year, 24-hour storm	4.78	1,896.9	1,723.3
10-year, 24-hour storm	8.18	5,131.1	4,874.0
25-year, 24-hour storm	10.4	7,429.6	7,146.3
50-year, 24-hour storm	12.2	9,336.0	9,036.3
100-year, 24-hour storm	14.1	11,358.2	11,054.1

For example, DEIS Appendix K reports that a 2-year, 24-hour rainfall of 4.78 inches would result in a peak runoff rate of 1,896.9 cfs downstream of the HDF site; however, Exponent's SWMM modeling for existing conditions and for a rainfall event of 6.01 inches over a 12-hour period would produce a peak runoff rate of between 363 cfs (Curve Number method) and 490 cfs (Horton's method) at the bottom of the watershed.

Comment 12: It appears that the hydrologic modeling in DEIS Appendix K failed to consider the impact of irrigation practices on soil moisture, and thus may not have represented design peak flow rates downstream of the HDF site accurately.

The hydrologic model results reported in DEIS Appendix K may underestimate the relative impact of the proposed HDF project on peak runoff rates downstream of the site. As shown in Table 5, Appendix K reports that peak runoff rates are expected to remain roughly the same (or drop slightly) under project conditions relative to existing conditions. This parity or decrease in peak flow rates under project conditions is attributed to improved "tillage, cultivation, maintenance, and maturation of the pastures" planned under project conditions (Group 70 International 2016b, p. 23); however, it appears that the analysis in DEIS Appendix K fails to account for proposed irrigation practices and their effect on antecedent soil moisture conditions. Results of Exponent's SWMM model, which does account for proposed irrigation practices, suggest that downstream peak runoff rates for large rainfall events will increase under project conditions by between 4% (Horton's method) to up to 175% (Curve Number method) (Table 3).

As noted in Comment 2, a quantitative hydrologic model is required to evaluate soil moisture conditions and peak flow rates from the site.

Comment 13: Appendix K hydrologic modeling fails to evaluate potential erosion impacts in the Waiopili Stream downstream of the project site.

Exponent's analysis of peak flow rates from the HDF site indicates that peak flow rates may increase by as much as 175% as a result of the proposed project. An increase in flow rates will correspond with an increase in flow velocity, which will increase the potential for erosion within the earthen ditches and the Waiopili Stream, and which in turn will increase the potential for sediment transport to the nearshore ocean. Potential impacts on erosion and sediment transport should be evaluated using hydrologic modeling (see comments in the next section for further description of potential impacts).

Surface Water and Groundwater Quality

In addition to the hydrologic analysis presented in DEIS Appendix E, DEIS Appendices E and F (TNWRC, 2016, and MRC, 2016) provided an assessment of potential impacts to surface water and groundwater quality. The analysis focused on the potential for elevated nutrient concentrations (i.e., nitrogen and phosphorus) since significant quantities of nutrients would be added to the site under project conditions in the form of cow manure and commercial fertilizer.

DEIS Appendix E estimates that 332 pounds per year of nitrogen and 27 pounds per year of phosphorus are discharged from the proposed HDF site via groundwater under existing conditions (TNWRE, 2016, p. 39). DEIS Appendix E also estimates that 1,170 pounds per year of nitrogen and 80 pounds per year of phosphorus are discharged from the site via surface water under existing conditions (TNWRE, 2016, p. 39); thus DEIS Appendix E estimates that 1,502 pounds of nitrogen and 107 pounds of phosphorus currently leave the site in groundwater and surface water. Under project conditions, DEIS Appendix E estimates that 490,000 pounds per year of nitrogen and 87,000 pounds per year of phosphorus would circulate at the site, and that two percent of nitrogen and one percent of phosphorus applied at the site would be lost to shallow groundwater or surface water transport from the site (TNWRE, 2016, p. 43; however, no basis is provided for these estimates). Taken at face value, the numbers in DEIS Appendix E indicate that roughly 10,000 pounds per year of nitrogen and 900 pounds per year of phosphorus would be transported from the site, corresponding to increases in loads of nitrogen from the site of about 640% and increases in loads of phosphorus of about 840%. DEIS Appendix E notes that estimates of current domestic wastewater and landscaping fertilizer nitrogen loads along the nearby Po‘ipū shoreline are roughly 3.8 times and 1.4 times as large as the calculated project condition nitrogen load from HDF (TNWRE, 2016, p. 45).

DEIS Appendix F employed field observations to assess potential water quality impacts to the nearshore ocean environment where drainage from the proposed HDF site would discharge via the Waiopili Stream. It concluded that increased nutrient loads estimated in DEIS Appendix E would be discharged at the shoreline only during large storm runoff events (no more than ten days per year) and that "extreme physical factors in the marine receiving environment should result in mixing of surface water to background marine conditions within a small area near the point of discharge from the ditch" (MRC, 2016, p. 13). A similar conclusion was drawn with respect to indicator bacteria; thus, DEIS Appendix F asserts that no significant nearshore water quality impacts are expected.

Comments on Water Quality Impacts of the HDF Project

Comment 14: Proposed best management practices are not described in sufficient detail, and their effectiveness is not quantified.

DEIS Appendix F states that the Best Management Practices (BMPs) would include "setbacks, filter strips, and buffer plantings on both sides of drainageways" and that "herbaceous cover area will be 35 feet wide on both sides of the drainageways" (MRC, 2016, p. 11); however, design details for these features were not provided, and their effectiveness was not evaluated in terms of their impacts to runoff quantity, timing, or water quality. Because design details are not provided, it was not possible for Exponent to assess how well planned BMPs will perform. It further does not appear that conditions that may impact the efficiency of BMPs (e.g., soil saturation with water and with nutrients) were evaluated. Design details for BMPs should be provided, including hydrologic calculations describing flow rates, flow velocities, retention times, and expected performance (both hydrologic and water quality performance) of proposed BMPs. In addition, the DEIS describes "management of surface water after a significant rain event (diversion to a retention area, etc.)" and "[d]rains [that] may also be installed and used to remove non-nutrient laden water" from areas of the site with poorly drained soils (see DEIS Appendix D at pp. 94-95); the location, extent, and design of retention areas and drains is not described and has not been evaluated. In addition, areas with poorly drained soils include paddocks where cows will be present and areas to be irrigated with liquid and solid manure (slurry); if drains are installed in these areas, it is unclear how they could be designed to transport only "non-nutrient laden water."

Comment 15: Assumptions about nitrogen and phosphorus losses from the HDF site are unfounded.

As noted above, DEIS Appendix E assumed that two percent of nitrogen and one percent of phosphorus applied at the site in the form of manure and commercial fertilizer would be "lost" (transported from the site) in shallow groundwater and surface water leaving the site; however, no basis is provided for these assumptions regarding nutrient loss. In addition, it appears these loss rates are assumed to apply as a long-term (perhaps annual) average, and seasonal loss rates are not considered but will be important. For example, the nutrient loss rates do not appear to consider grass uptake and growth rates, which are expected to vary seasonally (see CH2M, 2016). No measurements of nitrogen and phosphorus concentrations in groundwater or surface water leaving test plots were reported. Given the large quantities of nitrogen and phosphorus proposed to be applied at the HDF site, even small errors in the assumptions regarding the percent of nutrients that will be lost from the site would translate to significant additional loads of nutrients, and water quality impacts, to receiving waters. No uncertainty or error analysis was conducted.

Comment 16: Quantitative analysis shows that nutrient losses from the HDF site in groundwater and surface water under project conditions would be much larger than the assumed 1% and 2% losses.

The nutrient analysis conducted by CH2M shows that nutrient loads available for transport from the HDF site (i.e., applied nutrients that are not taken up by grass) in shallow groundwater and surface water would be significant, particularly during the winter months (when plant growth is diminished). CH2M's analysis shows that nutrient losses are expected to be significantly larger than the one and two percent losses assumed in DEIS Appendix E (CH2M, 2016). Although CH2M's calculated nutrient loads are representative of wet year conditions in which irrigation is optimal (i.e., CH2M adjusted irrigation rates from the DEIS to optimal irrigation rates), even under optimal conditions, nutrient loss from the site is expected to be significant. If irrigation is not optimal—as is likely in an actual wet year—then loads from the site would likely be higher. Further, if drains are installed at the site (see DEIS Appendix D at pp. 94-95), the quantity of nutrients leaving the site and flowing via the drains to surface waters may be greater than estimated in the DEIS. HDF failed to analyze the expected concentrations and loads of nitrogen and phosphorus in surface and groundwater discharges from the site. The results of a detailed analysis of nutrients at the site should be considered together with the results of quantitative hydrologic modeling to estimate monthly and annual loads and concentrations of nitrogen and phosphorus in runoff and in groundwater flows from the site.

Comment 17: Calculations of the nutrient content of domestic wastewater and landscape fertilizer along the Po‘ipū coastline are unsupported.

No basis is provided in DEIS Appendix E for the loads of nutrients from domestic wastewater and landscape fertilizer to the ocean along the Po‘ipū coastline. DEIS Appendix E provides no references or data to support the assumptions that "nitrogen and phosphorus concentrations in the domestic wastewater are 40 and 10 mg/L, respectively" or that "15 percent of the nitrogen and two (2) percent of the phosphorus [from domestic wastewater] enter the marine environment" (TNWRE, 2016, p. 45). It is not clear how these values were derived, or if they considered the level of treatment given to wastewater sources prior to injection. Because the sources described in DEIS Appendix E (TNWRE, 2016) vary widely (i.e., authorized disposal wells, household cesspools, and septic tank-leach field systems), and because flow rates from these various sources are also likely to vary widely, references and calculations should be provided to support the calculations of nutrient loads from other sources.

Comment 18: Water quality sampling reported in DEIS Appendix F does not represent the range of baseline conditions expected.

DEIS Appendix F (MRC, 2016) reports that water quality sampling in the Waiopili Stream and downstream coastal ocean areas was conducted to establish existing baseline conditions; however, sampling was conducted only during dry weather when pollutant concentrations are expected to be low. During wet weather events, stream flows from the Waiopili Stream will enter the ocean in the form of a plume, which will dilute more slowly than dry weather flows; thus water quality sampling does not capture wet weather conditions and does not represent a realistic baseline condition.

Comment 19: The DEIS does not describe how baseline monitoring will be used, the monitoring and sampling regime proposed to evaluate project impacts, whether sampling data gathered after the project is implemented will be shared with agencies or the public, or the actions that will be taken if water quality impacts are observed.

Baseline monitoring was conducted on a limited number of occasions and during dry weather conditions only; thus baseline monitoring is not sufficient to describe water quality under existing conditions. In addition, the DEIS does not describe how baseline monitoring will be used and does not provide a monitoring and analysis plan for additional (post-project) monitoring. HDF should conduct additional baseline sampling to characterize the full range of existing conditions (e.g., during wet weather). HDF should also specify the details of their sampling design, including sample locations, sample handling and analysis methods, and chain of custody protocols. HDF should also indicate how and when sample results will be made available to regulatory agencies and the public, the process for determining if impacts are significant, and the relevant thresholds to be used for determining significance. Finally, HDF needs to specify in detail the actions that will be taken, potentially up to and including the removal of dairy cows or cessation of the land application of liquid and/or solid manure at the site, if subsequent monitoring determines impacts are occurring.

Comment 20: Appendix F fails to provide quantitative support for its assessment of water quality impacts.

The water quality impact assessment in DEIS Appendix F (MRC, 2016) is qualitative, not quantitative, and relies upon the unfounded assumptions and calculations presented in the DEIS. As noted above, nutrients will be carried to the nearshore ocean in both groundwater and in surface water flows. DEIS Appendix F does not evaluate these two sources separately, asserting instead, and generally, that "extreme physical factors" in the marine receiving water environment "should result" in rapid mixing of surface water contaminants in the Waiopili Stream to background marine concentrations within a small area near the point of discharge (DEIS Appendix F at p. 13); however, no quantitative modeling or analysis was conducted to evaluate post-project anticipated nutrient or pathogen concentrations in the stream or ocean in support of this claim.

Wet weather events will deliver episodic "pulses" of freshwater, nutrients, and pathogens to the nearshore environment where the Waiopili Stream enters the ocean. The impacts of wet weather flow events, which will result in a discharge plume that may hug the shoreline and that is unlikely to be dispersed immediately, were not evaluated. Similarly, the impacts to the nearshore ocean of increased groundwater flow rates, and of increased nutrient concentrations in groundwater, were not evaluated either in terms of concentration or mass loading. In contrast to surface water flows, groundwater flows to the ocean represent a long-term, continuous, ongoing source of nutrients to the nearshore environment. Finally, the DEIS did not consider chemical and biological reactions that may occur within the groundwater along the flow path from the HDF to the ocean. The DEIS should use quantitative modeling and analysis to evaluate the water quality impacts due to nutrients, pathogens, and sediment on the ocean environment.

Comment 21: Exponent's quantitative analysis shows that the HDF project would result in significant surface water quality impacts.

Exponent's analysis of pathogen impacts (see Exponent 2016a) indicates that pathogen concentrations and loadings from the dairy are expected to be significant and that pathogens from the dairy may persist in the environment. These impacts were not evaluated in the DEIS.

In addition, CH2M's analysis indicates that nitrate and phosphorus loads from the site are expected to be significant and will vary seasonally (CH2M, 2016). CH2M made assumptions regarding the irrigation rates at HDF (i.e., that irrigation water will be applied at optimal rates). If HDF's operations do not follow these assumptions, loads of nutrients in runoff from the site may be higher than presented in CH2M (2016).

HDF has not evaluated the concentrations of pathogens, nutrients, or sediment in discharges from the HDF to the Waiopili Stream or the nearshore ocean and has not compared expected concentrations expected to occur in receiving waters against water quality standards for these constituents. Increased nutrient and pathogen loads to the nearshore environment will worsen the number and magnitude of exceedances of water quality standards. Ocean waters along the coast near the outlet from the Waiopili Stream are considered high quality ocean waters and are classified as Class A waters (DOH, 2014); thus, anti-degradation regulatory considerations may

also apply, since the project will result in degradation of receiving waters (see the section titled "Additional Considerations Related to Water Quality" below for more on anti-degradation requirements).

Comment 22: Water quality impacts of the HDF project may have impacts on coral and marine life that were not identified or evaluated in the DEIS.

Exponent's surface water quality analysis shows that concentrations and loads of nutrients, pathogens transported to the nearshore ocean environment as a result of the HDF project will increase. Given that Exponent's SWMM modeling results estimate increases in peak runoff rates under project conditions (ranging from 4 % [high infiltration] to 175 % [low infiltration]), it is expected that sediment concentrations and loads to the nearshore environment would also increase under project conditions. The amount and fate of additional sediment transported to the ocean is not evaluated in the DEIS. In addition, nutrient, pathogen, and sediment/turbidity impacts on the nearshore ocean have not been evaluated and may result in significant impacts to both human and ecological health. Without a detailed evaluation of the potential impacts of erosion, sediment transport, nutrient loadings, and pathogen loadings to the ocean, the magnitude of impacts to coral and marine life cannot be evaluated (see Exponent, 2016a and 2016c, for further information on pathogen and ecological impacts).

Comment 23: Measures aimed at ameliorating water quality in the effluent ponds are unclear and inadequately described.

Generic NRCS measures (Waste Treatment Lagoon standards) aimed at improving water quality in the effluent ponds, including aeration, are included in an appendix to the WMP, but these features are not described in detail in the report and it is not clear how they would be sized and operated. It is not clear if the HDF has designed the effluent ponds to function as aerobic or anaerobic features, or how the requirements of the NRCS measures will be met (e.g., minimum depth requirements, volume requirements for anticipated volatile solids loading rates, minimum treatment area or aeration rates based on BOD5 loading). If they are to be implemented, details about their location, sizing, and operations, should be described for both the 699- and 2,000-cow dairy configurations.[5]

Comment 24: Effluent ponds are likely to exhibit poor water quality and noxious odors.

The HDF WMP proposes that a stirrer pump be "operated two hours per day to break up the solids in the settling pond" (Group 70 International, 2014, p. 34). Beyond that measure, nothing concrete is proposed in order to manage the water quality of the settling and storage ponds.[6] Manure and animal waste contain a high biochemical oxygen demand (BOD) in addition to high nutrient concentrations. As a result, there is a high likelihood that, if improperly managed, the settling pond would be anaerobic and the storage pond would be either aerobic (which would be difficult to maintain given the two-pond design) or anaerobic at the bottom of the pond and aerobic at the top. Anaerobic conditions in the settling pond (and perhaps the storage pond) would likely generate substantial odors that could impact offsite properties (see also Exponent, 2016b). These pond conditions should have been fully evaluated in the DEIS; however, the DEIS includes no discussion of them. Without a quantitative analysis of anticipated water quality within the settling and storage ponds, and without a detailed description of the water quality control measures to be employed at the HDF, water quality within the ponds cannot be evaluated. The DEIS should include a detailed description of the sizing, design, and operation of water quality control measures and detailed calculations describing the anticipated effectiveness of these measures.

[5] Although the DEIS appears to avoid the term "wastewater treatment" in referring to the ponds at the site, the WMP includes a section (Section 7.0) entitled "Wastewater Treatment," which includes subsections on "Effluent/Manure Volume," "Effluent Ponds," "Effluent Application," and "De-Sludging." As described in the text, the WMP also includes the NRCS Waste Treatment Lagoon standards.

[6] Indeed, the purpose of the stirrer pump is not clear. The objective may be to minimize the formation of crust on the surface of the settling pond. It should be noted that the majority of settleable solids will accumulate on the bottom of the pond within a few hours; therefore, operating a stirrer for 2 hours per day will not be effective in breaking up all solids in the pond, nor would it be consistent with the intent of a "settling pond."

Comment 25: The WMP fails to present a permissible method for disposing of waste solids from the settling pond.

The original WMP proposes to disperse solids from the settling pond via irrigation gun (Group70 International, 2014, p. 54); however, a recent letter from the Hawaii Department of Health (HDOH) states that "wastewater effluent from the storage pond should not be used to irrigate… if gun irrigation is proposed" (HDOH 2016). Presumably, if gun irrigation may not be used to distribute wastewater effluent from the storage pond, then HDOH would also prohibit the distribution of solid wastes from the settling pond via irrigation gun. Given HDOH's stance, it is not clear how solids from the settling pond will be disposed of, particularly for the 2,000-cow configuration, when the DEIS indicates that slurry would be applied over a large portion of the site, including the southwest corner of the site nearest the Kawailoa properties. The DEIS should be amended to include a detailed and quantitative description of how solid and liquid manure in the settling and storage ponds will be handled onsite.

Additional Considerations Related to Water Quality

Federal and State CAFO Regulations

Title 40 of the Code of Federal Regulations, §122.23 (40 CFR 122.23) outlines federal regulations pertaining to concentrated animal feeding operations (CAFOs). Hawaiian regulators use and apply these federal regulations (see University of Hawaiʻi-Manoa, Hawaii State DOH, 2010).

Title 40 CFR 122.23 defines an "Animal Feeding Operation" (AFO) as a lot or facility where (1) non-aquatic animals "have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period, and (2) crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility."

According to 40 CFR 122.23, "Concentrated animal feeding operations" (CAFOs) fall into three categories—large, medium, or small—which are defined as follows:

(1) A large CAFO is an AFO that stables or confines either 700 or more mature dairy cows (whether milked or dry) or 1,000 or more cattle other than mature dairy cows, including heifers, steers, bulls, and cow/calf pairs;

(2) A medium CAFO is an AFO that stables or confines either 200-699 mature dairy cows (whether milked or dry) or 300 to 999 cattle other than mature dairy cows, including heifers, steers, bulls, and cow/calf pairs, and that exhibits a discharge of pollutants into waters of the U.S. through a ditch, flushing system, or similar device, or directly into waters of the U.S.

(3) A small CAFO is an AFO that is not a medium or large CAFO, but that has been designated as a CAFO since it is a "significant contributor of pollutants to waters of the United States."

An AFO can also be designated at a CAFO "upon determining that it is a significant contributor of pollutants to waters of the United States." As detailed throughout these comments, the HDF

is expected to cause a significant worsening of water quality in the Waiopili Stream and in the ocean. In addition, the contemplated project size of 2,000 cows appears to clearly meet the definition of a CAFO.

All operators or owners of CAFOs (small, medium, or large) must seek coverage under an NPDES permit. Hawaii does not have an NPDES general permit for CAFOs, so coverage under an individual permit is required. An individual NPDES permit for a CAFO in Hawaii would require that a comprehensive nutrient management plan be implemented at the CAFO site; that the CAFO operator submit annual reports to the HDOH; that NPDES permit be kept current until the operation is no longer a CAFO; and that records of nutrient management practices be kept for at least five years. The nutrient management plan must describe "how the operation will manage nutrients and waste in terms of storage, management of dead animals, clean water management, preventing animals from contact with state waters, chemical handling, runoff, testing, land application, and recordkeeping" (University of Hawaiʻi-Manoa, Hawaii State DOH 2010, p. 13). NPDES permits for CAFOs prohibit discharges of process wastewater pollutants except when discharges are due to a storm event exceeding 25-year, 24-hour rainfall, and HDF must demonstrate these requirements can be met; thus containment structures for CAFO process wastewater must be designed to contain all process wastewater plus runoff from an event of that frequency and magnitude. NPDES permits for CAFOs may include technology-based and water quality-based effluent limitations (U.S EPA 2000, pp. 23–24).

Comment 26: HDF should be designated as a CAFO and be subject to an individual NPDES permit.

The contemplated milking facility at the HDF would clearly be a large CAFO given the contemplated number of cattle (~2,000 mature dairy cows). The proposed milking facility at the HDF may be a medium CAFO depending on whether there is a discharge of manure, litter, or process wastewater from the facility to waters of the U.S. or whether the facility is properly understood as a "significant contributor of pollutants to waters of the United States."

As noted previously, fields are anticipated to be fertilized using wastewater and waste solids from the proposed settling pond; thus it is likely that storm water runoff would wash waste materials into the Waiopili Stream—a water of the U.S.—and into the ocean during significant storm events. Title 40 CFR 122.23 does not consider such storm water discharges (“agricultural storm water discharges”) as qualifying a facility for medium CAFO status or requiring coverage under an NPDES permit as long as the application of waste material is “applied in accordance with site specific nutrient management practices that ensure appropriate agricultural utilization of the nutrients in the manure, litter, or process wastewater.”

Nevertheless, given the water quality analysis above, it seems likely that the facility will be a significant contributor of pollutants to waters of the U.S; therefore it seems likely that the facility should be designated as a medium CAFO and subject to the requirements of an individual NPDES permit issued by the HDOH, as described above.

Anti-degradation Requirements

HAR Section 11-54-1.1, Hawaii’s anti-degradation policy, provides that “Existing uses and the level of water quality necessary to protect the existing uses shall be maintained and protected.” Even in cases where the director finds that “allowing lower water quality is necessary to accommodate important economic or social development in the area,” “the director shall assure water quality adequate to protect existing uses fully.”

The waters of the Waiopili Stream and the nearshore ocean near the stream currently contain concentrations of indicator bacteria that exceed water quality standards (MRC, 2016). In addition, much of the coastline near the HDF already receives high concentrations and loads of nutrients (TNWRE, 2016). Concentrations and loads of nutrients and pathogens are expected to increase markedly as a result of dairy operations at the HDF. The HDF has not evaluated water quality in a quantitative manner. HDF has not described the monitoring approach to determine if water quality degradation occurs as a result of the project, nor have they described mitigation measures that are planned to be employed if water quality degradation does occur.

Exceedances of Water Quality Standards

The ocean waters into which the Waiopili Stream flows are classified as “Class A” waters, which requires that their use for recreational purposes or aesthetic enjoyment be protected. HAR 11-54-3 also requires that “these waters shall not act as receiving waters for any discharge which has not received the best degree of treatment or control compatible with the criteria established for this class.”

Water quality criteria applicable to all waters of the state include a requirement that “[a]ll waters shall be free of substances attributable to domestic, industrial, or other controllable sources of pollutants, including: … materials that will settle to form objectionable sludge or bottom deposits; … substances in amounts sufficient to product taste in the water or detectable off-flavor in the flesh of fish, or in amounts sufficient to produce objectionable color, turbidity or other conditions in the receiving waters; … pathogenic organisms … or other deleterious substances at levels or in combinations sufficient to be toxic or harmful to human, animal, plant, or aquatic life, or in amounts sufficient to interfere with any beneficial use of the water; … soil particles resulting from erosion on land involved in earthwork, such as the … cultivation and management of agricultural lands.”

Water quality criteria for inland waters, including streams, include numeric criteria for total nitrogen, nitrate + nitrite nitrogen, total phosphorus, total suspended solids, and turbidity. For Class A marine waters, numeric water quality criteria are provided for total nitrogen, ammonia nitrogen, nitrate + nitrite nitrogen, total phosphorus, light extinction coefficient, chlorophyll a, turbidity, pH, and dissolved oxygen (among others).

HDF has not evaluated water quality for these constituents, nor has HDF compared anticipated water quality with applicable water quality standards.

Comment 27: The potential for additional exceedances of water quality standards and for degradation of water quality in Waiopili Stream and in the ocean should be evaluated in a rigorous and quantitative fashion.

As detailed above, it is likely that water quality will degrade significantly and that the frequency and magnitude of exceedances of water quality criteria can be expected to increase. These impacts should be evaluated.

Limitations

The information upon which we rely in preparing this report is from the HDF DEIS and from publicly available information. We have generally not verified these data independently, and unless otherwise stated, assume that they are accurate. In addition, some data and information generated or reported by the HDF is unclear, and we have interpreted that information to the best of our ability. This report summarizes work performed to-date and presents the findings resulting from that work. We reserve the right to supplement this report and to expand or modify opinions based on review of additional material as it becomes available.

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Appendix A SWMM Results for Curve Number Method

Table A-1. Monthly water balance in millions of gallons (MG) for existing conditions at the proposed HDF site (Curve Number method for infiltration).

Month	Inflows			Outflows			
	Precipitation (MG)	Irrigation (MG)	Stream flow from upstream (MG)	Evapotran-spiration (MG)	Runoff from HDF site (MG)	Stream flow from upstream (MG)	Infiltration to Groundwater (MG)
Jun-96	70	159	3	45	74	3	109
Jul-96	27	159	0	35	53	0	96
Aug-96	13	159	0	28	56	0	88
Sep-96	124	0	50	9	53	50	58
Oct-96	112	0	8	14	17	8	79
Nov-96	191	0	45	23	75	45	91
Dec-96	88	0	20	7	24	20	55
Jan-97	90	0	8	10	16	8	62
Feb-97	32	0	0	4	2	0	26
Mar-97	140	0	7	22	35	7	80
Apr-97	56	0	2	8	7	2	42
May-97	159	0	69	22	64	69	74
Total	1102	478	211	226	474	211	860

Table A-2. Monthly water balance in millions of gallons (MG) for proposed project conditions at the proposed HDF site (Curve Number method for infiltration).

Month	Inflows			Outflows			
	Precipitation (MG)	Irrigation (MG)	Stream flow from upstream (MG)	Evapotran-spiration (MG)	Runoff from HDF site (MG)	Stream flow from upstream (MG)	Infiltration to Groundwater (MG)
Jun-96	70	84	3	102	42	3	9
Jul-96	27	92	0	105	10	0	4
Aug-96	13	94	0	98	6	0	2
Sep-96	124	88	50	100	98	50	12
Oct-96	112	88	8	98	88	8	14
Nov-96	191	83	45	85	174	45	16
Dec-96	88	89	20	81	87	20	10
Jan-97	90	88	8	77	89	8	11
Feb-97	32	81	0	76	32	0	5
Mar-97	140	84	7	92	120	7	14
Apr-97	56	84	2	90	44	2	7
May-97	159	82	69	103	125	69	13
Total	1102	1034	213	1108	915	213	116

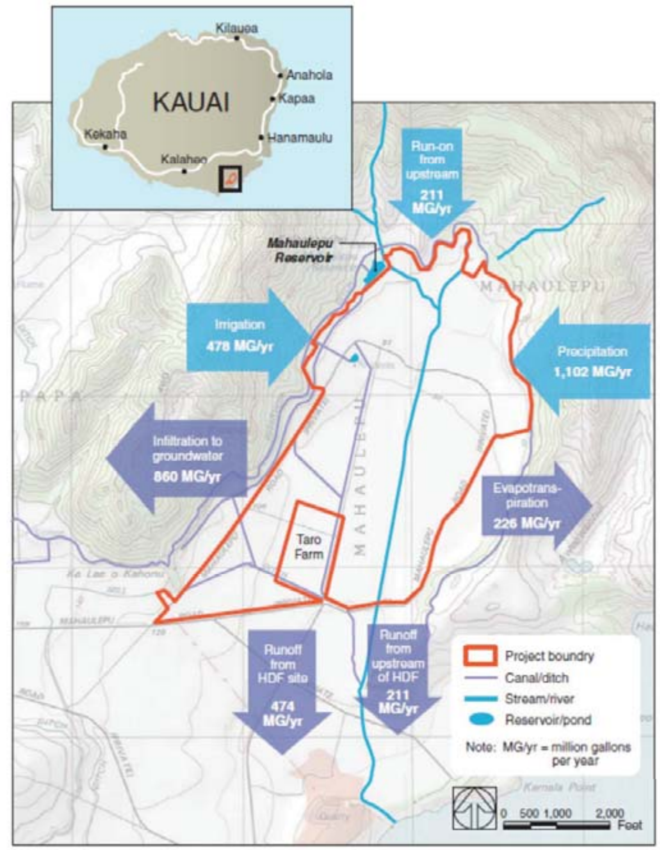

Figure A-1. Annual water balance at the HDF site, existing conditions, Curve Number method for infiltration

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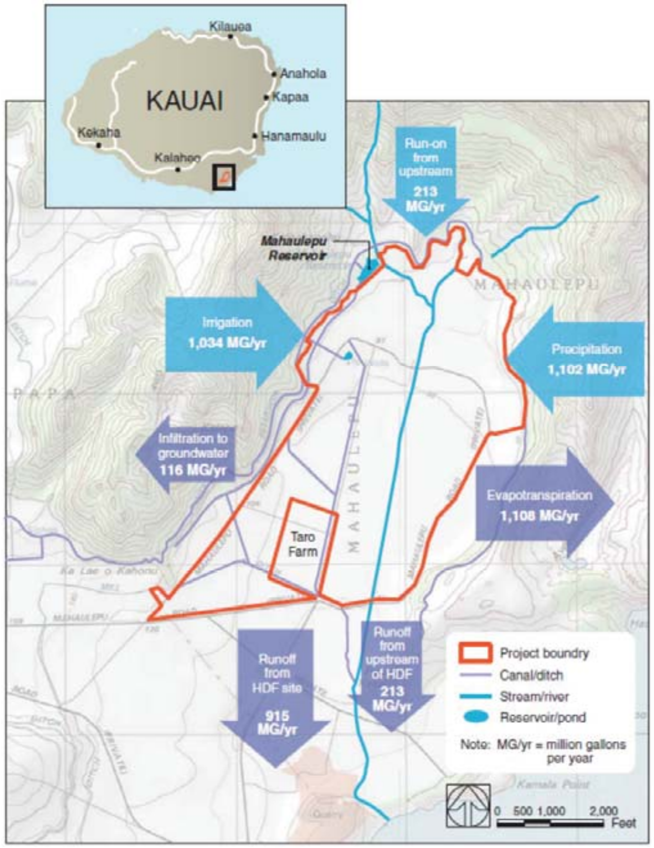

Figure A-2. Annual water balance at the HDF site, project conditions, Curve Number method for infiltration

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Appendix H

Comments on Dairy Management, Dairy Waste Management, Cropping, and Soil Conditions Relative to Dairy Waste Management in Draft Environmental Impact Statement for Hawai'i Dairy Farms, Māhāʻulepū, Kauai, May 2016

Prepared for

Goodsill Anderson Quinn & Stifel LLP

July 21, 2016

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Contents

Attachment A: Detailed Tables and Figures from Water and Nutrient Balance Model Runs

Executive Summary

CH2M subject matter experts reviewed the Draft Environmental Impact Statement for Hawai'i Dairy Farms (HDF), Māhā'ulepū, Kauai, May 2016 (DEIS), with a focus on dairy management, dairy waste management, cropping, and soil conditions relative to dairy waste management. The DEIS uses many simplifying generalizations such as estimating the yield and nutrient uptake of Kikuyu grass as uniform every day of the year on every soil type and slope whether irrigated or non-irrigated. Simplifications such as this result in incorrect estimates of nutrient losses to the environment. The authors of the detailed appendix reports all referenced the incorrect nutrient balance of the DEIS and came to conclusions that the impact of the Dairy was less than it actually will be when accurate accounting of water and nutrients through the dairy farm are considered.

To have a basis for comparison to the DEIS, CH2M modeled the soil, water, and nutrient movement through the root zone of Kikuyu grass with a detailed model that calculates crop yield, water and nutrient uptake, and nutrient losses to the environment considering the variables of climatic conditions and how these variable influence crop growth and nutrient removal. This model is used every week by CH2M to recommend best management practices in irrigation rates, fertilizer, and manure applications for two mainland dairy farms. The model has been used for over 5 years on one of these dairies with good correlation between model predictions and actual crop water and nutrient uptake.

The scenario modeled for HDF was for 2000 cows with wetter than average climatic conditions, no commercial fertilizer application, and optimal irrigation water application to meet all crop needs but not over-irrigate. Four models were developed to represent the four water and nutrient conditions proposed in the DEIS of: 1.) manure as excreted on non-irrigated areas, 2.) manure as excreted plus manure slurry from the holding pond on non-irrigated areas, 3.) manure as excreted plus manure effluent on the pivot irrigated areas, 4.)and manure as excreted plus manure slurry from the holding pond on big gun irrigated areas. All four models predict high nitrogen loss with a total discharge of nitrogen from the dairy to the water environment of 335,934 pounds per year. Without modeling and with oversimplification and averaging of variables, the DEIS makes a first order approximation of 10,000 pounds per year of nitrogen discharged to the environment.

The DEIS uses rainfall data from the local Māhā'ulepū 941.1 rain gauge which has hundreds of missing data points in 30 years of record and over 50 missing data points in every year of record. This station is not suitable for irrigation scheduling or manure management. HDF's use of this poor quality partial data set for the critical climatic input to dairy management decisions has resulted in the DEIS recommending over-irrigation, unrealistic yield estimates, and nutrient discharges that are an order of magnitude too low.

The HDF claims to have one of the highest yields in the world for Kikuyu grass pasture but does not provide any scientific design for sampling or farm trial quality control. The dairy does not currently have cows, so yield estimates are for clipped samples which over-estimate actual

yields from cattle grazing. The nitrogen removal rates of 1090 pounds per acre per year presented in the DEIS are unprecedented and are not supported by scientific data or references for pastures in Hawai'i grazed by cattle on an 18 day rotation. The nitrogen removal rates are presented as the same for non-irrigated areas and irrigated areas even though Kikuyu grass in Hawaii is documented to have half the yield when non-irrigated.

The HDF proposes to apply manure slurry with big gun irrigation sprinklers with a trajectory radius of 65 ft. This method of slurry application is the poster child of manure odor complaints as it creates a plume with a wide range of droplet sizes and mist that can drift in the wind and volatilize odor agents over a large area. Big gun sprinkler irrigation has a higher instantaneous application rate than almost all sprinkler, spray, or drip irrigation systems and is prone to creating ponding and runoff from poorly drained and sloped soils. The risk of runoff from big gun sprinklers for applying manure slurry is increased by the additional use of big gun sprinklers for irrigation water application on the same fields as the DEIS states will be done with the 2000 head dairy.

The HDF has already built smart valve center pivot irrigation machines that cross drainage ways and Waiopili stream on narrow bridges multiple times in every rotation. The many valves on individual sprinklers on these pivots are programmed to stop manure effluent irrigation as the machine approaches the stream or drainage and reopen when the machine is on the other side. These machines are the most complex center pivot irrigation equipment available and contain hundreds of addition components when compared to standard center pivot machines including

GPS guidance, an air control pilot tube to every valve and a programmable controller. It is because of the increased complexity that these machines fail more often than standard center pivots. The use of manure effluent increases the risk of corrosion, scale build-up, and plugging failures. There appears to be no precedent for use of these machines to apply manure while crossing a stream and the time to failure is unknown.

The soil conditions across the dairy vary significantly in infiltration rate, texture, water holding capacity, background nutrient content, slope, and yield potential, yet the DEIS ignores all variables and selects a condition to use as average for all paddocks. The selected condition is not average or worst case and under-represents the risk of nutrient losses to the environment.

Introduction

Goodsill Anderson Quinn & Stifel LLP retained CH2M on behalf of Kawailoa Development LLP to review and comment on the Draft Environmental Impact Statement (DEIS) for Hawaiʻi Dairy Farms (HDF), Māhāʻulepū, Kauaʻi.

Project Background

HDF proposes to develop a dairy on 557 acres near Poʻipū in a three sided box canyon that opens to the ocean and is drained by Waiopili Stream that flows through the center of the farm. The dairy will have 469.9 acres of paddocks. The paddocks will grow Kikuyu grass pasture on irrigated and non-irrigated paddocks where conditions are extremely variable: some soils are well drained and others are poorly drained soils; milking barn manure effluent and slurry will be applied on some paddocks but not others; and irrigation by different methods. HDF proposes 346.5 acres of irrigation including pivots and hose supplied big gun sprinklers. Milking barn manure liquid effluent will be applied with the pivots, and the manure solids will be applied with big gun sprinklers.

HDF plans to establish the dairy with 699 cows, and a future phase of dairy expansion will include 2000 cows. The date of the expansion is not presented in the DEIS but information on the operations and management of the dairy with 2000 cows is presented. HDF states that the dairy will discharge 10,000 pounds of nitrogen annually to surface water, groundwater, and the ocean from excess manure application and uncontrollable losses in runoff and deep percolation water. The DEIS presents monthly or annual averages for manure application, weather, irrigation, and crop yield and nutrient uptake. Wetter than average or drier than average climatic conditions are not accounted for in the proposed dairy management.

Purpose and Overview of Report

This document presents CH2M's comments relating to the Hawai'i Dairy Farms' (HDF) Draft Environmental Impact Statement ("DEIS") dated May 2016. Agricultural Engineers, Environmental Engineers, Civil Engineers, a Soils Scientist, and a Meteorologist performed the CH2M review. CH2M's review is focused on water balance and the influence of irrigation, nutrient balance with manure application and nutrient removal and losses, crop management including potential yield impacts of variable weather, irrigation, and nutrient availability, the impact of harvest by grazing rather than cutting, and the variability and limitations of soils.

CH2M utilized a root zone water balance model that tracks water and nutrient movements through the crop root zone and simulates crop uptake, deep percolation, and runoff of water and nutrients. The model is regularly used as a tool for irrigated farms and dairies to recommend best management practices for irrigation, fertilization, and manure application. The model was used to simulate the water and nutrient movement through the soils of the HDF. CH2M used inputs as stated in the DEIS where they were supported by data, and used other input data where the DEIS inputs were based on assumptions or found to be in error. The proposed operations of the HDF were simulated for a wetter than average year to expose the impacts of greater than average rainfall.

For the greater than average rainfall year, CH2M assumed HDF would have optimal irrigation water management and no fertilizer application to determine the extent of manure nutrient losses with rainfall as the primary uncontrollable variable. CH2M performed this analysis to evaluate impacts from these assumed operations. If HDF's irrigation water management is not perfect, actual impacts are likely to be greater.

Root Zone Water and Nutrient Balance

CH2M's model evaluated the fate of applied irrigation water, all of which was assumed to infiltrate, and which was applied at rates determined by CH2M to be optimal. In contrast, precipitation events that exceed soil infiltration rates will create surface runoff plus infiltration and the rainfall is split by the model according to SCS runoff curve number for the soil conditions and vegetative cover to estimate percent runoff. During periods of rainfall that meet crop water needs no irrigation is assumed and during periods with rainfall that infiltrates exceeding crop water needs deep percolation occurs.

CH2M prepared a root zone water and nutrient balance to evaluate the water and nutrient movement for both the irrigated and non-irrigated portions of the HDF site. The primary purpose of this analysis was to evaluate the site water balance including water and nutrients lost to deep percolation under wet year conditions under the best possible irrigation and nutrient management using the proposed nutrient loading rates. Although direct surface runoff could also mobilize a portion of nutrients on and within near surface soils to surface water discharges, this model assumes that all nutrients are routed through the crop root zone and are subject to plant uptake from the crop prior to any release to deep percolation. The close connection between surface water and shallow groundwater suggests that all nutrients lost from the site, whether in surface water or groundwater, will enter the near shore and shoreline waters in or near Waiopili stream. Routing all nutrients through the crop root zone instead of removing a portion of them with surface runoff is conservative as it allows the maximum potential plant uptake and soil retention. The percent of nutrients lost from the site with runoff is influenced by many variables including time between manure excretion or application and a rainfall event that creates the runoff, time since the previous irrigation or rainfall event, and soil and crop conditions specific to each paddock. Many additional models will be required to accurately calculate nutrients lost to runoff and these models should be developed by HDF. The CH2M models include surface runoff, which reduces the total amount of water moving through the soil as deep percolation. The models calculate the soil water holding capacity and recommend irrigation for optimal crop yield when rainfall minus runoff is not adequate. The models for irrigated fields show that the soils over the entire Kikuyu root zone are near field capacity almost continuously throughout the year to optimize yield which results in surface soils being at saturation much of the time. The models predict runoff will occur 9 months during the 12-month period modeled resulting in 10.09 inches of surface runoff. The CH2M modeling is intended to test the best possible conditions for crop utilization of nutrients with perfect irrigation management and no surface loss of nutrients in a wet year.

Climate Conditions

CH2M used monthly rainfall data from the Lihue WSO AP 1020.1 weather station (http://climod.nrcc.cornell.edu/runClimod/66f95a99e542907d/5/) in the model. The Lihue site

was selected due to it being close to the proposed HDF site and having a complete daily precipitation record from 1950 through 2015. The average annual rainfall at the Lihue site is 40.59 inches, which is slightly lower than the average precipitation recorded at the Māhā'ulepū station used in the DEIS of 44.26 inches. CH2M is using a complete rainfall data set, which is accurate but is for a location with less average rainfall than HDF and underestimates the total impact of rainfall. The DEIS underestimation of rainfall is based on incomplete Mahaulepu data which results in an underestimation plus an unknown amount of error. CH2M's underestimation is greater the HDF underestimation of total rainfall, but still results in significant nitrogen loss.

In order to simulate a wet year condition within which deep percolation losses could mobilize excess applied nutrients to groundwater and subsequently to surface water, precipitation data for the time period from June 1996 through May 1997 were used in the model. The total precipitation during this 12-month period at the Lihue WSO AP 1020.1 weather station was 70.14 inches.

CH2M estimated surface runoff of precipitation using daily precipitation data and the SCS Runoff Curve Number (CN) method as described in USDA Technical Release-55. CH2M utilized a weighted CN value of 72 as referenced in Table 3 of the "Hydrologic Assessment for the Pasture Areas for Hawai'i Dairy Farms"[1] . On average over the 30-year period from 1986 through 2015,

[1] DEIS Appendix K.

the average percent of rainfall projected to be lost to surface runoff was 11 percent. For the 12-month period from June 1996 through May 1997, CH2M projected that 14.4 percent of rainfall would be lost to surface runoff under these soil and cover conditions.[2]

CH2M obtained evapotranspiration (ET) for average monthly values of Grass Reference Surface Potential ET (ET_o) from the same website and location as used in the DEIS (http://evapotranspiration.geography.hawaii.edu/interactivemap.html). There is some variation in ET_o across the HDF site using this gridded data source. However, the location selected in the DEIS was used for the modeling. CH2M applied a crop coefficient of 0.85 representing mid-season for warm season grasses[3] to the monthly ET_o values to estimate the monthly potential crop ET for Kikuyu grass. This is the same assumption used in the DEIS. Therefore, estimated potential crop ET is the same in this model as used in the DEIS. For the wet year conditions simulated, the actual crop ET would be expected to be lower than average year values but data were not immediately available to calculate crop ET specifically for the June 1996 through May 1997 time period. Lower crop ET values would generally result in higher deep percolation amounts during the wet periods.

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2 CH2M's methodology is purposefully different from the methodology used by Exponent in "Water and Water Quality Impacts, Hawai'i Dairy Farms DEIS, Māhā'ulepu, Kaua'i. July 2016. ("Exponent Water Report") CH2M's analysis looks at long-term average conditions and is not intended to explicitly model hydrology. In contrast, the Exponent Water Report models hydrology, resulting in different conclusions not directly comparable to this report.

3 See table 12 in ***FAO*** Irrigation and drainage paper ***56***. By Richard G. Allen, L. Pereira, D. Raes, M. Smith, ***FAO*** - Food and Agriculture Organization of the United Nations. Rome, 1998.

Irrigation Applications

Water applied in the models includes rainfall and irrigation, of which a portion of the irrigation is liquid effluent in the case of the pivot areas.[4] Although the DEIS did not explicitly describe or identify methods for optimizing irrigation, for irrigated portions of the site, CH2M assumed irrigation to be scheduled according to crop water demands, varied accordingly to represent the best possible irrigation management. CH2M did not apply irrigation during periods in which there was no calculated irrigation demand.

Under rainfed conditions for the non-irrigated portions of the HDF site, crop water stress is calculated in the model using a soil water balance. Under these conditions, the model reduces the potential crop ET to a lower actual crop ET based on soil water availability and water stress; potential nutrient uptake is also reduced in proportion to the reduction in actual crop ET, as crop yield will be reduced under rainfed conditions since water is not as available as it would be in irrigated areas of the site.

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4 The Hawai'i Department of Health (HDOH) sent a letter to Mr. Paul T. Matsuda at Group 70 International on 15 June 2016 stating that wastewater effluent from the proposed storage pond should not be distributed via irrigation gun. Presumably, HDOH would also object to distributing manure slurry from the settling pond via irrigation gun. Thus, it is not clear that the proposed slurry distribution methodology is feasible from a regulatory perspective.

Nutrient Applications

CH2M input nutrients in the form of as-excreted manure, effluent, and slurry into the model. The manure production estimates and the nitrogen content of each of these products for the 2000 cow scenario was provided by Dr. Deanne Meyer.[5] CH2M did not consider commercial fertilizer addition in the water and nutrient balance since the amounts could be easily adjusted from proposed values to lower rates as needed. Manure inputs, however, were not adjusted, as they are tied directly to the number of cows.

Nutrient Uptake

Plant nitrogen uptake for the proposed Kikuyu grass is assumed to be no greater than 545 lb/ac/year, as discussed in this report. The monthly pattern of nitrogen uptake is estimated to be proportional to biomass accumulation (plant growth) rates which are also proportional to crop ET. Consequently, the proportion of monthly to annual crop ET was applied to the annual potential plant nitrogen uptake of 545 lb/ac/yr to estimate the monthly potential plant nitrogen uptake rates.

5 Comments on Animal and Manure Management in Hawai'i Dairy Farms Draft Environmental Impact Statement. July 2016. ("Meyer Report")

Results

Model runs were performed with the data discussed above, for eight water and nutrient application configurations to simulate the 2000 cow scenario using the four different nutrient application areas described by HDF.

A summary of nitrogen and water balance results are presented in Tables 1 and 2. Detailed Tables and Figures from the Water Balance model runs are provided in Attachment A.

For the 2000 cow scenario, there is significant nitrogen overloading of the site. Under this scenario, an estimated 57 percent of the total applied nitrogen is lost to deep percolation for an annual loss of 335,934 lbs of nitrogen. This is primarily due to heavy nitrogen loading from manure excretion on pastures of 1,155 lbs/ac/yr in contrast to the potential plant nitrogen uptake of 545 lb/ac/yr.

Comments on DEIS and appendix documents

Comment 1: The DEIS claims to have nearly the best yield in the world for Kikuyu grass based upon a farm trial but does not present any scientific design for the trial or any raw data or statistical analysis of data to support the claim. The high yield that is the basis of the nutrient balance is unfounded.

HDF presents the yield of Kikuyu grass at 16.4 ton/ac dry matter to remove 64 pounds per acre of nitrogen from the soil per ton of yield. None of the raw data from the on-farm yield trials or lab analysis are presented. Both yield and nitrogen content in forage are optimistic values. The United Nations Food and Agriculture Organization (FAO), a standard reference for crop yield predictions and nutrient content, reports that frequent cutting of Kikuyu grass significantly reduced yield. Studies showed that frequent cutting (every two weeks) reduced dry-matter yield by 54 to 25 percent, compared with a maximum yield at the 12-week cutting interval; this depression was greater in the presence of nitrogen fertilizer. The maximum production of green herbage and protein was obtained from a Kikuyu/clover sward cut to 5 cm every nine weeks. The yield of 16.4 tons dry matter/acre/year[6] proposed in the DEIS is at a frequent grazing interval of 18 days.

While it may be possible to obtain higher protein content and yield with luxuriant nutrient uptake from over–fertilization, this practice would result in the high risk of nutrients in runoff and deep percolation to groundwater. Some paddocks are non-irrigated and will have further reduced yield.

6 HDF DEIS p. 3-24; HDF DEIS Appendix C at p. 4.

Table 1. Nitrogen Additions for the 2000 Cow Scenario

Scenario: 2000 cows	Total Area	N from Manure As Excreted	N from Effluent	N Applied from Slurry	Total Applied N	N from Manure As Excreted	N from Effluent	N Applied from Slurry	Total Applied N
	acres	lb/ac/yr	lb/ac/yr	lb/ac/yr	lb/ac/yr	lb/yr	lb/yr	lb/yr	lb/yr
Pivot, manure as excreted & effluent	285.1	1,155	104	-	**1,259**	329,266	29,601	-	**358,867**
Big gun irrigation, manure as excreted & slurry application	61.4	1,155	-	115	**1,270**	70,912	-	7,086	**77,997**
Non-irrigation, manure as excreted & slurry application	109.6	1,155	-	115	**1,270**	126,579	-	12,648	**139,227**
Non-irrigation, no slurry, manure as-excreted only	13.8	1,155	-	-	**1,155**	15,938	-	-	**15,938**
Totals	**469.9**					**542,694**	**29,601**	**19,734**	**592,029**

Table 2. Nitrogen Balance and Losses for the 2000 Cow Scenario

Scenario: 2000 cows	Total Area	Applied Irrigation Water	Deep Percolation	Total Applied N	Crop N Uptake	Deep Percolation N Loss	Total Applied N	Crop N Uptake	Deep Percolation N Loss
	acres	in	in	lb/ac/yr	lb/ac/yr	lb/ac/yr	lb/yr	lb/yr	lb/yr
Pivot, manure as excreted & effluent	285.1	29.7	6.4	1,259	545	714	358,867	155,380	203,487
Big gun irrigation, manure as excreted & slurry application	61.4	29.7	6.4	1,270	545	725	77,997	33,463	44,534
Non-irrigation, manure as excreted & slurry application	109.6	-	2.0	1,270	545	725	139,227	59,732	79,495
Non-irrigation, no slurry, manure as-excreted only	13.8	-	2.0	1,155	545	610	15,938	7,521	8,417
Totals	**469.9**						**592,029**	**256,096**	**335,934**

http://www.fao.org/ag/AGP/AGPC/doc/Gbase/DATA/Pf000298.HTM

Comment 2: The DEIS uses rainfall data from the local Māhāʻulepū 941.1 rain gauge which has hundreds of missing data points in 30 years of record and is not suitable for irrigation scheduling or manure management.

The DEIS reports that in 30 years only 5 times has rain occurred for more than a week of consecutive days. A review of the average running total precipitation for days 1 to 7 for the years was done for station 941.1. Unfortunately, this does not take into account the number of missing days which would upend the consecutive day analysis. Lihue is the only station that can be used for that analysis. The Māhāʻulepū 941.1 rain gauge has hundreds of days of missing data in the past 30 years and is not considered by CH2M meteorologists as a valid weather station with continuous data record. Nearly every month of the 30 years of record has some missing data with many months having more than 7 days per month of missing data. As an example, September of 1992 has 19 days of missing data. Using this data set results in underestimation of storm events, overestimation of irrigation requirements, and overestimation of the number of days that are suitable for effluent and slurry application. Weather is a critical component of the water and nutrient balance and the balance is not accurate with the data utilized, which underestimate the actual impact of the proposed dairy.

Comment 3: The use of annual average manure application and annual average yield estimates grossly underestimates the nitrogen discharge from the slurry application paddocks.

The non-irrigated area of 42 acres is the only area proposed for land application of all of the manure solids collected in the settling basin at the milking barn for the 699 head herd size. This area also receives manure excreted from grazing cows. The nutrient application on this

area is the highest on the farm and because it is not irrigated it is also the lowest yielding area on the farm. Therefore, the nutrients removed with grazing are less than the nutrients applied with slurry application and excretion, resulting in nitrogen discharge to surface water and groundwater in the winter months when rainfall exceeds Kikuyu grass water use.

Comment 4: HDF proposes the unprecedented use of manure effluent application pivots across a stream and depends upon complex failure prone smart valve center pivots to stop flow and not drip while the pivots are on bridges over the stream.

The "smart valve" center pivot irrigation systems cross both Waiopili stream and a drainage ditch that ultimately discharge to the ocean near coral beds. Both pivots will be used for liquid manure application. The design of the pivots allows each individual sprinkler head to be turned on and off with an automated valve that can be programmed. An individual control signal is sent to each valve every time the pivot crosses the ditch or stream, which can be multiple times per day. The two pivots will each have about 100 sprinkler heads with automated control. A valve failing and not closing can be expected to occur many times during the life of the project, resulting in irrigation of manure directly into the stream and drain ditch and contamination of the waters of the state (stream and ocean), as well as the beach. HDF has not provided references of other dairies successfully using this same type of effluent disposal pivot while crossing over waters of the state or drain ditches that discharge to waters of the state. The DEIS fails to present mitigation for standard failure rates on these complex machines.

Comment 5: The DEIS underestimates the discharge of nutrients to the stream and groundwater by an order of magnitude.

HDF assumes that only 2 percent of the nitrogen and 1 percent of the phosphorus applied to the farm will be carried to drainages, streams, and groundwater. This would amount to

10,000 pounds per year of nitrogen and 900 pound per year of phosphorus discharged to water off site. Compared to existing farming conditions, this is a 6.6 times increase in nitrogen discharge and an 8.4 times increase in phosphorus discharge. These data are for average weather conditions but are based upon the Māhā'ulepū 941.1 gauge, which has missing data.

The CH2M detailed water and nutrient balance models utilizing more complete weather data indicate that HDF's DEIS estimates are an order of magnitude less than the total nutrient loss that will occur during years that have higher than average precipitation.

The DEIS makes a comparison that the proposed dairy discharge of 900 pounds of phosphorus is less than all other discharges in the region from domestic wastewater and fertilizing landscape of 1,260 pounds per year.[7] This estimate is also based upon gross assumptions and a first order approximation of 1 percent of all phosphorus on the dairy being discharged. The CH2M models predict that the discharge of nitrogen from the dairy will exceed the total combined discharge of all domestic wastewater and landscape fertilization in the region and will be in addition to the existing load to more than double the current impact. Much of the discharge from the dairy will occur in the stream, and the stream itself is effectively a point source discharge to marine waters at the beach and near shore coral beds. For the 2000 cow herd the nitrogen loss to the environment is 335,934 pounds per year or 33 times more than the first order approximation in the DEIS

7 HDF DEIS, Appendix F at p. 12.

Comment 6: The DEIS states that the dairy will be operated in accordance with NRCS code 590 but disregards the code guidance by not considering wetter than average conditions.

NATURAL RESOURCES CONSERVATION SERVICE (NRCS) PACIFIC ISLANDS AREA

CONSERVATION PRACTICE STANDARD NUTRIENT MANAGEMENT (Ac.) CODE 590 states:

"The soil and tissue tests must include analyses pertinent to monitoring or amending the annual nutrient budget, e.g., pH, electrical conductivity(EC) and sodicity where salts are a concern, soil organic matter, phosphorus, potassium, or other nutrients and test for nitrogen where applicable." Code 590 also states:

- "Nutrients must not be surface-applied if nutrient losses offsite are likely. This precludes spreading on:
  - fields when the top 2 inches of soil are saturated from rainfall."
- "The total single application of liquid manure:
  - must not exceed the soil's infiltration or water holding capacity
  - be based on crop rooting depth
  - must be adjusted to *avoid* runoff or loss to subsurface tile drains."

HDF's plan to apply effluent in nearly equal amounts every month disregards the large variable of available soil moisture holding capacity that changes month to month and from soil type to soil type. Uniform land application regardless of soil type and weather patterns is not a good management practice, nor a generally accepted agricultural management practice. Code 590 precludes spreading of effluent when the top 2 inches of soil are saturated from rainfall. The rate of saturation and draining of the top 2 inches of soil will be different for every soil type and is not presented or accounted for in the DEIS.

Comment 7: The DEIS uses erroneous weather data to size the manure lagoon and proposes intentionally discharging manure from the storage lagoon before cataclysmic storms resulting in most of the manure running off directly to surface water.

The report uses average weather conditions from a weather station with missing data plus a 25-year, 24-hr storm but the actual weather data include many significantly wetter than average winters with extended periods of soil saturation. The DEIS proposal to empty the storage lagoon with the prediction of a cataclysmic storm puts all of the stored manure on the site surface with the expectation that it is going to discharge with storm water. The unusually heavy and prolonged rains that preceded the breach of the Kaloko Dam in March 2006 would have prompted the dairy to empty the lagoon during a rainstorm. Nearly the entire contents of the manure lagoon would have been discharged just before a prolonged intense period of rainfall that would have carried most of the manure to the stream and the ocean.

Comment 8: Dung beetles are misrepresented as being capable of consuming manure year round even though they are not active in the winter.

Dung beetles are presented as a solution for manure odor and flies. The life cycle of dung beetles includes a long period annually during winter when they are not actively moving manure. Parasite control commonly used on dairy cows may kill dung beetles.

Comment 9: No documentation is presented for 16.4 tons per acre of Kikuyu grass yield with grazing and no documentation is presented to support even higher proposed yields of 20 tons per acre.

The proposed improvement for 16.4 tons per acre of forage to 20 tons per acres is an increase of about 20 percent. It is not possible to feed 2000 cows on the same pasture as 699 cows with only a 20 percent yield increase. A very large nutrient supplement, salt, and feed import will also be needed that is vastly understated or ignored in HDF's DEIS. No scientific documentation is presented to support either 16.4 tons/acre or 20 tons/acre of Kikuyu grass yield with grazing on variable soil types and with 26 percent of the paddocks non-irrigated yet these yields are the basis of the nutrient balance.

Comment 10: The milk production predicted by the HDF is presented without scientific references or any data to show actual milk production on Kaua'i with Kikuyu grass rotational grazing.

The farm trials referenced by HDF are presented without data or a scientific design or statistical analysis. The sample collection by cutting grab samples results in very different yields than would result with grazing that will include trampling grass, partial harvest, and manure deposited on grass that will not then be grazed until the next rotation when it is too mature for high protein. The farm trials are not valid to produce data for an assessment of environmental impact and over-state actual crop nitrogen and phosphorus removal for grazing by a factor of 2. The 18-day rotation does not produce maximum yield or protein as is claimed, and grazing leaves behind plants that have more stem and dead matter that are not accounted for by HDF. Table 1 shows the cumulative effect of cutting Kikuyu at an interval equivalent to 2, 4 or 6 leaves/tiller in summer. This is the same as grazing at 6, 12 and 18 days. Cutting at a 2 leaves/tiller interval produces the most leaf in summer, but over the whole year the yield is less.

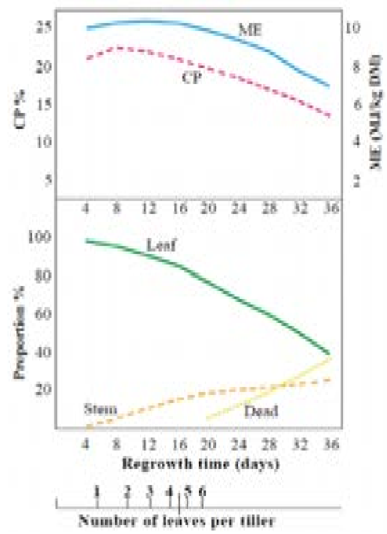

Figure 1: Changes in crude protein percentage (CP percent) and metabolisable energy (MJ ME/kg DM) with age of regrowth (upper). The proportion Kikuyu of leaf, stem and dead components of total DM above 5cm stubble (lower).
Source: PRIMEFACT 1068, MILK PRODUCTION FROM KIKUYU GRASS BASED PASTURES.

If cut at 6 leaves/tiller, (18 days) the summer leaf yield is lowest but stem growth is substantially higher than when cut earlier at either 2 or 4 leaves/tiller. Lower leaf yield results in lower nitrogen removal. This is significant because less nitrogen removed by the Kikuyu grass means a higher potential that nitrogen will be discharged to ground and surface water. HDF's DEIS does not account for this higher discharge potential.

Table 1: The yield of Kikuyu leaf and stem in summer and yield of leaf, percent leaf and average metabolisable energy (ME*) annually when Kikuyu is cut at 2, 4 or 6 leaves/tiller (Fulkerson et al. 1999)

leaves/tiller (Fulkerson et al. 1999) **Defoliation Interval (leaves/ tiller)**	**Summer**		**All Year**		
	Leaf	***Stem***	***Leaf***	***Leaf***	***ME***
	(kg DM/ha)	**(kg DM/ha)**	**(kg DM/ha)**	**perc ent**	**(MJ/kg DM)**
2 (6 days)	4240	340	8,707	91	9.1
4 (12 days)	3530	470	10,399	87	8.8
6 (18 days)	2500	1440	9,336	79	8.6

The rate of emergence of leaves depends primarily on temperature. From December to March, the 'leaf appearance interval' for Kikuyu might be as low as 3 days giving a 12 day (4 leaves x 3 days/leaf) grazing interval. Thus a 12- to 14-day grazing interval at this time of the year is recommended. In April and November, the grazing interval extends to around 20 days.

HDF's 18-day grazing rotation year round will not allow maximum yields indicated in the DEIS. Yields proposed by HDF are significantly higher than supported by reference documents and are not possible on a farm wide average as presented. Non-irrigated paddocks will have significantly lower yields than the farm wide average. The recommendation in multiple references for Kikuyu grass dairy pasture management is 200 to 500 lbs./ac/yr of total nitrogen removal by yields up to 16 tons/acre/year. HDF claims double the nutrient uptake that is documented in peer reviewed journals or scientific studies.

References for Kikuyu frass agronomy:

1. Fulkerson, B., Griffiths, N., Sinclair, K., and Beale, P. PrimeFacts. 2016. Milk production from Kikuyu grass based pastures.
2. http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0012/359949/Milk-production-fromKikuyu-grass-based-pastures.pdf (accessed 3/25/2016)

Comment 11: The HDF prediction of nitrogen removal with Kikuyu grass grazing is overstated and not documented.

Two species of Kikuyu on Hawai'i have been documented to have widely variable yields (Yield lbs/ac) seasonally which results in variable nutrient removal and does not match with relatively uniform manure applications planned by HDF. These varieties also have about ½ of the crude protein (CP percent) content and therefore nitrogen removal per ton as predicted by HDF. [See reference tables below.]

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Glen Fukumoto
County Extension Agent

Grasses

24 – Kikuyu Whittet (*Pennisetum clandestinum*)

Dry Matter, Yield and Nutrient Compostion at 12-weeks

	Fall 12/10/96	Winter 03/10/97	Spring 06/10/97	Summer 09/10/97	Fall 12/10/97	Winter 03/10/98	Spring 06/16/98	Summer 09/17/98	Fall 12/16/98	Average	Standard Deviation
DM, %	28.28	21.46	24.24	25.62	16.69	22.22	23.18	21.27	16.09	22.12	3.92
Yield, lb/ac	3376.15	1300.12	827.35	2226.12	1571.75	88.64	938.16	842.12	2314.26	1,498.30	996.75
CP, %	6.88	7.92	9.09	7.11	8.13	9.25	9.32	11.81	7.5	8.56	1.52
ADF, %	40.66	39.77	37.96	39.9	34.62	30.67	32.03	31.1	34.42	35.68	3.98
P, %	0.17	0.23	0.24	0.26	0.31	0.31	0.26	0.37	0.29	0.27	0.06
K, %	1.23	1.35	0.75	0.95	1.23	0.84	0.73	1.06	0.79	0.39	0.23
Ca, %	0.37	0.43	0.26	0.3	0.38	0.63	0.24	0.5	0.41	0.39	0.12

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Glen Fukumoto
County Extension Agent

Grasses

04 – Hosaka kikuyu (*Pennisetum clandestinum*)

Dry Matter, Yield and Nutrient Compostion at 12-weeks

	Fall 12/10/96	Winter 03/10/97	Spring 06/10/97	Summer 09/10/97	Fall 12/10/97	Winter 03/10/98	Spring 06/16/98	Summer 09/17/98	Fall 12/16/98	Average	Standard deviation
DM, %	21.99	21.64	39.3	24.4	20.9	31.03	23.72	26.44	19.42	25.43	6.24
Yield lb/ac	4927.82	760.87	664.84	855.52	819.96	132.97	490.16	509.71	1567.61	1,194.05	1,453.73
CP, %	7.13	8.32	7.47	7.92	8.39	7.76	8.66	10.43	8.47	8.28	0.95
ADF, %	38.43	39.08	38.09	36.31	30.34	28.68	29.21	24.19	25.38	32.19	5.84
P, %	0.15	0.22	0.18	0.25	0.22	0.21	0.2	0.22	0.19	0.20	0.03
K, %	1.18	0.99	0.76	1	1.01	0.81	1.51	1.04	1.19	1.05	0.22
Ca, %	0.44	0.55	0.52	0.52	0.67	0.87	0.5	0.87	1.23	0.69	0.26

Using the HDF yield predictions and the protein content at the upper crude protein percent plus one and a half standard deviation to represent maximum crude protein in the CTAHR data, the total nitrogen removal is 545 lbs/ac/yr not the 1090 lbs/ac/yr proposed in the DEIS without reference documentation.

Protein x 3.4 = lbs of nitrogen/ton of forage at 9.7 percent protein = 33 pounds N/ton so 16.4 tons = 545 lbs N/yr/ac

Actual farm wide average yields will likely be closer to the CTAHR data which will further reduce the nutrients removed and increase the nutrients discharged.

Comments on: HDF DEIS APPENDIX C (HAWAI'I DAIRY FARMS SOILS BASELINE NUTRIENT STATUS: IMPLICATIONS FOR LONG-TERM SUSTAINABILITY, PRODUCTIVITY, AND SOIL HEALTH. RUSSELL YOST, NICHOLAS KRUEGER UNIVERSITY OF HAWAI'I AT MĀNOA)

Comment 12: Kikuyu grass in the nutrient balance analysis is presented incorrectly as having a uniform nutrient uptake every day of the year.

HDF presents the nutrient balance analysis in Appendix C of the DEIS as the basis of nutrient production and removal. However, The nutrient analysis uses undocumented yield and nutrient uptake information from a farm trial. The total annual nutrient uptake from the farm trial is uniformly distributed over 365 days per year. No plants in Hawai'i and no Kikuyu grass in any climate are documented to use nutrients uniformly every day of the year. All plants respond to sunlight, temperature, and moisture and have variable growth rates and nutrient uptake rates that trend with these environmental variables even if all other conditions are ideal.

The authors of Appendix C report that the Kikuyu grass yield of 16.3 tons dry matter/ac/yr has a range of 3.0 – 25.1 (minimum in March, maximum in September).[8] The nutrient uptake is proportional to yield and is presented in Appendix C to have a very wide range.

8 HDF DEIS Appendix C at p. 4.

HDF's nutrient balance is not correct in presenting uniform nutrient uptake every day of the year. When variable grass yield and variable nutrient uptake is compared to the uniform nutrients deposited by a constant number of grazing cattle it becomes obvious that there are many days, weeks, and months when the nutrients applied exceed the nutrient uptake of the grass which is variable with climatic conditions. Further, the high end of the yield of 25.1 tons of dry matter/acre in September is not possible with any crop with the solar energy available in Kauai. No mention of making hay or reserve forage is detailed in the DEIS and forage is only mentioned in the note to Table 2 of Appendix C ("Note: It is likely that forage yields would increase considerably with optimal irrigation and application of nutrients. These preliminary results indicate that productivity varies sharply throughout the year requiring some reserve forage").

A large amount of additional imported feed will be required if reserve forage is not available and significant feed supplements will be needed to provide required sodium, potassium, magnesium and calcium needs of dairy cattle since Kikuyu grass is deficient in these elements (Marias 2001). The 2000 head herd cannot make the projected milk yields with the forage that is possible on the land available with yields documented in scientific studies.

Comment 13: The nutrient balance incorrectly applies the same amount of nutrients uniformly to all soil types in all paddocks under each irrigation method.

HDF's nutrient balance erroneously presents uniform nutrient applications on every paddock under each irrigation method in tables 22A and 22B regardless of whether the paddocks have different soil types. At the same time, Appendix C to the DEIS acknowledges variability:

"Fertilization, especially the additional of nitrogen from a commercial fertilizer can be inefficient with respect to forage production and protein content, and fertilization needs can be as much as 25 percent to 50 percent greater than the arithmetical difference resulting from a nitrogen balance calculation. The addition of phosphorus from a commercial fertilizer is also quite inefficient, because of the extensive sorption and binding reactions of phosphorus with the soils at the HDF site, sharply reducing the amount that becomes plant available (Jackman et al. 1997). The soil map units varied widely for the values of soil pH, potassium, calcium, magnesium, salinity (EC), and sodium (**Table 4**). These baseline results indicate major differences among the soils of the dairy."[9]

Table 4. Overall means (and range) for soil pH, soil nutrients phosphorus, potassium, calcium, magnesium and sodium

Soil Measurement Mean (Range)	pH – water 6.8 (4.7 – 8)
Extractable phosphorus	mg kg-1 17.2 7.1 – 49
Exchangeable potassium	cmol kg-1 0.58 0.1 – 6.7
Exchangeable calcium	cmol kg-1 21.3 5.2 – 46.5
Exchangeable magnesium	cmol kg-1 11.1 4.8 – 19.7
Exchangeable sodium	cmol kg-1 1.13 0.24 – 4.44
Soil salinity (electrical conductivity)	dS m-1 0.44 0.04 – 1.73
Total Carbon	percent 2.49 0.68 – 6.2
Total Nitrogen	percent 0.17 0.002 – 0.51

HDF presents a range of background nutrient concentrations in the soils as shown in Table 4 of the DEIS. The range of background nutrient concentrations in the soils as shown in Table 4 is very large among the soil types and will result in major differences in nutrient losses

9 HDF DEIS Appendix C at p. 67.

from the soils when the soils are all loaded with equal amounts of manure as presented in the DEIS. The background nutrients in soil that will be available for plant uptake have not been accounted for in HDF's nutrient balance.

Comments on: HDF DEIS APPENDIX D (*NUTRIENT BALANCE ANALYSIS FOR HAWAI'I DAIRY FARMS*. GROUP 70 INTERNATIONAL AND RED BARN CONSULTING.)

Comment 14: Appendix D incorrectly dismisses the importance of protecting Waiopili Stream and the coastal waters and beach.

HDF's Appendix D states:

> "The drainage ways and ditches within Māhā'ulepū Valley and within the project site are not classified for protection by the Department of Health" and "This stretch of open coastal waters is classified as Class A for water quality standards in HAR §11-54, which states: the objective of Class A [marine] waters is that their use for recreational purposes and aesthetic enjoyment be protected."[10]

The stream through the center of the valley as Waiopili Stream, a natural water course, that has been modified by man but still meets the criteria of waters of the state and should be protected.

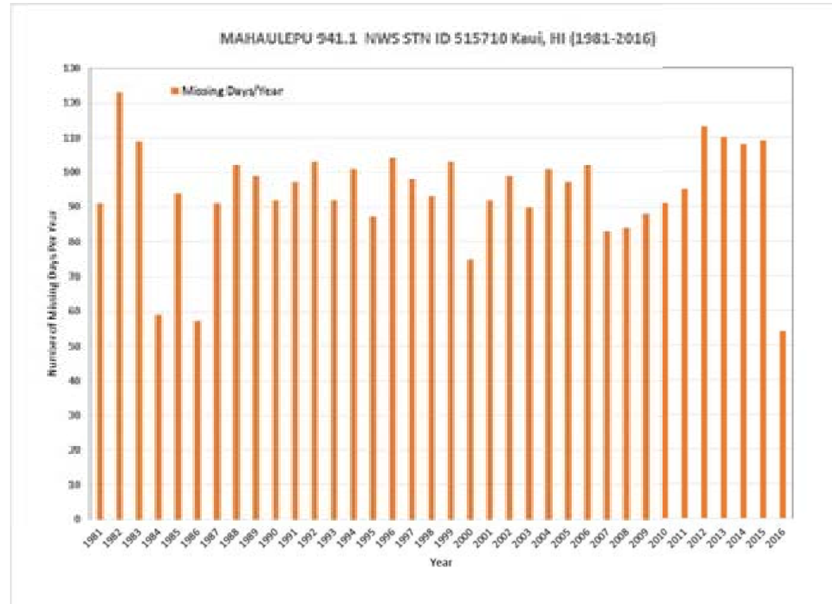
10 HDF DEIS Appendix D at p. 7.

The discharge of manure on the beach and near shore waters as referenced in the Appendix E will impair recreational use. Waiopili Stream crosses the beach at a point that has a well used hiking path and horseback riding trail. The beach is a final destination at the end of the path for hikers and riders that are going to observe the nearby cave entrance and unique geology. Manure in the stream and on the beach will be in contact with humans wading across the stream following the beach trail.

Comment 15: HDF used faulty climatic data as the basis of the water balance and nutrient balance analysis.

The HDF water balance and nutrient balance are incorrect partially because they are based upon rain gauge data obtained from NOAA National Climatic Data Center for the Māhāʻulepū 941.1 rain gauge located on the farm off of Māhāʻulepū Road (GHCND:USC00515710 – MĀHĀʻULEPŪ 941.1 HI US). The rain gauge is located at: Elevation = 24.4, Latitude = 21.90194, Longitude = -159.42111. The HDF makes the statement that "The data record analyzed included daily precipitation records from 1/1/1984 to 12/31/2013 for a total of approximately 10,957 days (30 years). The rainfall events were ranked based on days of consecutive rainfall (DAPR) and the corresponding multiday precipitation total (MDPR). The data suggests that having more than a week of consecutive rain is very unusual for Māhāʻulepū Valley with this only having occurred 5 times in the last 30 years." An evaluation of the data from station 941.1 by a climatologist reveals that the site is missing over 50 days of record for every year and over 100 days of record for many years. Data are commonly missing on weekends when apparently, the manually operated station is not maintained and data are not recorded. This station is not suitable for use in a

dairy water balance or nutrient balance analysis. The graphic below is an analysis of the missing data from the record of station 941.1.



Comment 16: HDF used faulty climatic data for the irrigation water balance.

HDF used daily rain gauge data from Māhāʻulepū to determine the irrigation water balance.[11]

11 HDF DEIS Appendix C, Table 4 on p. 12.

HDF utilized multiple sources of climatic data and appears to selectively utilize the data that produce a more favorable result even if the data source is not the best choice. HDF obtained pan evaporation data from State of Hawai'i DLNR Pan Evaporation Report R74 dated August 1985 for station Māhā'ulepū 940.00. HDF obtained evapotranspiration data from UH Mānoa Department of Geography, 2014 Evapotranspiration Maps (Lat 21.907N, 159.422W).

The data quality from Māhā'ulepū Station 941.1 is poor and incomplete. This station contains missing data in every year of record and nearly every month. Some months contain up to 18 days of missing data. The use of this station with missing data has caused HDF to believe that the site has less rainfall, less frequent storms that are of reduced intensity, and longer periods of no rainfall than actual. HDF also uses the UH Mānoa Dept of Geography interactive map weather data and Lihue airport weather data which are both high quality but are only used when it reduces the apparent risk of inclement weather causing environmental impacts.

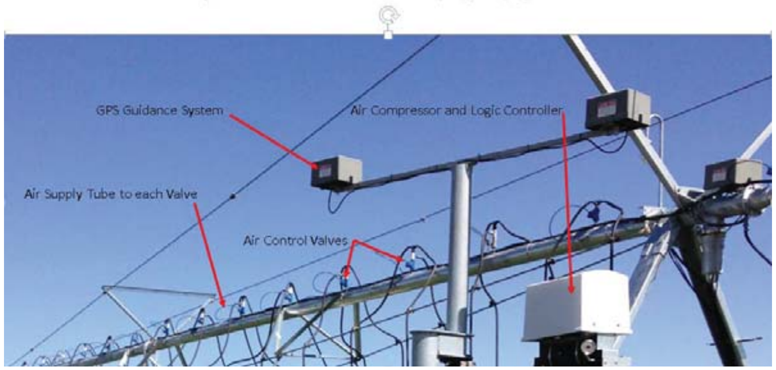
Comment 17: HDF is setting a new precedent for unacceptable risk of spraying manure effluent directly into a stream by use of smart valve pivots that cross the stream on bridges.

The smart valve pivots are complex irrigation machines available. It is because of their complexity that they have more failures than common center pivot irrigation machines. HDF does not present, and CH2M could not identify precedent for any regulatory acceptance of this type of irrigation machine being used to apply manure effluent while crossing a stream relying on the smart valves to stop and start manure application as the machine approached the stream buffer.

Smart valve pivots should not be used for manure application while crossing water courses because of the consequence of a failure causing manure irrigation directly into the steam. See the following example photo of less than 1/10th of the equipment on a smart pivot used on a dairy for irrigation water only with no manure and no stream nearby. The increased number of components and the addition of GPS location equipment and programmable logic valves and valve control air system greatly increases the number of components prone to failure as compared to standard center pivot irrigation machines.

The smart valve pivot is capable of spraying at a rate of 1,030 gpm. A somewhat typical application rotation and irrigation rate for this machine would include a 48-hour rotation and application of up to 0.39 inches of irrigation onto the paddocks. The application rate of 0.39in/irrigation exceeds the water infiltration capacity of most of the soil under the pivots and will result in ponding and runoff. The CH2M models assume irrigation application rates that are less than soil infiltration rates to result in complete infiltration.

Zoom in of air control system for "smart valve" control at a Dairy irrigation project in California



Comment 18: HDF has selected big gun spray irrigators to apply manure slurry even though this is the application method most commonly associated with odor complaints.

The gun irrigation system for irrigation water will utilize a rotating, hard-hose reel gun system in makai areas of the farm, where the center pivots are unable to reach. A separate rotating, hard-hose reel gun system will be installed for slurry application. This system will be used to apply solids from the settling pond where needed to provide nutrients to the paddocks much like commercial fertilizer would be applied, is not relied upon for regular irrigation to meet the daily water demand of the grass crop. The slurry application system will be completely separate from the gun irrigation system in the makai areas of the farm.

The hard hose reel gun system for manure slurry is the most common application equipment associated with manure application odors. Gun Irrigation sprays manure in a 65+ foot radius from the gun and can have over 30 ft. of vertical trajectory causing a mist of droplets of all sizes that volatilize odor agents and drift in the wind. Many application

methods such as spray tank trailers apply the slurry near the ground surface with gravity pressure and do not create as much odor volatilization and mist as gun sprinklers. The instantaneous application rate of gun irrigation systems is several times higher than pivot irrigation systems and often results in increased ponding and runoff. The use of gun irrigation for manure application plus gun irrigation for water application on the same field will greatly increase the frequency and duration of ponding and the magnitude of manure runoff and is not a best management practice for manure application.

Comment 19: HDF does not account for the reduction of yields from non-irrigated pasture which is documented in Hawai'i to be approximately ½ of the irrigated yield.

Approximately 26.2 percent of the total pasture area will not be irrigated, primarily in the mauka areas of the farm where the pivots and gun irrigation systems are unable to reach. While non-irrigated areas do not receive regular irrigation to meet crop water demands, some non-irrigated pasture areas will still receive water in the form of precipitation as well as nutrients in the form of fertilizer, slurry, and manure from grazing cows.

The areas with slurry application but no irrigation will result in reduced grass yields because of water stress in summer and will have reduced nutrient uptake. HDF puts all manure slurry on only 42 acres of non-irrigated pasture making this area the most nutrient overloaded area on the farm. HDF does not mention the reduction of yields from non-irrigated pasture which is documented in Hawai'i to be approximately ½ of the irrigated yield.

The DEIS states: "The demand indicates a clear deficit in precipitation (and need for irrigation) during the spring, summer and fall seasons with only a modest demand for irrigation during the winter season."[12] HDF assumes effective precipitation is assumed to be up to 0.80 inches of the daily rainfall amount with the assumption that remaining rainfall greater than 0.80 inches is either lost to deep percolation into the soil or runoff,[13] thereby reducing precipitation available to the crop.

HDF fails to present yields from non-irrigated areas as part of the farm trials, no adjustment for the reduced feed availability is presented, and no reduction in nutrient loading in these areas is documented even though 26.2% of the pasture area is non-irrigated and will have reduced production and reduced nutrient uptake.

Comment 20: HDF presents multiple irrigation application rates and most of them are in excess of soil infiltration rates on at least part of the soil under each irrigation method.

The DEIS states:

> "A somewhat typical application rotation and irrigation rate for the center pivot machines would include a 48-hour rotation and application of up to 0.39 inches of irrigation onto the paddocks. . . Under typical conditions, the irrigation systems will be designed and sized for an upper – end application rate of 0.24 inches per acre per day on 285.1 acres of pivot area and 61.4 acres of gun Nutrient Balance Analysis irrigation area, which equates to

12 HDF DEIS, Appendix C at p. 36.

13 HDF DEIS, Appendix C at p. 36.

> approximately 2.26 million gallons per day (MGD) of irrigation per day, on average." [14]

The irrigation rate must be less than the infiltration rate of the most limiting soil to prevent runoff and ponding but HDF gives no consideration of the variable soil infiltration rates under each irrigation method. Some areas of low infiltration rate soils exist under every irrigation machine.

Comment 21: The significant variability of rainfall across the farm is not considered in HDF's yield estimates, irrigation and manure application rates, and nutrient balance.

The DEIS utilizes the following sources for climatic data:

ETo, Grass Reference	Monthly evapotranspiration rate (in/mo) for a grass reference obtained from UH Mānoa Dept. of Geography, 2014 Evapotranspiration Maps (Lat 21.907N, 159.422W)
ETc, Crop	Monthly crop evapotranspiration rate (in/mo) for Kikuyu grass calculated using a crop coefficient of 0.85
P	Average rainfall from the 30-year daily record of Māhā'ulepū Station 941.1 from January 1984 through December 2013.
Pe	Effective precipitation assumed to consist of up to 0.80 inches of rain, shown at the Māhā'ulepū Station 941.1. Daily amounts greater than 0.80 inches are assumed to become runoff[15]

The latitude and longitude used for ETo are for the dry lower end of the valley. The worst case (lowest ETo) is the wet upper end of the valley of the dairy farm. Moving the sample location to the wet end of the valley dramatically changes the results giving by the UH Manoa Dept of Geography interactive maps. The maps interpret data from many sources and show the variation of rainfall and ET over the area of the farm to be quite variable. The

14 HDF DEIS, Appendix C at p. 29 and 35.

15 HDF DEIS Appendix C, notes to Table 12 on p. 7.

point selected to represent the farm is not the average and is not the worst case. As presented in other comments the use of Station 941.1 is not valid.

Comment 22: HDF fails to discuss mitigation for livestock water troughs which will provide ideal habitat for mosquito breeding.

Two concrete troughs, at minimum, will be installed in each paddock to give animals easy access to drinking water at all times. Mosquitos will breed in the water troughs and can travel beyond the site boundaries to impact the local resort and community. Mosquito breeding in livestock water in troughs is a common problem worldwide and mitigation is not addressed by HDF.

Comment 23: The grass yield and nutrient uptake are from a farm trial that is not supported by any raw data, data analysis, or discussion of the scientific analysis and scientific design of the trial to validate the results.

HDF does not currently have cattle and therefore, cannot utilize grazing as a method of harvest for the trials. Clipping forage always results in higher yield estimates than grazing which leaves behind forage that is trampled, has manure on it, or is too coarse to be selected by grazing animals. The pasture-based system enables the mature dairy cows to spend 22 hours (16 waking hours) in the paddocks, where a corresponding proportion of their excreted manure will be discharged directly onto the grass in the paddocks. Additionally, grass yields are directly related to soil compaction, whether through hoof compaction of soils or disturbance in the soil structure caused by machine cultivation.

The DEIS states: "Kikuyu's response to fertilization is very good and linear, and combined with irrigation, anticipated growth rates in Māhāʻulepū are estimated to be some of the best in the world."[16]

No information is provided on the rate of fertilization applied to the field trial plot. CH2M anticipates that over-fertilization may have produced luxuriant growth that is not sustainable on a farm wide basis with grazing and consideration of nutrient losses to the environment. The trial results are not supported by peer reviewed journals or scientific papers.

Comment 24: The DEIS fails to address the negative impacts of intentional over application of phosphorus.

The DEIS states:

> "At 2,000 mature dairy cows, the amount of phosphorus applied in the form of manure only slightly exceeds the crop demand at a crop yield of 16.3 tons of DM per acre per year, in both the liquid application and slurry application areas. An excess of over 300 lbs of phosphorus per month from these two application types, could be expected." [17]

Over-application of phosphorus by 300 lbs/month is 3600 pounds per year and 72,000 pounds in a 20-year planning period.

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16 HDF DEIS Appendix C at p. 62.

17 HDF DEIS Appendix C at 71.

It will only take a few years at this rate of excess application of phosphorus to overwhelm the soil storage capacity and result in release of phosphorus to the environment. The excess phosphorus will enter groundwater and surface water and create nuisance algae and aquatic weed growth. The excess of phosphorus applied over the amount utilized by the grass would be greater due to the increased manure production calculated in the Meyer Report and the more likely lower phosphorus removal rates of the grazed Kikuyu based upon other peer-reviewed studies (Fukumoto 2003 and Marias 2001). This would also be compounded by the reduced yield likely to occur in the non-irrigated fields.

Comment 25: The HDF has erroneously used average soil conditions, average manure applications, average weather, average irrigation, and average yields to present a flawed nutrient balance.

HDF's Appendix C on soils presents extreme differences in soil conditions under every type of irrigation method. HDF uses the weather station with the poorest quality of record in the region to erroneously present rainfall risks as lower than indicated by all other weather data in the region.

HDF presents the yield of Kikuyu as high as 25 tons/month in September and averages 16.3 tons annually[18] but many paddocks are not irrigated, many are not receiving slurry or effluent, and nowhere is the variable growth curve of grass with variable temperatures and solar inputs (growing degree days) documented.

18 HDF DEIS Appendix C at 4.

CH2M prepared a water and nutrient balance to compare to HDF's DEIS. A description of the model and assumptions and model output are included in Attachment 1. CH2M's detailed water and nutrient balance estimates nitrogen losses to the environment to be many times higher than the average conditions presented in the DEIS.

Comment 26: HDF plans to empty the manure storage ponds onto paddocks prior to cataclysmic storms but fails to provide analysis of environmental impacts or mitigation.

The DEIS states:

> "Nonetheless, if the storage pond were full and if a cataclysmic storm was forecast, the time to empty the pond is around 100 hours. If warranted due to potential impact from an approaching storm event, the settling pond could also be pumped empty within an additional 40 hours. If the forecasted storm is forecast six days prior, then virtually no effluent would remain in the ponds when the storm arrives."[19]

Emptying the ponds onto the fields prior to the storm would provide even greater amounts of nitrogen and phosphorous available to infiltrate or runoff the site during the period of high rainfall. Rapid dosing of all stored manure just prior to a major storm event will result in most of the manure ponding and running off the site during the storm, as there is no way that this quantity of nutrients could be taken up by Kikuyu grass in a short period of time. The environmental impact of this practice is unacceptable.

19 HDF DEIS p. 3-32.

Comment 27: HDF's nutrient balance calculations fail to consider using reduced land areas for manure application even though the report identifies the limitations of many paddocks and presents addition of drains that are not well defined.

The Māhā'ulepū soils, particularly in the south-central portion of the farm are perceived as heavy, flood frequently and are difficult to grow crops upon. Much of the water from the northern part of the farm runs through this area. The dominant soils on the lower farm are Ka'ena Clay, Kalapa Silty Clay and Kalihi Clay, which are prone to compaction and the USDA characterizes as "poorly drained". The DEIS states:

> "The poorly drained soils retain nutrients as the soils tend to hold water. While this makes grazing difficult, it also protects other surface water resources as runoff, and therefore nutrients, are contained. However, less than two days after heavy rain and with management of surface water after a significant rain event (diversion to a retention area, etc.), the soils are observed to be dry enough to graze, even without a Kikuyu thatch. Drains may also be installed and used to remove non-nutrient laden water from the surface of these areas to reduce soil dry time and to restore grazing. Once the farm is in operation, different operational conditions may be used to manage different areas of the farm based on soil types and drainage characteristics. Kikuyu itself doesn't grow as effectively in inundated or overly-wet conditions, so the farm must be managed to make sure the

> drainage system is effective. Winter weather may dictate if certain areas or paddocks are used, and if nutrients are applied at all in specific areas."[20]

HDF's nutrient balance calculations assume use of all areas, but if nutrients are not applied at all in some areas, then others must be overloaded to take the additional nutrients. HDF's discussion of adding drains to remove surface water is not supported by any design or water quality consideration. Any drainage of paddocks with grazing cattle on an 18 day rotation will certainly drain manure with surface water when the cattle are on the paddock during a storm event. Any drain will be a short circuit of manure directly to the stream. Even if it drains to a retention basin, the basin will have infiltration of high nutrient water in a concentrated area. The presentation of the idea that different operational conditions may be used to manage different areas of the farm based on soil types and drainage characteristics is not defined and could easily result in greater environmental impact than is presented in the DEIS.

All operational conditions should be defined for review. A vast area of the farm has poorly drained soils which are not ideal for Kikuyu grass production and are not represented in the farm trial yield estimates. Yields across the farm will be highly variable.

20 HDF DEIS Appendix C at p. 94-95.

Comments on: HDF DEIS APPENDIX E (*ESTIMATES OF THE POTENTIAL IMPACT ON GROUNDWATER AND SURFACE WATER BY HAWAII DAIRY FARMS IN MAHAULEPU, KAUAI.* TOM NANCE WATER RESOURCE ENGINEERING ESTIMATES OF POTENTIAL IMPACTS TO GROUNDWATER AND SURFACE WATER.)

Comment 28: Potential increases of nitrogen and phosphorus leaving the proposed HDF site are underestimated by use of the flawed nutrient balance analysis as the basis of nutrient availability.

The DEIS Appendix E states:

> "The approach to estimate potential increases of nitrogen and phosphorus in surface and groundwater resulting from the development of HDF is to calculate the flow volumes and nutrient loading under "present" (pre-HDF) conditions and to compare those amounts to forecast conditions with the initial farm size of 699 cows and the possible subsequent expansion of up to 2000 cows. The estimates herein rely heavily on information in the "Nutrient Balance Analysis for Hawaii Dairy Farms" (by Group 70 and Red Barn Consulting dated March 2016) and "Hawaii Dairy Farms Drainage Memorandum" (by Group 70 and dated August 2015)."[21]

The science of HDF's Appendix E is compromised by the use of the flawed nutrient balance analysis and the Hawaii Dairy Farms Drainage Memorandum, which were both prepared by

21 HDF DEIS Appendix E at p. 38.

the DEIS author utilizing incomplete climatic data and the many errors and omissions identified in previous comments.

Comment 29: The DEIS underestimates potential impacts of rain plus irrigation and disregards the variation of rainfall across the farm.

Appendix E states: "Rainfall across the alluvium varies from 45 inches per year at the makai end (site of Māhā'ulepū Station 941.1) to about 55 inches at its mauka end."[22] The DEIS water and nutrient balance uses only 49.95" of rainfall and the irrigation schedule uses only 44.26" of rainfall. Both of these water balance calculations should also be performed for the wet end of the valley, which includes one of the effluent irrigation pivots to correct the nutrient losses for 55 inches of rainfall.

The appendix also states:

> "One order of magnitude estimate assumes 10 percent of the rainfall on the 373 acres of unirrigated area and 10 percent of the applied irrigation on the remaining 347 acres becomes recharge to groundwater in the alluvium. These assumptions amount to a year-round average flowrate of groundwater in the alluvium of about 0.27 MGD."[23]

The estimate as an order of magnitude may be correct since the runoff will not be 0 percent or 100 percent. However, order of magnitude is too rough of an estimate to determine environmental impacts. The statement that 10 percent of rainfall is runoff on only 373

22 HDF DEIS Appendix E at p. 38.

23 HDF DEIS Appendix E at p. 38.

acres of unirrigated land erroneously deletes rainfall runoff from irrigated lands. Irrigated lands will be near saturation more often than non-irrigated lands and will have at least as much or more runoff of rainfall as the non-irrigated lands. In addition, the irrigated lands will also have additional runoff from irrigation water applications so the runoff percent for rainfall and the runoff percent for irrigation would be additive on irrigated lands.

Comment 30: Appendix E underestimates the total nitrogen associated with manure from 2000 cows by 100,000 pounds per year.

Appendix E states:

> "In rounded numbers and on an annual basis for both herd sizes, HDF will be circulating 490,000 pounds of nitrogen and 87,000 pounds of phosphorus. These amounts are about 325 and 815 times greater than the estimates of nitrogen and phosphorus currently carried in surface and groundwater moving through the HDF site and ultimately discharging into the marine environment."[24]

The Meyer Report and CH2M's Root Zone Water Balance Models calculate that the total nutrients in manure from 2000 cows is 592,029 pounds per year even with no commercial fertilizer applications. This is over 100,000 pounds more than is considered in the calculations in Appendix E. The nitrogen circulating annually is 390 times more than the current rate not 325 times more, which has a significant influence on the predicted environmental impact.

24 HDF DEIS Appendix E at p. 41.

COMMENTS ON DAIRY MANAGEMENT, DAIRY WASTE MANAGEMENT, CROPPING, AND SOIL CONDITIONS RELATIVE TO DAIRY WASTE MANAGEMENT IN DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR HAWAI'I DAIRY FARMS, MĀHĀ'ULEPŪ, KAUAI, MAY 2016

Comment 31: The use of a first order approximation underestimates the loss of nitrogen to the environment by a quarter of a million pounds per year for 2000 cows.

Appendix E states:

> "As a first order approximation, it is assumed that two (2) percent of the nitrogen and one (1) percent of the phosphorus of HDF's annual manure and commercial fertilizer amounts are carried into the drainage ways and/or percolate to the shallow groundwater in the alluvium."

In round numbers, this would amount to about 10,000 pounds per year of nitrogen and 900 pounds per year of phosphorus. Notably, these amounts would be the same for both the 699- and 2000-cow herd sizes. Compared to the present contribution from and through the HDF site, these additions would represent 6.6- and 8.4- fold increases of nitrogen and phosphorus moving to ultimate discharge into the marine environment, respectively."

The detailed modeling by CH2M calculates that the nitrogen loss from 2000 cows is 335,934 pounds per year. This is a 220-fold increase over existing conditions at the farm not an 8.4 fold increase. The detailed modeling is far more accurate than a first order approximation.

Comment 32: HDF uses first order approximations to erroneously predict the impact to the local environment as only 26 percent of the existing nitrogen discharges but CH2M's modeling calculates the nitrogen discharge from 2000 cows at 870 percent of existing nitrogen discharges.

HDF makes the unusual argument that a substantial new environmental impact is acceptable because it is not as great as the combination of all other existing environmental impacts:

> "Relative to the nutrient loading under existing conditions, the potential increases due to the operation of HDF are obviously substantial. To provide

some perspective, a comparison to ongoing nutrient additions to the marine environment by other projects and/or users along the Poipu coastline is instructive. These additions include the production of domestic wastewater and the application of fertilizers on the area's two golf courses and other landscaping."[25]

For this set of assumptions, HDF tallies the ongoing input to the marine environment along the Poʻipū shoreline. For nitrogen, the ongoing amount is about 3.8 times the estimated potential contribution from HDF. For phosphorus, the ongoing discharge is about 1.4 times as great as the potential discharge from HDF. These discharges are essentially constant throughout the year in comparison to the expected episodic discharges from HDF.

"Estimate of Current Input of Nitrogen and Phosphorus Into the Marine Environment Along the Poipu Shoreline

Contributing Source	**Nitrogen (lbs/yr)**	**Phosphorus (lbs/yr)**
Domestic Wastewater	27,360	910
Fertilizing Landscaping	11,150	350
Total	38,510	1260"[26]

The CH2M models predict that the nitrogen discharge to the water environment from 2000 cows is 335,934 pounds per year or 870 percent of the total of existing discharges. The

25 HDF DEIS Appendix E at 43 and 45.

26 HDF DEIS Appendix E at 45.

COMMENTS ON DAIRY MANAGEMENT, DAIRY WASTE MANAGEMENT, CROPPING, AND SOIL CONDITIONS RELATIVE TO DAIRY WASTE MANAGEMENT IN DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR HAWAIʻI DAIRY FARMS, MĀHĀʻULEPŪ, KAUAI, MAY 2016

environmental impact of an increase in nitrogen discharge to the regional waters of this extent cannot be predicted simply by looking at existing environmental impacts from a much smaller total discharge of nitrogen. The impact of existing discharges is distributed over a vast area. The dairy discharge is into shoreline waters from Waiopili stream which drains both surface water and shallow groundwater from the dairy.

Comments on: HDF DEIS APPENDIX F (BASELINE CONDITIONS AND AN ASSESSMENT OF THE EFFECT OF THE PROPOSED HAWAII DAIRY FARM ON SURFACE WATER AND MARINE WATER CHEMISTRY MAHAULEPU, KAUAI. HAWAII MARINE RESEARCH CONSULTANTS, INC.)

Comment 33: It is unfortunate that the scientists that prepared each appendix have used the erroneous data from the Group 70 and Red Barn DEIS as the base assumption for nutrient balances and water balances. Most of the same comments made previously apply to this report where the previously discussed incorrect data is used.

DEIS Appendix F states (from Appendix E):

> "Relative to the annual nutrient loading under existing conditions, the potential increases resulting from the operation of HDF are substantial. For this set of assumptions, the ongoing input to the marine environment along the Poipu shoreline is about 38,510 lb./yr. for nitrogen and 1,260 lb./yr. for phosphorus. This amount of nitrogen is about 3.8 times (380 percent) higher than the potential contribution from HDF (10,000 lbs./yr.). For phosphorus, the ongoing discharge from the Poipu area is about 1.4 (140 percent) times as great as the potential discharge from HDF (900 lb./yr.). In addition, these discharges from Poipu are essentially constant throughout the year in comparison to the episodic discharges from HDF that will only occur as a result of rainfall associated with storm conditions."

In response, CH2M reiterates its above comments 30, 31, and 32.

Comment 34: The assessment of impacts to the shoreline were made with consideration of low levels of nitrogen and phosphorus which are not correct.

DEIS Appendix F states:

> "The nearshore marine environment consists of a shallow intertidal reef flat that terminates in a reef crest that slopes sharply on the seaward side to sand and rubble flats. The intertidal reef flat where surface water mixes with ocean water is consistently subjected to substantial wave action and current flow to the west. Owing to shallow depth and almost continuous rough water conditions, the reef flat where mixing occurs can be considered dangerous for humans to use, and does not represent an area of safe or unique recreational use. Measurements made of water chemistry in the marine environment on a rare day of with low wind and wave action indicated that mixing of surface water in the ocean occurs rapidly within a short distance of the shoreline.
>
> With the exception of Silica (Si), surface water samples revealed relatively consistent patterns for all nutrient constituents (NO3-, PO43-, NH4+, TN, and TP). Concentrations of these nutrients were lowest at the stations outside the upper mauka HDF site, increased at stations located within the HDF site, and returned to low levels between the makai end of the site and the ocean. The concentrations of Si displayed a different pattern, with the highest values at mauka sampling stations that steadily decreased closer to the ocean. As Si is typically higher in groundwater than in surface water, the

observed pattern for Si indicates that the groundwater contribution to surface water is highest at the mauka end of the property, and decreases through the HDF site and downgradient towards the ocean.

Analysis of water chemistry constituents sampled in the marine environment indicates two major patterns. Small elevations of inorganic nutrients (Si, NO3-, PO43-, TN, and TP) along with corresponding decreases in salinity along the Māhā'ulepū shoreline indicate only a small input of groundwater to the ocean. While detectable in the nearshore area, groundwater nutrient input is mixed to background oceanic values within meters of the shoreline."[27]

If this analysis where made after the 2000 cow dairy were in place the results would be different. No assessment or prediction of the impact of 335,934 pounds per year of nitrogen is made. The title of this appendix implies that it makes an assessment of the impacts of the dairy on the surface water and marine water but it does not accurately present the nutrient discharge from the dairy and makes no assessment of the environmental impacts.

[27] HDF DEIS Appendix F. at p. 15.

Comments on: HDF DEIS APPENDIX K (HYDROLOGIC ASSESSMENT FOR THE PASTURE AREAS FOR HAWAI'I DAIRY FARMS, MĀHĀ'ULEPŪ, KAUA'I, HAWAI'I. GROUP 70 INTERNATIONAL.)

Comment 35: Appendix K of the DEIS erroneously states that the proposed dairy is not expected to significantly impact drainage conditions and peak flow patterns on the farm.

Compaction of soil from 1200-pound cows grazing will increase the runoff potential. Increased antecedent moisture conditions of irrigated paddocks above current conditions will increase runoff from rain events as compared to the current site conditions. The peak flows of runoff from the farm will increase when storm events fall on irrigated land that is maintained at near field capacity (i.e., near saturation) to maximize yield. See the CH2M root zone water balance models for calculations of deep percolation losses with perfect irrigation management. Actual irrigation management will be less than perfect and result in increased discharges because of the uncertainty that HDF will have predicting weather compared to the accuracy of the CH2M modeling using known historic weather.

Attachment A
Detailed Tables and Figures from Water and Nutrient Balance Model Runs

Root Zone Water Balance Working Model

Project Name: **2016 Hawaii Dairy**
Project Number: **pivot,2000 cows,Meyer Ncalc,hi rainfall**

Designer: Emond/Madison/Smesrud
Crop: **kikuyu grass**

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
	Days/Month	31	28	31	30	31	30	31	31	30	31	30	31	365
Water Supply														
Average Precipitation	[in]	5.63	2.02	8.79	3.52	9.96	4.39	1.83	0.94	7.85	7.24	12.25	5.72	70.14
% Effective Precipitation	[%]	90%	100%	92%	99%	88%	98%	100%	100%	62%	89%	80%	79%	
Surface Runoff	[in]	0.55	0.00	0.68	0.04	1.25	0.10	0.00	0.00	3.01	0.79	2.49	1.20	10.09
Effective Rainfall	[in]	5.08	2.02	8.11	3.48	8.72	4.29	1.83	0.94	4.84	6.45	9.76	4.52	60.05
Irrigation Requirements and Management														
Potential Crop Evapotranspiration	[in]	5.85	5.80	6.67	6.77	7.53	7.70	7.98	8.00	7.73	7.31	5.98	6.04	83.35
Actual Crop Evapotranspiration	[in]	5.85	5.80	6.67	6.77	7.53	7.70	7.98	8.00	7.73	7.31	5.98	6.04	83.35
Net Irrigation Requirement	[in]	0.77	3.78	0.00	3.29	0.00	3.41	6.15	7.06	2.88	0.86	0.00	1.51	29.71
Gross Irrigation Requirement	[in]	0.77	3.78	0.00	3.29	0.00	3.41	6.15	7.06	2.88	0.86	0.00	1.51	29.71
	[MG]	5.9	29.2	0.0	25.5	0.0	26.4	47.6	54.6	22.3	6.7	0.0	11.7	230.0
	[ac-ft]	18.2	89.7	0.0	78.3	0.0	80.9	146.2	167.7	68.5	20.4	0.0	35.9	705.9
Total Irrigation Applied	[in]	0.77	3.78	0.00	3.29	0.00	3.41	6.15	7.06	2.88	0.86	0.00	1.51	29.71
	[MG]	5.9	29.2	0.0	25.5	0.0	26.4	47.6	54.6	22.3	6.7	0.0	11.7	230.0
	[ac-ft]	18.2	89.7	0.0	78.3	0.0	80.9	146.2	167.7	68.5	20.4	0.0	35.9	705.9
Irrigation Losses	[in]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Soil Profile Water Balance														
Beginning Soil Moisture	[in]	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	
Ending Soil Moisture	[in]	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	
Deep Percolation	[in]	0.0	0.0	1.4	0.0	1.2	0.0	0.0	0.0	0.0	0.0	3.8	0.0	6.4
Nitrogen Balance Summary														
Nitrogen Additions	[lb/ac]	104.9	104.9	104.9	104.9	104.9	104.9	104.9	104.9	104.9	104.9	104.9	104.9	1258.7
Potential Crop Nitrogen Uptake	[lb/ac]	38.2	37.9	43.6	44.3	49.3	50.3	52.2	52.3	50.5	47.8	39.1	39.5	545.0
Actual Crop Nitrogen Uptake	[lb/ac]	38.2	37.9	43.6	44.3	49.3	50.3	52.2	52.3	50.5	47.8	39.1	39.5	545.0
Deep Percolation Nitrogen Losses	[lb/ac]	0.0	0.0	141.4	0.0	114.9	0.0	0.0	0.0	0.0	0.0	457.5	0.0	713.7
Soil Profile Salt Balance														
Beginning Soil Salinity, ECe	[dS/m]	0.3	0.3	0.3	0.2	0.3	0.2	0.3	0.3	0.4	0.4	0.4	0.2	
Ending Soil Salinity, ECe	[dS/m]	0.3	0.3	0.2	0.3	0.2	0.3	0.3	0.4	0.4	0.4	0.2	0.3	

Irrigated Land = 285.1 acres
Total Deep Percolation Nitrogen Losses for Irrigated Area: 203,487 lbs

Soil Water Storage at Field Capacity = 15.68 inches
Soil Water Storage at Permanent Wilting Point = 10.77 inches
Available Water Holding Capacity = 4.91 inches
Soil Water Storage at Minimum Management Allowed Soil Moisture = 12.98 inches

Root Zone Water Balance Working Model

Project Name: 2016 Hawaii Dairy
Project Number: **no irrig, slurry, 2000 cows,Meyer Ncalc,hi rainfall**

Designer: Emond/Madison/Smesrud
Crop: **kikuyu grass**

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
	Days/Month	31	28	31	30	31	30	31	31	30	31	30	31	365
Water Supply														
Average Precipitation	[in]	5.63	2.02	8.79	3.52	9.96	4.39	1.83	0.94	7.85	7.24	12.25	5.72	70.14
% Effective Precipitation	[%]	90%	100%	92%	99%	88%	98%	100%	100%	62%	89%	80%	79%	
Surface Runoff	[in]	0.55	0.00	0.68	0.04	1.25	0.10	0.00	0.00	3.01	0.79	2.49	1.20	10.09
Effective Rainfall	[in]	5.08	2.02	8.11	3.48	8.72	4.29	1.83	0.94	4.84	6.45	9.76	4.52	60.05
Irrigation Requirements and Management														
Potential Crop Evapotranspiration	[in]	5.85	5.80	6.67	6.77	7.53	7.70	7.98	8.00	7.73	7.31	5.98	6.04	83.35
Actual Crop Evapotranspiration	[in]	5.38	4.10	4.92	6.05	6.05	6.93	3.15	1.15	3.37	5.20	5.72	6.03	58.04
Net Irrigation Requirement	[in]	0.77	3.78	0.00	3.29	0.00	3.41	6.15	7.06	2.88	0.86	0.00	1.51	29.71
Gross Irrigation Requirement	[in]	0.77	3.78	0.00	3.29	0.00	3.41	6.15	7.06	2.88	0.86	0.00	1.51	29.71
	[MG]	2.3	11.2	0.0	9.8	0.0	10.1	18.3	21.0	8.6	2.6	0.0	4.5	88.4
	[ac-ft]	7.0	34.5	0.0	30.1	0.0	31.1	56.2	64.5	26.3	7.8	0.0	13.8	271.4
Total Irrigation Applied	[in]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	[MG]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	[ac-ft]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Irrigation Losses	[in]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Soil Profile Water Balance														
Beginning Soil Moisture	[in]	14.2	13.9	11.8	15.0	12.4	15.1	12.4	11.2	10.9	12.4	13.7	15.7	
Ending Soil Moisture	[in]	13.9	11.8	15.0	12.4	15.1	12.4	11.2	10.9	12.4	13.7	15.7	14.2	
Deep Percolation	[in]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	2.0
Nitrogen Balance Summary														
Nitrogen Additions	[lb/ac]	105.9	105.9	105.9	105.9	105.9	105.9	105.9	105.9	105.9	105.9	105.9	105.9	1270.3
Potential Crop Nitrogen Uptake	[lb/ac]	38.2	37.9	43.6	44.3	49.3	50.3	52.2	52.3	50.5	47.8	39.1	39.5	545.0
Actual Crop Nitrogen Uptake	[lb/ac]	38.2	37.9	43.6	44.3	49.3	50.3	52.2	52.3	50.5	47.8	39.1	39.5	545.0
Deep Percolation Nitrogen Losses	[lb/ac]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	725.3	0.0	725.3
Soil Profile Salt Balance														
Beginning Soil Salinity, ECe	[dS/m]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Ending Soil Salinity, ECe	[dS/m]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Irrigated Land = 109.6 acres
Total Deep Percolation Nitrogen Losses for Irrigated Area: 79,495 lbs

Soil Water Storage at Field Capacity = 15.68 inches
Soil Water Storage at Permanent Wilting Point = 10.77 inches
Available Water Holding Capacity = 4.91 inches
Soil Water Storage at Minimum Management Allowed Soil Moisture = 12.98 inches

Root Zone Water Balance Working Model

Project Name: **2016 Hawaii Dairy**
Project Number: **pivot,2000 cows,Meyer Ncalc,hi rainfall**

Designer: Emond/Madison/Smesrud
Crop: **kikuyu grass**

General Design Parameters

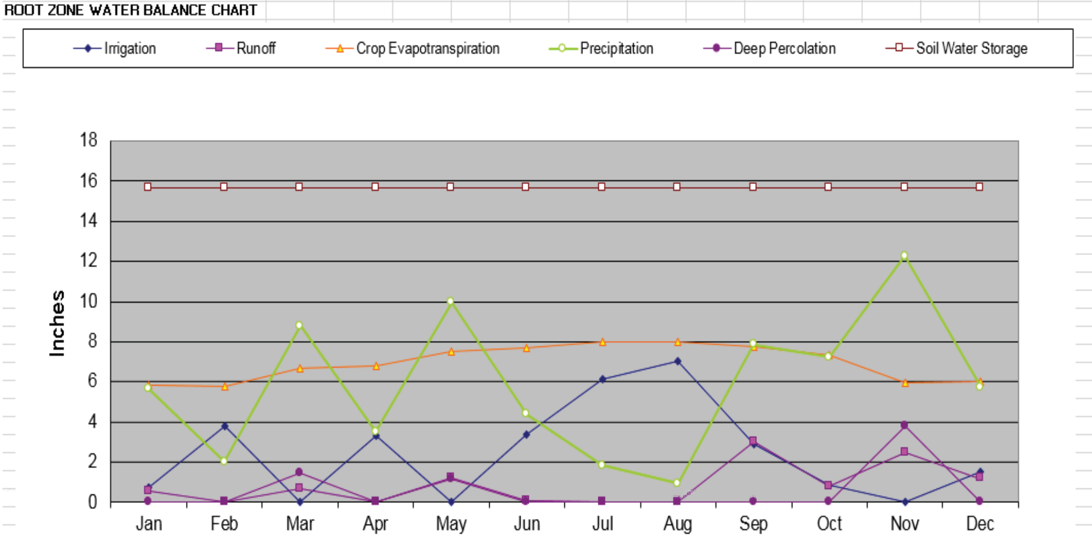
Crop Parameters		
Depletion Fraction	[-]	0.55
Rooting Depth	[ft]	3.30
Yield Response Factor	[-]	1.10
Salinity Induced Yield Reduction	[%/(dS/m)]	6.40
Threshold ECe	[dS/m]	6.90
Soil Parameters		
Field Capacity	[in/in]	0.40
Permanent Wilting Point	[in/in]	0.27

Notes:

Depletion Fraction - Average fraction of total available soil water that can be depleted from the root zone before moisture stress resulting in ET reduction occurs. Yield Response Factor - A slope factor describing the reduction in relative yield according to the reduction in ETc caused by soil water shortage. Salinity Induced Yield Reduction - A slope factor describing the reduction in relative yield according to an incremental increase in ECe for values above the threshold ECe. Threshold ECe - Electrical conductivity of the saturation extract at the threshold of ECe when crop yield first reduces

Field Capacity - Defined as the water held at a tension of 0.33 Bar. Permanent Wilting Point - Defined as the water held at a tension of 15 Bar. All water content measurements expressed in inches of water per inch of rooting depth

ROOT ZONE WATER BALANCE CHART



Root Zone Water Balance Working Model

Project Name: 2016 Hawaii Dairy
Project Number: Big Gun, slurry, 2000 cows,Meyer

Designer: Henriette Emond/Mark Madison
Crop: kikuyu grass

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
	Days/Month	31	28	31	30	31	30	31	31	30	31	30	31	365
Water Supply														
Average Precipitation	[in]	5.63	2.02	8.79	3.52	9.96	4.39	1.83	0.94	7.85	7.24	12.25	5.72	70.14
% Effective Precipitation	[%]	90%	100%	92%	99%	88%	98%	100%	100%	62%	89%	80%	79%	
Surface Runoff	[in]	0.55	0.00	0.68	0.04	1.25	0.10	0.00	0.00	3.01	0.79	2.49	1.20	10.09
Effective Rainfall	[in]	5.08	2.02	8.11	3.48	8.72	4.29	1.83	0.94	4.84	6.45	9.76	4.52	60.05
Irrigation Requirements and Management														
Potential Crop Evapotranspiration	[in]	5.85	5.80	6.67	6.77	7.53	7.70	7.98	8.00	7.73	7.31	5.98	6.04	83.35
Actual Crop Evapotranspiration	[in]	5.85	5.80	6.67	6.77	7.53	7.70	7.98	8.00	7.73	7.31	5.98	6.04	83.35
Net Irrigation Requirement	[in]	0.77	3.78	0.00	3.29	0.00	3.41	6.15	7.06	2.88	0.86	0.00	1.51	29.71
Gross Irrigation Requirement	[in]	0.77	3.78	0.00	3.29	0.00	3.41	6.15	7.06	2.88	0.86	0.00	1.51	29.71
	[MG]	1.3	6.3	0.0	5.5	0.0	5.7	10.3	11.8	4.8	1.4	0.0	2.5	49.5
	[ac-ft]	3.9	19.3	0.0	16.9	0.0	17.4	31.5	36.1	14.8	4.4	0.0	7.7	152.0
Total Irrigation Applied	[in]	0.77	3.78	0.00	3.29	0.00	3.41	6.15	7.06	2.88	0.86	0.00	1.51	29.71
	[MG]	1.3	6.3	0.0	5.5	0.0	5.7	10.3	11.8	4.8	1.4	0.0	2.5	49.5
	[ac-ft]	3.9	19.3	0.0	16.9	0.0	17.4	31.5	36.1	14.8	4.4	0.0	7.7	152.0
Irrigation Losses	[in]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Soil Profile Water Balance														
Beginning Soil Moisture	[in]	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	
Ending Soil Moisture	[in]	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	
Deep Percolation	[in]	0.0	0.0	1.4	0.0	1.2	0.0	0.0	0.0	0.0	0.0	3.8	0.0	6.4
Nitrogen Balance Summary														
Nitrogen Additions	[lb/ac]	105.9	105.9	105.9	105.9	105.9	105.9	105.9	105.9	105.9	105.9	105.9	105.9	1270.3
Potential Crop Nitrogen Uptake	[lb/ac]	38.2	37.9	43.6	44.3	49.3	50.3	52.2	52.3	50.5	47.8	39.1	39.5	545.0
Actual Crop Nitrogen Uptake	[lb/ac]	38.2	37.9	43.6	44.3	49.3	50.3	52.2	52.3	50.5	47.8	39.1	39.5	545.0
Deep Percolation Nitrogen Losses	[lb/ac]	0.0	0.0	143.7	0.0	116.7	0.0	0.0	0.0	0.0	0.0	464.9	0.0	725.3
Soil Profile Salt Balance														
Beginning Soil Salinity, ECe	[dS/m]	0.3	0.3	0.3	0.2	0.3	0.2	0.3	0.3	0.4	0.4	0.4	0.2	
Ending Soil Salinity, ECe	[dS/m]	0.3	0.3	0.2	0.3	0.2	0.3	0.3	0.4	0.4	0.4	0.2	0.3	

Irrigated Land = 61.4 acres
Total Deep Percolation Nitrogen Losses for Irrigated Area: 44,534 lbs

Soil Water Storage at Field Capacity = 15.68 inches
Soil Water Storage at Permanent Wilting Point = 10.77 inches
Available Water Holding Capacity = 4.91 inches
Soil Water Storage at Minimum Management Allowed Soil Moisture = 12.98 inches

Root Zone Water Balance Working Model

Project Name: 2016 Hawaii Dairy
Project Number: **no irrig, slurry, 2000 cows,Meyer Ncalc,hi rainfall**

Designer: Emond/Madison/Smesrud
Crop: **kikuyu grass**

General Design Parameters

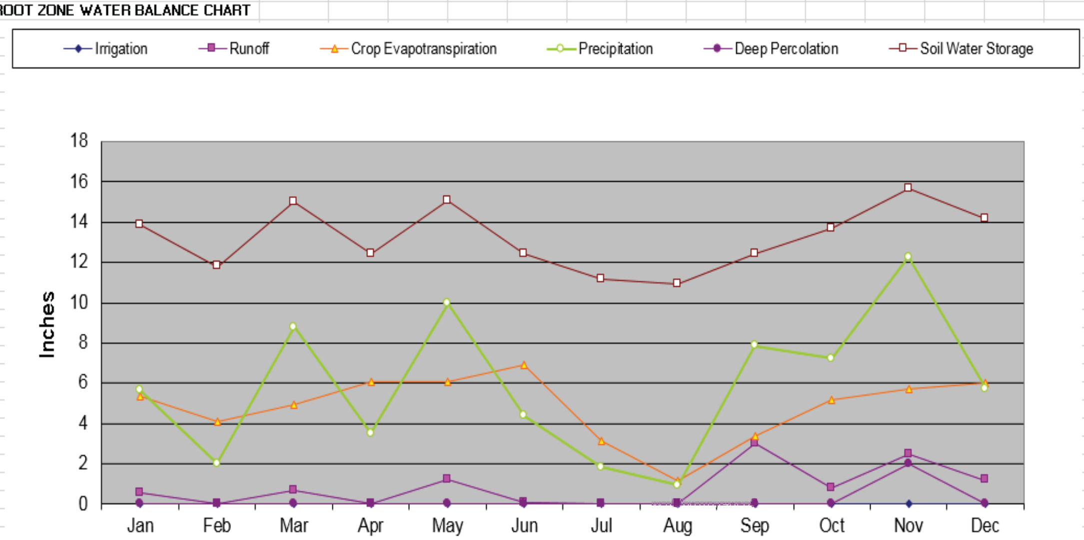
Crop Parameters		
Depletion Fraction	[-]	0.55
Rooting Depth	[ft]	3.30
Yield Response Factor	[-]	1.10
Salinity Induced Yield Reduction	[%/(dS/m)]	6.40
Threshold ECe	[dS/m]	6.90
Soil Parameters		
Field Capacity	[in/in]	0.40
Permanent Wilting Point	[in/in]	0.27

Notes:

Depletion Fraction - Average fraction of total available soil water that can be depleted from the root zone before moisture stress resulting in ET reduction occurs. Yield Response Factor - A slope factor describing the reduction in relative yield according to the reduction in ETc caused by soil water shortage. Salinity Induced Yield Reduction - A slope factor describing the reduction in relative yield according to an incremental increase in ECe for values above the threshold ECe. Threshold ECe - Electrical conductivity of the saturation extract at the threshold of ECe when crop yield first reduces

Field Capacity - Defined as the water held at a tension of 0.33 Bar. Permanent Wilting Point - Defined as the water held at a tension of 15 Bar. All water content measurements expressed in inches of water per inch of rooting depth

ROOT ZONE WATER BALANCE CHART



Root Zone Water Balance Working Model

Project Name: 2016 Hawaii Dairy | Designer: Emond/Madison/Smesrud

Project Number: **no irrig,no slurry,2000 cows,Meyer Ncalc,hi rainfall** | Crop: **kikuyu grass**

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
	Days/Month	31	28	31	30	31	30	31	31	30	31	30	31	365
Water Supply														
Average Precipitation	[in]	5.63	2.02	8.79	3.52	9.96	4.39	1.83	0.94	7.85	7.24	12.25	5.72	70.14
% Effective Precipitation	[%]	90%	100%	92%	99%	88%	98%	100%	100%	62%	89%	80%	79%	
Surface Runoff	[in]	0.55	0.00	0.68	0.04	1.25	0.10	0.00	0.00	3.01	0.79	2.49	1.20	10.09
Effective Rainfall	[in]	5.08	2.02	8.11	3.48	8.72	4.29	1.83	0.94	4.84	6.45	9.76	4.52	60.05
Irrigation Requirements and Management														
Potential Crop Evapotranspiration	[in]	5.85	5.80	6.67	6.77	7.53	7.70	7.98	8.00	7.73	7.31	5.98	6.04	83.35
Actual Crop Evapotranspiration	[in]	5.38	4.10	4.92	6.05	6.05	6.93	3.15	1.15	3.37	5.20	5.72	6.03	58.04
Net Irrigation Requirement	[in]	0.77	3.78	0.00	3.29	0.00	3.41	6.15	7.06	2.88	0.86	0.00	1.51	29.71
Gross Irrigation Requirement	[in]	0.77	3.78	0.00	3.29	0.00	3.41	6.15	7.06	2.88	0.86	0.00	1.51	29.71
	[MG]	0.3	1.4	0.0	1.2	0.0	1.3	2.3	2.6	1.1	0.3	0.0	0.6	11.1
	[ac-ft]	0.9	4.3	0.0	3.8	0.0	3.9	7.1	8.1	3.3	1.0	0.0	1.7	34.2
Total Irrigation Applied	[in]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	[MG]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	[ac-ft]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Irrigation Losses	[in]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Soil Profile Water Balance														
Beginning Soil Moisture	[in]	14.2	13.9	11.8	15.0	12.4	15.1	12.4	11.2	10.9	12.4	13.7	15.7	
Ending Soil Moisture	[in]	13.9	11.8	15.0	12.4	15.1	12.4	11.2	10.9	12.4	13.7	15.7	14.2	
Deep Percolation	[in]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	2.0
Nitrogen Balance Summary														
Nitrogen Additions	[lb/ac]	96.2	96.2	96.2	96.2	96.2	96.2	96.2	96.2	96.2	96.2	96.2	96.2	1154.9
Potential Crop Nitrogen Uptake	[lb/ac]	38.2	37.9	43.6	44.3	49.3	50.3	52.2	52.3	50.5	47.8	39.1	39.5	545.0
Actual Crop Nitrogen Uptake	[lb/ac]	38.2	37.9	43.6	44.3	49.3	50.3	52.2	52.3	50.5	47.8	39.1	39.5	545.0
Deep Percolation Nitrogen Losses	[lb/ac]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	609.9	0.0	609.9
Soil Profile Salt Balance														
Beginning Soil Salinity, ECe	[dS/m]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Ending Soil Salinity, ECe	[dS/m]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Irrigated Land = 13.8 acres

Total Deep Percolation Nitrogen Losses for Irrigated Area: 8,417 lbs

Soil Water Storage at Field Capacity = 15.68 inches

Soil Water Storage at Permanent Wilting Point = 10.77 inches

Available Water Holding Capacity = 4.91 inches

Soil Water Storage at Minimum Management Allowed Soil Moisture = 12.98 inches

Root Zone Water Balance Working Model

Project Name: 2016 Hawaii Dairy | Designer: Henriette Emond/Mark Madison

Project Number: Big Gun, slurry, 2000 cows,Meyer | Crop: kikuyu grass

General Design Parameters

Crop Parameters		
Depletion Fraction	[-]	0.55
Rooting Depth	[ft]	3.30
Yield Response Factor	[-]	1.10
Salinity Induced Yield Reduction	[%/(dS/m)]	6.40
Threshold ECe	[dS/m]	6.90
Soil Parameters		
Field Capacity	[in/in]	0.40
Permanent Wilting Point	[in/in]	0.27
Irrigation System Parameters		
Combined Irrigation Application Efficiency	[-]	1.00

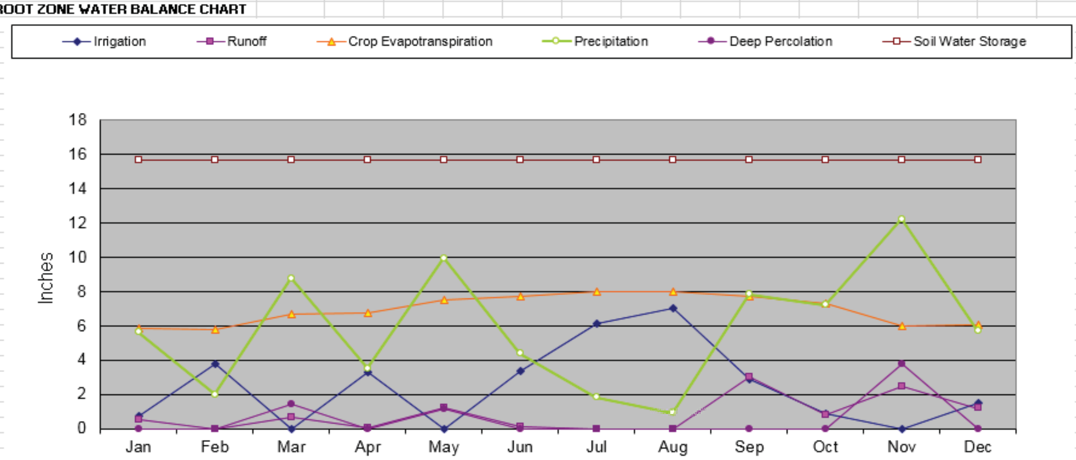
Notes:

Depletion Fraction - Average fraction of total available soil water that can be depleted from the root zone before moisture stress resulting in ET reduction occurs. Yield Response Factor - A slope factor describing the reduction in relative yield according to the reduction in ETc caused by soil water shortage. Salinity Induced Yield Reduction - A slope factor describing the reduction in relative yield according to an incremental increase in ECe for values above the threshold ECe. Threshold ECe - Electrical conductivity of the saturation extract at the threshold of ECe when

Field Capacity - Defined as the water held at a tension of 0.33 Bar. Permanent Wilting Point - Defined as the water held at a tension of 15 Bar. All water content measurements expressed in inches of water per inch of rooting depth

Combined Irrigation Application Efficiency - (average depth of water infiltrated and retained in the root zone following irrigation) / (average depth of water applied). A value of 1.0 routes all water through the root zone.

ROOT ZONE WATER BALANCE CHART



Root Zone Water Balance Working Model

Project Name: 2016 Hawaii Dairy
Project Number: **no irrig,no slurry,2000 cows,Meyer Ncalc,hi rainfall**

Designer: Emond/Madison/Smesrud
Crop: **kikuyu grass**

General Design Parameters

Crop Parameters		
Depletion Fraction	[-]	0.55
Rooting Depth	[ft]	3.30
Yield Response Factor	[-]	1.10
Salinity Induced Yield Reduction	[%/(dS/m)]	6.40
Threshold ECe	[dS/m]	6.90
Soil Parameters		
Field Capacity	[in/in]	0.40
Permanent Wilting Point	[in/in]	0.27
Storage Constraints		
Limiting Reservoir Depth	[ft]	0.00

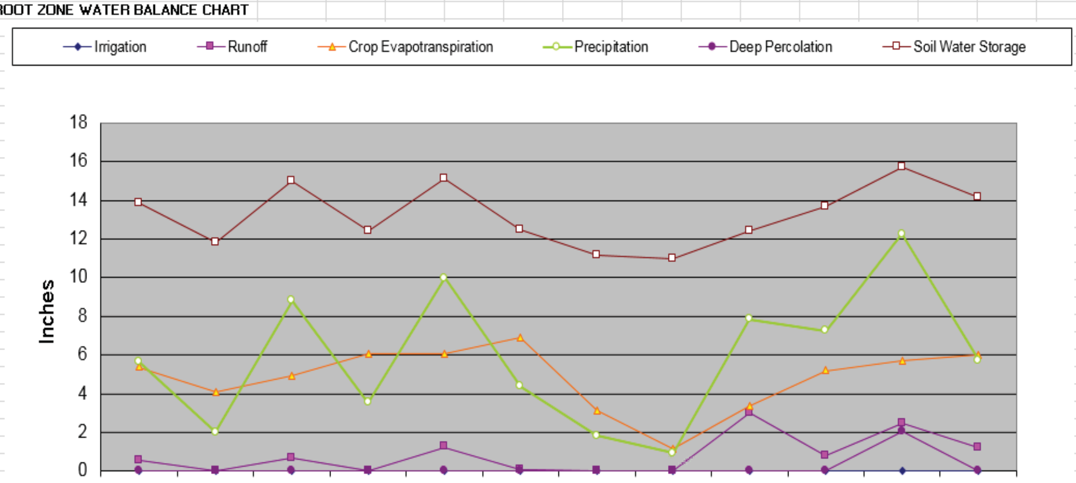
Notes:

Depletion Fraction - Average fraction of total available soil water that can be depleted from the root zone before moisture stress resulting in ET reduction occurs. Yield Response Factor - A slope factor describing the reduction in relative yield according to the reduction in ETc caused by soil water shortage. Salinity Induced Yield Reduction - A slope factor describing the reduction in relative yield according to an incremental increase in ECe for values above the threshold ECe. Threshold ECe - Electrical conductivity of the saturation extract at the threshold of ECe when crop yield first reduces

Field Capacity - Defined as the water held at a tension of 0.33 Bar. Permanent Wilting Point - Defined as the water held at a tension of 15 Bar. All water content measurements expressed in inches of water per inch of rooting depth

Limiting Reservoir Depth - Maximum allowable depth for reservoir facilties.

ROOT ZONE WATER BALANCE CHART



EXHIBITS

Exhibit 1

KAWAILOA
DEVELOPMENT LLP

April 9, 2014

Alec Wong, P.E., Chief
Clean Water Branch
Hawai'i State Department of Health
P.O. Box 3378
Honolulu, HI 96801-3378

Sina Pruder
Wastewater Branch
Environmental Management Division
Hawai'i State Department of Health
919 Ala Moana Blvd., Room 309
Honolulu, HI 96814-4920

Re: Hawai'i Dairy Farms' Project in Maha'ulepu

Dear Mr. Wong and Ms. Pruder:

I am writing on behalf of Kawailoa Development regarding the proposed dairy farm in Maha'ulepu on Kaua'i. Kawailoa Development is the owner of the Grand Hyatt Kaua'i Resort & Spa and the Poipu Bay Golf Course, which are less than three miles away from the proposed location of the dairy farm and its effluent ponds. We therefore have serious concerns about how the dairy farm would impact Hawaii's environment and our business. In particular, we are concerned about the odor from the dairy's nearly 2,000 cows and the impacts on Kauai's water quality.

We received a letter on March 11, 2014 from Warren Haruki, President and Chief Executive Officer of Grove Farm, which referred to Hawai'i Dairy Farms ("HDF") as a "World-Class Operation with Zero Effluent Discharge." His letter stated that the "operation is designed as a zero effluent discharge farm, meaning, that it creates no groundwater pollution or surface water run off." Mr. Haruki also sent us a presentation deck, dated February 27, 2014, which referred to the "zero discharge system" and stated that an Animal Feed Operation ("AFO") permit was in the process of being obtained from the Hawai'i State Department of Health ("DOH").

We learned, however, that prior to making these representations, HDF had received a letter from DOH on February 26, 2014. In that letter, DOH stated that if the dairy farm qualifies as a Concentrated Animal Feeding Operation ("CAFO") and it discharges effluent into State waters, HDF must obtain a National Pollutant Discharge Elimination System ("NPDES") permit from the DOH Clean Water Branch. Therefore, HDF was fully aware that the dairy farm might qualify as a CAFO before it made public representations that it is simply an AFO with zero effluent discharge.

In addition, we recently received copies of a proposed agenda for a March 19, 2014 meeting between HDF, Ulupono Initiative, DOH and the Department of Agriculture. The agenda specifically included time for a discussion on CAFO versus AFO criteria. Moreover, according to the agenda, HDF sought confirmation that its dairy plan "meets [NPDES] criteria for no discharge finding or agreement to submit supplemental plan that meets the agreed criteria and data."

We also received copies of an email dated the next day, March 20, 2014, in which you informed HDF that, based on information provided by the U.S. Environmental Protection Agency's ("EPA") CAFO Coordinator, the proposed dairy farm operation would be considered a Large CAFO. You wrote that the dairy farm "meets the definition of an AFO and because it contains more than 700 mature dairy cows, it would be considered a Large CAFO."

HDF has publicly represented its operations as an AFO with a "zero discharge system," when it is actually a Large CAFO that requires an NPDES permit. As demonstrated by your determination—in coordination with the EPA—that the dairy farm qualifies as a Large CAFO, these representations made by HDF are inherently misleading. Moreover, we sent a letter to Grove Farm on March 20, 2014, asking questions relating to the farm's operations and waste management plans, but we have not received any answers. We have been misinformed by HDF and Grove Farm, and we have been denied answers to our questions. As neighboring landowners, running a highly reputable hotel and golf course, we have a lot at stake with this proposed dairy farm. We cannot continue to be kept in the dark. More than just to our own hotel business, of course, the proposed dairy farm will also pose substantial risks to the environment and the public health. The manure generated by the farm will be substantial. The plans of the dairy farm require full disclosure and careful scrutiny by DOH. We encourage the Department of Health to ask for answers to the same questions we are asking.

In light of our concerns, we seek your assistance in keeping the public informed of the dairy farm's progress in obtaining approval as a Large CAFO. We are particularly concerned that accurate information is provided by HDF in the NPDES permitting process, particularly in connection with the farm's waste management plans.

We would also like the opportunity to offer comments and further information, as well as the opportunity to comment on the draft NPDES permit. Please include my name on any future notices or communications regarding the dairy's compliance with Hawaii's environmental laws. Thank you in advance for your attention to this matter.

Very truly yours,

Jun Fukada
General Manager

Enclosures:

Letter from Warren Haruki dated March 11, 2014
Hawai'i Dairy Farms' presentation deck dated February 27, 2014
Letter to Warren Haruki dated March 20, 2014

Exhibit 2

GOODSILL ANDERSON QUINN & STIFEL
A LIMITED LIABILITY LAW PARTNERSHIP LLP

LISA A. BAIL

FIRST HAWAIIAN CENTER, SUITE 1600 • 999 BISHOP STREET
HONOLULU, HAWAII 96813

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TELEPHONE (808) 547-5600 • FAX (808) 547-5880
info@goodsill.com • www.goodsill.com

DIRECT DIAL:
(808) 547-5787

INTERNET:
lbail@goodsill.com

May 7, 2014

Peter Tausend
West Kaua'i Soil and Water Conservation District
4334 Rice Street, Room 104
Lihue, Hawaii 96766-1801

Re: Hawai'i Dairy Farm's Proposed Dairy Farm in Maha'ulepu, Kaua'i

Dear Mr. Tausend:

I am writing on behalf of Kawailoa Development LLP, the landowner of the Grand Hyatt Kaua'i and Poipu Bay Golf Course. As our properties are in very close proximity to Hawai'i Dairy Farms' proposed dairy farm in Maha'ulepu, Kaua'i, we are deeply concerned with the effect the dairy farm's operations might have on our business. Given our unique circumstances, we would like to be in dialogue with the agencies and organizations working with Hawai'i Dairy Farms, including the West Kaua'i Soil and Water Conservation District.

We would like to set up a meeting with you during which we can discuss the status of Hawai'i Dairy Farms' Comprehensive Nutrient Management Plan. We would also like to request an updated copy of the Comprehensive Nutrient Management Plan, which was recently submitted to your office for review.

Thank you for your attention to this matter. Your attention to our requests is very much appreciated.

Very truly yours,

Lisa A. Bail

LAB

4784175.1

Exhibit 3

GOODSILL ANDERSON QUINN & STIFEL
A LIMITED LIABILITY LAW PARTNERSHIP LLP

FIRST HAWAIIAN CENTER, SUITE 1600 · 999 BISHOP STREET
HONOLULU, HAWAII 96813

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TELEPHONE (808) 547-5600 • FAX (808) 547-5880
info@goodsill.com • www.goodsill.com

May 16, 2014

VIA FACSIMILE AND
CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Peter Tausend, Chairman
West Kauai Soil & Water Conservation District
4334 Rice Street, Room 104
Lihue, HI 96766-1801
Facsimile No.: (808) 246-4639

Ben Vinhateiro
District Conservationist
NRCS Service Center
4334 Rice Street, Room 104
Lihue, HI 96766-1801
Facsimile No.: (808) 246-4639

Re: Hawaii Dairy Farms

Dear Mr. Tausend and Mr. Vinhateiro:

This office represents Kawailoa Development, LLP. We understand that the West Kauai Soil & Water Conservation District ("West Kauai SWCD") and the U.S. Department of Agriculture Natural Resources Conservation Service approved a soil conservation plan for Hawai'i Dairy Farms plans to develop a 582-acre dairy farm in Maha'ulepu Valley on Kaua'i ("Dairy") which will operate with 1,800 milking cows.

The December 17, 2013 West Kauai SWCD soil conservation plan approval letter states,

> In issuing this conservation plan, the West Kauai Soil & Water Conservation District relies on the information and data which you provided to us. If, subsequent to the issuance of this approved conservation plan, such information and data prove to be false,

> incomplete or inaccurate, this approval may be modified, suspended or revoked.

Moreover, the NRCS planning process requires that the planner must "[r]evisit earlier steps if new objectives or resource concerns are identified." USDA, NRCS National Planning Procedures Handbook ("NPPH") at 600-C.16, 600-C.24 (Jan. 2013).

After the West Kauai SWCD issued its approval of the Dairy's Soil Conservation Plan, the State of Hawaii Department of Health Wastewater Branch reviewed the Dairy's Comprehensive Nutrient Management Plan ("CNMP") and determined that improper rainfall data was used and the effluent ponds were undersized. We further understand that the Dairy has updated its CNMP with the new rainfall data and recalculated the size of its effluent ponds. The capacity of the Dairy's wastewater treatment ponds in its Soil Conservation Plan is also based on the erroneous rainfall data used in the CNMP. (Soil Conservation Plan unnumbered pages 85-89). The capacity calculations for the wastewater treatment ponds in the Soil Conservation Plan are therefore incorrect.

In addition, the Soil Conservation plan states that the soil type is "free draining volcanic soil and therefore its rest period from rain can be as little as 6 hours" before irrigation. (Soil Conservation Plan at unnumbered pages 51 and 93). We understand that Roy Yamakawa of CTAHR was invited to visit the Dairy location in late April and during that site visit determined that the soil is primarily vertisol, a clay soil that holds moisture, impeding drainage increasing the risk for wastewater runoff. The Soil Conservation Plan does not indicate that the primary soil type is vertisol, and instead inaccurately describes "free draining volcanic soil." Where, during the evaluation process, "incorrect or insufficient data has been formulated," the planner needs to return to previous planning steps before proceeding. *See* NPPH at 600-C.24.

Lastly, on March 20, 2014 the Concentrated Animal Feeding Operation ("CAFO") coordinator of the United States Environmental Protection Agency ("EPA") determined that the Dairy is a Large CAFO. The EPA concluded that the Dairy, "Meets the definition of an AFO and because it contains more than 700 mature dairy cows, it would be considered a Large CAFO." A copy of the relevant correspondence is enclosed. The Dairy's Soil Conservation Plan, however, makes no mention of its status as a Large CAFO.

This letter therefore requests that West Kauai SWCD and the NRCS revoke their approval of the Dairy's Soil Conservation Plan in its entirety.

Very truly yours,

Lisa A. Bail

LAB

Enclosure

cc: William Aila, Jr., Chairperson
Hawai'i State Department of Land and Natural Resources
Jun Fukada
Dennis Chan

Pruder, Sina L

From:	Jim Garmatz [jim@hawaiidairyfarms.com]
Sent:	Thursday, March 20, 2014 11:46 AM
To:	Pruder, Sina L; Kyle Datta; amy@ulupono.com; mclay@ulupono.com; James Garmatz; Paul Matsuda; scott.enright@hawaii.gov
Cc:	Gill, Gary L.; Wong, Alec Y; Tomomitsu, Mark S; Lum, Darryl C; Okubo, Watson T; Ueunten, Gary R.; Mitschele, Becky
Subject:	Re: Clarification of a CAFO
Attachments:	NRCS Approval Letter.pdf

Sina

I have attached a copy of the approval letter from our NRCS Plan that you requested from me yesterday.

Thank You

Jim Garmatz
Hawaii Dairy Farms
Note my new email address: jim@hawaiidairyfarms.com
Phone: 808-212-5985

From: Pruder, Sina L
Sent: Thursday, March 20, 2014 7:48 AM
To: Kyle Datta ; amy@ulupono.com ; mclay@ulupono.com ; James Garmatz ; Paul Matsuda ; scott.enright@hawaii.gov
Cc: Gill, Gary L. ; Wong, Alec Y ; Tomomitsu, Mark S ; Lum, Darryl C ; Okubo, Watson T ; Ueunten, Gary R. ; Mitschele, Becky
Subject: Clarification of a CAFO

Hi All,

As requested, I contact Becky Mitschele, EPA's CAFO Coordinator, to clarify the definition of a CAFO and the 45 day confinement period. Based on the information that Becky provided below, the proposed dairy farm operation in Kauai would be considered a Large CAFO.

The dairy meets the definition of an AFO and because it contains more than 700 mature dairy cows, it would be considered a Large CAFO.

Should you have any questions, please feel free to contact me at 586-4294.

Thanks,
Sina

From: Mitschele, Becky [mailto:Mitschele.Becky@epa.gov]
Sent: Thursday, March 20, 2014 6:46 AM
To: Pruder, Sina L
Subject: RE: Kauai Dairy

Hi Sina,

Here is the paragraph where I was reading (from our permit writer's guidance):

The first part of the regulatory definition of an AFO means that animals must be kept on the lot or facility for a minimum of 45 days in a 12-month period. If an animal is confined for any portion of a day, it is considered to be on the facility for a full day. For example, dairy cows that are brought in from pasture for less than an hour to be milked are counted as being confined (i.e., on the lot or facility) for the day. In addition, the same animals are not required to remain on the lot for 45 days or more for the operation to be defined as an AFO. Rather, the first part of the regulatory definition is met if some animals are fed or maintained on the lot or facility for 45 days out of any 12-month period. The 45 days do not have to be consecutive, and the 12-month period does not have to correspond to the calendar year.

Link available: http://www.epa.gov/npdes/pubs/cafo_permitmanual_chapter2.pdf

See discussion on page 2-2 (bottom of page).

Thanks,
Becky Mitschele

On detail to R9 NPDES Permits Office
(415) 972 - 3492
CAFO Coordinator

U.S. EPA, Office of Wastewater Management
(202) 564 - 6418

3/20/2014

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Sent To: Ben Vinhateiro
District Conservationist
Street, Apt. No., or PO Box No.: NRCS Service Center
4334 Rice Street, Room 104
City, State, ZIP+4: Lihue, HI 96766-1801

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Ben Vinhateiro
District Conservationist
NRCS Service Center
4334 Rice Street, Room 104
Lihue, HI 96766-1801

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X [signature]
☐ Agent
☐ Addressee

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Peter Tausend, Chairman
West Kauai Soil & Water
Conservation District
4334 Rice Street, Room 104
Lihue, HI 96766-1801

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1. Article Addressed to:

Peter Tausend, Chairman
West Kauai Soil & Water
Conservation District
4334 Rice Street, Room 104
Lihue, HI 96766-1801

COMPLETE THIS SECTION ON DELIVERY

A. Signature
X M Stanpwill ☐ Agent ☐ Addressee

B. Received by (Printed Name) M Stanpwill
C. Date of Delivery 5-19-14

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If YES, enter delivery address below: ☐ No

3. Service Type
☑ Certified Mail ☐ Express Mail
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4. Restricted Delivery? (Extra Fee) ☐ Yes

2. Article Number (Transfer from service label) 7012 3460 0002 2608 6409

PS Form 3811, February 2004 — Domestic Return Receipt — 102595-02-M-1540

Exhibit 4

West Kauai
Soil & Water Conservation Districts

May 23, 2014

Lisa A. Bail
Goodsill Anderson Quinn & Stifel
PO Box 3196
Honolulu, HI 96801

Re: Hawaii Dairy Farms

Dear Ms. Bail:
Your letter of May 7, 2014 requests a copy of Hawaii Dairy Farms' Comprehensive Nutrient Management Plan (CNMP). It is our understanding that the review and permitting of the CNMP is done by the State of Hawaii Department of Health. West Kauai Soil and Water Conservation District does not have the CNMP.

Your letter of May 16, 2014 requests that West Kauai SWCD revoke the approval of the Dairy's Conservation Plan in its entirety. At this time, West Kauai SWCD is not planning to revoke Hawaii Dairy Farms' Conservation Plan.

Sincerely yours,

Peter Tausend

Peter Tausend
Chairman, West Kauai Soil and Water Conservation District

Exhibit 5

GOODSILL ANDERSON QUINN & STIFEL
A LIMITED LIABILITY LAW PARTNERSHIP LLP

FIRST HAWAIIAN CENTER, SUITE 1600 • 999 BISHOP STREET
HONOLULU, HAWAII 96813

MAIL ADDRESS: P.O. BOX 3196
HONOLULU, HAWAII 96801

TELEPHONE (808) 547-5600 • FAX (808) 547-5880
info@goodsill.com • www.goodsill.com

May 30, 2014

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Jim Garmatz
Hawai'i Dairy Farms, LLC
3083 Akahi Street
Līhu'e, Hawai'i 96766

Sina Pruder, P.E.
Hawai'i Department of Health
Wastewater Branch
Environmental Management Division
919 Ala Moana Blvd, Room 309
Honolulu, Hawai'i 96814

Peter Tausend
West Kaua'i Soil and Water Conservation District
4334 Rice Street, Room 104
Līhu'e, Hawai'i 96766-1801

Mayor Bernard P. Carvalho, Jr.
County of Kaua'i
4444 Rice Street, Suite 235
Līhu'e, Hawai'i 96766

William J. Aila, Jr.
Chairperson
Hawai'i Department of Land and Natural Resources
1151 Punchbowl Street
Honolulu, Hawai'i 96813

Michael Moule, P.E.
County of Kaua'i
Department of Public Works
4444 Rice Street, Suite 275
Līhu'e, Hawai'i 96766

Re: Failure to Comply with Hawaii Revised Statutes Chapter 343

Dear Sirs and Madam:

This office represents Kawailoa Development, LLP, owner of the Grand Hyatt Kauai and Poipu Bay Golf Course. We understand that Hawai'i Dairy Farms plans to develop a 582-acre dairy farm ("Dairy") in Maha'ulepu Valley on Kaua'i in close proximity to the Hotel and golf course. The Dairy will operate with 1,800 milking cows.

Based on documents prepared by Hawai'i Dairy Farms, we understand that the Dairy's operations include a wastewater treatment system. Manure collected from the Dairy's milking parlor and yards will be transferred into a two-pond effluent system, which ponds will serve as holding ponds for the material to be recycled for irrigation. The Dairy's manure will be

transferred into the first settling pond for treatment. A stirrer pump will break up the solids in the settling pond. In addition, the effluent ponds will utilize aeration equipment. Treatment of the wastewater using solid separators, two stage lagoons, two-stage waste holding ponds, etc., may be needed to further reduce solids. The liquid effluent from the Dairy's settling pond overflows into the second storage pond through screen pipes, where it is diluted before being applied to the pasture.

The Hawai'i Environmental Policy Act ("HEPA") is found in Hawai'i Revised Statutes ("HRS") Chapter 343. The legislative purpose of HEPA is to integrate the review of environmental concerns with existing planning processes and to alert decision-makers to significant environmental effects which may result from the implementation of certain actions.

The proposed Dairy is subject to HEPA. HRS § 343-5(a)(9)(A) provides that an environmental assessment shall be required for any "Wastewater treatment unit, except an individual wastewater system or wastewater treatment unit serving fewer than fifty single-family dwellings or the equivalent." We note that the Dairy's wastewater treatment system is neither an individual wastewater system, nor does it serve the equivalent of fewer than fifty single-family dwellings. The waste produced per day by one dairy cow is equal to that of 20-40 people.

Whenever HEPA is triggered, an environmental assessment must be prepared "at the earliest practicable time to determine whether an environmental impact statement shall be required." HRS § 343-5(a)-(b). An environmental assessment is not discretionary; it is mandatory. We therefore demand that Hawai'i Dairy Farms prepare an environmental assessment as required by HEPA.

We understand that Hawai'i Dairy Farms has sought certain permits or approvals from the County of Kaua'i and state agencies. However, the county and state agencies may not issue permits or approvals unless and until (1) they makes a determination that an environmental assessment is not required, or (2) an environmental assessment is prepared.

It is our understanding that neither the County nor any state agency has determined that an environmental assessment is not required. We are not aware of any exemption applicable to the proposed Dairy.[1] We therefore demand that the County and state agencies require Hawai'i Dairy Farms to prepare an environmental assessment as required by HEPA before any permit or approval is issued.

[1] Even if an exemption were applicable, any such exemption would be inapplicable here as the Dairy will impact a particularly sensitive environment which is presently frequented by endangered species. Hawai'i Administrative Rule §11-200-8(b) provides that all exemptions are inapplicable "when an action that is normally insignificant in its impact on the environment may be significant in a particularly sensitive environment."

An environmental assessment is not only required by law, we believe the community should have the opportunity to review the documents that are being reviewed by county, state and federal agencies at this time. We have requested copies of the Dairy's current plans, including the Comprehensive Nutrient Management Plan, from federal and state agencies, but they have refused to provide documents as Hawai'i Dairy Farms claims they contain confidential information. Such information should be available to the public.

This is a matter that has generated much community concern. The plans for the proposed dairy have been the subject of a number of articles in the press and of several community meetings. The Dairy itself has generated its own op-ed news articles. It would be consistent with the very policies of HEPA that on issues of wide public interest such as this, an environmental assessment be prepared. The information contained in the environmental assessment should be available to the public before irreversible decisions are made.

Thank you for your attention to this matter. We look forward to joining the community in participating in the environmental assessment process.

Very truly yours,

Lisa Woods Munger
Lisa A. Bail

cc: Warren Haruki, President & CEO, Grove Farm Company, Inc.
Akihiro Tachibana, General Manager, Global Real Properties & Investment, Takenaka Corporation – Investment & Development Department
Jessica Wooley, Office of Environmental Quality Control
Edward Bohlen, Esq., Office of the Attorney General
Mauna Kea Trask, Esq., County of Kauai
Jun Fukada, General Manager, Kawailoa Development, LLP
Patricia McHenry, Esq., Cades Schutte, LLP

Exhibit 6

West Kauai
Soil & Water Conservation Districts

Lisa A. Bail, Esq.
Goodsill Anderson Quinn & Stifel
First Hawaiian Center, Suite1600
999 Bishop Street
Honolulu, Hawaii 96813

Dear Ms. Bail:

We are in receipt of your correspondence dated June 27, 2014. We are withholding the Hawaii Dairy Farms' soil conservation plan and the West Kauai Soil and Water Conservation District approval letter for the conservation plan because disclosure of said documents are not mandated by the Hawaii Uniform Information Practices Act (UIPA). Under Haw. Rev. Stat. (HRS) § 92F-13(4), the UIPA does not require the disclosure of "[g]overnment records which, pursuant to ... federal law ... are protected from disclosure." Section 1619(b)(2) of the Food, Conservation and Energy Act of 2008 provides in part:

> Except as provided in paragraphs (3) and (4), ... any ... cooperator of the Department shall not disclose –
>
> (A) Information provided by an agricultural producer or owner of agricultural land concerning the agricultural operation, farming or conservation practices, or the land itself in order to participate in programs of the Department....

The West Kauai Soil and Water Conservation District is a cooperator of the United States Department of Agriculture. We are not authorized to disclose the information you requested. HRS § 92F-13(4) protects the documents you requested from disclosure under the UIPA because they are protected by Section 1619(b)(2) from disclosure. HRS § 92F-13(4) does not require that the federal law specifically provide that the documents be protected from UIPA disclosure. It merely allows documents to be withheld when they are protected by federal law from disclosure.

Sincerely yours,

Peter Tausend

Peter Tausend
Chairman, West Kauai Soil and Water Conservation District

Exhibit 7

WASTE MANAGEMENT PLAN

for

HAWAI'I DAIRY FARMS

MAHA'ULEPU, KAUA'I, HAWAI'I

TMK: (4) 2-9-003: 001 por and 006 por
(4) 2-9-001: 001 por

Prepared for:
Hawai'i Dairy Farms, LLC
P.O. Box 1690
Koloa, Hawai'i 96756-1690

Prepared by:
GROUP 70 INTERNATIONAL
925 Bethel Street, 5th Floor
Honolulu, Hawai'i 96813
(808) 523-5866

July 23, 2014

Farm Name:	HAWAI'I DAIRY FARMS
Facility Location:	Maha'ulepu Road
	Maha'ulepu, Kaua'i, Hawai'i
	TMK: (4) 2-9-003: 001 por and 006 por
	(4) 2-9-001: 001 por
Land Owner:	Maha'ulepu Farms, LLC
	3-1850 Kaumuali'i Hwy
	Lihu'e, Hawai'i 96766
Dairy Owner/Operator:	Hawai'i Dairy Farms, LLC
Contact person:	Kyle Datta (Manager)
Address:	P.O. Box 1690, Koloa, Hawai'i 96756
Phone:	(808) 544-8960
Email:	kdatta@ulupono.com
Operated by:	James Garmatz (Farm Manager)
Address:	P.O. Box 1690, Koloa, Hawai'i 96765
Phone:	(808) 212-5985
Email:	jim@hawaiidairyfarms.com

As the Owner/Operator of Hawai'i Dairy Farms, LLC, I agree to manage the dairy operation in accordance with this waste management plan and maintain those practices described in the plan.

Signature: ______________________ Date: ____________

Table of Contents

LIST OF FIGURES

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OPERATION & MAINTENANCE WORKSHEETS

APPENDICES

1.0 Project Overview

Hawai'i Dairy Farms LLC (HDF) intends to ultimately develop a 2,000-cow dairy in the Maha'ulepu Valley at Grove Farm on the island of Kaua'i. The entire project will be a pastoral-based rotational pasture system, and has been designed by U.S. and New Zealand dairy experts to be zero-point source discharge. At full production the dairy will double current milk production to provide more fresh, local milk to Hawaii's families. To demonstrate the environmental sustainability of the dairy, HDF will develop the project in two phases: Phase 1 will have no more than 699 cows, and Phase 2 will have up to 2,000 cows. THIS APPLICATION IS SOLELY FOR PHASE 1 OF THE HDF PROJECT.

All the facilities and infrastructure presented in this application are sized for the Phase 2 full-scale production. The Waste Management Plan calculations presented reflect Phase 1 stocking rates of ~1.3 animals per acre or 699 milking cows (grazing on ~517 acres). The animals will be managed in small groups (of 115-150 cow mobs) and are milked twice a day (1 hour per milking). Only one mob can be held in the dairy at any one time. The effluent pond calculations demonstrate that the Phase I margin for safety would exceed regulatory compliance requirements and contain roughly 100 days of storage capacity. Similarly, the pasture stocking rate is consistent with temperate zone dairies and the more productive Hawai'i ranching pastures, even though the carrying capacity of the pasture is far greater due to consistent fertilization and irrigation. The grazing pasture will be primarily Kikuyu, which HDF grass trials have shown to be highly productive and nutritious forage. The cows spend 22 hours in the paddock and only 2 hours in the milking area each day.

HDF is submitting this Waste Management Plan for its Animal Feeding Operation (AFO) to the Hawai'i State Department of Health for approval, in accordance with the "Guidelines for Livestock Waste Management", prepared by the University of Hawai'i-Mānoa Cooperative Extension Service, College of Tropical Agriculture and Human Resources (CTAHR), and applicable state and county regulations.

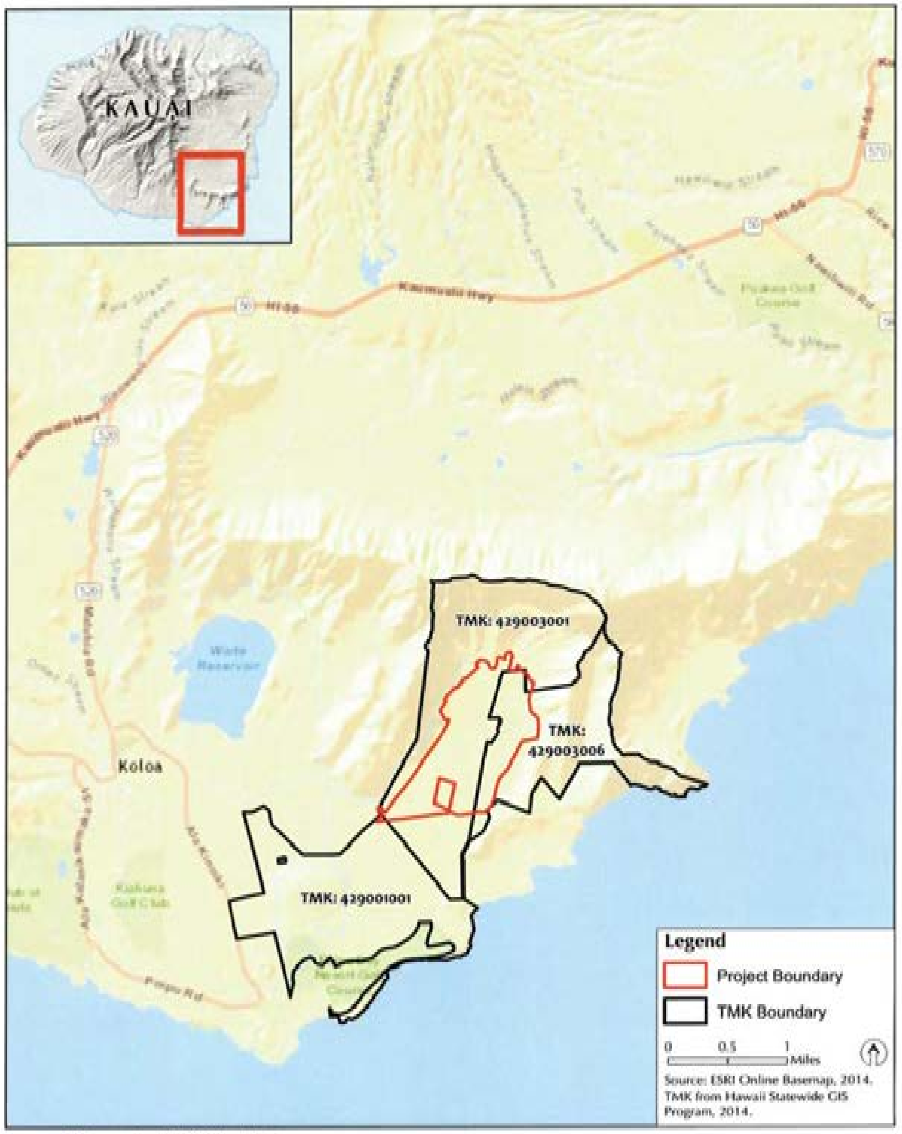

Figure 1 – Vicinity Map

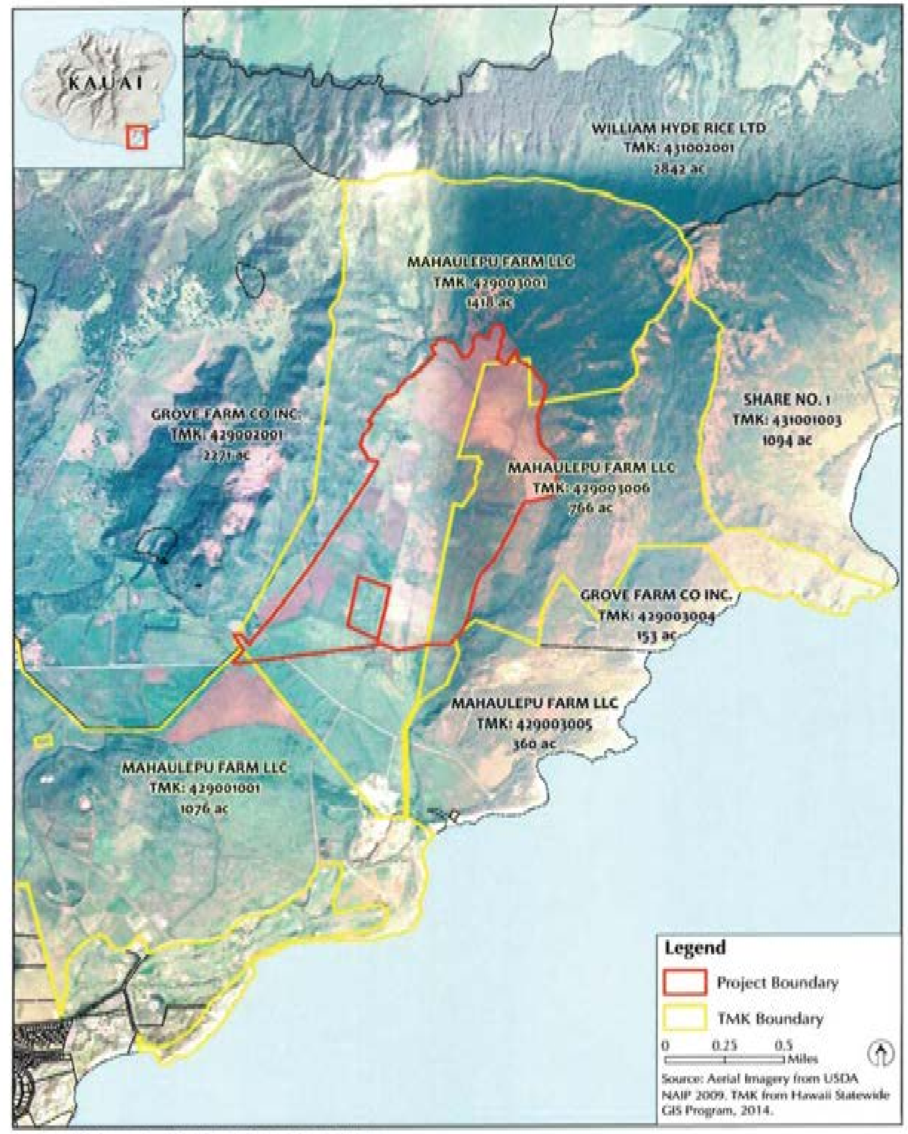

Figure 2 – Project Location Map

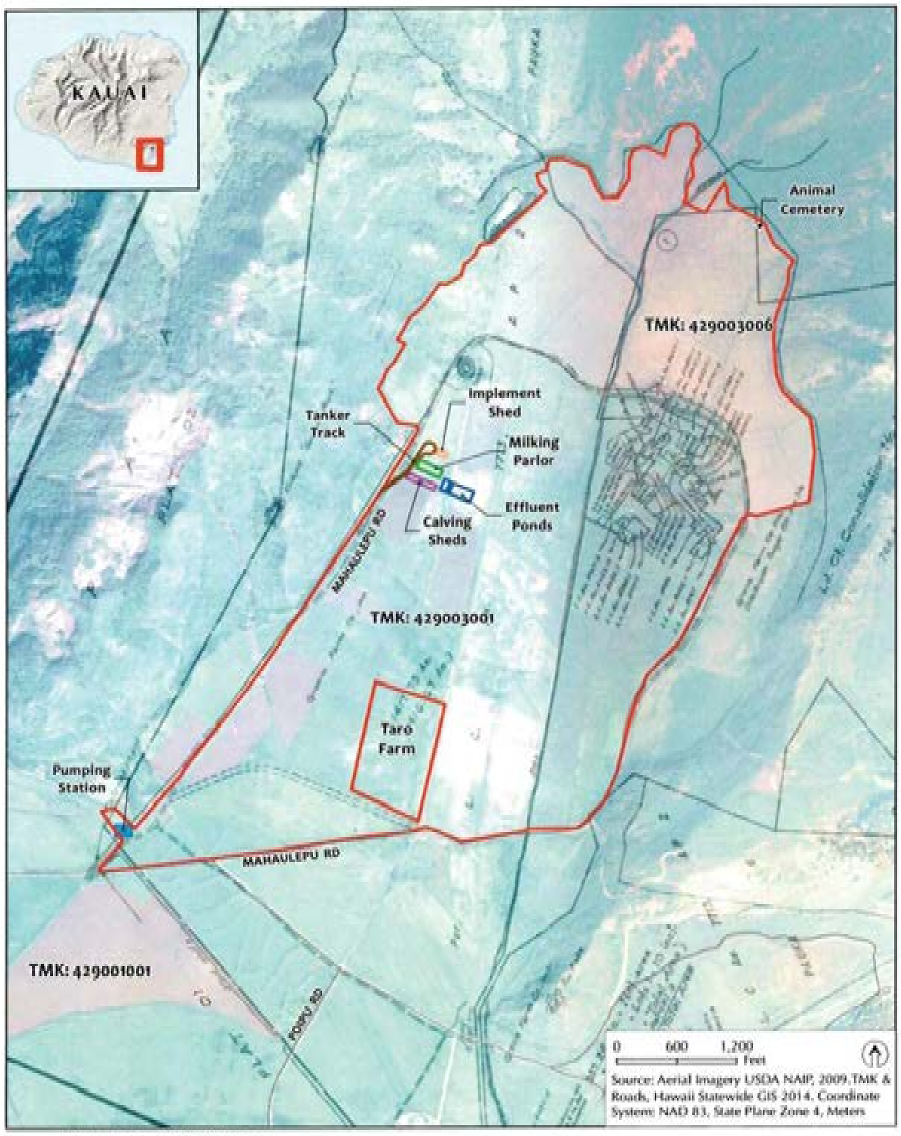

Figure 3 – TMK Map

2.0 Existing Conditions

The project area has historically been used for sugar cane production as part of the Koloa Plantation until the late 1990s when the Koloa Mill closed. Since the mill closed, the project area has been leased to various tenants for ranching and diversified agricultural operations. A small plot of land in the lower center of the valley is currently used for taro lo'i and will continue to be leased and farmed after the dairy and related pastures are in full operation. See Figure 3 – TMK Map.

The original agricultural infrastructure from the sugar plantation is largely still in place and continues to be used for on-going agricultural activities. Much of this existing infrastructure will also be used for the dairy, but with a significant amount of upgrades and improvements. The existing infrastructure in the project area includes: gravel access roads, field roads, water wells, reservoirs, pipelines, pumps, irrigation ditches, drainage ways and culverts.

2.1 Topography

The project site is situated in the Maha'ulepu Valley on the island of Kaua'i. The valley is on the leeward side of the Ha'upu mountain ridge, which runs in the east-west direction, and the valley is also flanked by ridge lines on both sides. Mt. Ha'upu is the highest point on the ridge line at the back of the valley with an elevation of 2,297 feet. From this point, the ground drops very quickly down to the bottom of the valley to about an elevation of 150 feet. The base of the valley itself is somewhat gradually sloped from an elevation of 150 feet to an elevation of 60 feet along Maha'ulepu Road on the makai side of the project site near the taro farm. See Figure 4, USGS Map.

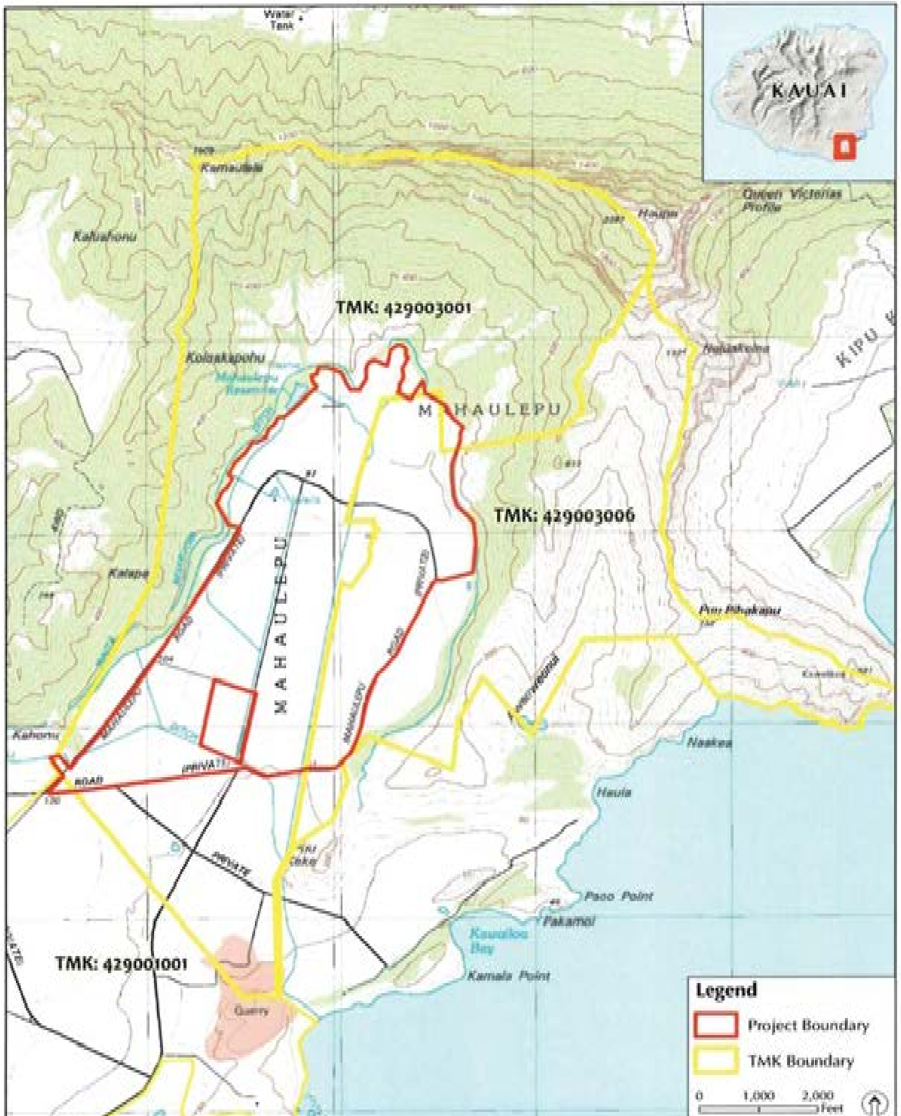

Figure 4 – USGS Map

2.2 Water Resources

The Maha'ulepu Valley has been in agricultural use for a very long time and much of the water resources and infrastructure in the valley are man-made and were constructed to provide irrigation water to the sugar cane lands throughout the valley. Systems of ditches, reservoirs and irrigation pipes and pumps are still in place and are still used to irrigate fields and pasture. Much of this infrastructure is shown on the USGS maps and in other datasets. See Figure 5, Water Resources. Water resources shown in Figure 5 include: canals, ditches, streams and ponds as identified in the National Hydrography Dataset (NHD), water wells from the State of Hawai'i, Department of Land and Natural Resources (DLNR), and wetlands from the National Wetlands Inventory (NWI).

2.2.1 Receiving Water Body State Water Quality

The drainage ways within Maha'ulepu Valley and within the project site are classified by the DOH Clean Water Branch (CWB) to be Class 2 inland waters as defined in Hawai'i Administrative Rules (HAR) Title 11, Chapter 54 (§11-54). These canals and ditches flow in the makai direction beyond the project site across Maha'ulepu Road and into the agricultural lands on the opposite side of the road. The unnamed drainage ways from the valley all converge near Pu'u Keke and are discharged into Class A marine waters along the Maha'ulepu coastline between Kamala Point and Punahoa Point. The Maha'ulepu coastline is classified as Class 1 critical habitat by the State.

2.2.2 Wetlands

According to the United States Fish and Wildlife Service (FWS), the agricultural canals, ditches and ponds within the valley are listed in the National Wetlands Inventory (NWI). There is also a freshwater wetland on the makai side of Maha'ulepu Road outside the project site. FWS classifies the wetlands as follows:

Table 1 – NWI Wetlands Classification

Location (Wetland Code)	System	Sub-System	Class	Sub-Class	Modifiers
R4SBCx	Riverine	Intermittent	Streambed		• Seasonally Flooded • Excavated
PUBHh	Palustrine		Unconsolidated Bottom		• Permanently Flooded • Diked/Impounded
PEM1Hh	Palustrine		Emergent	Persistent	• Permanently Flooded • Diked/Impounded
PEM1Kx	Palustrine		Emergent	Persistent	• Artificially Flooded • Excavated

2.2.3 Water Wells

The State Department of Land and Natural Resources (DLNR) Commission on Water Resource Management (CWRM) manages and tracks water resources in the State including groundwater wells. The State database identifies two primary well sites in the Maha'ulepu Valley. The Koloa F Well is a public drinking water source used by the County of Kaua'i Department of Water Supply. The Maha'ulepu Well site includes up to 14 irrigation wells drilled by the sugar cane plantations. The water wells are shown on Figure 5, Water Resources. The Koloa F well is located over ½ mile away from the dairy facility site.

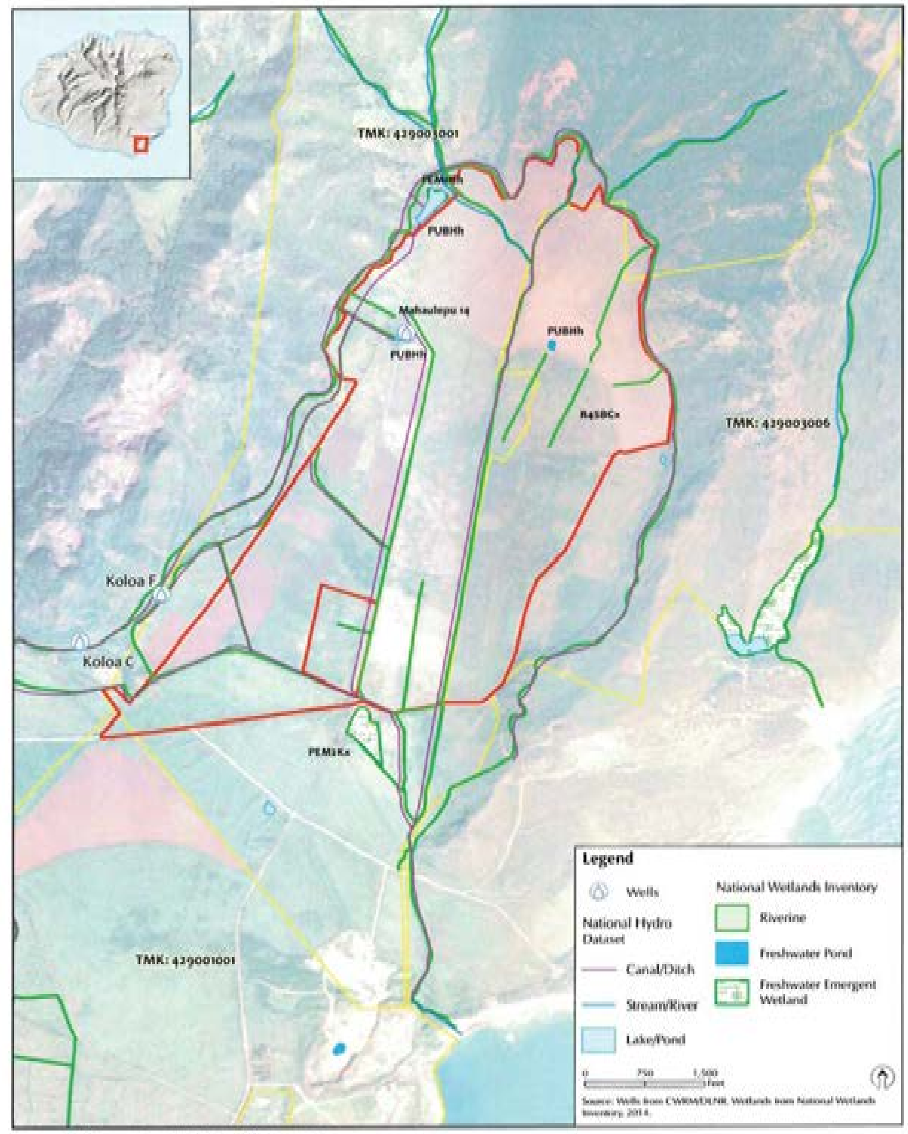

Figure 5 – Water Resources

2.3 Rainfall Data

The data sources used for sizing of the waste management systems and irrigation scheduling of the dairy facility site are described in this section.

2.3.1 Normal Precipitation

Normal monthly precipitation depths were obtained from the University of Hawai'i Rainfall Atlas of Hawai'i (2011). The average monthly precipitation depths will be used for sizing of the waste management systems and irrigation scheduling as required by the standards.

Table 2 – Average Monthly Precipitation Data

Month	Mean Monthly Rainfall (in)
January	4.88
February	4.20
March	5.04
April	3.66
May	3.05
June	2.86
July	3.13
August	3.20
September	3.25
October	4.96
November	6.01
December	5.71
Annual	49.95

2.3.2 NOAA 24-Hour Rainfall

Precipitation depths for various durations and recurrence intervals were obtained from NOAA Atlas 14, Volume 4, Version 3. The 25-year 24-hour precipitation data will be used for sizing of waste management systems as required by the standards.

Table 3 – NOAA 24-Hour Rainfall Data

Storm Event (Recurrence Interval)	Storm Duration	
	1-hour	24-hour
1-year	1.18"	3.47"
2-year	1.55"	4.78"
10-year	2.54"	8.18"
25-year	3.17"	**10.4"**
50-year	3.70"	12.2"
100-year	4.25"	14.1"

2.3.3 NOAA Rain Gauge Data

Rain gauge data was obtained from NOAA National Climatic Data Center for the Maha'ulepu 941.1 rain gauge located on the farm off of Maha'ulepu Road (GHCND:USC00515710 - MAHA'ULEPU 941.1 HI US). The rain gauge is located at: Elevation = 24.4, Latitude = 21.90194, Longitude = -159.42111. The data record analyzed included daily precipitation records from 1/1/1984 to 12/31/2013 for a total of approximately 10,957 days (30 years). The rainfall events were ranked based on days of consecutive rainfall (DAPR) and the corresponding multiday precipitation total (MDPR). The data suggests that having more than a week of consecutive rain is very unusual for Maha'ulepu Valley with this only having occurred 5 times in the last 30 years.

Table 4 – NOAA Rain Gauge Data

GHCND:USC00515710 - MAHA'ULEPU 941.1 HI US			
DATE	MDPR, in	DAPR	Occurrence
19960108	1.90	17	1
19920922	2.60	12	1
19930104	3.70	7	3
19960930	0.20	7	3
19980105	1.48	7	3
19920928	0.02	6	5
19940105	0.03	6	5
19960923	0.03	6	5
19970106	0.05	6	5
20031229	0.20	6	5
19861229	0.04	5	21

MDPR – Multiday precipitation total

DAPR – Number of days included in the multiday precipitation total (MDPR)

Occurrence – number of occurrences in 10,957 day record between 1/1/1984 to 12/31/2013

2.4 Flood Hazards

The entire project area is located within Federal Emergency Management Agency (FEMA) Zone X based on FEMA Flood Insurance Rate Map (FIRM) panels 1500020316E and 1500020318F. Zone X includes areas determined to be outside the 0.2% annual chance floodplain.

2.5 Soils

According to the United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) survey data, the project area consists of a variety of soils. Soil characteristics are summarized in the table below. See Figure 6, Soil Map.

Table 5 – Soil Characteristics Summary

Soil Classification	Soil Classification	Slope Range (%)	Hydrologic Soils Group	Drainage Class	Depth to Water Table (inches)	Capacity to transmit water - Ksat (in/hr)	Typical Soil Profile - Layer 1 (depth from surface)	Typical Soil Profile - Layer 2 (depth from surface)	Typical Soil Profile - Layer 3 (depth from surface)
Hanamaulu Silty Clay	HsD	15 to 20%	B	Well Drained	> 80"	0.14 to 1.98	0 to 11" Silty Clay	11 to 36" Silty Clay	36 to 72" Silty Clay Loam
Hanamaulu Stony Silty Clay	HtE	10 to 35%	B	Well Drained	> 80"	0.20 to 2.00	0 to 11" Stony Silty Clay	11 to 36" Silty Clay	36 to 72" Silty Clay Loam
Ka'ena Clay, Brown Variant	KavB	1 to 6%	D	Poorly Drained	24 to 60"	0.00 to 0.20	0 to 10" Clay	10 to 37" Stony Clay	37 to 54" Stony Clay
Ka'ena Clay, Brown Variant	KavC	6 to 12%	D	Poorly Drained	24 to 60"	0.00 to 0.20	0 to 10" Clay	10 to 37" Stony Clay	37 to 54" Stony Clay
Kalapa Silty Clay	KdF	40 to 70%	B	Well Drained	> 80"	0.00 to 0.20	0 to 10" Silty Clay	10 to 60" Clay	
Kalihi Clay	Ke	n/a	D	Poorly Drained	24 to 60"	0.06 to 0.60	0 to 16" Clay	16 to 70" Clay	
Kalapa Very Rocky Silty Clay (Very Rocky)	KEHF	40 to 70%	B	Well Drained	> 80"	0.00 to 0.20	0 to 10" Silty Clay	10 to 60" Clay	
Kalapa Very Rocky Silty Clay (Rock Outcrop)	KEHF	40 to 70%	D			0.00 to 0.06	0 to 60" Bedrock		
Lualualei Clay	LuB	2 to 6%	D	Well Drained	> 80"	0.00 to 0.20	0 to 10" Clay	10 to 60" Clay	

Table 5 – Soil Characteristics Summary (continued)

Soil Classification	Soil Classification	Slope Range (%)	Hydrologic Soils Group	Drainage Class	Depth to Water Table (inches)	Capacity to transmit water - Ksat (in/hr)	Typical Soil Profile - Layer 1 (depth from surface)	Typical Soil Profile - Layer 2 (depth from surface)	Typical Soil Profile - Layer 3 (depth from surface)
Pakala Clay Loam	PdA	0 to 2%	B	Well Drained	> 80"	0.60 to 1.98	0 to 16" Clay Loam	16 to 60" Silty Clay Loam	
Pakala Clay Loam	PdC	2 to 10%	B	Well Drained	> 80"	0.60 to 1.98	0 to 16" Clay Loam	16 to 60" Silty Clay Loam	
Rock Land	rRK	n/a	D	Well Drained	> 80"	0.00 to 0.06	0 to 4" Silty Clay	4 to 8" Silty Clay	8 to 20" Bedrock
Rock Land (Rock Outcrop)	rRK	n/a	D			0.00 to 0.06	0 to 60" Bedrock		
Waikomo Stony Silty Clay	Ws	n/a	D	Well Drained	> 80"	0.00 to 0.06	0 to 14" Stony Silty Clay	14 to 20" Stony Silty Clay Loam	20 to 30" Bedrock

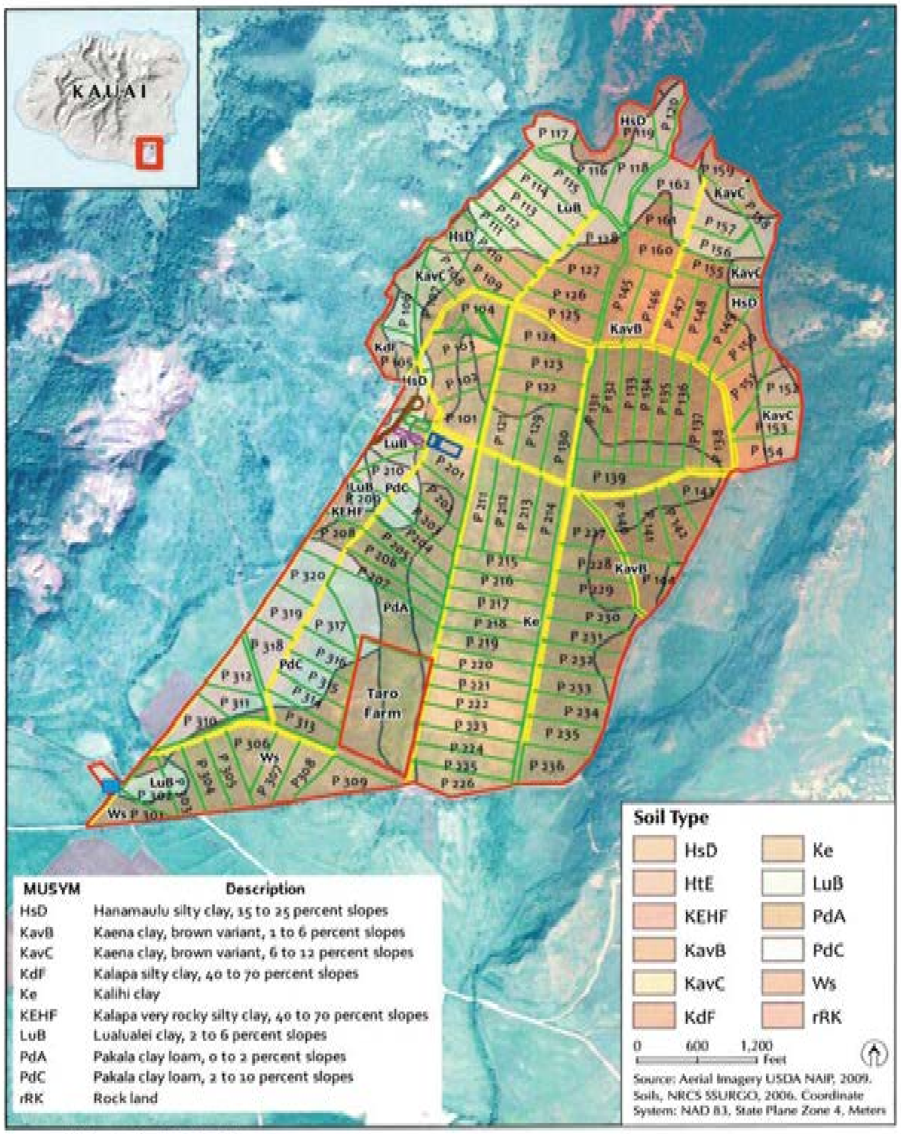

Figure 6 – Soils Map

3.0 Land Use Summary

The total dairy farm area inclusive of pasture and dairy facility, but excluding the existing taro farm, is 577.9 acres. The dairy project site has been divided into two land use areas as described in Table 6 (below): Field 1, 563.4 acres of pasture; and Field 2, 14.5 acres for the dairy facility. See Figure 7, Field Map.

Table 6 – Land Use Summary

Land Use	Acres
Field 1	
Paddocks	517.3
Cow Races, Farm Roads, Drainage Ways	46.1
Subtotal	**563.4**
Field 2	
Dairy Facility, Yard, Sheds, Road	4.6
Open Space	9.9
Subtotal	**14.5**
TOTAL	**577.9**

Field 1 is broken up into a total of 118 paddocks which are approximately 4 to 5 acres in size. See Figure 8, Paddock Map and Table 7, Paddock Area Summary. Other land uses within Field 1 include the cow races, walkways, farm roads, drainage ways, animal cemetery, and effluent ponds. The animal cemetery is located on paddock 159, and the effluent ponds are located on paddock 201. Both uses are included in the total paddock area.

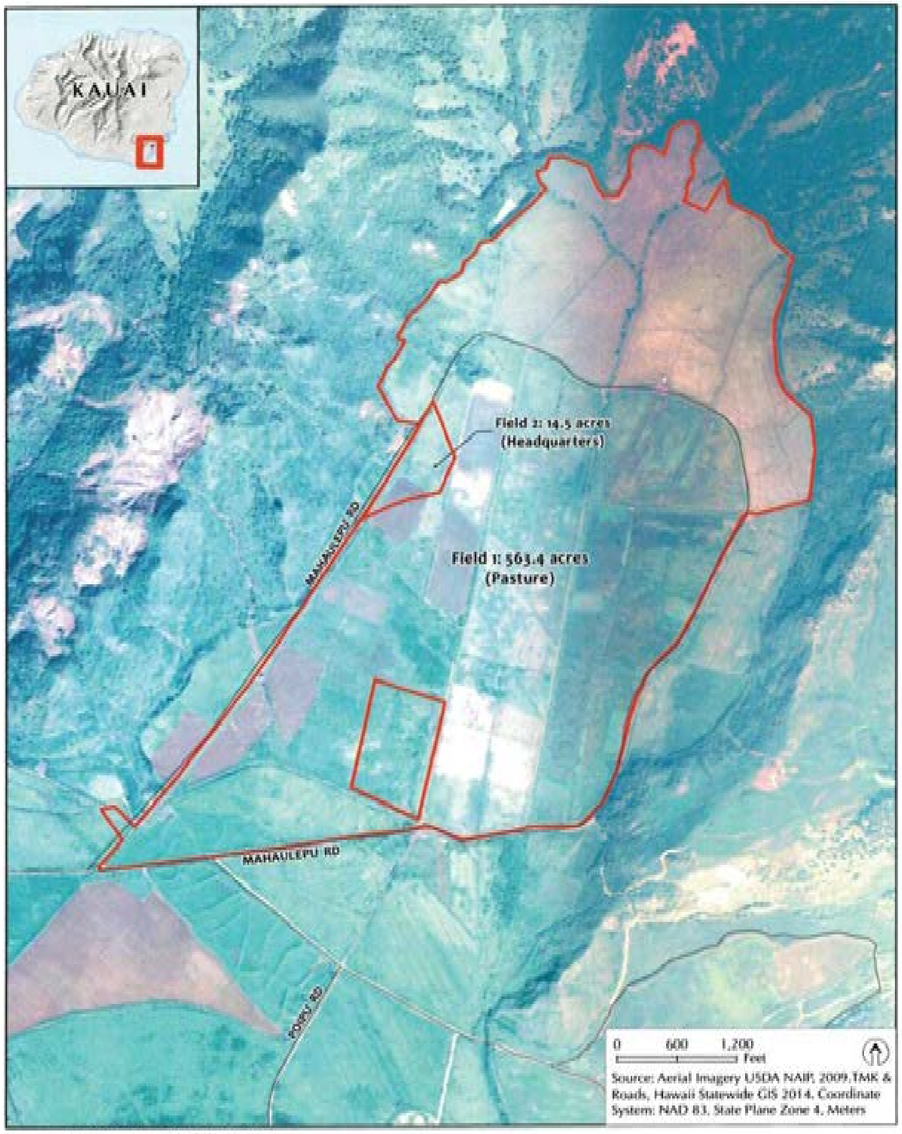

Figure 7 – Field Map

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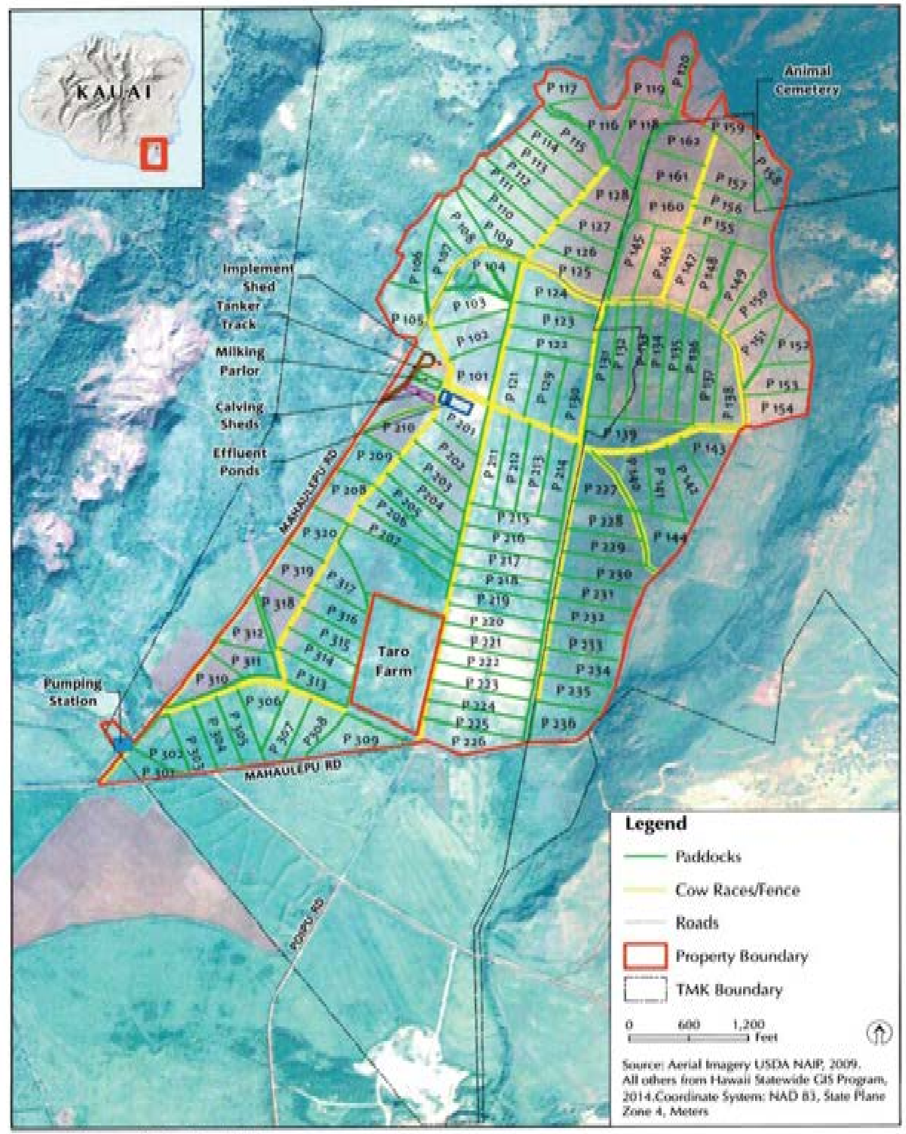

Figure 8 Paddock Map

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Table 7 – Paddock Area Summary

Field	Acres	Field	Acres	Field	Acres	Field	Acres
P 101	4.82	P 131	4.35	P 161	4.67	P 229	4.59
P 102	4.82	P 132	4.35	P 162	4.67	P 230	4.59
P 103	4.82	P 133	4.35	P 201	4.94	P 231	4.59
P 104	4.82	P 134	4.35	P 202	4.27	P 232	4.59
P 105	4.69	P 135	4.35	P 203	4.27	P 233	4.59
P 106	4.69	P 136	4.35	P 204	4.27	P 234	4.59
P 107	4.27	P 137	4.45	P 205	4.27	P 235	4.59
P 108	4.27	P 138	4.50	P 206	4.27	P 236	4.94
P 109	4.27	P 139	5.63	P 207	4.27	P 301	3.04
P 110	4.27	P 140	4.30	P 208	3.95	P 302	3.95
P 111	4.27	P 141	4.30	P 209	3.95	P 303	4.20
P 112	4.27	P 142	4.30	P 210	3.95	P 304	4.30
P 113	4.27	P 143	4.30	P 211	4.62	P 305	4.05
P 114	4.27	P 144	4.30	P 212	4.62	P 306	4.30
P 115	4.27	P 145	4.67	P 213	4.62	P 307	4.30
P 116	5.06	P 146	4.67	P 214	4.62	P 308	4.20
P 117	3.24	P 147	4.67	P 215	4.59	P 309	4.94
P 118	5.06	P 148	4.67	P 216	4.54	P 310	3.85
P 119	3.58	P 149	4.67	P 217	4.54	P 311	3.85
P 120	3.58	P 150	4.67	P 218	4.54	P 312	3.85
P 121	4.67	P 151	4.67	P 219	4.54	P 313	4.03
P 122	4.67	P 152	4.08	P 220	4.54	P 314	4.03
P 123	4.67	P 153	4.08	P 221	4.54	P 315	4.27
P 124	4.67	P 154	4.08	P 222	4.54	P 316	4.12
P 125	4.05	P 155	4.67	P 223	4.54	P 317	4.03
P 126	4.05	P 156	4.67	P 224	4.54	P 318	4.03
P 127	4.05	P 157	4.67	P 225	4.54	P 319	4.03
P 128	4.05	P 158	3.58	P 226	4.59	P 320	4.03
P 129	4.67	P 159	3.58	P 227	4.64		
P 130	4.67	P 160	4.67	P 228	4.59	*Total*	*517.29*

4.0 Farm Description

HDF is located on 577.9 acres of agricultural lands leased from Maha'ulepu Farms, LLC (a wholly-owned subsidiary of Grove Farm). HDF is a pasture-based dairy that will be developed in two phases. Phase 1 will include up to 699 cows and Phase 2 will include up to 2,000 cows (total). The facilities will be built out during Phase 1 to support full operation at 2,000 cows.

The majority of the dairy farm area (i.e. ~90%) is dedicated to pasture. The dairy facility including effluent ponds is contained within a 4.6-acre area in Field 2, which represents less than 1% of the entire dairy farm area. The corresponding building areas are under 0.1% of the total farm area. The dairy building and infrastructure are summarized as follows and are shown on Figure 9, Farm Map:

- Paved Access Road and Truck Turnaround
- Cow Walkways/Races and Farm Roads
- Concrete Holding Yards and Gravel Farm Races
- Milking Parlor
- Implement Shed
- Calf Sheds
- Waste Settling Pond and Storage Pond
- Effluent and Sludge Pumps and Distribution System
- Irrigation Water Storage and Distribution System
- Potable Well and Transmission Main to Milking Parlor
- Potable Water Tank for Milking Parlor and Livestock Consumption
- Livestock Water Distribution System
- Feed Silos
- Milking Parlor - Individual Wastewater System (IWS)
- Animal Cemetery

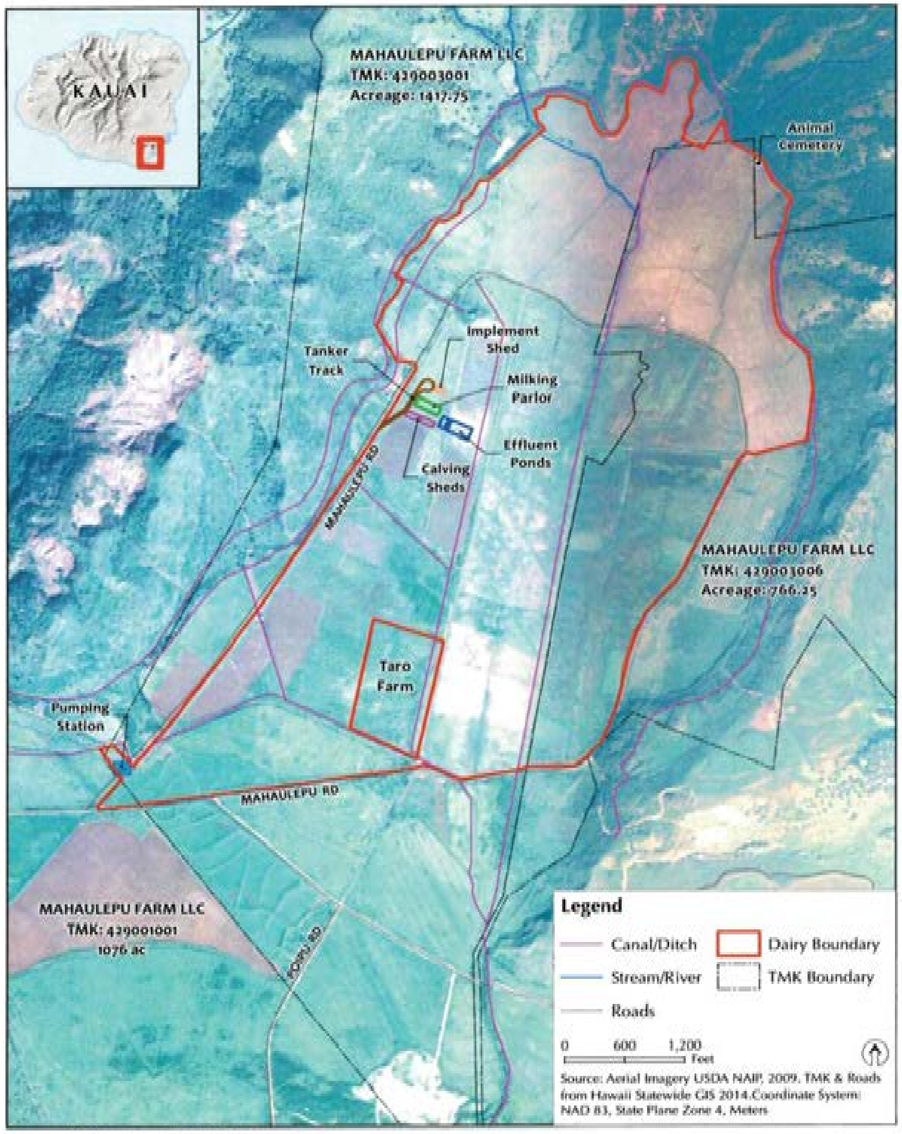


Figure 9 – Farm Map

4.1 Cows Walkways and Races

The dairy farm pasture areas are divided into 4- to 5-acre paddocks as shown on Figure 8, Paddock Map. A network of walkways and races connect the paddocks together and provide access to and from the dairy facility. The walkways and races are generally aligned with existing farm roads where possible, but additional walkways and races will be constructed through the existing fields. See Figure 10, Cow Walkways/Races

The walkways and races are compacted crushed rock access ways that are approximately 16 to 20 feet in width. The cow races allow twice daily movement of the cows from the paddocks to the Milking Parlor. The cow races are not irrigated and are frequently maintained to maximize efficient and rapid movement to and from the dairy with minimal injury to livestock. The races are bordered by 3 wire electrical fencing.

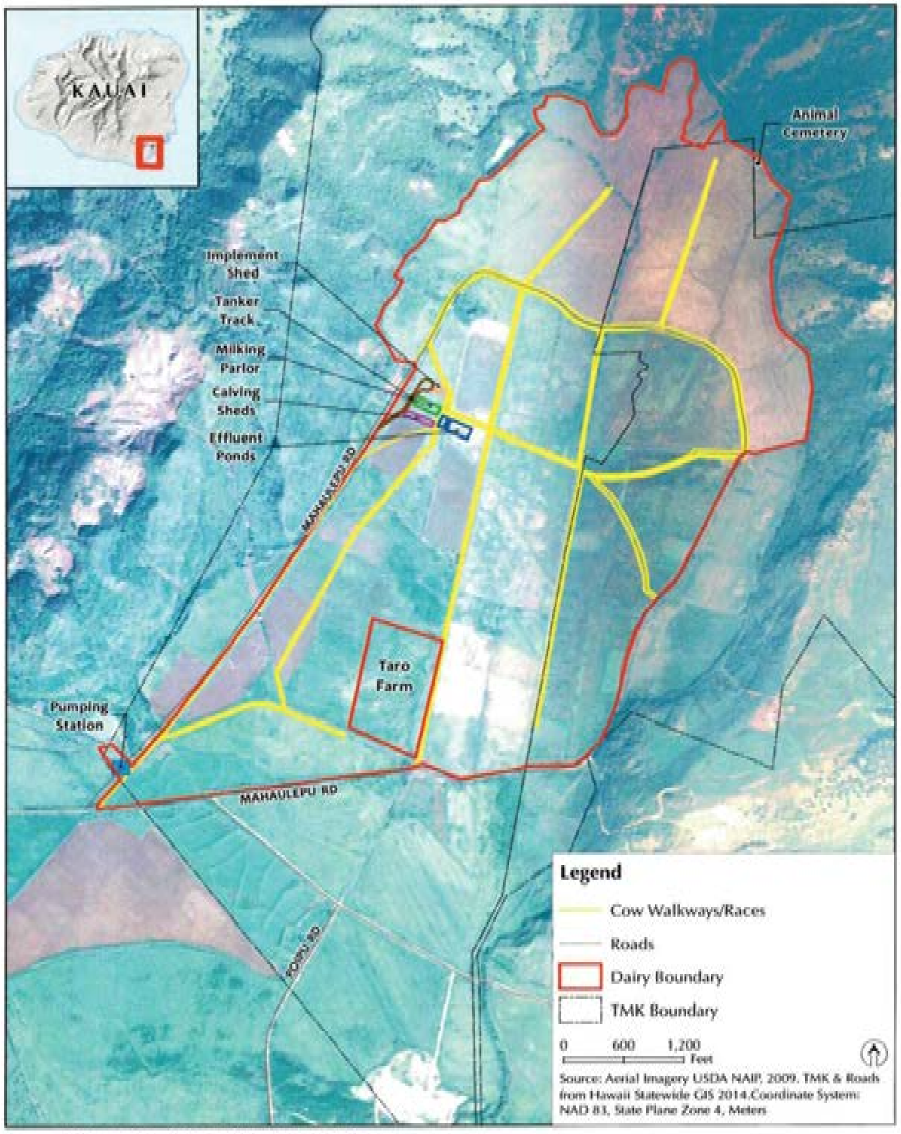


Figure 10 – Cows Walkways/Races

4.2 Dairy Facility

4.2.1 Calf Sheds

Calf sheds will be constructed to provide safe housing to newly born calves. There are two open bay calf sheds, which will be steel structures with metal roofs on concrete slabs. Each shed will be approximately 81 ft. long by 26 ft. wide by 15 ft. tall for a total area of 2,106 sq. ft. each. A minimum 21.52 sq. ft. area is allocated for each calf and 20 calves are kept in one pen (26 ft. x 16 ft.). Each pen is divided in two areas (feeding area and bedding area). The feeding area is washed daily and wastewater is transferred to the effluent ponds. Calf bedding will be constructed of non-skid interlocking plastic tiles. Calves are moved into open paddocks after 3-4 weeks. See Figure 11, Site Plan.

4.2.2 Implement Shed

An implement shed will be constructed for storage of equipment and tools and farm machinery parking. The implement shed will be an open bay steel structure with metal roofs on a concrete slab, similar to the calving sheds. The implement shed will be approximately 65 ft. long by 26 ft. wide by 15 ft. tall for a total area of 1,690 sq. ft. See Figure 11, Site Plan.

4.2.3 Milking Parlor

The Milking Parlor is the single largest structure on the dairy farm with dimensions of approximately 256 ft. long by 88.5 ft. wide by 33 ft. tall. The Milking Parlor contains a highly-automated 60-stall rotary, which completes one rotation of 60 cows in approximately 8-10 minutes. It will operate 365 days a year.

In Phase 1, the 699 cows are managed in small mobs of 105-115 cows. The mobs are brought into the holding yard and Milking Parlor twice a day. Per milking, an individual cow's maximum milking time is 10 minutes and the maximum time off pasture is 1 hour. In Phase 2, the cows are managed in larger groups (300-330 cows per mob) according to their calving, lactation and health status. Similar to Phase 1, the mobs are brought into the holding yard and Milking Parlor twice a day for milking. The individual milking time is the same in both phases, the total time for the mob is less, corresponding to the smaller size of the mob.

The Milking Parlor building includes the following components:

- Covered Loading Area
- Milking Area
- Holding Pens
- Mechanical Room and Pump Room
- Office Space
- Veterinary Space and Storage
- Staff Restrooms
- Milk Storage

4.2.4 Milking Parlor Feeding System

In-parlor feeding is offered to the cows to provide additional nutrients, which improve animal health and milk production. Cows are eager to enter into the parlor to be milked so milking time is typically improved. A small portion of feed (6.6 lbs.) is offered to cows during the milking time (8-10 min), which will be stored in two 44-ton – 60-degree cone silos.

4.2.5 Holding Yard

The holding yard is designed to hold a single 330-cow mob at any one time, and is approximately 150 ft. long by 82 ft. wide for a total area of 12,300 sq. ft. Yard area is heavily used by livestock and needs to be cleaned frequently. Manure/contaminated water is transferred to the effluent pond through underground pipes. No feed is offered in the holding yard and each mob spends less than one hour in the yard before entering into the Milking Parlor.

4.2.6 Access Road and Tanker Truck Turnaround

A new 20-foot wide paved access road will be constructed off of Maha'ulepu Road down to the dairy facility. The access road will serve as the primary access to the dairy and will be used by milk tanker trucks for transport of milk off site. A paved truck turnaround is located at the end of the access road and leads up to a covered loading area where milk is pumped directly into the trucks.

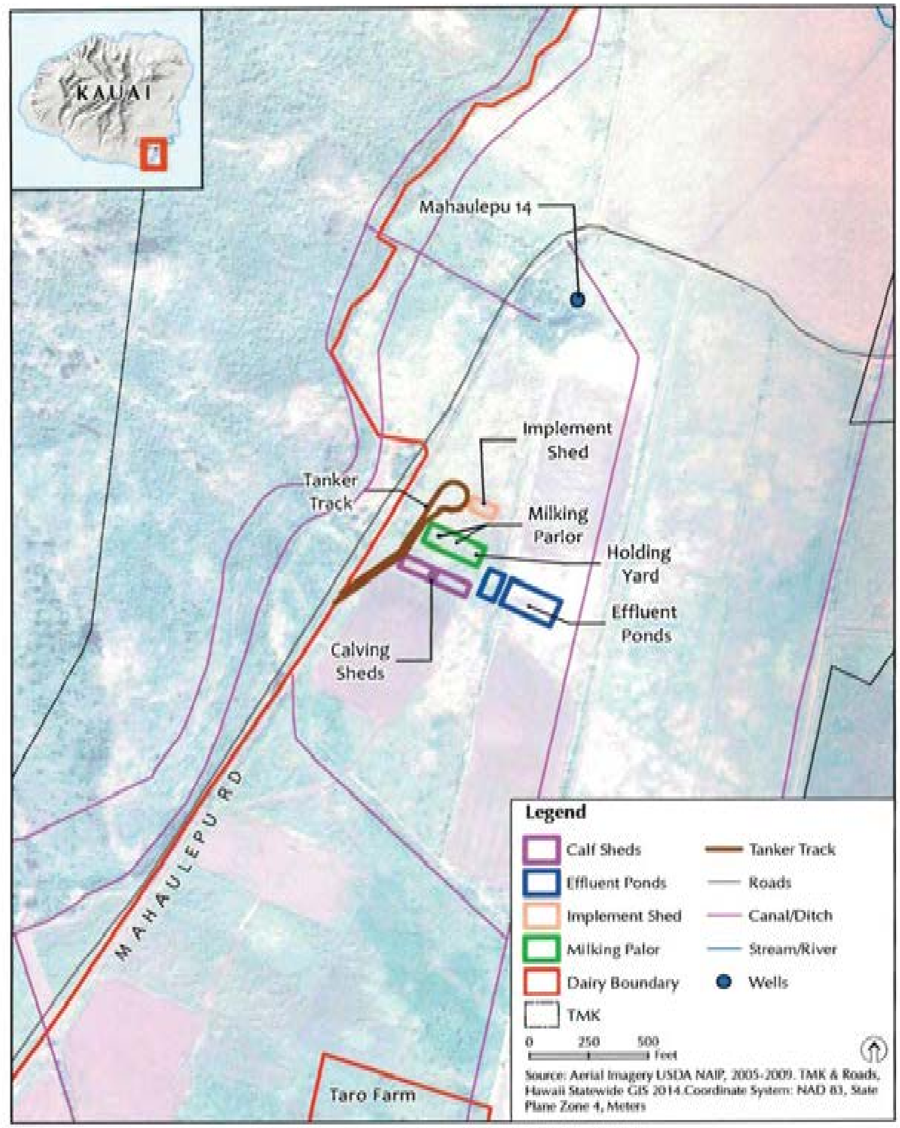


Figure 11 – Site Plan

5.0 Potable Water Systems

Potable water is required for: washing down the Milking Parlor and yards, milk cooling, livestock consumption, and potable consumption within the dairy facility. Total potable water demand for the dairy facility (primarily for wash water) is approximately 0.03 millions of gallons per day (MGD). Total potable water demand for livestock is 0.02 MGD for Phase 1 and 0.05 MGD at full operation of 2,000 cows (i.e. approximately 25 gallons per day/head).

5.1 Water Source and Quality

Potable water for the dairy facility and livestock consumption must be of acceptable quality. Water will either be sourced from the Maha'ulepu Well located within the project site or from a packaged water treatment plant capable of bringing water from the Waita Reservoir up to potable standards. The well site contains up to 14 wells, which were drilled by the sugar plantation. The water source has been tested and is of an acceptable quality. See test results below.

Table 8 – Maha'ulepu Well Water Quality

Sample Type: Aqueous					
	Sample Name:	Mahaulepu Palama Well 16-May-2013 2:00 pm		Guideline Value	Maximum Acceptable Values (MAV)
	Lab Number:	1140368.1			
Routine Water Profile					
pH	pH Units	7.6	-	7.0 - 8.5	-
Total Alkalinity	g/m³ as $CaCO_3$	171	-	-	-
Free Carbon Dioxide	g/m³ at 25°C	7.6	-	-	-
Total Hardness	g/m³ as $CaCO_3$	250	-	< 200	-
Electrical Conductivity (EC)	mS/m	92.6	-	-	-
Electrical Conductivity (EC)	µS/cm	926	-	-	-
Approx Total Dissolved Salts	g/m³	620	-	< 1000	-
Total Boron	g/m³	0.120	-	-	1.4
Total Calcium	g/m³	55	-	-	-
Total Copper	g/m³	0.00073	-	< 1	2
Total Iron	g/m³	< 0.021	-	< 0.2	-
Total Magnesium	g/m³	27	-	-	-
Total Manganese	g/m³	< 0.00053	-	< 0.04 (Staining) < 0.10 (Taste)	0.4
Total Potassium	g/m³	3.4	-	-	-
Total Sodium	g/m³	101	-	< 200	-
Total Zinc	g/m³	0.041	-	< 1.5	-
Chloride	g/m³	165	-	< 250	-
Nitrate-N	g/m³	1.55	-	-	11.3
Sulphate	g/m³	30	-	< 250	-

The well site has a total capacity of 2 MGD, with redundancy in the form of multiple well heads and potential additional backup source and interconnection with the Waita Reservoir water supply.

The irrigation water supply is an alternative source for potable water. If the well water is not utilized, a water treatment system will be installed to treat the available irrigation water to an acceptable quality for potable consumption in the dairy facility and for livestock.

5.2 Livestock Water Distribution System

Availability of drinking water has an impact on animal health and milk production. The livestock water distribution system has been designed to supply a large volume of water to meet the seasonal high daily water demand of 25 gpd per cow. The total livestock drinking water demand is estimated to be 17,475 gpd for Phase 1 (699 cows) and 50,000 gpd for Phase 2 (2,000 cows). Two large covered and lined water storage tanks totaling 39,682 gallons are located at the Milking Parlor (i.e. providing total storage of nearly 80,000 gallons).

Water from the storage tanks will be distributed into the Milking Parlor and to adjacent buildings for dairy use. Water will also be distributed throughout the paddocks for livestock consumption. Small booster pumps will be used to ensure the required flow is delivered throughout the farm.

Small diameter water mains 2 to 3 inches in size deliver water to the paddocks. Two concrete troughs will be installed in each paddock to give animals free access to drinking water at all times. Troughs are raised and placed on a crushed rock base to provide a firm and stable surface for animal movement around the trough. The trough is high enough for the animal to reach over and in, but will discourage the animal from stepping into the trough. The troughs are also fitted with valves to stop the flow of water into the trough when the trough is full and refill the trough as the water is consumed.

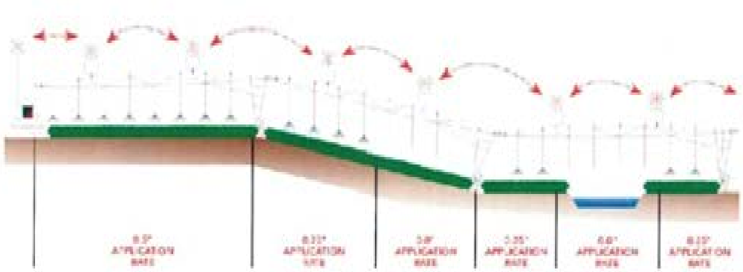
6.0 Irrigation

The total pasture area of the farm is 517.3 acres. The majority of the pastures will be irrigated through either spray or drip irrigation systems. See Figure 12, Irrigation Map.

6.1 Spray Irrigation System

The spray irrigation system will consist of two central pivot irrigation systems. A central pivot irrigation system is an overhead irrigation system, which includes irrigation pipes supported on trusses mounted on wheeled towers that rotate around a central water supply point. The farm will have two pivots; irrigation pivot #1 will be a full circle (FC) pivot and irrigation pivot #2 will be a partial circle (PC) pivot. See Figure 13, Center Pivots. The irrigation system including irrigation application rates and emitters is controlled using computer software and GPS receivers to allow very precise application of irrigation on the pasture.

The various components of a typical spray irrigation control system are described below:



Precision VRI Controller
Controls the irrigator ground speed and the water outlets including individual sprinklers and the end gun (as an optional extra).

- The Precision VRI controller reads the irrigation plan and uses data from other inputs (such as GPS coordinates) to calculate which valves need to be actuated at any one time.
- Communication within the system is via wireless links from the Precision VRI controller to the wireless nodes. Node control signals are packet-based, thus any form of information desirable for control of the irrigator can be transmitted to the wireless nodes.
- The Precision VRI controller is placed next to the irrigator's main controller (generally

situated at or near the center of the irrigator), operating on 12V DC.
- The Precision VRI controller contains a Windows-based touchscreen panel PC. A large number of plans that can be loaded into the Precision VRI controller if desired.

Wireless Nodes
The wireless nodes consist of a watertight enclosure and a Printed Circuit Board (PCB) containing the wireless transceiver, processor and drivers to individually control four latching relays.

- Each wireless node provides both power and control signals via wired connections to four (or less) valves. The wireless node will either turn the sprinklers on, off or pulse at a duty cycle determined by the Precision VRI controller.
- Each wireless node is powered by a common 24V DC power line.
- Each wireless node also acts as a wireless repeater to send signals further up and down the length of the irrigator.

Wiring Loom

- The looms consist of a power cable that runs between wireless nodes and four wires from the wireless node to control each valve.
- Each loom is pre-wired into the wireless nodes at the factory.

Power Source

- 1 x 90~264VAC input, 24VDC output, 225W switch mode power supply with constant current limiting.
- The system converts power from the high voltage line and provides 24V DC to the power line.
- Three phase power option, 340~550VAC Input, 24VDC 10A Output, 240W fully self-protected switch mode power supply

GPS
The GPS system consists of an industrial grade GPS unit with high receiver sensitivity (waterproof -22°F to +176°F operating temperature range).

- A GPS unit at the end of the pivot (or one GPS unit at each end of a lateral-move) sends a signal back through the wireless node network to notify the Precision VRI controller the position of the irrigator. The Precision VRI controller uses this position to calculate the valve control signals at this point.

PC Software

- Irrigation plans are created in the Field Map farm mapping software.

- The Field Map software takes in to account both source and field information to optimize water application for each irrigation plan.
- Irrigation plans are loaded into the controller either manually via a USB stick or through a wireless connection.

6.2 Drip Irrigation System

The drip irrigation system is a subsurface irrigation system using either drip tubing or tape installed in the ground. Irrigation water will be filtered and pumped at low pressures into the subsurface irrigation system. See Figure 14, Drip Irrigation.

6.3 Non-Irrigated Pasture

Approximately 11% of the pasture area is not irrigated as shown on Figure 15, Non Irrigated Pasture.

6.4 Irrigation Setbacks

Setback distances have been established to limit activity and irrigation within non-irrigated areas within the irrigation pivot areas. The spray irrigation systems are configured with GPS controlled emitters that will turn off so that water is not directly applied to the ditches, cow races and any agricultural or natural water resources. The following setbacks are incorporated into the design and are indicated on Figure 16, Irrigation Setbacks:

- Streams, agricultural water, and natural water resource - 50 feet on both sides.
- Cow walkways and races - 6 feet on both sides
- Existing taro farm - 20 feet on each side

The setback areas will also be re-vegetated with native plants. See example below of a restored setback area along a stream for the AgResearch Tokanui Farm in New Zealand.

6.5 Irrigation Demand

The irrigation areas are summarized in the table below. Irrigation water demand is based on a rate of 6 mm/0.24 inches per day over the irrigated area. The total irrigation demand to irrigate all areas is 2.93 MGD.

Table 9 - Irrigation Demand Summary

Irrigation Area		Acres	Demand, MGD
Irrigation Pivot #1 (FC)		216	1.36
Irrigation Pivot #2 (PC)		162	1.04
Drip Irrigation Area		82	0.53
	Subtotal	460	2.93
Non Irrigated Area		57	0
	TOTAL	517	2.93

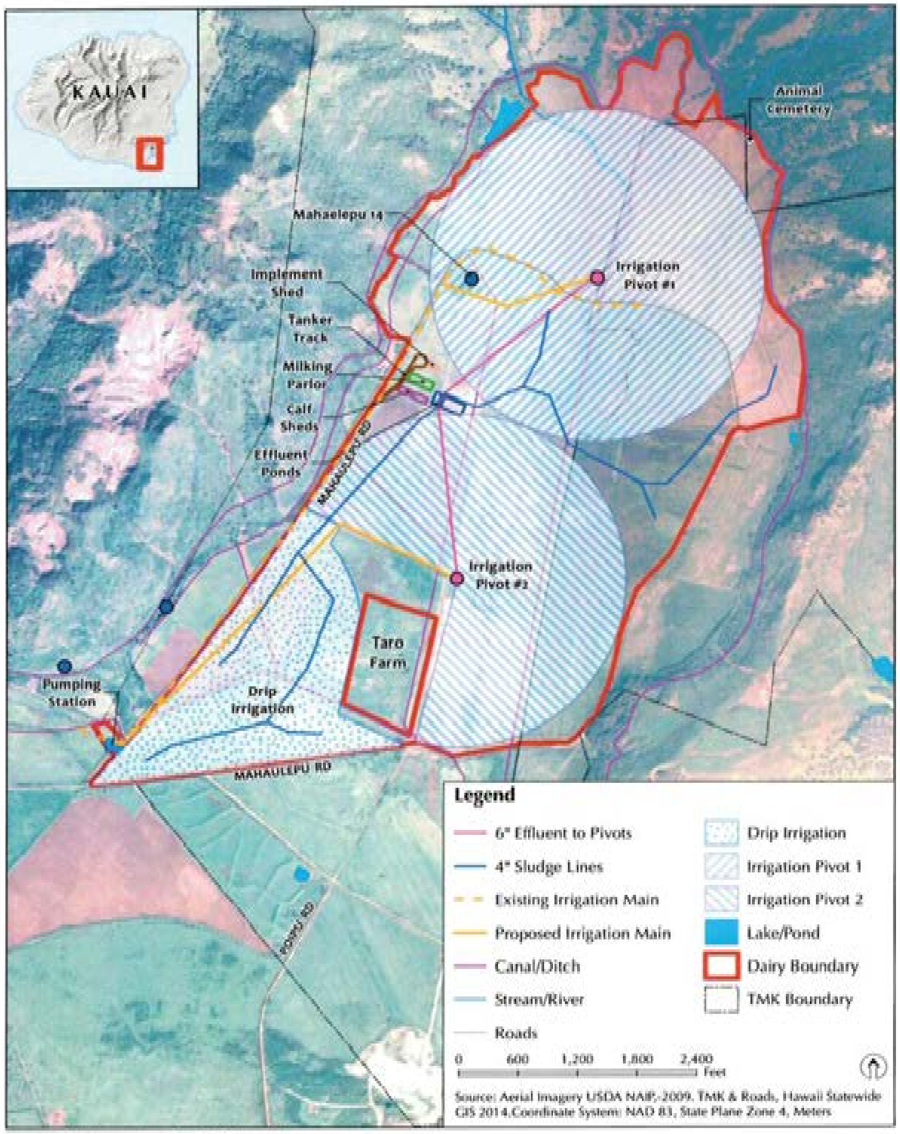


Figure 12 – Irrigation Map

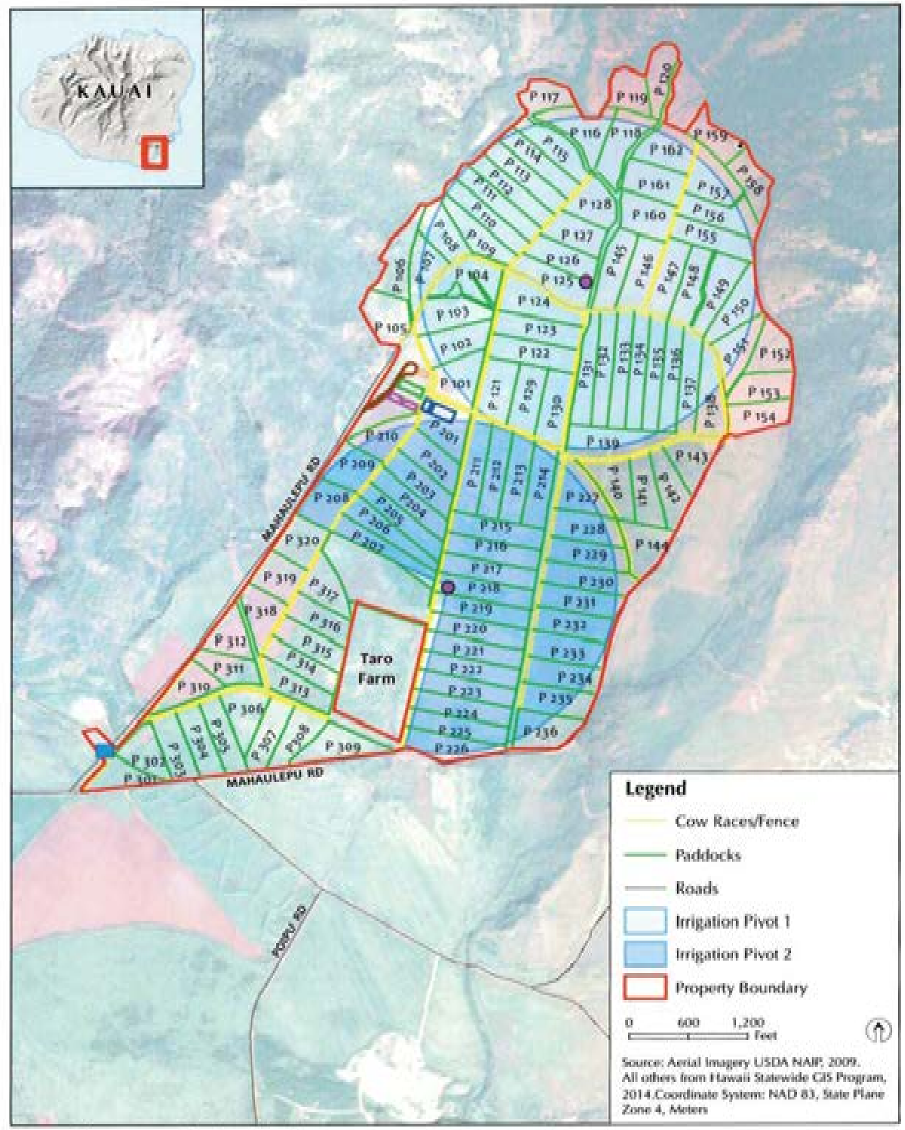


Figure 13 – Center Pivots

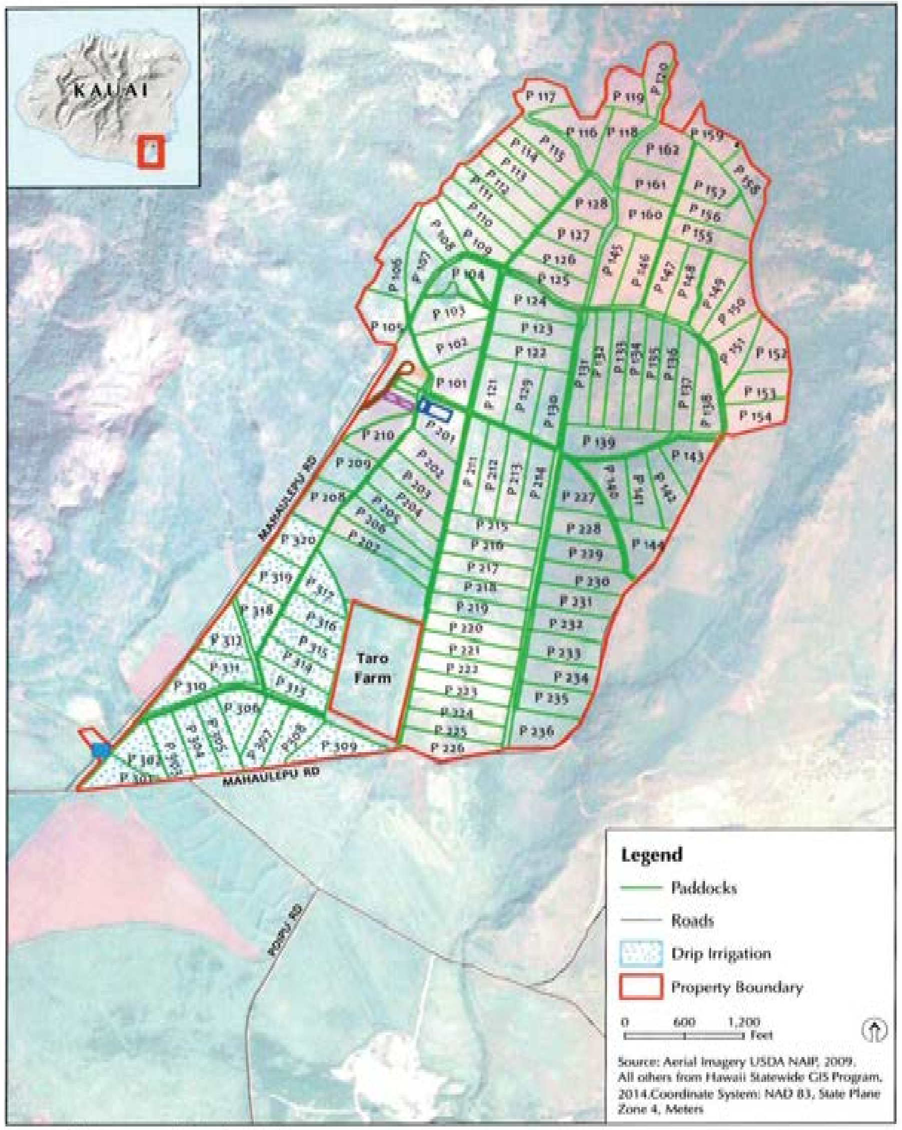


Figure 14 – Drip Irrigation

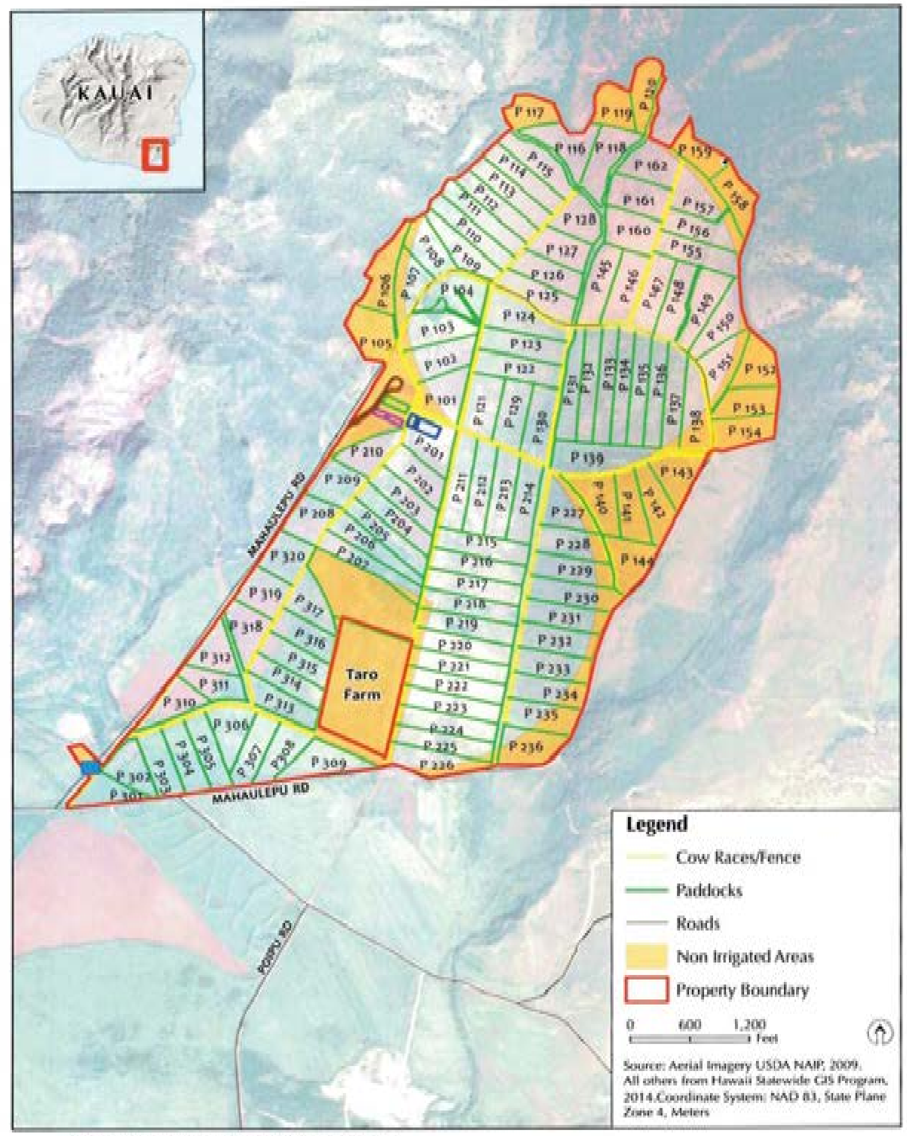


Figure 15 – Non-Irrigated Pasture

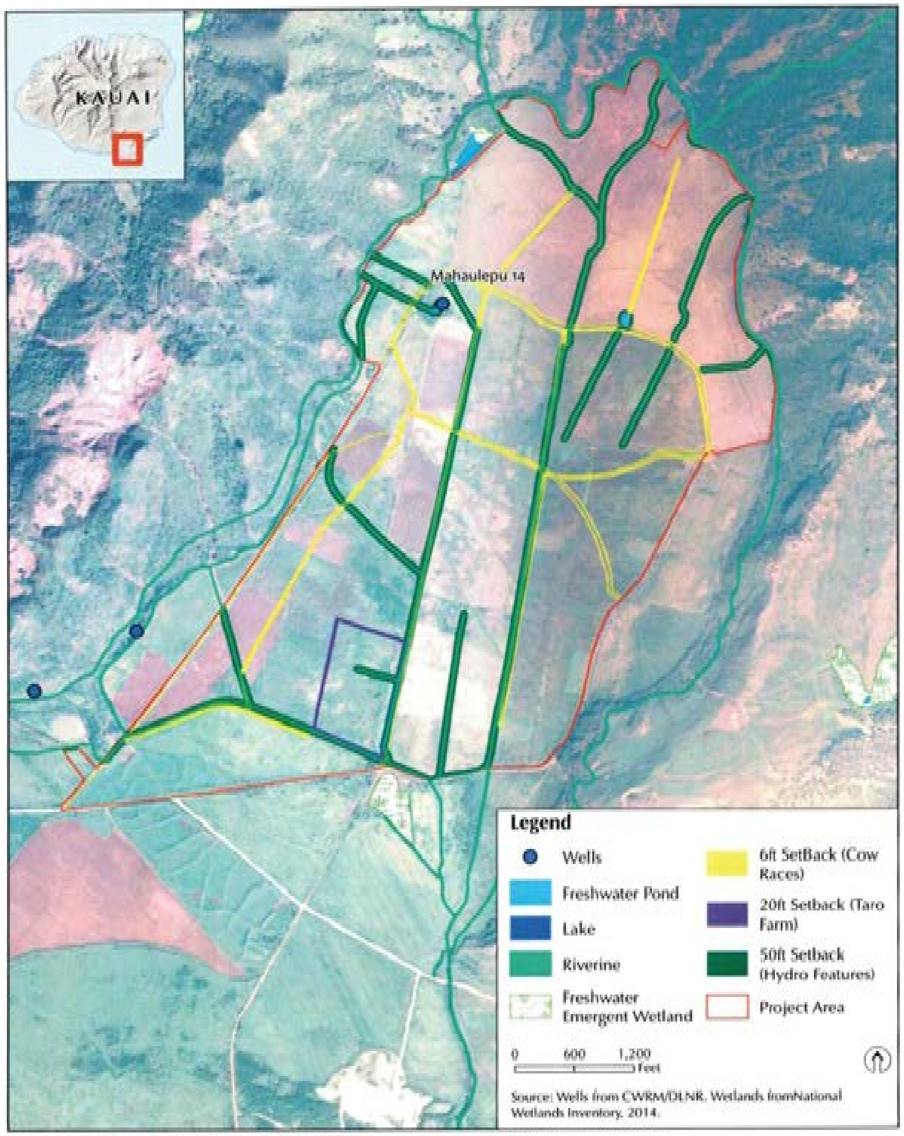


Figure 16 - Irrigation Setback

6.1 Irrigation Schedule

At full irrigation, the pasture will require 2.93 MGD of water per day, to achieve an average application of 6 mm/0.24 inches per acre (over the irrigated area, which includes the areas previously described in Table 9). The actual schedule of irrigation days will depend on the days that it rains. The following discussion and associated tables provide the methodology for determining seasonal irrigation demand and associated number of irrigation days per month.

Table 10 provides the average monthly rainfall and pan evaporation rates which demonstrate a clear deficit in water supply during the spring, summer and fall seasons with only a modest demand for irrigation during the winter season.

Table 10 – Monthly Average Rainfall and Evaporation

Month	Days	Mean Monthly Rainfall (in) UH Rainfall Atlas of Hawai'i 2011 (30 years data)	Evaporation rates per month (in) Weather Station 941-00
January	31	4.88	5.14
February	28	4.2	5.65
March	31	5.04	6.93
April	30	3.66	7.43
May	31	3.05	7.82
June	30	2.86	8.05
July	31	3.13	9.10
August	31	3.2	9.37
September	30	3.25	8.23
October	31	4.96	7.33
November	30	6.01	6.17
December	31	5.71	5.40
Total	365	49.95	86.62

During the wet winter months of November, December and January, the frequency and need of use of the irrigators is significantly lower than other times of the year, but irrigation is still required as there are a number of dry days in those months.

The winter rain pattern is typified by episodic storms followed by several days of no/zero rainfall. Since the fields will need to be irrigated after five days of mostly dry weather, the number of dry days in the winter months was evaluated to gauge irrigation demand. The table below shows the number of days with less than 0.12 inches of rainfall in January, November, and December from 1989-2012.

Table 11 - Dry Days Data (including 0.12 inch (3mm) or less rainfall)

Year/Month	Jan	Nov	Dec
1989	15	18	25
1990	17	16	16
1991	27	14	14
1992	23	18	11
1993	22	14	16
1994	16	21	16
1995	29	16	14
1996	14	9	17
1997	20	19	16
1998	23	16	21
1999	15	17	18
2000	17	14	23
2001	24	20	19
2002	22	18	17
2003	21	16	16
2004	19	17	17
2005	18	18	28
2006	16	16	21
2007	20	21	14
2008	20	19	21
2009	17	14	27
2010	16	17	18
2011	8	21	13
2012	18	14	9
Average Dry Days	19	17	18

We assume irrigation is required approximately every 5 dry days. Therefore, we assume the irrigators will run on average 3 times per month during the wet season (December to February), plus the average difference between rainfall and evaporation. (eg. 4 irrigation days for

November, December and January shown on Table 12). For the other months, we calculate the irrigation days as the differential between the evaporation rate and the mean monthly rainfall divided by the daily demand of 0.24 inches per acre.

Table 12 – Irrigation Days per Month

Month	Number of Irrigation days required at 0.24 inches per day
January	4
February	9
March	8
April	16
May	20
June	22
July	25
August	26
September	21
October	10
November	4
December	4
Total	154

A weather station is already installed on-site, capable of measuring temperature, humidity, rain, wind direction and speed, irradiance and evaporation. Soil moisture meters will also be added to determine the ideal moisture bandwidth for grass growth and support irrigation decisions. It will be sensible to load the soil towards its maximum moisture level before July and August, as little rainfall in these months is possible and during that time the soil could enter into a deficit greater than the rate of available irrigation. It will also be sensible to dry the soil towards its minimum moisture level before November, December and January, as significant rainfall in these months is probable and could cause the soil to exceed capacity from rainfall alone. However, we have modelled the days where it has not rained in these wet months since the irrigators are likely to be needed to run in these dry spells. Furthermore, the evaporation rate will dry the soils if it doesn't rain regularly and affect pasture growth rates after several days without rain.

In addition to the need for irrigation during the dry spell days, the irrigators can run in November, December and January (if no dry spells occur) to distribute only effluent water. In the case of a continuously wet period that keeps soil at capacity, (the longest on 30-year record is 17 days) the irrigators can be programmed to drop effluent water only and at a rate as low as 0.04 inches, and the placement of the effluent water can be targeted to the freest draining soils on the farm. A target zone for an exceptionally wet season application is paddocks 111 - 115, where the Lualualei Clay soil is classified as "well drained" and a raceway (acting as a berm) separates the paddocks from any water ways. The irrigation system will track and plot any such exception placement of effluent and its corresponding nutrient loading. Other "well drained" soil type options are Hanamaulu Silty Clay, Hanamaulu Stony Silty and Pakala Clay Loam.

The upper pivot, irrigation pivot #1 (FC), will irrigate 216 acres under one rotation. It is expected that the upper pivot will do a rotation every 40 hours, applying 0.39 inches/10 mm of water onto 47 paddocks during normal operation.

The bottom pivot, irrigation pivot #2 (PC), will irrigate 162 acres in a similar time period to the upper pivot, but with the addition of a 'fast cycle' for the end of each pass of the pivot. This fast cycle is done at maximum machine speed so that a minimum of water is applied at the end of the run, which reduces the wetness of the ground when the machine reverses direction and then applies a 'normal' amount onto this same area. The whole cycle takes about 40 hours applying 0.39 inches/10 mm water onto 36 paddocks.

Drip Irrigation system will be installed to irrigate 82 acres.

7.0 Wastewater Treatment

The dairy is a pasture-based operation, and livestock spend a limited time in the holding yard and Milking Parlor. Livestock waste and wastewater generated from the dairy facility, including any runoff, will be collected, treated and reused on the farm. Fundamentally, the water treatment system recycles 100% of all wastes with zero point source discharge into State waters. The objectives of the design are:

i. To capture all of the effluent that is produced at the dairy facility
ii. To spread the effluent on the grazing land to meet nutrient demand of the plants/pasture
iii. To control the effluent application rate and spread effluent only on the desired areas within boundaries
iv. To keep effluent completely separate from potable water to prevent contamination
v. To comply with all regulatory requirements under the state and federal laws

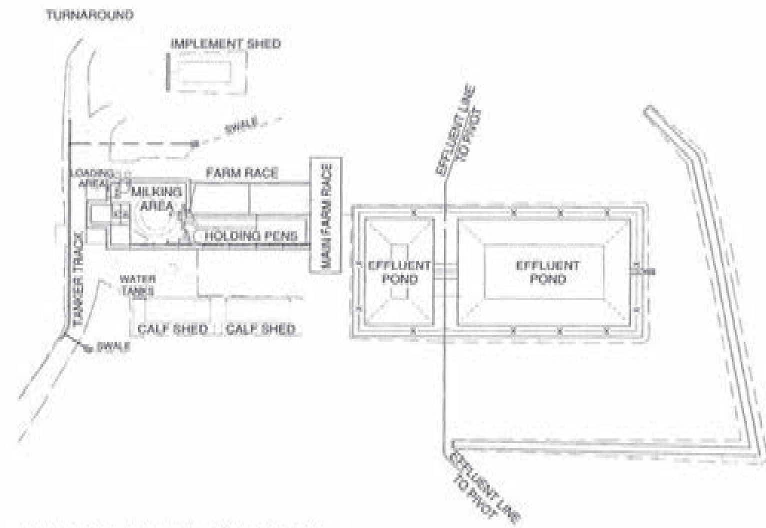


Figure 17 – Dairy Facility Site Plan

The dairy facility including the wastewater treatment ponds and other infrastructure will be sized and constructed for the Phase 2 capacity of 2,000 cows. However, the calculations in this report are based on the Phase 1 capacity of 699 cows. A future amendment to the Waste Management Plan will be submitted for review and approval for Phase 2. Refer to NRCS Practice Code Standard 633 Waste Utilization.

7.1 Effluent/Manure Volume

HDF is a pasture-based dairy farm that is being designed for kiwi-cross animals. A mature kiwi-cross cow's weight is about 1,210 lbs. and it produces an average of 143 lbs. of manure per day or 8.8 lbs. (1.05 gallons) average per waking hour. The 699 cows in Phase 1 will be maintained in mobs of 105-115 animals, on a 54-acre block, that is subdivided into 18 paddocks. The cows graze for one day per paddock, so once every 18 days the entire mob (all 105-115 animals) will produce the majority of its effluent on that one paddock as it grazes.

Grass-fed cattle produce significantly more liquid manure than cattle fed on concentrate and Kikuyu is also a relatively wet grass (87% water). The total amount of manure produced in the milking platform each day will be 1,477 gpd [699 cows x (1hr x 2 milkings per day) x manure of 1.05 gallon per hour = 1,477 gpd].

The holding yard and Milking Parlor are washed twice a day after each milking. All of the manure produced in the Milking Parlor and yards is washed out and the contaminated water is transferred to the settling pond. The milk storage tanks located within the Milking Parlor are also washed out after milk is pumped to tanker trucks for delivery. Wash water from the milk tanks is also transferred to the settling pond. The total wastewater volume for 699 cows from the machine wash, yard wash, and other milking activity is 10,667 gpd. See Figure 18, Water Flow Schematic.

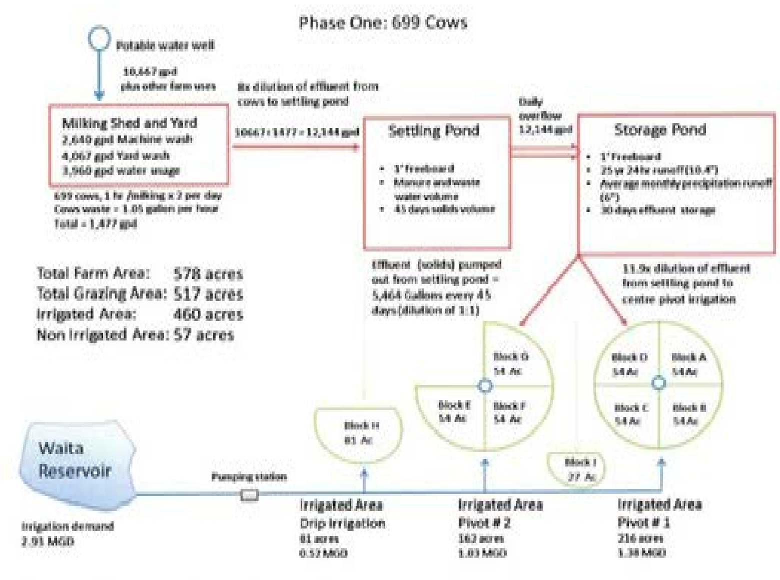


Figure 18 - Water Flow Schematic

All of the manure that is collected from the Milking Parlor and yards is transferred to the settling pond. The settling pond remains full in normal steady state, and any excess liquid overflows into the storage pond through screened overflow pipes. The clear screens are fitted into the overflow pipes and do not allow solids to enter into the storage pond. A stirrer pump is operated two hours per day to break up the solids in the settling pond. The accumulated sludge in the settling pond will be pumped out every 45 days. The minimum settling pond volume will include 45 days of sludge storage plus an appropriate mixing volume of liquid required for stirring and pumping for application to the pastures.

Liquid effluent from the settling pond overflows into the storage pond which is then applied from the storage pond onto the pastures aftering being diluted and injected into the irrigation water through the center pivots. The level of the storage pond will rise gently during each milking washdown and fall on irrigation days. The total amount of effluent from the storage pond (0.012 MGD) is only a small fraction of the total daily irrigation demand of 2.93 MGD. As a result, effluent pumped to the center pivots is diluted approximately 12x and applied to the grazing land at an application rate significantly less than the nutrient requirement of the grass and at a rate significantly less than the daily draining capacity of the soil.

The storage pond will be emptied according to a 4-day application schedule (i.e. every 4 days). The effluent will be applied only when there has been no heavy rain in the last two days and no rain is forecasted for the next two days. Any single nutrient application (i.e. from a 4-day block of storage pond effluent) is enough to supply approximately 20% of the nutrient needs of the grass for the 54 acres the effluent is applied to.

The minimum required effluent storage volume in the pond shall include the 4 days of effluent required for the typical application schedule and also the additional storage required during periods of rainfall when irrigation application of effluent is not possible. The design effluent storage period includes allowance for the following volumes:

- Effluent volume for 4-day storage period between scheduled irrigation of effluent
- Effluent volume for maximum 17 consecutive rain days based on NOAA rain gauge data, See Table 4 – NOAA Rain Gauge Data
- Effluent volume for 2 days minimum of pasture dry time

Based on the above volumes, the minimum effluent storage should include 23 days of effluent volume. The design storage volume required will be set to 30 days of effluent, which will provide an additional storage buffer.

The storage pond will be sized and constructed for the ultimate Phase 2 capacity of 2,000 cows. The minimum storage requirement for Phase 2 full operation is estimated to be approximately 30,360 gpd for a 30-day storage period. Phase 1 has a lower effluent volume of 12,144 gpd; therefore, the storage pond effectively has excess storage and could hold approximately 100 days of effluent storage capacity (for 699 cows).

7.2 Effluent Ponds

The effluent ponds will be constructed for effluent collection, management and proper utilization of nutrients available from livestock waste. The pond design is based on a two-step system, which includes a settling pond and storage pond. The settling pond allows for the settlement and accumulation of wastewater sludge with the overflow of liquid effluent entering the storage pond. The ponds will be located outside of wetlands and at a minimum distance of 1,000 feet from public drinking water resources and 50 feet from surface water resources. See Figure 11, Site Plan.

Ponds will have minimal potential impacts from breach of embankment, accidental release, and liner failure. Ponds have been designed to be protected from inundation or damage from a 25-year flood event.

The ponds have the capacity for storage of the following volumes:

- Volume of accumulated sludge for the storage period between sludge removal events
- Volume of manure, wastewater, and other wastes accumulated during the storage period between irrigation application
- Depth of average precipitation for the storage period
- Depth of the 25-year, 24-hour storm precipitation

The pond volume calculations are based on the following assumptions:

Table 13 – Effluent Pond Sizing Criteria

Design Criteria/Assumption	Phase 1 699 Cows	Phase 2 2,000 Cows
Daily Wastewater Generation	12,144 gpd	30,360 gpd
Percentage of Solids	1%	1%
Minimum Volume of Accumulated Sludge	5,464 gal – 45 days	13,662 gal – 45 days
Daily Overflow to Storage Pond	12,144 gpd	30,360 gpd
Minimum Volume of Effluent Storage	0.36 MG – 30 days	0.91 MG – 30 days
Depth of 25-Year, 24 Hour Storm	10.4 inches	
Depth of normal precipitation for storage period	6 inches	

The effluent ponds and concrete holding areas are not covered. All rainfall in these areas, and from any area that could generate contaminated runoff is collected and conveyed to the ponds. Approximately 1.76 acres of area drain to the ponds and are accommodated in the pond sizing and minimum volume requirements. The areas included are; the calf sheds and concrete gutter, the uncovered holding pens and yards, the uncovered loading areas, and the settling and storage pond areas. The rainfall onto the roofs of the Milking Parlor and implement shed is discharged directly to the pasture areas adjacent to the buildings, and does not enter the effluent system.

7.2.1 Settling Pond

Wastewater from the dairy is discharged into the settling pond first. Solids are accumulated in this pond and liquid effluent overflows to the adjacent storage pond. The volume of accumulated solids is sized to allow 45 days of sludge storage based on the solids application schedule. The minimum required sludge volume for each phase is shown in Table 13 above. The pond is oversized in Phase 1 to allow for Phase 2 sludge volume requirements.

In addition to the sludge volume, a mixing volume will be provided to allow for stirring and suspension of solids during de-sludging and application of sludge to the pastures. The minimum mixing volume is dependent on type of equipment, operational needs and operator preferences. For the settling pond, the mixing volume will be set to a nominal volume of 0.5 MG.

The top of the settling pond is 87' x 133' with a total depth of 12' from invert to overflow spillway. The settling pond minimum required Phase 1 volumes and total available volumes are shown in the figure below.

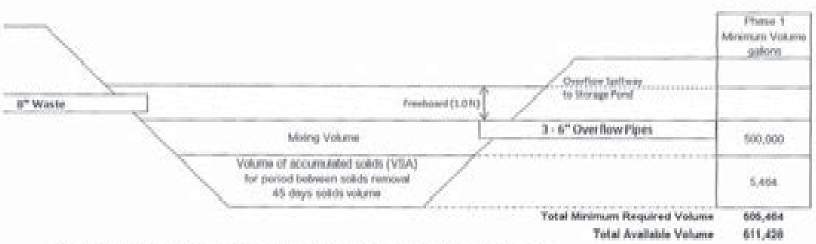


Figure 19 - Settling Pond Typical Section & Volumes

7.2.2 Storage Pond

Effluent from the settling pond overflows through three 6-inch screened overflow pipes. The volume of effluent storage is sized to allow a minimum of 30 days effluent storage based on the irrigation schedule. The top of the storage pond is 215' x 133' with a total depth of 15.5'. The pond is oversized to allow for Phase 2 effluent volume requirements. The storage pond minimum required Phase 1 volumes and total available volumes are shown in the figure below.

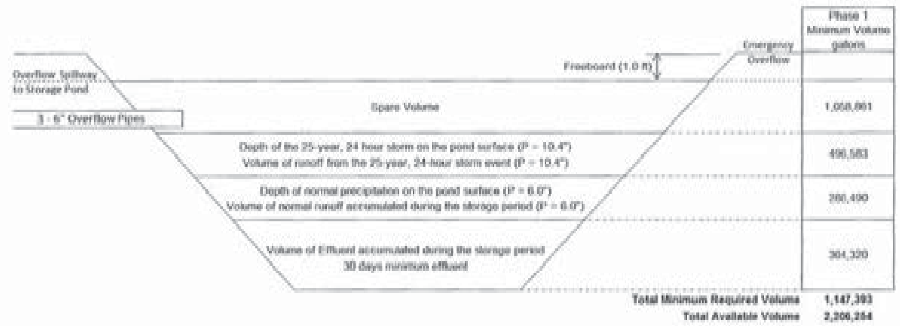


Figure 20 - Storage Pond Typical Section and Volumes

7.2.3 Effluent Pond Design

Ponds will have a minimum of 2-feet bottom elevation above the seasonal high water table. Excavated side slopes will not be steeper than 2 horizontal to 1 vertical. The inlet pipe at the effluent pond will be a concrete pipe with a minimum of 6 inches diameter. A pipe with a minimum diameter of 8 inches will be used for Milking Parlor waste. The pipe terminates a sufficient distance from the shoreline of the pond to ensure good distribution. A cleanout is also provided for removing obstructions. Irrigation intake pipes from the required volume are designed to resist corrosion and plugging. The irrigation system will not automatically pump from the required volume of the pond based on water level. The irrigation system is on a predetermined schedule which can also be manually controlled.

The minimum elevation of the top of the settled embankment shall be 1 foot above the pond's required volume. The combined side slopes of the settled embankment shall not be less than 5 horizontal to 1 vertical, and neither slope shall be steeper than 2 horizontal to 1 vertical unless provisions are made to provide stability.

Safe drawdown of the liquid level in the pond is provided. Embankments and disturbed areas surrounding the pond are treated to control erosion. This includes the inside slopes of the pond as needed to protect the integrity of the liner.

The pond perimeter will be fenced and warning signs posted to prevent children and others from using it for other than its intended purpose. A marker or water level measuring device will be installed in the pond to measure the stored volume and/or storage capacity remaining.

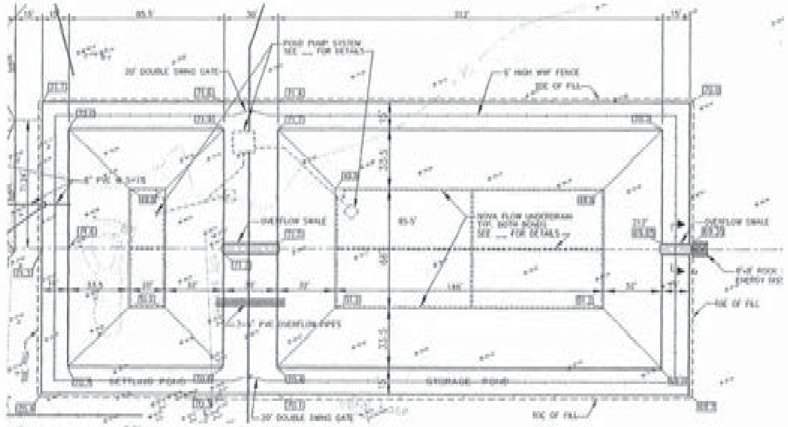


Figure 21 - Effluent Pond Plan

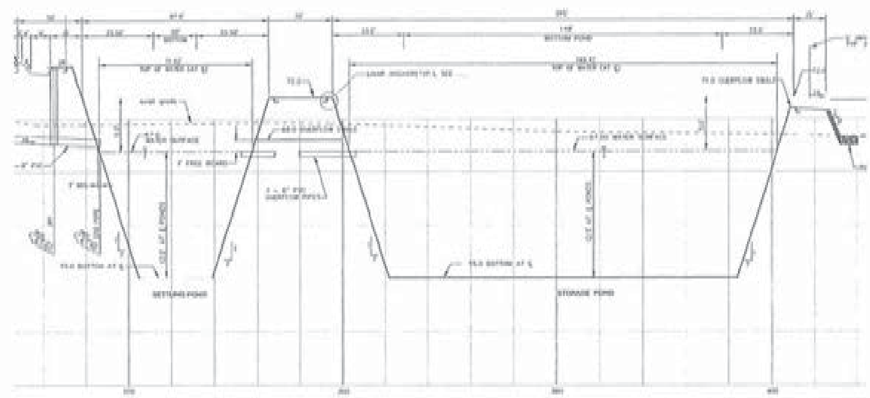


Figure 22 - Effluent Ponds Section

7.2.4 Emergency Spillway

The storage pond will have an emergency spillway that will allow discharge from the pond in the event of a cataclysmic emergency such as a rainfall event greater than the 25-year, 24-hour storm or other natural disaster. A secondary berm will also be constructed downhill of the effluent ponds at the edge of the paddock before the existing drainage way and farm road. Although not required by the guidelines, this secondary containment area will provide a large overflow volume in case of an emergency. The total available volume within the secondary containment area will be roughly equivalent to the total effluent volume over the 30-day storage period.

7.2.5 Effluent Ponds Construction Specifications

The entire pond area will be cleared of all trees, stumps, roots, brush, boulders, sod and debris. Topsoil containing more than 10% organic matter will be removed. All material cleared from the area will be disposed of at sites away from the work area, in accordance to state and county laws.

To establish vegetation, the topsoil and sod will be stockpiled and spread on the completed pond. Foundation surfaces will be sloped no steeper than 1:1. The foundation area will be stripped of all loose material, and thoroughly scarified before placement of the first layer of fill material.

The foundation surface will have moisture added and be compacted prior to fill placement. Required excavations will be cut to the lines and grades shown on the drawings.

Excavated materials could be used to construct the embankment. The material placed in the fill should be free of sod, roots, and stones over 3 inches in diameter. All fill material is obtained from required excavations and designated borrow areas.

Fill will be placed once required excavation and foundation preparation have been completed and the foundation has been inspected and approved. The foundation surface should be scarified and loosened to a depth of not less than 2 inches (51 mm) before placement of the first layer of fill. If the surface of any layer becomes too hard and smooth for proper bond with the succeeding layer, it shall be scarified parallel to the axis of the fill to a depth of not less than 2 inches (51 mm) before the next layer is placed.

The placing and spreading of fill material is started at the lowest point of the foundation. The fill should be brought up in horizontal layers of a maximum thickness as shown in the Compaction section below.

The fill will be constructed in continuous horizontal layers except where openings or sectionalized fills are required. The bonding surface will be treated the same as that specified for the foundation so as to insure a good bond with the new fill.

Embankments shall be constructed in continuous horizontal layers. The distribution and gradation of materials shall be such that no lenses, pockets, streaks, or layers of material differ substantially in texture or gradation from the surrounding material. The complete work will conform to the lines, grades and elevations shown on the drawings or as staked in the field.

Selected backfill material is placed around structures and pipe conduits at about the same rate on all sides of prevent damage from unequal loading. Fill placed around structures will be brought up at approximately uniform height, not to exceed a difference in elevation of 8 inches, on all sides of the structure.

The moisture content of the foundation and fill material should be such that the required compaction can be obtained. The moisture content is as uniform as feasible throughout each

layer. The proper moisture content for compaction will be determined by inspection during the placement operation.

The material should maintain a ball shape when squeezed in the hand.

Construction equipment is operated over the areas of each layer of fill to ensure the required compaction. Fill, adjacent to structures and pipe conduits, shall be compacted to a density equivalent to that of the surrounding fill by means of hand tamping, manually directed power tampers, or plate vibrators. Heavy equipment should not be operated within two feet of any structure.

Hand directed tampers or compactors are used on areas not accessible to heavy compaction equipment, and within 2 feet of any structure. Fills compacted in this manner will be placed in layers not greater than 4 inches in thickness before compaction, and shall meet the same density requirement as for the adjacent area.

Fill not meeting the specified requirements should be reworked or removed and replaced with acceptable fill. Compacting of fill adjacent to structures should not be started until 7 days have elapsed since the placement of the concrete. Once the backfill operations have been completed, the surface area shall be graded to convey any surface runoff away from the structure.

A hazard warning sign will be posted and fence will be constructed around the facility to prevent unwanted entry. Refer to NRCS Waste Storage Structure Practice Code 319 and Practice Code 359 Waste Treatment Lagoon.

7.2.5.1 Pond Sealing, Lining and Flexible Membrane

Pond lining will be installed to control seepage of contamination from waste impoundment structure for water conservation and environmental protection. All inlets, outlets, ramps, and other appurtenances will be installed in a manner that does not damage or impair the proper operation of the liner. To ensure human and livestock safety, warning signs, fences and ladders/ropes will be installed. Manufacturer recommendations will be followed with regard to protection from weather and exposure.

Lining material for ponds will be High Density Polyethylene (HDPE) geomembrane that has 6.5 mm thickness cover (1.5 mm HDPE + 5 mm Bidim). The maximum size of soil cover material will be 3/8-in unless the liner is cushioned by an 8-ounce or greater needle punched, non-woven geotextile padding material. Cover materials will be stable against slippage down the slope under all operational and exposure conditions.

The subgrade will be smooth with no sharp corners or angular stones to avoid damaging the liner or adversely affecting its function. No sharp objects shall protrude through subgrade material. Subgrade material shall be formed with no loose material on or around embankments or floor. Pond construction should have a good Maximum Dry Density (MDD). All surfaces will be of smooth finish.

The area to be lined will be drained and allowed to dry until the surface is firm and will support the workers and equipment that must travel over it during installation of the lining. The foundation area for flexible membrane linings shall be smooth and free of projections that might damage the lining. Stumps and roots will be removed. Rocks, hard clods, and other such material will be removed, or rolled so as to provide a smooth surface. No sharp or hard objects larger than 3/8 inches in diameter will allowed in the top 1-inch of the surface to be covered. The surface should provide a firm, unyielding foundation for the membrane. If the subgrade is coarse-textured and open after preparing and compacting, or in rocky soils, geotextile or a 2-inch cushion layer of sand or fine grained soil such as silty clay or silt will be applied.

All lining material should be free of damage or defect. Membranes will be carefully spread over the subgrade so they lie in a relaxed state. Polyethylene film requires about 5% slack for satisfactory results. Backfill in anchor trench will be compacted to a density equivalent to that of the surrounding area. All field splices will be made in accordance with the manufacturer's recommended technique, using materials furnished for the purpose. The joints will be watertight and maintain their integrity through the expected life of the lining.

The maximum particle size of soil cover material will be 3/8-inch unless the liner is cushioned by an 8-ounce or greater needle punched, non-woven geotextile padding material. The cover shall be placed to the specified depth without damage to the membrane.

The liner installation will be complete with product panel placement, seam placement and test results. As the liner is fabricated on site the information is documented post install.

A standard Quality Assurance (QA) is completed post installation. This QA includes:

- Material type/size/date deployed and roll number
- Technician details
- Subgrade material acceptance
- Trial weld log including shear/peel testing and machine settings
- Panel placement log including pipe boots/attachments/appurtenances
- Non-destructive testing reports (seam tested welds)
- Repair report logged in diagram also in panel log
- Completion certificate
- Warranty certificate, refer to NRCS Practice Code 521 A Pond Sealing or Lining, Flexible Membrane

7.3 Effluent Application

Effluent water will be applied through either center pivot, providing a total application area of 378 acres (this area excludes the cow lanes and a 50-ft. setback from drains/watercourses). Although it is possible to apply effluent through both machines at the same time, it is much simpler from a management and control perspective to only apply through one machine at a time – the other machine will either be applying straight irrigation water or not operating. The best time to apply the effluent water is just after the cows have finished grazing, allowing 17 days for the grass to utilize the nutrients before the cows next enter the paddock.

The design allows both pivots to do a rotation every 40 hours. The maximum flow rate from the pump injecting the effluent from the storage pond is 320 gallons per minute (gpm), which is 30% of the total flow capacity of the nozzle package fitted to either centre pivot. Based on the 40-hour cycle mentioned above, this calculates as 0.3x10 mm = 3 mm or 0.12 in. of effluent in an application. There is room to cut back the amount of effluent applied, however 0.12 in. is considered a low figure and even twice this amount at 0.25 in. won't be excessive if the soil moisture levels allow.

Soil moisture will determine the total amount of water and effluent to be applied in an application, with the deficit below field capacity determining the amount that can be applied (provided that there isn't any rain forecast for the application period). The worst draining soil types will have soil moisture tapes installed to allow real-time monitoring of soil moisture.

As stated in Section 7.2, the effluent ponds are designed to withstand a 25-year, 24-hour storm event at the full 2,000 cow (Phase 2) effluent output. In Phase 1, the excess capacity of approximately 1MG provides a considerable factor of safety well above the minimum required by standards.

Nonetheless, if a cataclysmic storm was forecast, the time to completely empty the storage pond, if it were full, is around 96 hours. If warranted due to potential impact from the approaching storm event, the settling pond could also be pumped empty within an additional 40 hours. If the forecasted storm is forecast six days prior, then virtually no effluent would remain in storage when the storm arrives. Refer to NRCS Practice Code Standards 430 Irrigation Pipeline, 442 Irrigation System, Sprinkler, 449 Irrigation Water Management.

7.4 De-sludging

The first of the effluent ponds is for the settling of solids. It will normally be full of effluent with the solids content having settled to the bottom, and the liquid component will then flow from the top of this pond into the second pond which is for storage (i.e. the storage pond).

Solids (mostly soft organic matter, but also some sand and mud, etc.) will be applied on a designated area after every 5 weeks (within 45 days), and it will be applied through a 'gun type' application system to areas outside the liquid effluent application.

The solids in the pond are brought into suspension through stirring the pond and then this liquid, along with the suspended solids, is pumped through a 4-inch underground pipe to a number of hydrants which have a 'gun sprinkler' with a 5/8-inch nozzle attached via a length of flexible hose. The guns (and their 65 foot radius of spray area) will be moved around the paddocks after a period of running (2 hours) so that the solids become evenly spread. The application rate is 9mm/hr. Each time solids are applied, the guns will be run for 3 hours. The nutrients within this 3 hour application will be absorbed by the pasture within approximately 3.3 days. Refer to Section 8.0 – Nutrient Management.

The flow from the solids pump will depend on how many guns are being run at the same time. However, in normal circumstances there will be two guns running and the pump will be pumping 158 gpm. At this rate it will take a total of 40 to 50 hours to nearly empty the settling pond depending on the amount of mixing volume.

8.0 Nutrient Management

HDF will be developed in two phases. Phase 1 is a 699 milking cow operation, which will utilize HDF's initial herd purchase and fit into the Animal Feeding Operation (AFO) regulatory framework. Phase 2 is an expansion to 2,000 milking cows (total). This expansion will require a Concentrated Animal Feeding Operation (CAFO) permit to be issued prior to the animal population exceeding 700 mature dairy cows. The Phase 1 HDF nutrient management plan utilizes soil fertility recommendations provided by a certified US laboratory to support all nutrient applications. Fertilizer applications will be optimized and balanced to insure proper timing, placement, and nutrient utilization. Planned nutrient application rates were also compared to the Hawai'i NRCS 590 Nutrient Management Standard. This standard insures that the total amount of nutrients applied is not at a risk for nitrogen leaching or phosphorus indexing.

8.1 Historical Background

The historical use of the land has been for sugar cane production, terminated in the late 1980s, and after that time, for a beef cattle operation. The historical uses of the farm have left the soils depleted of the essential nutrients required for crop growth. A well-managed pasture-based dairy focused on the application of nutrients will be a benefit to the existing soil structure and composition.

8.2 Pasture-Based Dairy

The pasture-based system enables the dairy cows to spend 22 hours in the paddocks, where a corresponding proportion of their excreted manure will be discharged directly onto the paddocks. The dominant grass is Kikuyu; (Pennisetum clandestinum) a high yielding C4, that (when properly fertilized) will yield more than 20 tons (U.S.) per acre. The perennial grasses can be classified as either C3 or C4 plants. These terms refer to the different pathways that plants use to capture carbon dioxide during photosynthesis. All species have the more primitive C3 pathway, but the additional C4 pathway evolved in species in the wet and dry

tropics. These differences are important because the two pathways are also associated with different growth requirements. C3 plants are adapted to cool season establishment and growth in either wet or dry environments. On the other hand, C4 plants are more adapted to warm or hot seasonal conditions under moist or dry environments. Some C4 grasses are known to produce more than 35 tons of dry matter per acre per year.

This 20 ton Kikuyu yield goal for mature pasture grass is the basis for all nutrient application rates. In Phase 1, the grass will need significant additional nutrient application with conventional fertilizers as the excreted manure will supply less than 20% of the nutrient needs of the grass. Nutrients applied to the soil will be in balance with the grass' nutrient needs, and therefore, not result in an over application of nitrogen (N) or phosphorus (P). A managed soil sampling schedule will allow refinement and adjustments to nutrient applications as the soil heath continues to improve. Application rates of sludge and liquid manure will be constantly monitored and adjusted accordingly, as nutrients are applied to Blocks A through J as shown on Figure 23 – Nutrient Management Map.

The effluent ponds have been designed to allow for flexibility in nutrient application. The effluent will not be applied when it is raining, or when the soil is completely saturated. The water holding capacity of each soil type has been taken into consideration for all effluent application rates. The current design allows for a minimum of 30 days effluent storage in both Phase 1 and Phase 2. The effluent is highly diluted, to the extent that it will have next to no odor in the storage pond and certainly no odor at the farm boundary. The settling pond will also be aerated to help mitigate odor. To help further mitigate any odors arising from the facility a Windbreak / Shelterbelt (i.e. a multiple row planting of trees) will be established along the prevailing wind pattern of the pond. This design will follow the guidance of NRCS Conservation Plan Standard 380 Windbreak / Shelterbelt Establishment.

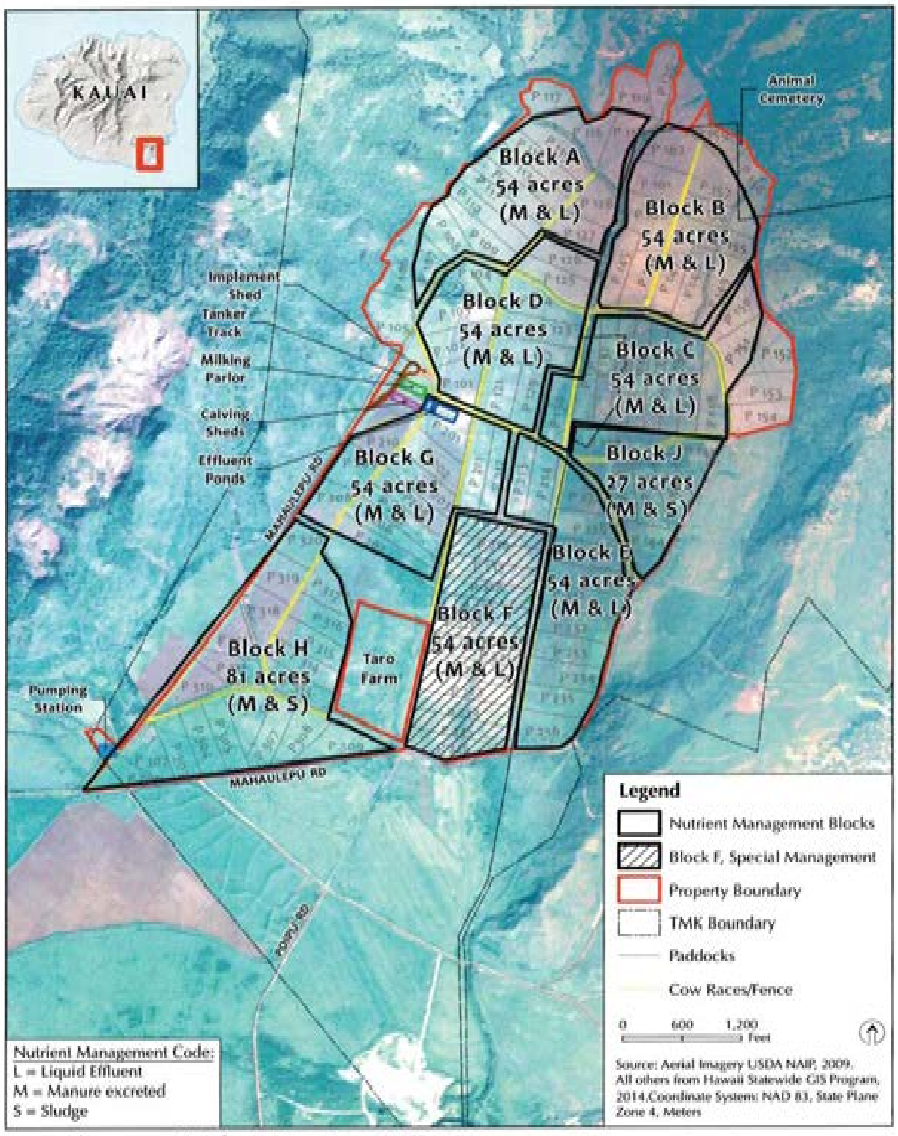


Figure 23 – Nutrient Management Map

Site specific soil moisture will be monitored, in real time, to ensure irrigation water, liquid effluent and cattle are not applied to soils when conditions are suboptimal. HDF will ensure that soils conditions can support Kikuyu growth and are not wet enough to potentially cause pugging (penetration of cow hoofs into the soil), even through the thatch.

The Kikuyu is extremely effective in the tropics and adds significant protection to soils in terms of creating a tight organic thatch, which also reduces hoof compaction via the thatch. Some of the current issues with soil compaction are related directly to the disturbance in the soil structure caused by machine cultivation. Once the Kikuyu thatch is established, the soil itself is not disturbed by cultivation; the thatch will be exposed to grazing pressure and annual mulch.

As the cattle excrete on the Kikuyu thatch, it is incorporated into what is effectively an organic net. Due to the high moisture and moderate temperatures, the microbial activity in the thatch is very high and the effluent will be largely broken down by microbial activity within 24 hours. The effluent is less than 20% of the daily nutrient needs, and therefore readily absorbed in Kikuyu.

The project has budgeted 20 tons (U.S.) of dry matter production of Kikuyu per acre. The average local temperature is in the ideal 60 and 104°F range for Kikuyu. Kikuyu yield ranges between 4 tons unfertilized and 20 tons of dry matter (DM)/acre/year depending on levels of N fertilization. Kikuyu's response to fertilization is very good and linear combined with irrigation, anticipated growth rates in Maha'ulepu are estimated be some of the best in the world.

The current key hubs of Kikuyu-based dairy farms are Northland of New Zealand, Australia's Hunter Valley and in the Eastern Cape of South Africa (George and Knysnal) where current farmers consistently achieve greater than 20 metric tons (mt) of dry matter production of Kikuyu per acre in the temperature ranges that best match those available in Hawai'i all year round.

Author	Quoted Metric Tons of Dry Matter per Acre per Year	Notes
Taylor et al (1976)	36.204	Irrigated Kaitaia NZ
Rojas (1999)	20.240	Costa Rica
Murtagh (1988)	34.580	CSIRO Australia

Local Hawai'i data is available for Kikuyu and similar C4 grasses:

Author	Quoted Metric Tons of Dry Matter per Acre per Year	Notes
Fukumoto, Lee (2003)	13.450	Unfertilized
Roche (2010)	20.100	Peak Fertilized

The farm will be equipped with state-of-the-art technology, called Ag Hub, to ensure management systems and operational uses achieve optimal growth and environmental sustainability. Ag Hub technology will be deployed at HDF to ensure proper application rates and timing of all irrigation events. Ag Hub is a modular online farm management system that collects and displays automated irrigation data. Ag Hub data capture devices and soil tapes will provide electronic and GIS mapped proof of placement of nutrients and real time monitoring.

Figure 24 - Example Nutrient Placement Map (Not HDF)

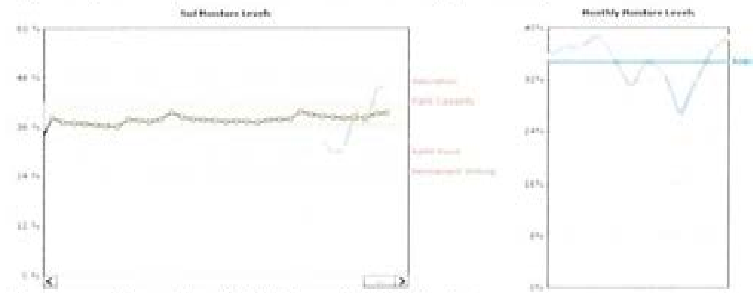


Figure 25 - Example of Field Capacity Monitoring

Animal waste (manure) is applied to the pastures that have a significant deficit from the total grass nutrient requirement. The deficit between grass nutrient requirements and nutrients from cattle effluent, produced either in the paddock or the recovered from the milking platform, will be balanced with supplemental fertilizer. To simplify the management of the recovered cattle effluent, solids from de-sludging the settling pond are only applied to areas outside the pivots in Block H & J. See Figure 23 - Nutrient Management Map. Blocks A through G, under the pivot, will technically be able to receive water and effluent water in different application rates to reflect how the soil is responding and grass is growing, i.e. using or not using the water and or nutrients. The nutrient residue or deficit is reflected in the on-going individual soil test data from those blocks, which will be used to refine applications over time to identify where the nutrients are imported and/or recovered. Given the current degraded state of the soils, HDF should add more nutrients and rebuild the soils to normal levels over the coming years.

Manure will be utilized in a manner to avoid any contamination of surface and ground water supplies and records of the use of wastes will be kept for a minimum of five years. The manure will be sampled and analyzed at least once each year to identify nutrient and specification concentrations. Manure application rates will be consistent with legal requirements. The application rate will not exceed the infiltration rate of the soil, and the amount of waste applied will not exceed the moisture holding capacity of the soil profile at the time of application.

8.3 Soils Analysis

The NRCS soils classifications and descriptions provide a good base layer of information to use for nutrient budgeting. However, additional soil testing is required to determine soil nutrient levels to be used in the nutrient budget analysis. Soil samples have been analyzed for pH, phosphorus, nitrogen, potassium, calcium, magnesium, organic matter, salinity, micronutrients and other constituents.

The farm has approximately 517 acres in pasture, which is divided up into 118 total paddocks of about 4- to 5-acres in size. Soil sample grabs were taken at 5 to 10 locations within each paddock and combined into one representative sample per paddock. Soil samples from approximately 5 paddocks were aggregated into Conservation Management Units (CMUs) based on the underlying NRCS soils classification. See Figure 26 - Conservation Map Units. The baseline test results will be used for design and subsequent sampling will occur during operation to monitor nutrient levels so the nutrient budgets can be adjusted during operation. Samples have been tested by Spectrum Analytical and soil fertility recommendations are shown in Table 15.

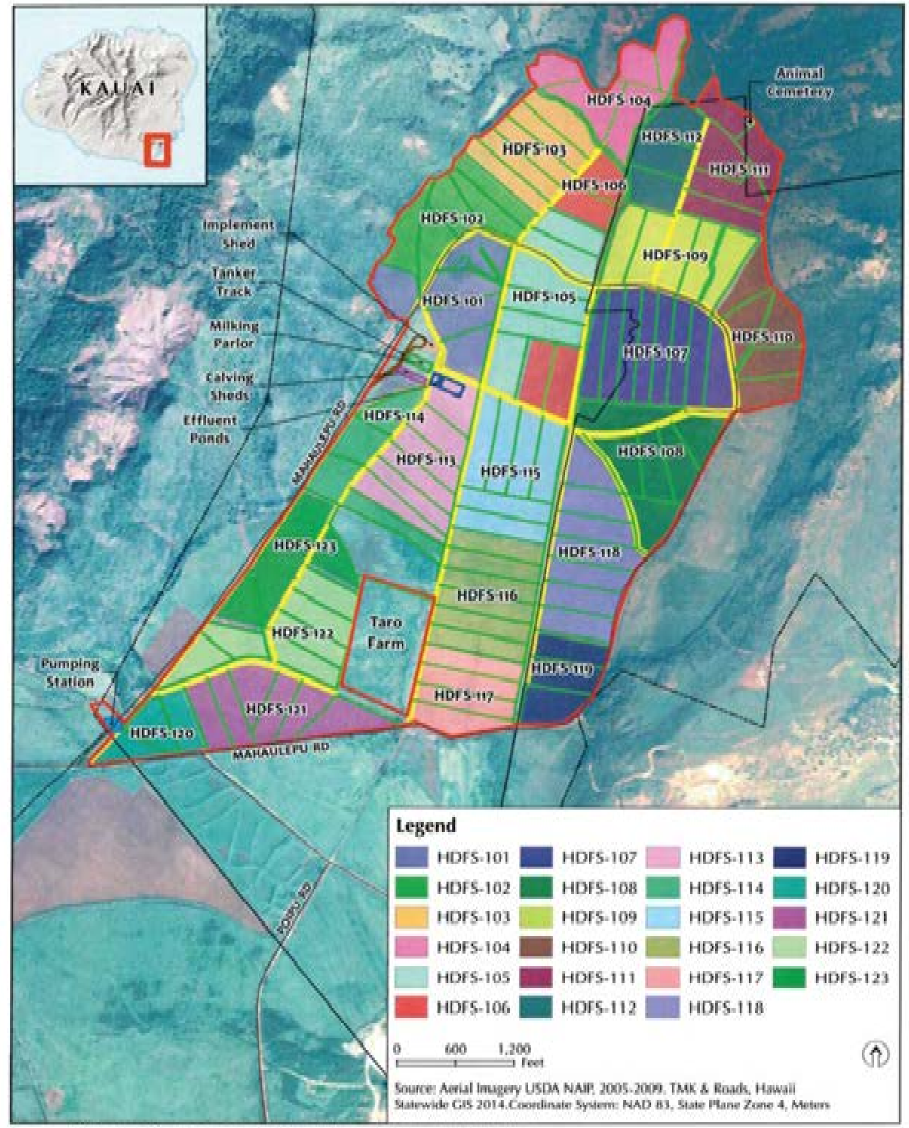


Figure 26 – Conservation Management Unit Map

The Conservation Management Units (CMUs) and related paddocks and NRCS soil types are summarized in the table below.

Table 14 – Conservation Management Units (CMUs)

Paddock Number	Conservation Management Units (CMU)	NRCS Soil
		Type
101		KavB, Ke
102		KavB, Ke
103	HDFS-101	KavB, Ke
104		KavB
105		KdF, HsD
106		KavC, KdF
107		LuB, KavC, KavB
108	HDFS-102	HsD, KavC, KavB
109		HsD, KavC, KavB
110		HsD, KavC, KavB
111		KavB, LuB
112		LuB
113	HDFS-103	LuB
114		LuB
115		Lub
116		LuB, HsD
117		LuB, HsD
118		LuB, HsD
119	HDFS-104	LuB, HsD
120		LuB, HsD
121		Ke, KavB
122		KavB
123	HDFS-105	KavB
124		KavB
125		KavB
126		KavB
127		KavB, LuB
128		KavB, LuB
129	HDFS-106	KavB, Ke
130		KavB, Ke

Paddock Number	Conservation Management Units (CMU)	NRCS Soil
		Type
131		KavB, Ke
132		KavB, Ke
133	HDFS-107	KavB, Ke
134		KavB, Ke
135		KavB, Ke
136		KavB, Ke
137		KavB, Ke
138		KavB, Ke
139	HDFS-108	KavB
140		KavB
141		KavB
142		KavB
143		KavB
144		KavB
145		KavB
146		KavB
147	HDFS-109	KavB
148		KavB
149		KavB
150		KavB, Hsd
151		KavB, KavC, Hsd
152	HDFS-110	KavC
153		KavB, KavC
154		KavB, KavC
155		LuB
156		LuB
157	HDFS-111	LuB, KavC
158		KavC
159		Kavc

Table 14 – Conservation Management Units (CMUs) (continued)

Paddock Number	Conservation Management Units (CMU)	NRCS Soil
		Type
160	HDFS-112	KavB
161		KavB, LuB
162		KavB, LuB
201		Ke
202		Ke, PdA
203	HDFS-113	Ke, PdA, PdC
204		Ke, PdA, PdC
205		Ke, PdA
206		Ke, PdA
207		Ke, PdA, PdC
208		PdA, PdC, KefH
209	HDFS-114	PdA, PdC, KefH,
210		PdC
211		Ke
212		Ke
213	HDFS-115	Ke
214		Ke
215		Ke
216		Ke
217		Ke
218		Ke
219	HDFS-116	Ke
220		Ke
221		Ke
222		Ke
223		Ke
224		Ke
225	HDFS-117	Ke
226		Ke

Paddock Number	Conservation Management Units (CMU)	NRCS Soil
		Type
227		Ke, KavB
228		Ke, KavB
229	HDFS-118	Ke, KavB
230		Ke, KavB
231		Ke, KavB
232		Ke, KavB
233		Ke, KavB
234		Ke
235	HDFS-119	Ke
236		Ke
301		LuB, Ws
302	HDFS-120	Lub, Ws
303		Lub, Ws
304		Ws
305		Ws
306	HDFS-121	Ws
307		Ws
308		Ws
309		Ws
310		PdC, PdA
311		Pdc, Pda
313	HDFS-122	Pdc, Pda
314		Pdc, Pda
315		Pdc, Pda
316		Pdc, Pda
312		Pdc
317		Pdc
318	HDFS-123	Pdc
319		Pdc
320		Pdc

Table 15 - Spectrum Analytic – Soil Fertility Recommendations

Spectrum Analytic

www.spectrumanalytic.com

Report To	Prepared For	
HAWAII DAIRY FARM LLC 3083 AKAHI ST STE 301 LIHUE, HI 96766	HAWAII DAIRY FARM LLC	Sampled 04-04-2014 Tested 04-09-2014

HDFS 101	D21097	6.1	6.6	5.2	15 L	108 M	1127 V	1459 M	18.8	1.2	44.0	39.2	16 M	0.6L	5.5 G	182 V	5.5 G	155 H	
HDFS 102	D21098	6.3	6.6	6.3	7 L	128 M	920 V	1466 M	17.3	1.6	39.0	31.7	6 L	0.5L	2.7 M	124 V	5.1 G	139 G	
HDFS 103	D21099	6.1	6.5	5.1	16 L	132 M	970 V	1259 M	18.2	1.6	39.4	26.0	6 L	0.4L	3.3 M	129 V	4.9 G	80 G	
HDFS 104	D21100	5.6	6.4	6.4	5 L	118 M	988 V	718 L	14.3	1.8	29.1	18.8	22 G	0.4L	1.8 M	95 H	3.9 G	142 H	
HDFS 105	D21101	6.4	6.7	6.9	10 L	215 G	962 V	1128 M	15.3	3.0	46.0	27.6	10 M	0.5L	5.8 G	126 V	5.0 G	182 H	
HDFS 106	D21102	6.9	6.9	6.2	9 L	162 M	1016 V	2338 M	19.4	1.6	38.4	45.2	9 L	0.7L	3.0 M	143 V	5.8 G	110 G	
HDFS 107	D21103	6.6	6.9	5.1	6 L	110 M	797 V	3186 G	22.5	1.1	25.9	53.0	28 G	0.6L	3.6 M	104 V	7.0 G	125 G	
HDFS 108	D21104	7.4		5.1	6 L	113 M	988 V	6078 V	22.5	1.1	32.2	66.7	16 M	0.9M	3.1 M	89 H	5.4 G	131 G	
HDFS 109	D21105	5.8	6.3	6.2	5 L	91 L	836 V	1964 M	22.1	0.9	27.8	33.3	9 L	0.4L	4.7 G	112 V	5.8 G	133 H	
HDFS 110	D21106	6.5	6.6	4.6	14 L	147 M	1332 V	1426 M	19.6	1.6	49.5	27.1	6 L	0.5L	3.7 M	156 V	4.5 G	106 G	

* P, K, Mg and Ca are extracted by Mehlich 3 (ICP) and are reported in ppm

HDFS 101	D21097	14	Kikuyugrass (Forage)	20		1652 C	746	299	1136	0	9	0.20	0	0	0	0
HDFS 102	D21098	14	Kikuyugrass (Forage)	20		0	737	310	1113	0	11	0.50	0	0	0	2
HDFS 103	D21099	14	Kikuyugrass (Forage)	20		1036 C	749	301	1112	0	13	0.50	0	0	0	2
HDFS 104	D21100	14	Kikuyugrass (Forage)	20		4887 C	736	310	1113	0	7	0.50	0	0	0	3
HDFS 105	D21101	14	Kikuyugrass (Forage)	20		0	731	310	1014	0	10	0.50	0	0	0	0
HDFS 106	D21102	14	Kikuyugrass (Forage)	20		0	738	310	1086	0	11	0.25	0	0	0	2
HDFS 107	D21103	14	Kikuyugrass (Forage)	20		0	749	310	1143	0	8	0.25	0	0	0	2
HDFS 108	D21104	14	Kikuyugrass (Forage)	20		0	749	310	1140	0	10	0.50	0	0	0	3
HDFS 109	D21105	14	Kikuyugrass (Forage)	20		4571 C	736	310	1160	0	11	0.50	0	0	0	0
HDFS 110	D21106	14	Kikuyugrass (Forage)	20		0	754	303	1102	0	14	0.50	0	0	0	2

*Lime expressed in 100% pure $CaCO_3$. Adjust accordingly. D = Dolomitic Lime, C = Calcitic Lime.

Kikuyugrass (Forage): Split apply fertilizer to best match grass growth and nutrient demand. Monitor and adjust nutrient program with annual plant analysis.

D21102 (Kikuyugrass (Forage)): Apply 40 lbs/A Calcium from gypsum and/or fertilizer sources.

D21106 (Kikuyugrass (Forage)): Apply 226 lbs/A Calcium from gypsum and/or fertilizer sources.

Analyzed by Spectrum Analytic Inc
www.spectrumanalytic.com

HID 4985-0137-3801-0013

Table 15 - Spectrum Analytic – Soil Fertility Recommendations (continued)

Spectrum Analytic

www.spectrumanalytic.com

Report To	Prepared For	
HAWAII DAIRY FARM LLC 3083 AKAHI ST STE 301 LIHUE, HI 96766	HAWAII DAIRY FARM LLC	Sampled 04-04-2014 Tested 04-09-2014

HDFS 111	D21107	6.2	6.6	5.0	5 L	84 L	942 V	1121 M	16.1	1.1	42.9	26.1	5 L	0.4L	2.3 M	135 V	4.3 G	84 G	
HDFS 112	D21108	6.4	6.6	6.6	4 L	84 L	880 V	1027 M	15.3	1.2	42.2	25.2	6 L	0.4L	2.6 M	137 V	4.6 G	130 G	
HDFS 113	D21109	7.3		3.3	9 L	322 H	699 V	4128 H	20.8	3.3	24.6	72.0	18 M	0.8M	1.5 L	119 V	3.1 G	113 G	
HDFS 114	D21110	6.6	7.0	4.3	13 L	265 G	727 V	3588 G	24.2	2.4	22.0	55.6	41 H	0.6L	1.9 M	113 V	3.0 G	97 G	
HDFS 115	D21111	7.9		5.0	21 M	144 M	1070 V	5960 V	23.2	1.3	33.9	64.8	24 G	1.1M	3.1 M	111 V	4.5 G	96 M	
HDFS 116	D21112	7.6		4.2	9 L	114 M	1219 V	4370 G	24.2	1.0	37.0	62.0	18 M	0.9M	1.9 M	143 V	3.8 G	105 G	
HDFS 117	D21113	6.3	6.8	4.3	4 L	51 L	409 V	657 M	8.0	1.4	37.6	30.9	10 M	0.5L	1.2 L	145 V	2.2 G	67 G	
HDFS 118	D21114	8.0		3.6	13 L	114 M	875 V	7135 V	21.7	1.1	29.6	69.2	25 G	1.1M	2.3 M	77 H	3.6 M	107 G	
HDFS 119	D21115	8.0		4.2	42 G	210 M	1137 V	7951 V	23.8	1.9	35.0	63.1	32 G	1.6M	2.6 M	84 H	3.8 L	82 M	
HDFS 120	D21116	6.4	6.8	7.6	8 L	380 V	368 H	734 M	11.1	7.4	24.4	24.9	9 L	0.5L	1.9 M	99 H	4.3 G	52 G	

* P, K, Mg and Ca are extracted by Mehlich 3 (ICP) and are reported in ppm

HDFS 111	D21107	14	Kikuyugrass (Forage)	20		862 C	750	310	1156	0	14	0.50	0	0	0	3
HDFS 112	D21108	14	Kikuyugrass (Forage)	20		0	734	310	1156	0	11	0.50	0	0	0	2
HDFS 113	D21109	14	Kikuyugrass (Forage)	20		0	767	310	485	0	11	0.25	0	0	0	5
HDFS 114	D21110	14	Kikuyugrass (Forage)	20		0	757	302	1012	0	3	0.25	0	0	0	4
HDFS 115	D21111	14	Kikuyugrass (Forage)	20		0	750	290	1114	0	7	0.50	2	0	2	4
HDFS 116	D21112	14	Kikuyugrass (Forage)	20		0	758	309	1143	0	10	0.75	0	0	0	6
HDFS 117	D21113	14	Kikuyugrass (Forage)	20		0	757	310	1174	0	13	0.25	0	0	0	5
HDFS 118	D21114	14	Kikuyugrass (Forage)	20		0	764	304	1138	0	9	0.50	2	0	0	6
HDFS 119	D21115	14	Kikuyugrass (Forage)	20		0	758	251	1058	0	8	0.25	2	0	2	5
HDFS 120	D21116	14	Kikuyugrass (Forage)	20		0	724	310	0	0	9	0.50	0	0	0	3

*Lime expressed in 100% pure $CaCO_3$. Adjust accordingly. D = Dolomitic Lime, C = Calcitic Lime.

Kikuyugrass (Forage): Split apply fertilizer to best match grass growth and nutrient demand. Monitor and adjust nutrient program with annual plant analysis.

Analyzed by Spectrum Analytic Inc
www.spectrumanalytic.com

HID 4985-0137-3801-0013

Table 15 - Spectrum Analytic - Soil Fertility Recommendations (continued)

Spectrum Analytic

Report To: HAWAII DAIRY FARM LLC
3083 AKAHI ST STE 301
LIHUE, HI 96766

Prepared For: HAWAII DAIRY FARM LLC

Sampled 04-04-2014
Tested 04-09-2014

HDFS 121	O21117	6.5	5.8	7.4	6 L	270 H	632 V	1257 M	12.7	4.6	36.5	37.1	8 L	0.4L	2.0 M	114 V	3.8 G	49 G	
HDFS 122	O21118	6.1	6.7	3.7	5 L	279 H	847 V	1079 M	14.6	4.2	43.0	26.0	14 M	0.4L	1.4 L	111 V	2.9 G	72 G	
HDFS 123	O21119	6.4	6.9	3.6	4 L	366 V	660 V	1440 M	12.4	6.4	40.3	43.6	43 H	0.4L	1.4 L	100 H	2.0 G	71 G	

[1] P, K, Mg and Ca are extracted by Mehlich 3 (ICP) and are reported in ppm

HDFS 121	O21117	14	Kikuyugrass (Forage)	20		0	726	310	352	0	10	0.50	0	0	0	3
HDFS 122	O21118	14	Kikuyugrass (Forage)	20		1368 C	763	310	416	0	15	0.50	0	0	0	5
HDFS 123	O21119	14	Kikuyugrass (Forage)	20		0	764	310	0	0	3	0.50	0	0	0	5

*Lime expressed in 100% pure CaCO3. Adjust accordingly. D = Dolomitic Lime, C = Calcitic Lime.

8.4 NMP

Managing the amount, source, placement, and timing of plant nutrients and soil amendments is the purpose of the nutrient management plan. This type of planning minimizes the agricultural nonpoint sources of pollution of surface and groundwater by properly utilizing manure and commercial fertilizers in balance with plant nutrient requirements. All nutrient applications, including manure and commercial fertilizer, will be applied to the Kikuyu grass utilizing the most current soil fertility recommendations from a certified laboratory. Spectrum Analytic Labs has provided fertility recommendations for Kikuyu based upon a 20 ton yield goal. Yield goals will be adjusted higher or lower based upon measured outputs and site specific data.

The Hawai'i NRCS Nutrient Management Practice standard 590 excel worksheets were utilized to insure that each Crop Management Unit (CMU) met the specific risk assessment profile as defined by NRCS. There are three risk assessment areas that were completed for each CMU. Each risk assessment identified and scored erosion rates, nitrogen leaching index, and phosphorus index.

8.4.1 Risk Assessment Classification

The planned CMUs are meeting all soil loss tolerance (T) in accordance with the approved Conservation Plan. Soil Loss T is attainable since the planned system is pasture-based and there is not a significant amount of annual tillage planned.

Nitrogen Leaching Index per Hawai'i NRCS 590 Standard:

Annual Rainfall	Soil Hydrologic Group A	B	C	D
>100"	H	H	M	M
50-100"	H	M	M	L
<50"	M	M	L	L

Low – No additional mitigation required
Mod – Timing of nitrogen applications must be applied to coincide with crop growing season
High – Timing of nitrogen applications must coincide with crop growing season and be split applied to prevent leaching

The nitrogen leaching index was run on each CMU. Below are the results by CMU:

CMU	Predominant Soil Type	Soil Hydrolic Group	Annual Rainfall	Nitrogen Leaching Potential
HDFS 101	KavB	D	<50"	Low
HDFS 102	KavB	D	<50"	Low
HDFS 103	LuB	D	<50"	Low
HDFS 104	LuB	D	<50"	Low
HDFS 105	KavB	D	<50"	Low
HDFS 106	KavB	D	<50"	Low
HDFS 107	KavB	D	<50"	Low
HDFS 108	KavB	D	<50"	Low
HDFS 109	KavB	D	<50"	Low
HDFS 110	KavB	D	<50"	Low
HDFS 111	LuB	D	<50"	Low
HDFS 112	KavB	D	<50"	Low
HDFS 113	Ke	D	<50"	Low
HDFS 114	PdC	B	<50"	Medium
HDFS 115	Ke	D	<50"	Low
HDFS 116	Ke	D	<50"	Low
HDFS 117	Ke	D	<50"	Low
HDFS 118	Ke	D	<50"	Low
HDFS 119	Ke	D	<50"	Low
HDFS 120	LuB	D	<50"	Low
HDFS 121	Ws	D	<50"	Low
HDFS 122	PdC	B	<50"	Medium
HDFS 123	PdC	B	<50"	Medium

Phosphorus Index Interpretation per Hawai'i NRCS 590 Standard:

Risk Assessment	Phosphorus Index Value
Low	<30
Mod	30-90
High	>90

Low - phosphorus can be applied at rates greater than crop requirement not to exceed the nitrogen requirement for the succeeding crop if manure or other organic materials are used to supply nutrients

Mod - phosphorus can be applied not to exceed the crop requirement rate

High - phosphorus can be applied not to exceed the crop removal rate if the following requirements are met: A soil phosphorus drawdown strategy has been implemented, and a site assessment for nutrients and soil loss has been conducted to determine if mitigation practices are required to protect water quality. Any deviation from these high risk requirements must have the approval of the Chief of the NRCS.

The phosphorus index interpretation was run on each CMU. Below are the results by CMU:

CMU	Risk Assessment	Phosphorus Index Value
HDFS 101	Low	18
HDFS 102	Low	18
HDFS 103	Low	12
HDFS 104	Low	18
HDFS 105	Low	18
HDFS 106	Low	18
HDFS 107	Low	18
HDFS 108	Low	18
HDFS 109	Low	10
HDFS 110	Low	18
HDFS 111	Low	18
HDFS 112	Low	18
HDFS 113	Low	10
HDFS 114	Low	10
HDFS 115	Low	10
HDFS 116	Low	10
HDFS 117	Low	10
HDFS 118	Low	10
HDFS 119	Low	10
HDFS 120	Low	10
HDFS 121	Low	10
HDFS 122	Low	10
HDFS 123	Low	10

8.4.2 Nutrient Mass Balance

The annual net nutrient (nitrogen, phosphorus and potassium) demand for 20 Ton Kikuyu is summarized in the following table. The crop nutrient needs will be satisfied by the application of manure and supplemental commercial fertilizer.

Hawai'i Dairy Farms - Nutrient Mass Balance
Plant Nutrient Demand by CMU - Kikuyu Grass Yield Goal of 20 Ton/ac

CMU Sample #	CMU Ac	N lbs/Ac	P_2O_5 / Ac	K_2O / Ac	Total N lbs / CMU	Total P_2O_5/CMU	Total K_2O/CMU
HDFS 101	24.0	748	296	1138	17,952.0	7,104.0	27,312.0
HDFS 102	21.8	737	310	1113	16,066.6	6,758.0	24,263.4
HDFS 103	21.4	749	301	1112	16,028.6	6,441.4	23,796.8
HDFS 104	20.5	736	310	1113	15,088.0	6,355.0	22,816.5
HDFS 105	26.8	731	310	1014	19,590.8	8,308.0	27,175.2
HDFS 106	17.4	738	310	1086	12,841.2	5,394.0	18,896.4
HDFS 107	35.0	749	310	1143	26,215.0	10,850.0	40,005.0
HDFS 108	27.1	749	310	1140	20,297.9	8,401.0	30,894.0
HDFS 109	23.3	738	310	1160	17,195.4	7,223.0	27,028.0
HDFS 110	21.6	754	303	1102	16,286.4	6,544.8	23,803.2
HDFS 111	21.2	750	310	1158	15,900.0	6,572.0	24,549.6
HDFS 112	17.6	734	310	1156	12,918.4	5,456.0	20,345.6
HDFS 113	26.3	767	310	485	20,172.1	8,153.0	12,755.5
HDFS 114	16.1	757	302	1012	12,187.7	4,862.2	16,293.2
HDFS 115	27.6	750	290	1114	20,700.0	8,004.0	30,746.4
HDFS 116	27.3	758	309	1143	20,693.4	8,435.7	31,203.9
HDFS 117	18.2	757	310	1174	13,777.4	5,642.0	21,366.8
HDFS 118	32.2	764	304	1138	24,600.8	9,788.8	36,643.6
HDFS 119	14.1	758	251	1058	10,687.8	3,539.1	14,917.8
HDFS 120	11.2	724	310	0	8,108.8	3,472.0	0.0
HDFS 121	26.1	726	310	352	18,948.6	8,091.0	9,187.2
HDFS 122	24.2	763	310	416	18,464.6	7,502.0	10,067.2
HDFS 123	20.0	764	310	0	15,280.0	6,200.0	0.0
Total	521.0				390,001.5	159,097.0	494,067.3

There are three types of organic manure nutrients that will be applied to the Kikuyu grass: liquid effluent, solid sludge, and the manure that is excreted directly onto the pasture by the dairy animals. Crop growth will be achieved by the application of supplemental fertilizer. Total annual nutrients applied is summarized in the following table:

Hawai'i Dairy Farms - Nutrient Mass Balance
Total Nutrients Applied

Nutrient Application	Area, ac	N Applied/ac/yr	P_2O_5 Applied/ac/yr	K_2O Applied/ac/yr
Liquid Effluent	378	24.0	16.0	35.0
	Subtotal	9,072.0	6,048.0	13,230.0
De-sludging	108	50.6	30.0	73.0
	Subtotal	5,464.8	3,240.0	7,884.0
Manure Excreted on Pasture	521	128.0	102.0	134.0
	Subtotal	66,688.0	53,142.0	69,814.0
Total Nutrients Applied from Animals		81,224.8	62,430.0	90,928.0
Plant Nutrient Demand		390,001.5	159,097.0	494,067.3
Percentage Demand from Animals		20.8%	39.2%	18.4%
Required Chemical Fertilizer		308,776.7	96,667.0	403,139.3
Percentage Demand from Fertilizer		79.2%	60.8%	81.6%

8.4.3 Block F – Special Management

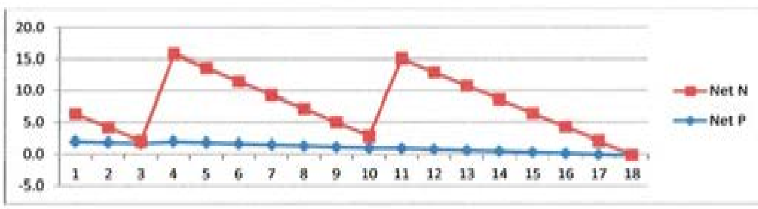
The Maha'ulepu soils, particularly in the south-central portion of the farm (Block F, See Figure 23 - Nutrient Management Map), are perceived as heavy, flood frequently and difficult to crop. Much of the water from the northern part of the farm runs through Block F. The dominant soils on the lower farm are Ka'ena Clay, Kalapa Silty Clay and Kalihi Clay, which are prone to compaction and are characteristically poor draining. However, less than two days after heavy rain, with rapid removal of the surface water during and after a significant rain event, they are observed as being dry enough to graze, even without a Kikuyu thatch.

The Kikuyu itself doesn't grow as effectively in wet conditions, so the farm is highly motivated to make sure the drainage system is as effective as it can be in the lower farm, particularly Block F. Winter weather may dictate if Block F will receive nutrients at all.

8.5 Application Schedule

The 18-day rotation for Blocks A to G assume the cattle enter the paddock on day 1, and all of the manure is excreted in the paddock on the first day. This essentially supplies enough N for three days pasture growth. On day 4, half of the chemical fertilizer is applied and is consumed by the grass over the next 7 days, the second application of chemical fertilizer is applied on day 11, and is consumed by the grass just before the cattle enter the paddock to graze again. The impact of the irrigated liquid effluent is negligible and can be done at any stage in the rotation without materially affecting the nutrient loading as it is less than a half of the daily N requirement of the grass.

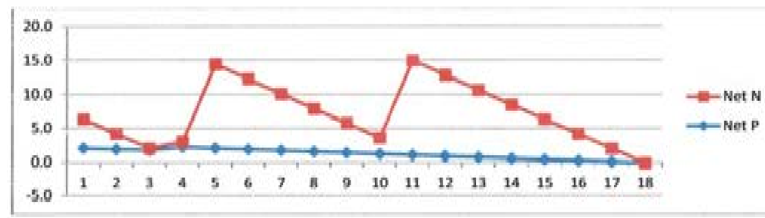
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	annualized
Chemical Fertilizers P				0.12							0.12								5
Chemical Fertilizers N				14.3							14.3								580
Dairy Manure Effluent - irrigated P - Liquids				0.35															7
Dairy Manure Effluent - irrigated N - Liquids				1.18															24
Cattle Manure as excreted P	2.17																		44
Cattle Manure as excreted N	6.31																		128
Daily P demand for Grass	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	60
Daily N demand for Grass	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	730
Net P	2.0	1.8	1.7	2.0	1.8	1.7	1.5	1.3	1.2	1.0	1.0	0.8	0.6	0.5	0.3	0.1	0.0	-0.2	
Net N	4.3	2.3	0.3	13.8	11.8	9.8	7.8	5.8	3.8	1.8	14.1	12.1	10.1	8.1	6.1	4.1	2.1	0.1	
DAY IN ROTATION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	



The 18-day rotation for Blocks H and J assume the cattle enter the paddock on day 1, and all of the manure is excreted in the paddock on the first day. This essentially supplies enough N for three days pasture growth. On day 4, the solids are applied, supplying enough N for further days pasture growth. Half the chemical fertilizer is applied on day 5 and is consumed by the grass over the next 6 days, the second application of chemical fertilizer is applied on day 11, and is consumed by the grass just before the cattle enter the paddock to graze again. The impact of the irrigated solids effluent is negligible and can be done at any stage in the rotation without

materially affecting the nutrient loading as it is a little more than a day's N requirement of the grass.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	annualized
Chemical Fertilizers P					0						0								0
Chemical Fertilizers N					13.6						13.6								550
Dairy Manure Effluent - irrigated P - Solids				0.64															13
Dairy Manure Effluent - irrigated N - Solids				2.52															51
Cattle Manure as excreted P	2.17																		44
Cattle Manure as excreted N	6.31																		128
Daily P demand for Grass	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	60
Daily N demand for Grass	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	730
Net P	2.0	1.8	1.7	2.2	2.0	1.8	1.7	1.5	1.3	1.2	1.0	0.8	0.7	0.5	0.3	0.2	0.0	-0.1	
Net N	4.3	2.3	0.3	0.8	12.4	10.4	8.4	6.4	4.4	2.4	14.0	12.0	10.0	8.0	6.0	4.0	2.0	0.0	
DAY IN ROTATION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	



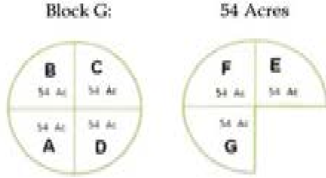
8.6 Effluent Application Schedule

Manure is applied in liquid form with irrigation equipment, and application conditions are documented in the nutrient management plan. All materials will be handled in a manner to minimize the generation of particulate matter, odors and greenhouse gases.

Waste will be applied at a rate significantly less than the crop (Kikuyu) nutrient requirements. Residue management practices will be used for maintenance of soil structure. Manure will be applied on recently grazed paddocks and before pasture re-growth starts.

The whole area of 378 acres where liquid manure will be applied has been divided into 7 blocks of 54 acres each. See Figure 23 – Nutrient Management Map.

Block A:	54 Acres
Block B:	54 Acres
Block C:	54 Acres
Block D:	54 Acres
Block E:	54 Acres
Block F:	54 Acres
Block G:	54 Acres



8.6.1 Effluent Volume:

All of the manure and contaminated water from the Milking Parlor and yard is washed out and transferred to the effluent ponds (manure from cows to the effluent pond is diluted about 12x). In Phase 1, an estimated 12,144 gallons effluent will be produced daily, which will enter into the settling pond. Only 1% of incoming wastewater is solids, which will remain in the settling pond. The remaining volume of wastewater overflows into the storage pond. For water and nutrient calculations, it is assumed that 100% of the volume is transferred to the storage pond.

8.6.2 Liquid Effluent Application Schedule:

Effluent is applied on 54 acres at any one time every 4th day. Total effluent volume after four days in the storage pond would be 48,576 gallons, which will be diluted (12x) with irrigation water. If it is raining on the scheduled application day, then the volume from that day will be carried over until the next scheduled day. If there are 17 contiguous rain days (longest on record), the worst case is the A, B, C and D are all delivered on E. The critical issue is not the lump of nutrients, but the day's effluent that can be stored in the pond. The day's storage as designed far exceeds the 17 days of rain, at 100 days storage for Phase 1 (699 cows).

During the wet months of November, December and January, the frequency and need for use of the irrigators is significantly lower than other times of the year. During the wet season, the effluent will be applied 4 times a month instead of 7 times a month, as it will be in the dry season. In these 4 wet season applications, the effluent water will be spread over twice the area of the dryer months, hence no change to the concentration of the effluent, just the frequency.

Effluent is applied only when conditions are favorable; and the application day can be selected based upon weather and soil conditions to avoid any nutrient overloading or risk of flushing through excess rain.

Table 16 – Liquid Effluent Application Schedule

Month/Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
January								A & B								C & D								E & F				G			
February	A				B				C				D				E				F				G						
March	A				B				C				D				E				F				G				A		
April		B				C				D				E				F				G				A				B	
May				C				D				E				F				G				A				B			
June	C				D				E				F				G				A				B				C		
July			D				E				F				G				A				B				C				D
August				E				F				G				A				B				C				D			
September	E				F				G				A				B				C				D				E		
October			F				G				A				B				C				D				E				F
November								G & A								B & C								D & E				F			
December						G & A								B & C								D & E								F & G	

Month/Day	1	4	8	12	16	20	24	28	31
January			A, B		C, D		E & F	G	
Area (acres)			108		108		108	54	
Plant irrigation requirement (gal) on the application day @ 0.39 inch			1153852		1153852		1153852	576926.1	
Effluent volume in storage pond on application day (gal)			97152		97152		97152	48576	
Irrigation water mixed with effluent (gal)			1056700		1056700		1056700	528350.1	
Dilution rate			11.9		11.9		11.9	11.9	
Nitrogen (lbs) applied on 54 acres block/s (0.025%)			203		203		203	101	
P (lbs) applied on 54 acres block/s (0.006%)			49		49		49	24	
K (lbs) applied on 54 acres block/s (0.03%)			243		243		243	122	
N application per Acre (lbs)			1.88		1.88		1.88	1.88	
P application per Acre (lbs)			0.45		0.45		0.45	0.45	
K application per Acre (lbs)			2.25		2.25		2.25	2.25	

Month/Day	1	5	9	13	17	21	25	28
February	A	B	C	D	E	F	G	
Area (acres)	54	54	54	54	54	54	54	
Plant irrigation requirement (gal) on the application day @ 0.39 inch	576926	576926.1	576926.1	576926.064	576926.1	576926.1	576926.1	
Effluent volume in storage pond at day 5 (gal)	48576	48576	48576	48576	48576	48576	48576	
Irrigation water mixed with effluent (gal)	528350	528350.1	528350.1	528350.064	528350.1	528350.1	528350.1	
Dilution rate	11.9	11.9	11.9	11.9	11.9	11.9	11.9	
Nitrogen (lbs) applied on 54 acres block (0.025%)	101	101	101	101	101	101	101	
P (lbs) applied on 54 acres block (0.006%)	24	24	24	24	24	24	24	
K (lbs) applied on 54 acres block (0.03%)	122	122	122	122	122	122	122	
N application per Acre (lbs)	1.88	1.88	1.88	1.88	1.88	1.88	1.88	
P application per Acre (lbs)	0.45	0.45	0.45	0.45	0.45	0.45	0.45	
K application per Acre (lbs)	2.25	2.25	2.25	2.25	2.25	2.25	2.25	

Table 16 – Liquid Effluent Application Schedule (continued)

Month/Day	1	5	9	13	17	21	25	29	31
March	A	B	C	D	E	F	G	A	
Area (acres)	54	54	54	54	54	54	54	54	
Plant irrigation requirement (gal) on the application day @ 0.39 inch	576926	576926.1	576926.1	576926.064	576926.1	576926.1	576926.1	576926.1	
Effluent volume in storage pond at day 5 (gal)	48576	48576	48576	48576	48576	48576	48576	48576	
Irrigation water mixed with effluent (gal)	528350	528350.1	528350.1	528350.064	528350.1	528350.1	528350.1	528350.1	
Dilution rate	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	
Nitrogen (lbs) applied on 54 acres block (0.025%)	101	101	101	101	101	101	101	101	
P (lbs) applied on 54 acres block (0.006%)	24	24	24	24	24	24	24	24	
K (lbs) applied on 54 acres block (0.03%)	122	122	122	122	122	122	122	122	
N application per Acre (lbs)	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88	
P application per Acre (lbs)	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	
K application per Acre (lbs)	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	

Month/Day	2	6	10	14	18	22	26	30
April	B	C	D	E	F	G	A	B
Area (acres)	54	54	54	54	54	54	54	54
Plant irrigation requirement (gal) on the application day @ 0.39 inch	576926.1	576926.1	576926.1	576926.1	576926.1	576926.1	576926.1	576926.064
Effluent volume in storage pond at day 5 (gal)	48576	48576	48576	48576	48576	48576	48576	48576
Irrigation water mixed with effluent (gal)	528350.1	528350.1	528350.1	528350.1	528350.1	528350.1	528350.1	528350.064
Dilution rate	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
Nitrogen (lbs) applied on 54 acres block (0.025%)	101	101	101	101	101	101	101	101
P (lbs) applied on 54 acres block (0.006%)	24	24	24	24	24	24	24	24
K (lbs) applied on 54 acres block (0.03%)	122	122	122	122	122	122	122	122
N application per Acre (lbs)	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88
P application per Acre (lbs)	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
K application per Acre (lbs)	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25

Month/Day	4	8	12	16	20	24	28	31
May	C	D	E	F	G	A	B	
Area (acres)	54	54	54	54	54	54	54	
Plant irrigation requirement (gal) on the application day @ 0.39 inch	576926.1	576926.1	576926.1	576926.1	576926.1	576926.1	576926.1	
Effluent volume in storage pond at day 5 (gal)	48576	48576	48576	48576	48576	48576	48576	
Irrigation water mixed with effluent (gal)	528350.1	528350.1	528350.1	528350.1	528350.1	528350.1	528350.1	
Dilution rate	11.9	11.9	11.9	11.9	11.9	11.9	11.9	
Nitrogen (lbs) applied on 54 acres block (0.025%)	101	101	101	101	101	101	101	
P (lbs) applied on 54 acres block (0.006%)	24	24	24	24	24	24	24	
K (lbs) applied on 54 acres block (0.03%)	122	122	122	122	122	122	122	
N application per Acre (lbs)	1.88	1.88	1.88	1.88	1.88	1.88	1.88	
P application per Acre (lbs)	0.45	0.45	0.45	0.45	0.45	0.45	0.45	
K application per Acre (lbs)	2.25	2.25	2.25	2.25	2.25	2.25	2.25	

Month/Day	1	5	9	13	17	21	25	29	30
June	C	D	E	F	G	A	B	C	
Area (acres)	54	54	54	54	54	54	54	54	
Plant irrigation requirement (gal) on the application day @ 0.39 inch	576926	576926.1	576926.1	576926.064	576926.1	576926.1	576926.1	576926.1	
Effluent volume in storage pond at day 5 (gal)	48576	48576	48576	48576	48576	48576	48576	48576	
Irrigation water mixed with effluent (gal)	528350	528350.1	528350.1	528350.064	528350.1	528350.1	528350.1	528350.1	
Dilution rate	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	
Nitrogen (lbs) applied on 54 acres block (0.025%)	101	101	101	101	101	101	101	101	
P (lbs) applied on 54 acres block (0.006%)	24	24	24	24	24	24	24	24	
K (lbs) applied on 54 acres block (0.03%)	122	122	122	122	122	122	122	122	
N application per Acre (lbs)	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88	
P application per Acre (lbs)	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	
K application per Acre (lbs)	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	

Table 16 – Liquid Effluent Application Schedule (continued)

Month/Day	3	7	11	15	19	23	27	31
July	D	E	F	G	A	B	C	D
Area (acres)	54	54	54	54	54	54	54	54
Plant irrigation requirement (gal) on the application day @ 0.39 inch	576926.1	576926.1	576926.1	576926.1	576926.1	576926.1	576926.1	576926
Effluent volume in storage pond at day 5 (gal)	48576	48576	48576	48576	48576	48576	48576	48576
Irrigation water mixed with effluent (gal)	528350.1	528350.1	528350.1	528350.1	528350.1	528350.1	528350.1	528350
Dilution rate	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
Nitrogen (lbs) applied on 54 acres block (0.025%)	101	101	101	101	101	101	101	101
P (lbs) applied on 54 acres block (0.006%)	24	24	24	24	24	24	24	24
K (lbs) applied on 54 acres block (0.03%)	122	122	122	122	122	122	122	122
N application per Acre (lbs)	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88
P application per Acre (lbs)	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
K application per Acre (lbs)	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25

Month/Day	4	8	12	16	20	24	28	31
August	E	F	G	A	B	C	D	
Area (acres)	54	54	54	54	54	54	54	
Plant irrigation requirement (gal) on the application day @ 0.39 inch	576926.1	576926.1	576926.1	576926.1	576926.1	576926.1	576926.1	
Effluent volume in storage pond at day 5 (gal)	48576	48576	48576	48576	48576	48576	48576	
Irrigation water mixed with effluent (gal)	528350.1	528350.1	528350.1	528350.1	528350.1	528350.1	528350.1	
Dilution rate	11.9	11.9	11.9	11.9	11.9	11.9	11.9	
Nitrogen (lbs) applied on 54 acres block (0.025%)	101	101	101	101	101	101	101	
P (lbs) applied on 54 acres block (0.006%)	24	24	24	24	24	24	24	
K (lbs) applied on 54 acres block (0.03%)	122	122	122	122	122	122	122	
N application per Acre (lbs)	1.88	1.88	1.88	1.88	1.88	1.88	1.88	
P application per Acre (lbs)	0.45	0.45	0.45	0.45	0.45	0.45	0.45	
K application per Acre (lbs)	2.25	2.25	2.25	2.25	2.25	2.25	2.25	

Month/Day	1	5	9	13	17	21	25	29	30
September	E	F	G	A	B	C	D	E	
Area (acres)	54	54	54	54	54	54	54	54	
Plant irrigation requirement (gal) on the application day @ 0.39 inch	576926	576926.1	576926.1	576926.064	576926.1	576926.1	576926.1	576926.1	
Effluent volume in storage pond at day 5 (gal)	48576	48576	48576	48576	48576	48576	48576	48576	
Irrigation water mixed with effluent (gal)	528350	528350.1	528350.1	528350.064	528350.1	528350.1	528350.1	528350.1	
Dilution rate	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	
Nitrogen (lbs) applied on 54 acres block (0.025%)	101	101	101	101	101	101	101	101	
P (lbs) applied on 54 acres block (0.006%)	24	24	24	24	24	24	24	24	
K (lbs) applied on 54 acres block (0.03%)	122	122	122	122	122	122	122	122	
N application per Acre (lbs)	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88	
P application per Acre (lbs)	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	
K application per Acre (lbs)	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	

Month/Day	3	7	11	15	19	23	27	31
October	F	G	A	B	C	D	E	F
Area (acres)	54	54	54	54	54	54	54	54
Plant irrigation requirement (gal) on the application day @ 0.39 inch	576926.1	576926.1	576926.1	576926.1	576926.1	576926.1	576926.1	576926
Effluent volume in storage pond at day 5 (gal)	48576	48576	48576	48576	48576	48576	48576	48576
Irrigation water mixed with effluent (gal)	528350.1	528350.1	528350.1	528350.1	528350.1	528350.1	528350.1	528350
Dilution rate	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
Nitrogen (lbs) applied on 54 acres block (0.025%)	101	101	101	101	101	101	101	101
P (lbs) applied on 54 acres block (0.006%)	24	24	24	24	24	24	24	24
K (lbs) applied on 54 acres block (0.03%)	122	122	122	122	122	122	122	122
N application per Acre (lbs)	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88
P application per Acre (lbs)	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
K application per Acre (lbs)	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25

Month/Day	1	4	8	12	16	20	24	28	29	30
November			G, A		B, C		D, E	F		
Area (acres)			108		108		108	54		
Plant irrigation requirement (gal) on the application day @ 0.39 inch			1153852		1153852		1153852	576926.1		
Effluent volume in storage pond on application day (gal)			97152		97152		97152	48576		
Irrigation water mixed with effluent (gal)			1056700		1056700		1056700	528350.1		
Dilution rate			11.9		11.9		11.9	11.9		
Nitrogen (lbs) applied on 54 acres block/s (0.025%)			203		203		203	101		
P (lbs) applied on 54 acres block/s (0.006%)			49		49		49	24		
K (lbs) applied on 54 acres block/s (0.03%)			243		243		243	122		
N application per Acre (lbs)			1.88		1.88		1.88	1.88		
P application per Acre (lbs)			0.45		0.45		0.45	0.45		
K application per Acre (lbs)			2.25		2.25		2.25	2.25		

Table 16 – Liquid Effluent Application Schedule (continued)

Month/Day	1	2	6	10	14	18	22	26	30	31
December			G & A		B & C		D & E		F & G	
Area (acres)			108		108		108		108	
Plant irrigation requirement (gal) on the application day @ 0.39inch			1153852		1153852		1153852		1153852	
Effluent volume in storage pond on application day (gal)			97152		97152		97152		97152	
Irrigation water mixed with effluent (gal)			1056700		1056700		1056700		1056700	
Dilution rate			11.9		11.9		11.9		11.9	
Nitrogen (lbs) applied on 54 acres block/s (0.025%)			203		203		203		203	
P (lbs) applied on 54 acres block/s (0.006%)			49		49		49		49	
K (lbs) applied on 54 acres block/s (0.03%)			243		243		243		243	
N application per Acre (lbs)			1.88		1.88		1.88		1.88	
P application per Acre (lbs)			0.45		0.45		0.45		0.45	
K application per Acre (lbs)			2.25		2.25		2.25		2.25	

Nitrogen applied (lbs) on each block

Effluent Block	A	B	C	D	E	F	G
Acres	54	54	54	54	54	54	54
January	101	101	101	101	101	101	101
February	101	101	101	101	101	101	101
March	203	101	101	101	101	101	101
April	101	203	101	101	101	101	101
May	101	101	101	101	101	101	101
June	101	101	203	101	101	101	101
July	101	101	101	203	101	101	101
August	101	101	101	101	101	101	101
September	101	101	101	101	203	101	101
October	101	101	101	101	101	203	101
November	101	101	101	101	101	101	101
December	101	101	101	101	101	101	203
Total Nitrogen application per year (lbs)	1317	1317	1317	1317	1317	1317	1317
Nitrogen application on each acre per annum (lbs)	24.4	24.4	24.4	24.4	24.4	24.4	24.4

Note: Since effluent application occurs every 4th day and days in each month vary, each block receives two applications in certain months as reflected in the table above. The total application per year is the same for all blocks.

Table 16 – Liquid Effluent Application Schedule (continued)

Phosphorous applied (lbs) on each block

Effluent Block	A	B	C	D	E	F	G
Acres	54	54	54	54	54	54	54
January	24	24	24	24	24	24	24
February	24	24	24	24	24	24	24
March	49	24	24	24	24	24	24
April	24	49	24	24	24	24	24
May	24	24	24	24	24	24	24
June	24	24	49	24	24	24	24
July	24	24	24	49	24	24	24
August	24	24	24	24	24	24	24
September	24	24	24	24	49	24	24
October	24	24	24	24	24	49	24
November	24	24	24	24	24	24	24
December	24	24	24	24	24	24	49
Total Phosphorous application per year (lbs)	316	316	316	316	316	316	316
Phosphorous application on each acre per annum (lbs)	5.9	5.9	5.9	5.9	5.9	5.9	5.9

Note: Since effluent application occurs every 4th day and days in each month vary, each block receives two applications in certain months as reflected in the table above. The total application per year is the same for all blocks.

Table 16 – Liquid Effluent Application Schedule (continued)

Potassium applied (lbs) on each block

Effluent Block	A	B	C	D	E	F	G
Acres	54	54	54	54	54	54	54
January	122	122	122	122	122	122	122
February	122	122	122	122	122	122	122
March	243	122	122	122	122	122	122
April	122	243	122	122	122	122	122
May	122	122	122	122	122	122	122
June	122	122	243	122	122	122	122
July	122	122	122	243	122	122	122
August	122	122	122	122	122	122	122
September	122	122	122	122	243	122	122
October	122	122	122	122	122	243	122
November	122	122	122	122	122	122	122
December	122	122	122	122	122	122	243
Total Potassium application per year (lbs)	1581	1581	1581	1581	1581	1581	1581
Potassium application on each acre per annum (lbs)	29.3	29.3	29.3	29.3	29.3	29.3	29.3

Note: Since effluent application occurs every 4th day and days in each month vary, each block receives two applications in certain months as reflected in the table above. The total application per year is the same for all blocks.

At Phase 1 steady state:

Daily effluent enters into storage pond	12,144 gal
Effluent volume in 4 days:	12,144 gal x 4 days = 48,576 gal
Effluent volume to be applied at any one time:	48,576 gal
Nitrogen percentage in effluent volume:	0.025%
Application area:	54 Acres
Nitrogen applied on day of application:	1.87 lbs/acre

Nutrient requirement of the Plant:

Kikuyu growth rate:	120.5 lbs DM/ac/day
Crude protein level:	22-23%
Crude protein lbs:	30 lbs CP/ ac/day
Nitrogen required per day for growth:	4.4 lbs N/ac/day
Nitrogen required on day 5:	4.4 x 4 = 17.7 lbs

At the application rate of 1.87 lb/acre (typically 1x per month per block), the nitrogen will minimally reach the soil surface, and instead will be absorbed through the plant leaves directly into the pasture/grass. The calculation for the nitrogen requirement is based on plant protein containing 16% N. Therefore if pasture is growing at 120.5 lbs. DM/ac/day and contains 23% Crude Protein, then the N requirement will be 4.4 lbs [120.5 X 0.23 X 0.16 = 4.4 lbs].

8.7 De-sludging Application Schedule

Table 17 – De-sludging Application Schedule

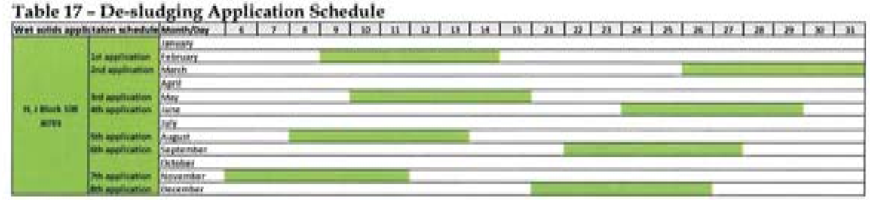


Table 17 – De-sludging Application Schedule (continued)

Wet solids application schedule		Month/Day	6	7	8	9	10	11	12	13	14	15	21	22	23	24	25	26	27	28	29	30	31
H, J Block 108 acres		January																					
	1st application	February				18	18	18	18	18	18												
						7500	7500	7500	7500	7500	7500												
						114	114	114	114	114	114												
						29	29	29	29	29	29												
						137	137	137	137	137	137												
						6.3	6.3	6.3	6.3	6.3	6.3												
						1.6	1.6	1.6	1.6	1.6	1.6												
						7.6	7.6	7.6	7.6	7.6	7.6												
	2nd application	March																18	18	18	18	18	18
																		7500	7500	7500	7500	7500	7500
																		114	114	114	114	114	114
																		29	29	29	29	29	29
																		137	137	137	137	137	137
																		6.3	6.3	6.3	6.3	6.3	6.3
																		1.6	1.6	1.6	1.6	1.6	1.6
																		7.6	7.6	7.6	7.6	7.6	7.6
		April																					
	3rd application	May					18	18	18	18	18	18											
							7500	7500	7500	7500	7500	7500											
							114	114	114	114	114	114											
							29	29	29	29	29	29											
							137	137	137	137	137	137											
							6.3	6.3	6.3	6.3	6.3	6.3											
							1.6	1.6	1.6	1.6	1.6	1.6											
							7.6	7.6	7.6	7.6	7.6	7.6											
	4th application	June														18	18	18	18	18	18		
																7500	7500	7500	7500	7500	7500		
																114	114	114	114	114	114		
																29	29	29	29	29	29		
																137	137	137	137	137	137		
																6.3	6.3	6.3	6.3	6.3	6.3		
																1.6	1.6	1.6	1.6	1.6	1.6		
																7.6	7.6	7.6	7.6	7.6	7.6		
		July																					
	5th application	August			18	18	18	18	18	18													
					7500	7500	7500	7500	7500	7500													
					114	114	114	114	114	114													
					29	29	29	29	29	29													
					137	137	137	137	137	137													
					6.3	6.3	6.3	6.3	6.3	6.3													
					1.6	1.6	1.6	1.6	1.6	1.6													
					7.6	7.6	7.6	7.6	7.6	7.6													
	6th application	September												18	18	18	18	18	18				
														7500	7500	7500	7500	7500	7500				
														114	114	114	114	114	114				
														29	29	29	29	29	29				
														137	137	137	137	137	137				
														6.3	6.3	6.3	6.3	6.3	6.3				
														1.6	1.6	1.6	1.6	1.6	1.6				
														7.6	7.6	7.6	7.6	7.6	7.6				
		October																					
	7th application	November	18	18	18	18	18	18															
			7500	7500	7500	7500	7500	7500															
			114	114	114	114	114	114															
			29	29	29	29	29	29															
			137	137	137	137	137	137															
			6.3	6.3	6.3	6.3	6.3	6.3															
			1.6	1.6	1.6	1.6	1.6	1.6															
			7.6	7.6	7.6	7.6	7.6	7.6															
	8th application	December											18	18	18	18	18	18					
													7500	7500	7500	7500	7500	7500					
													114	114	114	114	114	114					
													29	29	29	29	29	29					
													137	137	137	137	137	137					
													6.3	6.3	6.3	6.3	6.3	6.3					
													1.6	1.6	1.6	1.6	1.6	1.6					
													7.6	7.6	7.6	7.6	7.6	7.6					

Table 17 – De-sludging Application Schedule (continued)

Nitrogen applied (lbs) on each block

Effluent Block	H, J
Acres	108
January	0
February	683
March	683
April	0
May	683
June	683
July	0
August	683
September	683
October	0
November	683
December	683
Total Nitrogen application per year (lbs)	**5465**
Nitrogen application on each acre per annum (lbs)	**50.6**

Phosphorous applied (lbs) on each block

Effluent Block	H, J
Acres	108
January	0
February	173
March	173
April	0
May	173
June	173
July	0
August	173
September	173
October	0
November	173
December	173
Total Phosphorous application per year (lbs)	**1384**
Phosphorous application on each acre per annum (lbs)	**12.8**

Table 17 - De-sludging Application Schedule (continued)

Potassium applied (lbs) on each block

Effluent Block	H, J
Acres	108
January	0
February	820
March	820
April	0
May	820
June	820
July	0
August	820
September	820
October	0
November	820
December	820
Total Potassium application per year (lbs)	**6558**
Potassium application on each acre per annum (lbs)	**60.7**

8.8 Soil Sampling Procedures

8.8.1 Soil Testing Frequency

Soils samples and testing will be performed at least every three years. Soil samples will be collected from each field receiving manure as described in the University of Hawai'i CTAHR Cooperative Extension Service publication (SCM-9).

Soil samples will be submitted for analysis to the University of Hawai'i ADSC laboratory or another laboratory accepted in state-certified programs, the North American Proficiency Testing Program (Soil Science Society of America), or laboratories whose tests are accepted by the University of Hawai'i CTAHR Cooperative Extension Service. All soil analyses will be conducted by methods approved by the University of Hawai'i CTAHR.

Soil samples will be analyzed for pH and phosphorus, nitrogen, potassium, calcium, magnesium, organic matter, salinity, micronutrients, and other constituents pertinent to monitoring or amending the annual nutrient budget.

Refer to Table 15 - Spectrum Analytic - Soil Fertility Recommendations, for the initial soil testing and fertility recommendations at HDF.

8.9 Manure Analysis

Assumptions for manure volume and nutrient levels used in the nutrient budget analysis have been made based on available industry standards. Manure volume assumptions are based on a grazing system by NZ Genetics, which produces manure at a rate of 17.2 gal per cow per day (Vanderholm, Dale H., 1984). See reference below.

Table 1. Comparing estimated manure production.

	ASAE (1999)	ASAE (2005)	Nennich *et al.* (2005)	Vanderholm (1984)	Victoria [#]	Victoria [#]
Relevance	USA	USA	USA	NZ (pasture)	Victoria (pasture + grain)	Victoria (pasture + protein)
Milk yield (kg day^{-1})		*16.5*	*16.5*			
Body weight (kg)	*600*	*600*		*600*		
Total manure (faeces + urine) (kg day^{-1})	52	54	56	65		

The industry standard document "DairyNZ Facts and Figures Guide Book" is created by AgResearch and DairyNZ. This document has provided the basis of all effluent estimates and is the best fit to HDF's system being implemented on Kaua'i. It is based on 10 gal of wash down water per cow. HDF is using 17.4 gal of wash down water per cow. Therefore, the nitrogen concentration in effluent will be 0.025% (10/17.4 x 0.045 = 0.025).

Page 80 extract:

Some measured nutrient concentrations (%) in various effluents compared to farm dairy effluent

Source	%DM	%N	%P	%K
Farm dairy effluent	0.8	0.045	0.006	0.035

Page 81 extract:

Dairy shed and feed pad effluent volumes produced

	Dairy shed (litres) (Includes wash down water)		Feed pad (litres) (Raw manure only, no wash down water) Time on pad			
Herd size	Per cow/day	Herd size x per cow/day	0.5 hr	1.0 hr	1.5 hr	2.0 hr
1	50	50	1.7	3.4	5.1	6.8
150	50	7,500	255	510	765	1,020
250	48	12,000	425	850	1,275	1,700
500	43	21,500	850	1,700	2,550	3,400
750	38	28,500	1,275	2,550	3,825	5,100
1,000	34	34,000	1,700	3,400	5,100	6,800
2,000	23	46,000	3,400	6,800	10,200	13,600

The full DairyNZ Facts and Figures Guide Book is downloadable from the DairyNZ website: http://www.dairynz.co.nz/page/pageid/2145866931/Facts_and_Figures

8.9.1 Manure Sampling Frequency

Manure samples will be collected annually from both (liquid and solid) effluent ponds and the result of manure analyses will be used in determining land application rates of manure.

8.9.2 Liquid (Effluent) Manure Sampling

Effluent samples will be taken at the same depth from five sites around the pond.

Sub-samples will be mixed in a large, clean plastic container and analyzed while the contents are still swirling.

One pint of material will be collected in an unbreakable container that is no more than three quarters full and sent to the laboratory for analysis.

Samples will be transported in a cooler with ice packs, if necessary. Any stored samples will be refrigerated or frozen before being sent for analysis.

8.9.3 Solid Manure Sampling

Samples from five locations from around the settling pond will be taken at the same depth from which the sludge will be removed for application.

Sub-samples will be combined in a clean plastic container and mixed thoroughly.

At least one pint of material will be collected in an unbreakable container, that is no more than three quarters full (a quart-sized freezer bag will be used).

Samples will be transported in a cooler with ice packs. Any stored samples will be refrigerated or frozen before being sent for analysis.

8.10 Feed Management

A feed management plan will be developed and implemented utilizing the USDA NRCS Feed Management 592 Standard. This standard specifies certain criteria that must be followed and will become an essential component of the CNMP. Feed management uses an assortment of tools, including regular analysis of feeds, milk, and manure, to more frequently review nutritional diet formulas and reduce the uncertainties of feed delivery. This process enables maintenance efficiency, improvement in milk production, and/or the improved health of livestock. Decreasing or stabilizing nitrogen and phosphorus nutrient levels in the manure are also key objectives of HDF.

The feed management plan will contain the following information and be developed by a certified animal nutritionist:

- Diets and feed management strategies based upon a benchmark manure sample
- A laboratory analysis completed for the feedstuffs used to formulate the diet to determine nutrient content for the ration
- Feed analysis conducted by an accepted accredited laboratory
- Adjustments to nutritional levels to improve or sustain livestock productivity
- Diet adjustments to reduce (or not exceed) N and P levels in as excreted manure

- Feed management records will be kept on site and reviewed annually along with manure analysis results

8.10.1 Nutritional Requirements

The nutritional requirements are based on an approximately 1,000 lb animal producing 5.3 gal of milk per day. Total intake of 39.7 lbs. DM intake/day is about 4% of body weight. (This will be the maximum and not achievable under average management). The limiting factor for dairy cows is metabolic energy (ME). The example shown below is illustrated in metric units.

ME for maintenance:	60 MJ ME/Day = 60
ME for milk production:	6 MJ ME/Litre x 20 l = 120
ME for Pregnancy:	10 MJ ME/Day = 10
ME for activity:	8 MJ ME/Day = 8
	198 MJ ME/cow/day

Kikuyu @ 10 MJ ME / kg dm x 14 kg dm intake = 140 MJ ME/cow/day
Grain @ 11.5 MJ ME / kg dm x 5.4 kg dm intake = 59.4 MJ ME/cow/day
Total 199.4 MJ ME/cow/day

Protein
Daily requirement. (18 % of 18 kg intake) = 3240 gms
Kikuyu will be 14 kg dm @ 20 % protein so protein intake at +/- 2800 gms/cow/day.
6 kg grain at 90% dm = 5.4 kg dm @ 9% protein = protein intake of +/- 486 gms/cow/day.
Total 3286 gms/cow/day

Starch
Daily requirement. (30 %)
Kikuyu @ 4 % x 14kg = 560
Grain @ 75 % x 6 kg = 4500
Total. 5060 gms/cow/day
Fibre NDF about 35 % of diet
Kikuyu 14 x 40% NDF =5600
Maize Grain 6 x 11% NDF = 660
Total 6260 = +/- 35 % of diet

9.0 Operations and Maintenance

An effective operations and maintenance (O&M) plan is essential for HDF. The O&M Plan for HDF includes the following components:

1) Wastewater System O&M Requirements
   a) Accidental Entry of Waste Storage Emergency
   b) Effluent Storage Ponds
   c) Effluent Sludge Management
2) Manure Sampling Protocol
3) Soil Testing Protocol
4) Animal Mortality Management Plan
5) Water Quality Monitoring Plan
6) Emergency Action Plan Storage Facility Spill, Leak, or Failure
7) Nutrient Management Record Keeping

9.1 Water Quality Monitoring

HDF will implement a plan for water quality monitoring to assess baseline water quality and monitor water quality during operation, as well as assess the effectiveness and adjust HDF irrigation, nutrient management and conservation practices.

Monitoring Goals

- Determine baseline water quality
- Monitor water quality during operation of the dairy
- Evaluate and adjust the frequency and timing of nutrient application and irrigation schedule
- Evaluate and adjust conservation practices
- Detect any potential problems early to allow adjustment of practices before the impacts are significant

9.1.1 Monitoring Stations

Water quality monitoring will be done at several stations located throughout the farm. At a minimum, monitoring points will located upstream of the farm, at multiple drainage ways and water bodies in the farm and at locations downstream of the farm. The initial baseline sampling may be more intensive and evaluate and test water quality from locations further away from the farm both upstream and downstream and possibly near the coastline.

9.1.1.1 Sampling Plan and Procedures

A detailed sampling plan will be developed after baseline test results are available. However, it is anticipated that the sampling plan will include the following components and requirements:

- Regular samples will be taken at a 1- to 3-month intervals
- Specific samples will be taken during and after storm events
- Sampling will also document weather conditions, flow measurement
- Sampling will follow Quality Control and Quality Assurance protocols established in the Sampling Plan

9.1.1.2 Sampling Parameters

Parameters for measurement may include the following:

- Temperature
- Flow
- pH
- Dissolved oxygen
- Turbidity
- Total Suspended Solids
- Bacteria
- Pesticides
- N, P, K

9.1.2 Response Planning

A detailed response plan will be prepared that outlines actions to be taken for problems that arise during farm operation. The response plan will include:

- Contact person
- Discussion of concern
- Outline of action to be taken

- Documentation of action taken and follow-up testing

A variety of actions could be taken to mitigate water quality issues that arise at the site. It is likely that one or more of the following actions would be considered and taken to address typical water quality concerns for this type of agricultural operation:

- Addition/modification to erosion and sediment controls
- Addition/modification to conservation measures
- Adjustment to irrigation application schedules
- Adjustment to effluent and sludge application schedules
- Adjustment to nutrient application
- Adjustment to pasture rotation
- Changes to sampling routines, procedure or scheduling

9.1.3 Record Keeping and Evaluation

The Water Quality Plan and records will be maintained by the Farm Manager onsite, including the following items:

- Emergency contact info
- Laboratory contact info
- Sampling Plan and Procedures
- Baseline sample test results
- Regular sample test results
- Specific sample details and test results
- Graphical depiction of test results and trends
- Response Plan and Actions Taken

Hawai'i Dairy Farm LLC
Operation and Maintenance Worksheet
Accidental Entry of Waste Storage Emergency

For: Lessor/Operator: Hawai'i Dairy Farm LLC
Job Location: Koloa, Hawai'i
County: Kaua'i
SWCD: West Kaua'i Soil & Conservation District
Tax Map Key(s): (4) 2-9-003:001
(4) 2-9-003:006
(4) 2-9-001:001

Prepared By: James Garmatz   Date: 4-16-14

Operations and Maintenance Items

Entry into the waste storage area is strictly prohibited by untrained personnel and should never be attempted by management or his employees.

The facility shall be surrounded by a woven wire fence to deter any animals or untrained personal from accidently falling in the waste storage facility. Gates will be located at each end to allow trained and supervised individuals access for maintenance and repairs.

Contact Person	Phone Number
Fire/Rescue	**911**
Primary Emergency Coordinator James Garmatz (Koloa, Hawai'i)	**808-212-5985**
Secondary Emergency Coordinator Adam Killerman (Koloa, Hawai'i)	**808-639-4311**

Action Plan

- Call for Help.
- Locate Emergency Rescue Equipment and attempt to reach the victim. (Grab Pole, Ladder, Flotation Device, Rope)
- Initiate CPR if Necessary.

Hawai'i Dairy Farms LLC
Operation and Maintenance Worksheet
Effluent Storage Ponds

For: Lessor/Operator: Hawai'i Dairy Farm LLC
Job Location: Koloa, Hawai'i
County: Kaua'i
SWCD: West Kaua'i Soil & Conservation District
Tax Map Key(s): (4) 2-9-003:001
(4) 2-9-003:006
(4) 2-9-001:001

Prepared By: James Garmatz   Date: 4-16-14

Operation and Maintenance Items

An Effluent Storage Structure is used for temporary storage of liquid effluent. It will be designed, installed, and contain a plastic liner that will meet the supplier's specifications.

At any time this structure is out of service, the Hawai'i Department of Agriculture will be contacted for guidance in decommissioning the structure to avoid environmental concerns.

The estimated life span of a structure is 20 years. This can be assured by developing and executing a suitable "Operation and Maintenance Program". A properly operated/maintained effluent storage structure is an asset to our farm.

This practice will require you to perform periodic operation and maintenance to maintain satisfactory performance. A valuable "Operation and Maintenance Program" will include:

______ Do not allow equipment that exceeds design loading to operate within 30 feet of the structure.

______ Continually maintain all pumps, agitators, piping valves and all other electrical and mechanical equipment in good operating condition by following the manufacturer's recommendations.

______ Continually maintain grounding rods and wiring for all electrical equipment in good condition.

______ Maintain all fences, gates, railings and/or warning signs to prevent of any humans or animals entrance to the facility.

______ Repair, immediately all livestock, vehicle and vandalism damage.

________ Remove all foreign debris within the structure that may cause damage to pumps, agitators and earthen structures.

________ On a monthly basis inspect all spillways and control gates for proper functioning for their ability to maintain the water level to design elevations. Remove any blockage or obstruction in spillways and maintain a minimum of 1 foot of freeboard from the top of the structure to the maximum water for earthen storage structure.

________ Maintain a vigorous growth of vegetative covering on earthen structures. This may include the seeding, fertilization, and mowing of this grass. Maintain any weeds that occur and keep eliminated.

________ Monitor all drains and screens on drains to make sure soil is not being transported thru the drainage system. Maintain screens and rodent guards.

________ Eradicate all rodents and repair any damage caused by them.

________ Facility should be low as possible prior to wet weather season.

________ Immediately empty storage facility if damage to the structure may cause failure and immediately seek a qualified engineer to assess the situation. During de-watering of the structure, ensure that the effluent is spread at minimum rates on permanent pastures. Spread the effluent no closer than 50 feet from open water sources when applying liquid effluent with an effluent gun traveler. Do not reduce the effluent level in the structure more than 1 foot per day when emptying the structure.

________ Protect the structures liner from erosive forces of filing operation, operating agitators at least 3 feet from the liner. Protect liner by keeping a layer of manure over the liner or keeping the liner moist.

Hawai'i Dairy Farms LLC
Operation and Maintenance Worksheet
Effluent Sludge Management

For: Lessor/Operator: Hawai'i Dairy Farm LLC
Job Location: Koloa, Hawai'i
County: Kaua'i
SWCD: West Kaua'i Soil & Conservation District
Tax Map Key(s): (4) 2-9-003:001
(4) 2-9-003:006
(4) 2-9-001:001

Prepared By: James Garmatz Date: 4-16-14

Operation and Maintenance Items

Ponds will have sludge buildup and will require dredging or pumping regularly. Proper maintenance of a pond, such as quarterly agitating and pumping to remove many of the solids will keep it functioning effectively for many years.

- Sludge cannot be measured or sampled from the edge of the pond, it must be done from a boat.
- For safety reasons, at least 3 people should be present: two in boat and one on pond bank.
- A long, lightweight, rigid pole with measurements should be used.
- Pole is slowly lowered into the pond until the liquid seems to become thicker and denser.
  - The depth on the pole is then recorded.
- The pole is then pushed deeper into the sludge until the bottom of the pond is reached.
  - That depth is recorded also.
- The difference between the two markings is the depth of the sludge.
- Sludge removal can be accomplished by:
  1) Agitating the pond and irrigating/land applying;
  2) Dewatering the pond, agitating the sludge and land applying the sludge;
- When using agitators, care should be taken to prevent damage to liners that are in place.
- More than one agitator may be required for large ponds
- The liquid can then be applied through large-bore irrigation equipment.

Proper maintenance of the pond also protects the environment, complies with regulations and demonstrates an ethics of civil responsibility.

Hawai'i Dairy Farms LLC
Operations and Management Worksheet
Manure Sampling Protocol

For: Lessor/Operator: Hawai'i Dairy Farm LLC
Job Location: Koloa, Hawai'i
County: Kaua'i
SWCD: West Kaua'i Soil & Conservation District
Tax Map Key(s): (4) 2-9-003:001
(4) 2-9-003:006
(4) 2-9-001:001
Prepared By: James Garmatz Date: 4-16-14

Operation and Maintenance Items

Manure Sampling Frequency
Manure samples will be collected annually from both (liquid and solid) effluent ponds and the result of manure analysis will be used in determining land application rates of manure.

Liquid (Effluent) Manure Sampling
- Effluent samples from five sites around the pond will be taken at the depth and from the portion of the pond from which effluent sample is taken.
- Sub samples will be mixed in a large clean plastic container and analyzed while the contents is still swirling.
- One pint of material will be collected in an unbreakable container, no more than three quarters full and send to the lab laboratory for analysis.
- Samples will be transported in a cooler with ice packs, if necessary; any stored samples will be refrigerated or frozen before being sent for analysis.

Solid Manure Sampling
- Samples from five locations around the settling pond will be taken at the same depth from which the sludge will be removed for application.
- Sub samples will be combined in a clean plastic container and mixed thoroughly.
- At least one pint of material will be collected in an unbreakable container, no more than three quarters full (A quart freezer bag will be used)
- Samples will be transported in a cooler with ice packs. Any stored samples will be refrigerated or frozen before being sent for analysis.

Hawai'i Dairy Farms LLC
Operation and Maintenance Worksheet
Soil Testing Protocol

For: Lessor/Operator: Hawai'i Dairy Farm LLC
Job Location: Koloa, Hawai'i
County: Kaua'i
SWCD: West Kaua'i Soil & Conservation District
Tax Map Key(s): (4) 2-9-003:001
(4) 2-9-003:006
(4) 2-9-001:001
Prepared By: James Garmatz Date: 4-16-14

General Information
HDF has a total of 517 acres in pasture. These pastures are divided up into 118 total paddocks that have an average area of 4 to 5 acres per paddock.

The spray irrigation that will apply effluent along with fresh water will only cover approximately 378 acres. 82 acres will have drip irrigation and no effluent will be applied here. The remaining 57 acres will not be irrigated and will only receive precipitation.

Each of the 118 paddocks will have a soil sample taken from 5-10 locations. Five paddock samples will be combined into one sample and mixed together. These composite sample combinations will be linked to the farm map, which is attached, taking into consideration each distinct sub-area found throughout the farm.

The use of clean tools, containers and clean bags to store the samples, is required. The sample will be gathered from the top 8 inches of the soil.

The method of sampling is as follows:
1. Clean surface of any litter or plant growth. Dig a hole about as wide as your spade and as deep as 8 inches.
2. One inch outside the edge of the hole, cut down to remove a slice of one side of the hole wall.
3. Keeping that slice on the blade of the spade, use a trowel to cut away the sides of the slice leaving a center section about 1 inch wide. A 1 x 1 inch vertical section of this soil is your sub-sample.

4. Place the sub-samples in a plastic container, mix them well and remove about 2 cups of this mixture. This is your composite sample, to send to the lab for analysis.
5. Retain equal parts of all samples for retained material in the event further testing is required.

Soil samples should be submitted for analysis to the University of Hawai'i, The Agricultural Diagnostic Service Center (ADSC) Laboratory or another laboratory accepted in state - certified programs, the North American Proficiency Testing Program (Soil Science of America), or laboratories whose test are accepted by University of Hawai'i, College of Tropical Agriculture and Human Resources (CTAHR) Cooperative Extension Services.

Soil samples should be analyzed for pH, Phosphorus, Nitrogen, Potassium, Calcium, Magnesium, Organic Matter, Salinity, Micronutrients and other constituents pertinent to monitoring or amending the annual nutrient budget.

All soil analyses should be conducted using methods approved by CTAHR. If a laboratory other than ADSC Laboratory is used, the laboratory and analytical methods used by that laboratory must be identified in the nutrient management plan.

The fertilizer recommendations associated with these samples should be based upon Kikuyu as the planned crop.

Laboratory choices are as follows:

1. The Agricultural Diagnostic Service Center (ADSC)
   College of Tropical Agriculture and Human Resources
   University of Hawai'i - Manoa
   1910 East-West Road
   Room 134
   Honolulu, Hawai'i 96822
   Raymond Uchida, Lab Director
   808.956.6706

2. Spectrum Analytical Inc.
   1087 Jamison Road NW
   Washington Court House, Ohio 43160-8748
   1.800.321.1562

Hawai'i Dairy Farms LLC
Operations and Management Worksheet
Animal Mortality Management Plan

For:	Lessor/Operator:	Hawai'i Dairy Farm LLC
	Job Location:	Koloa, Hawai'i
	County:	Kaua'i
	SWCD:	West Kaua'i Soil & Conservation District
	Tax Map Key(s):	(4) 2-9-003:001 (4) 2-9-003:006 (4) 2-9-001:001

Prepared By: James Garmatz Date: 4-16-14

Operation and Maintenance Items

If on-farm storage or handling of animal mortality is done, NRCS Standard 316, Animal Mortality, will be followed for proper management of dead animals. By following NRCS Standard 316, Animal Mortality, we decrease non-point source pollution of surface and ground water resources, reduce the impact of odors that result from improperly handled animal mortality, and decrease the likelihood of the spread of disease or other pathogens. An approved process shall be implemented in the handling of normal mortality losses.

The following outline describes how normal mortality will be managed in a manner that protects surface and ground water quality:

- Pits will be sized to accommodate appropriate weight to volume conversions.
  - Capacity will be in accordance with state and local regulatory agencies' guidelines.
- The burial pit will be a minimum of 2 feet wide with length necessary to accomplish mortality.
- The maximum size of the burial excavation will be 0.10 acre (about 4,400 sq. ft.)
- Pit bottoms will be level.
- Lengths will be limited to soil suitability and slope.
- Multiple pits must be separated by a minimum of three feet of undisturbed or compacted soil.
- Each carcass will be placed in a one-carcass-thick layer, covered with a minimum of 2 feet of soil.
  - Pits will never go deeper than 8 feet.

- Site consideration will include the following:
  - prevailing winds to neighbors
  - at least a 100 feet from any drainage way
  - at least 200 feet from any natural water course
  - at least 300 feet from any well
  - at least 20 feet from any building to prevent spontaneous combustion
  - as far from a fuel source as practical.
- Uncontaminated runoff must be diverted away from animal mortality facility.
- In soils with a permeability of more than 2 in/hr. a liner must be installed in accordance with NRCS standards
- Vehicular traffic will not be allowed within four feet of the pit edge.
- If the pit is four feet deep, a step or bench 18-inches wide and one foot deep will be dug around the perimeter of the main pit so the remaining vertical wall will not exceed four feet.

Hawai'i Dairy Farm LLC
Operation and Maintenance Worksheet
Emergency Action Plan Storage Facility Spill, Leak or Failure

For:

Lessor/Operator:	Hawai'i Dairy Farm LLC
Job Location:	Koloa, Hawai'i
County:	Kaua'i
SWCD:	West Kaua'i Soil & Conservation District
Tax Map Key(s):	(4) 2-9-003:001 (4) 2-9-003:006 (4) 2-9-001:001

Prepared By: James Garmatz Date: 4-16-14

Operation and Maintenance Items

In Case of an Emergency Storage Facility Spill, Leak or Failure

Implement the following first containment steps:

a. Stop all other activities to address the spill.
b. Stop the flow. For example, use skid loader or tractor with blade to contain or divert spill or leak.
c. Call for help and excavator, if needed.
d. Complete the cleanup and repair the necessary components.
e. Assess the extent of the emergency and request additional help, if needed.

In Case of an Emergency Spill, Leak or Failure during Transport or Land Application

Implement the following first containment steps:

a. Stop all other activities to address the spill and stop the flow.
b. Call for help if needed.
c. If the spill posed a hazard to local traffic, call for local traffic control assistance and clear the road and roadside of spilled material.
d. Contain the spill or runoff from entering surface waters using straw bales, saw dust, soil or other appropriate materials.
e. If flow is coming from a tile, plug the tile with a tile plug immediately.
f. Assess the extent of the emergency and request additional help, if needed.

Emergency Contacts

Department / Agency	Phone Number
Fire	911
Rescue services	911
State veterinarian	Dr. Jason D. Moniz, D.V.M 808-960-8409
Sheriff or local police	911

Nearest available excavation equipment/supplies for responding to emergency

Equipment Type	Contact Person	Phone Number
Waalani Bros	Ryan Waalani	808-645-1683
AJAR Inc	Adam Killerman	808-639-4311
George Kawamura Construction	George Kawamura	808-635-5894

Contacts to be made by the owner or operator within 24 hours

Organization	Phone Number
EPA Emergency Spill Hotline	1-888-ASK-USGS
County Health Department	1-808-586-4400
Other State Emergency Agency	1-888-246-2675

Be prepared to provide the following information:

a. Your name and contact information.
b. Farm location (driving directions) and other pertinent information.
c. Description of emergency.
d. Estimate of the amounts, area covered, and distance traveled.
e. Damage: employee injury, fish kill, or property damage.
f. Current status of containment efforts.

Hawai'i Dairy Farms LLC
Operations and Maintenance Worksheet
Nutrient Management Record Keeping

For: Lessor/Operator: Hawai'i Dairy Farm LLC
Job Location: Koloa, Hawai'i
County: Kaua'i
SWCD: West Kaua'i Soil & Conservation District
Tax Map Key(s): (4) 2-9-003:001
(4) 2-9-003:006
(4) 2-9-001:001

Prepared By: James Garmatz Date: 4-16-14

Operation and Maintenance Items

Nutrient Management record keeping is an essential task that needs to be completed on a daily basis. All applications of Nitrogen, Phosphorus and Potassium is required. The dates and application rates are also required in the record keeping. It also includes the different crops planted and the dates they are planted. The task involves the following methodology:

- Must include farm name on top line identified as Name.
- The field number is required on the second line identified as Field Number.
- Every field will have its own page and must be kept in a binder for easy access.
- When a particular crop is planted, log the crop name and the date planted.
- As fertilizer is applied, log each application with the date applied, application rate, and fertilizer formulation, for each crop.
- It is critical that anytime an activity is completed, the records are updated.
- All lime applications must also be entered.

Appendix A
NRCS Practice Codes

NATURAL RESOURCES CONSERVATION SERVICE
PACIFIC ISLANDS AREA

CONSERVATION PRACTICE STANDARD

WASTE STORAGE FACILITY

(No.)

CODE 313

DEFINITION

A waste storage impoundment made by constructing an embankment and/or excavating a pit or dugout, or by fabricating a structure.

PURPOSE

To temporarily store wastes such as manure, wastewater, and contaminated runoff as a storage function component of an agricultural waste management system.

CONDITIONS WHERE PRACTICE APPLIES

- Where the storage facility is a component of a planned agricultural waste management system
- Where temporary storage is needed for organic wastes generated by agricultural production or processing
- Where the storage facility can be constructed, operated and maintained without polluting air or water resources
- Where site conditions are suitable for construction of the facility
- To facilities utilizing embankments with an effective height of 35 feet or less where damage resulting from failure would be limited to damage of farm buildings, agricultural land, or township and country roads.
- To fabricated structures including tanks, stacking facilities, and pond appurtenances.

CRITERIA

General Criteria Applicable to All Waste Storage Facilities.

Laws and Regulations. Waste storage facilities must be planned, designed, and constructed to meet all federal, state, and local laws and regulations.

Location. To minimize the potential for contamination of streams, waste storage facilities should be located outside of floodplains. However, if site restrictions require location within a floodplain, they shall be protected from inundation or damage from a 25-year flood event, or larger if required by laws, rules, and regulations. Waste storage facilities shall be located so the potential impacts from breach of embankment, accidental release, and liner failure are minimized; and separation distances are such that prevailing winds and landscape elements such as building arrangement, landforms, and vegetation minimize odors and protect aesthetic values.

Various localities may have specific requirements which must be followed. For instance, the State of Hawaii, Department of Health, requires waste facilities be located a buffer distance of 1,000 feet from public drinking water resources and 50 feet from surface water resources. Waste storage facilities shall not be located in wetlands.

Storage Period. The storage period is the maximum length of time anticipated between emptying events. The minimum storage period shall be based on the timing required for environmentally safe waste utilization considering the climate, crops, soil, equipment, and local, state, and federal regulations.

Design Storage Volume. The design storage volume equal to the required storage volume shall consist of the total of the following as appropriate:

(a) Manure, wastewater, and other wastes accumulated during the storage period

(b) Normal precipitation less evaporation on the surface area (at the design storage volume level) of the facility during the storage period

(c) Normal runoff from the facility's drainage area during the storage period

(d) 25-year, 24-hour precipitation on the surface (at the required design storage volume level) of the facility

(e) 25-year, 24-hour runoff from the facility's drainage area

(f) Residual solids after liquids have been removed. A minimum of 6 inches shall be provided for tanks

(g) Additional storage as may be required to meet management goals or regulatory requirements

Inlet. Inlets shall be of any permanent type designed to resist corrosion, plugging, and ultraviolet ray deterioration while incorporating erosion protection as necessary.

The inlet pipe should have a minimum diameter of 6 inches. An inlet pipe shall terminate a sufficient distance from the shoreline to insure good distribution. A plumbing cleanout must be provided, as needed, to allow access to the pipe for removing blockage.

Emptying Component. Some type of component shall be provided for emptying storage facilities. It may be a facility such as a gate, pipe, dock, wet well, floating pump, pumping platform, retaining wall, or ramp. Features to protect against erosion, tampering, and accidental release shall be incorporated as necessary.

Accumulated Solids Removal. Provision shall be made for periodic removal of accumulated solids to preserve storage capacity. The anticipated method for doing this must be considered in planning, particularly in determining the configuration of ponds and type of seal, if any.

Safety. Design shall include appropriate safety features to minimize the hazards of the facility. Ramps used to empty liquids shall have a slope of 4 horizontal to 1 vertical or flatter. Those used to empty slurry, semi-solid, or solid waste shall have a slope of 10 horizontal to 1 vertical or flatter unless special traction surfaces are provided. Warning signs, fences, ladders, ropes, bars, rails, and other devices shall be provided, as appropriate, to ensure the safety of humans and livestock. Ventilation and warning signs must be provided for covered waste holding structures, as necessary, to prevent explosion, poisoning, or asphyxiation. Pipelines shall be provided with a water-sealed trap and vent, or similar device, if there is a potential, based on design configuration, for gases to enter buildings or other confined spaces. Ponds and uncovered fabricated structures for liquid or slurry waste with walls less than 5 feet above ground surface shall be fenced and warning signs posted to prevent children and others from using them for other than their intended purpose.

Erosion Protection. Embankments and disturbed areas surrounding the facility shall be treated to control erosion.

Liners. Liners shall meet or exceed the criteria in Pond Sealing or Lining, Compacted Clay Treatment (521D); or Pond Sealing or Lining, Flexible Membrane (521A).

<u>**Additional Criteria for Waste Storage Ponds**</u>

Soil and foundation. The pond shall be located in soils with an acceptable permeability that meets all applicable regulation, or the pond shall be lined. Information and guidance on controlling seepage from waste impoundments can be found in the Agricultural Waste Management Field Handbook (AWMFH), Appendix 10D.

The pond shall have a bottom elevation that is a minimum of 2 feet above the seasonal high water table unless features of special design are incorporated that address buoyant forces, pond seepage rate and non-encroachment of the water table by contaminants. The water table may be lowered by use of perimeter drains, if feasible, to meet this requirement.

Maximum Operating Level. The maximum operating level for waste storage ponds shall be the pond level that provides for the required

volume less the volume contribution of precipitation and runoff from the 25-year, 24-hour storm event plus the volume allowance for residual solids after liquids have been removed. A permanent marker or recorder shall be installed at this maximum operating level to indicate when drawdown should begin. The marker or recorder shall be referenced and explained in the O&M plan.

Outlet. No outlet shall automatically release storage from the required design volume. Manually operated outlets shall be of permanent type designed to resist corrosion and plugging.

Embankments. The minimum elevation of the top of the settled embankment shall be 1 foot above the waste storage pond's required volume. This height shall be increased by the amount needed to ensure that the top elevation will be maintained after settlement. This increase shall be not less than 5 percent. The minimum top widths are shown in Table 1. The combined side slopes of the settled embankment shall not be less than 5 horizontal to 1 vertical, and neither slope shall be steeper than 2 horizontal to 1 vertical unless provisions are made to provide stability.

Table 1 – Minimum Top Widths

Total embankment Height, ft.	Top Width, ft.
15 or less	8
15 – 20	10
20 – 25	12
25 – 30	14
30 – 35	15

Excavations. Unless supported by a soil investigation, excavated side slopes shall be no steeper than 2 horizontal to 1 vertical.

<u>**Additional Criteria for Fabricated Structures**</u>

Foundation. The foundations of fabricated waste storage structures shall be proportioned to safely support all superimposed loads without excessive movement or settlement.

Where a non-uniform foundation cannot be avoided or applied loads may create highly variable foundation loads, settlement should be calculated from site-specific soil test data. Index tests of site soil may allow correlation with similar soils for which test data is available. If no test data is available, presumptive bearing strength values for assessing actual bearing pressures may be obtained from Table 2 or another nationally recognized building code. In using presumptive bearing values, adequate detailing and articulation shall be provided to avoid distressing movements in the structure.

Foundations consisting of bedrock with joints, fractures, or solution channels shall be treated or a separation distance provided consisting of a minimum of 1 foot of impermeable soil between the floor slab and the bedrock or an alternative that will achieve equal protection.

Table 2 - Presumptive Allowable Bearing Stress Values[1]

Foundation Description	Allowable Stress
Crystalline Bedrock	12000 psf
Sedimentary Rock	6000 psf
Sandy Gravel or Gravel	5000 psf
Sand, Silty Sand, Clayey Sand, Silty Gravel, Clayey Gravel	3000 psf
Clay, Sandy Clay, Silty Clay, Clayey Silt	2000 psf

[1] Basic Building Code, 12th Edition, 1993, Building Officials and Code Administrators, Inc. (BOCA)

Liquid Tightness. Applications such as tanks, that require liquid tightness shall be designed and constructed in accordance with standard engineering and industry practice appropriate for the construction materials used to achieve this objective.

Structural Loadings. Waste storage structures shall be designed to withstand all anticipated loads including internal and external loads, hydrostatic uplift pressure, concentrated surface and impact loads, water pressure due to seasonal high water table in compliance with this standard and applicable local building codes.

The lateral earth pressures should be calculated from soil strength values determined from the results of appropriate soil tests. Lateral earth pressures can be calculated using the procedures in TR-74. If soil strength tests are not available, the presumptive lateral earth pressure values indicated in Table 3 shall be used.

TABLE 3 - LATERAL EARTH PRESSURE VALUES[1]

Soil		Equivalent fluid pressure (lb/ft²/ft of depth)			
		Above seasonal high water table[2]		Below seasonal high water table[3]	
Description[4]	Unified Classification[4]	Free-standing walls	Frame tanks	Free-standing walls	Frame tanks
Clean gravel, sand or sand-gravel mixtures (maximum 5% fines)[5]	GP, GW, SP, SW	30	50	80	90
Gravel, sand, silt and clay mixtures (less than 50% fines) Coarse sands with silt and and/or clay (less than 50% fines)	All gravel sand dual symbol classifications and GM, GC, SC, SM, SC-SM	35	60	80	100
Low-plasticity silts and clays with some sand and/or gravel (50% or more fines) Fine sands with silt and/or clay (less than 50% fines)	CL, ML, CL-ML SC, SM, SC-SM	45	75	90	105
Low to medium plasticity silts and clays with little sand and/or gravel (50% or more fines)	CL, ML, CL-ML	65	85	95	110
High plasticity silts and clays (liquid limit more than 50)[6]	CH, MH	-	-	-	-

[1] For lightly-compacted soils (85% to 90% maximum standard density.) Includes compaction by use of typical farm equipment.
[2] Also below seasonal high water table if adequate drainage is provided.
[3] Includes hydrostatic pressure.
[4] All definitions and procedures in accordance with ASTM D 2488 and D 653.
[5] Generally, only washed materials are in this category
[6] Not recommended. Requires special design if used.

Lateral earth pressures based upon equivalent fluid assumptions shall be assigned according to the following conditions:

- **Rigid frame or restrained wall.** Use the values shown in Table 3 under the column "Frame tanks," which gives pressures comparable to the at-rest condition.
- **Flexible or yielding wall.** Use the values shown in Table 3 under the column "Free-standing walls," which gives pressures comparable to the active condition.

Walls in this category are designed on the basis of gravity for stability or are designed as a cantilever having a base wall thickness to height of backfill ratio not more than 0.085.

Internal lateral pressure used for design shall be 65 lb/ft² where the stored waste is not protected from precipitation. A value of 60 lb/ft² may be used where the stored waste is protected from precipitation and will not become saturated. Lesser values may be used if supported by measurement of actual pressures of the waste to be stored. If heavy equipment will be operated near the wall, an additional two feet of soil surcharge shall be considered in the wall analysis.

Tank covers shall be designed to withstand both dead and live loads. The live load values for covers contained in ASAE EP378.3, Floor and Suspended Loads on Agricultural Structures Due to Use, and in ASAE EP 393.2, Manure Storages, shall be the minimum used. The actual axle load for tank wagons having more than a 2,000 gallon capacity shall be used.

If the facility is to have a roof, wind loads shall be as specified in ASAE EP288.5, Agricultural Building Snow and Wind Loads. If the facility is to serve as part of a foundation or support for a building, the total load shall be considered in the structural design.

Structural Design. The structural design shall consider all items that will influence the performance of the structure, including loading assumptions, material properties and construction quality. Design assumptions and construction requirements shall be indicated on standard plans.

Tanks may be designed with or without covers. Covers, beams, or braces that are integral to structural performance must be indicated on the construction drawings. The openings in covered tanks shall be designed to accommodate equipment for loading, agitating, and emptying. These openings shall be equipped with grills or secure covers for safety, and for odor and vector control.

All structures shall be underlain by free draining material or shall have a footing located below the anticipated frost depth. Fabricated structures shall be designed according to the criteria in the following references as appropriate:

- Steel: "Manual of Steel Construction", American Institute of Steel Construction.
- Timber: "National Design Specifications for Wood Construction", American Forest and Paper Association.
- Concrete: "Building Code Requirements for Reinforced Concrete, ACI 318", American Concrete Institute.
- Masonry: "Building Code Requirements for Masonry Structures, ACI 530", American Concrete Institute.

Slabs on Grade. Slab design shall consider the required performance and the critical applied loads along with both the subgrade material and material resistance of the concrete slab. Where applied point loads are minimal and liquid-tightness is not required, such as barnyard and feedlot slabs subject only to precipitation, and the subgrade is uniform and dense, the minimum slab thickness shall be 4 inches with a maximum joint spacing of 10 feet. Joint spacing can be increased if steel reinforcing is added based on subgrade drag theory.

For applications where liquid-tightness is required such as floor slabs of storage tanks, the minimum thickness for uniform foundations shall be 5 inches and shall contain distributed reinforcing steel. The required area of such reinforcing steel shall be based on subgrade drag theory as discussed in industry guidelines such as American Concrete Institute, ACI 360, "Design of Slabs-on-Grade".

When heavy equipment loads are to be resisted and/or where a non-uniform foundation cannot be avoided, an appropriate design procedure incorporating a subgrade resistance parameter(s) such as ACI 360 shall be used.

CONSIDERATIONS

Waste storage facilities should be located as close to the source of waste and polluted runoff as practicable.

Non-polluted runoff should be excluded from the structure to the fullest extent possible except where its storage is advantageous to the operation of the agricultural waste management system.

Freeboard for waste storage tanks should be considered.

Solid/liquid separation of runoff or wastewater entering pond facilities should be considered to minimize the frequency of accumulated solids removal and to facilitate pumping and application of the stored waste.

Due consideration should be given to environmental concerns, economics, the overall waste management system plan, and safety and health factors.

Considerations for Minimizing the Potential for and Impacts of Sudden Breach of Embankment or Accidental Release from the Required Volume.

Features, safeguards, and/or management measures to minimize the risk of failure or accidental release, or to minimize or mitigate impact of this type of failure should be considered when any of the categories listed in Table 4 might be significantly affected.

The following should be considered either singly or in combination to minimize the potential of or the consequences of sudden breach of embankments when one or more of the potential impact categories listed in Table 4 may be significantly affected:

1. An auxiliary (emergency) spillway
2. Additional freeboard
3. Storage for wet year rather than normal year precipitation
4. Reinforced embankment -- such as, additional top width, flattened and/or armored downstream side slopes
5. Secondary containment

Table 4 - Potential Impact Categories from Breach of Embankment or Accidental Release

1.	Surface water bodies -- perennial streams, lakes, wetlands, and estuaries
2.	Critical habitat for threatened and endangered species.
3.	Riparian areas
4.	Farmstead, or other areas of habitation
5.	Off-farm property
6.	Historical and/or archaeological sites or structures that meet the eligibility criteria for listing in the National Register of Historical Places.

The following options should be considered to minimize the potential for accidental release from the required volume through gravity outlets when one or more of the potential impact categories listed in Table 4 may be significantly affected:

1. Outlet gate locks or locked gate housing
2. Secondary containment
3. Alarm system
4. Another means of emptying the required volume

Considerations for Minimizing the Potential of Waste Storage Pond Liner Failure.

Sites with categories listed in Table 5 should be avoided unless no reasonable alternative exists. Under those circumstances, consideration should be given to providing an additional measure of safety from pond seepage when any of the potential impact categories listed in Table 5 may be significantly affected.

Table 5 - Potential Impact Categories for Liner Failure

1.	Any underlying aquifer is at a shallow depth and not confined
2.	The vadose zone is rock
3.	The aquifer is a domestic water supply or ecologically vital water supply
4.	The site is located in an area of solutionized bedrock such as limestone or gypsum.

Should any of the potential impact categories listed in Table 5 be affected, consideration should be given to the following:

1. A clay liner designed in accordance with procedures of AWMFH Appendix 10D with a thickness and coefficient of permeability so that specific discharge is less than 1 x 10^{-6} cm/sec
2. A flexible membrane liner over a clay liner
3. A geosynthetic clay liner (GCL) flexible membrane liner
4. A concrete liner designed in accordance with slabs on grade criteria for fabricated structures requiring water tightness

Considerations for Improving Air Quality

To reduce emissions of greenhouse gases, ammonia, volatile organic compounds, and odor, other practices such as Anaerobic Digester – Ambient Temperature (365), Anaerobic Digester – Controlled Temperature (366), Waste Facility Cover (367), and Composting Facility (317) can be added to the waste management system.

Adjusting pH below 7 may reduce ammonia emissions from the waste storage facility but may increase odor when waste is surface applied (see Waste Utilization, 633).

Some fabric and organic covers have been shown to be effective in reducing odors.

PLANS AND SPECIFICATIONS

Designs (drawings and specifications) shall be prepared in accordance with the criteria of this standard and shall describe the requirements for applying the practice to achieve its intended use.

The design will include quantities of materials required such as:

- Earth cuts and fills
- Volume of concrete,
- Steel reinforcement, and
- Length of pipe.

Ponds. Drawings shall include:

- A plan layout of the embankment and pond with topographic contours,
- Profile of the embankment,
- Cross section of the embankment,
- Profile and cross section of the auxiliary spillway, and
- Inlet and outlet pipe details and material requirements.

For ponds that require a lining, the lining requirements shall be incorporated into the drawings.

Structures. Drawings for structures shall include:

- The location,
- Capacity,
- Dimensions,
- Material requirements,
- Structural details, and
- Foundation requirements.

Construction drawings shall show sufficient detail so that the structures will be built as designed.

The Pacific Islands Area specification for Waste Storage Facility (313) shall be provided as a construction specification.

The drawings and operating instructions for the waste storage facility will be incorporated into the comprehensive nutrient management plan.

The design shall specify the recommended species, planting method, and fertilizer for protective vegetation on the embankment and other exposed areas.

OPERATION AND MAINTENANCE

The Pacific Islands Area operation and maintenance plan for this practice shall be developed for and reviewed with the client that is consistent with the purposes of the practice, its intended life, safety requirements, and the criteria for its design.

The plan shall contain the operational requirements for emptying the storage facility. This shall include the requirement that waste shall be removed from storage and utilized at locations, times, rates, and volume in accordance with the overall waste management system plan.

In addition, for ponds, the plan shall include an explanation of the permanent marker or recorder installed to indicate the maximum operating level.

The plan shall include a strategy for removal and disposition of waste with the least environmental damage during the normal storage period to the extent necessary to insure the pond's safe operation. This strategy is for the removal of the contribution of unusual storm events that may cause the pond to fill to capacity prematurely with subsequent design inflow and usual precipitation prior to the end of the normal storage period.

Development of an emergency action plan should be considered for waste storage facilities where there is a potential for significant impact from breach or accidental release. The plan shall include site-specific provisions for emergency actions that will minimize these impacts.

NATURAL RESOURCES CONSERVATION SERVICE
PACIFIC ISLANDS AREA

CONSERVATION PRACTICE STANDARD

WINDBREAK/SHELTERBELT ESTABLISHMENT

(Ft.)

CODE 380

DEFINITION

Windbreaks or shelterbelts are single or multiple rows of trees or shrubs in linear configurations.

PURPOSE

- Reduce soil erosion from wind.
- Protect plants from wind related damage.
- Alter the microenvironment for enhancing plant growth.
- Provide shelter for structures, animals, and people.
- Enhance wildlife habitat.
- Improve air quality by reducing and intercepting air borne particulate matter, chemicals and odors.
- Improve irrigation efficiency.
- Increase carbon storage in biomass and soils.
- Reduce energy use

CONDITIONS WHERE PRACTICE APPLIES

Apply this practice on any areas where linear plantings of woody plants are desired and suited for controlling wind, noise, and visual resources. Use other tree/shrub practices when wind, noise and visual problems are not concerns.

CRITERIA

General Criteria Applicable to All Purposes

The location, layout and density of the planting will accomplish the purpose and function intended within a 20-year period.

Composition of species will be adapted to site conditions and suitable for the planned purpose(s). Select from species listed in the PI Plant Materials Technical Note 7, Pacific Islands Area (PIA) Vegetative Guide, Table N.

A precondition for windbreak/shelterbelt establishment is appropriately prepared sites. Should any type or amount of site preparation be required, only conservation practice Tree/Shrub Site Preparation Standard (490) shall be planned and applied prior to planting. Conservation practices: Forest Stand Improvement (666), Brush Management (314) and/or Herbaceous Weed Control (315) shall not be planned or applied in conjunction with, or in sequence with Tree/Shrub Site Preparation (490) for the purposes of preparing a site for tree/shrub planting.

The maximum design height (H) for the windbreak or shelterbelt shall be the expected height of the tallest row of trees or shrubs at age 20 for the given site.

No plants on the Federal or state noxious weeds list shall be planted.

Spacing between individual plants shall be based on the needed growing space for plant type and species, the accommodation of maintenance equipment, and the desired characteristics of the stem(s), branches and canopy as required for a specific purpose.

The windbreak will be oriented as close to perpendicular to the troublesome wind as possible.

The length of the windbreak will be sufficient to protect the site including consideration for the "end effect" and changes in wind direction.

Avoid planting trees or shrubs where stems, branches, roots, debris and/or leaf litter will interfere with infrastructure, above or below ground utilities, or natural features.

Moisture conservation or supplemental watering shall be provided for plant establishment and growth where natural precipitation is too low for the selected species.

The planting and care of selected tree and shrub species will comply with all General Criteria detailed in the Tree/Shrub Establishment Standard (612).

Additional Criteria to Reduce Wind Erosion and Protect Growing Plants

The interval between windbreaks shall be determined using current, approved, wind erosion technology. Interval widths shall not exceed that permitted by the soil loss tolerance (T), or other planned soil loss objective. Calculations shall account for the effects of other practices in the conservation management system.

For wind erosion control, temporary measures will be installed to supplement the windbreak until it is fully functional.

Sites, fields, and plants are protected within an area 10 times the design height (H) on the leeward side and two times the design height (H) on the windward side of the windbreak.

Select species that are taller than the crops being protected.

Additional Criteria to Provide Shelter for Structures, Livestock and People

For wind protection, the minimum barrier density will be 65 percent during the months of most troublesome wind.

The area to be protected will fall within a leeward distance of 10H.

Drainage of livestock waste from the livestock area shall not flow into the windbreak.

Additional Criteria to Improve Air Quality by Reducing and Intercepting Airborne Particulate Matter, Chemicals and Odors

The windbreak interval shall be less than or equal to 10h depending on site conditions and related supporting conservation practices.

Windbreak density on the windward side of the problem source, (i.e. particulate, chemical or odor) shall be greater than 50% to reduce the airflow into the source area.

Windbreak density on the leeward side of the problem source, and windward of the area to be protected, shall be greater than 65%.

Select and maintain tree and shrub species with foliar and structural characteristics to optimize interception, adsorption and absorption of airborne chemicals or odors.

Additional Criteria for Increasing Carbon Storage in Biomass and Soils

Maximize width and length of the windbreak to fit the site.

For optimal carbon sequestration, select plants that have higher rates of sequestration in biomass and soils.

Plant and manage the appropriate plant spacing for the site that will maximize above and below ground biomass production

Minimize soil disturbance during establishment and maintenance of the windbreak/shelterbelt.

Additional Criteria for Enhancing Wildlife Habitat

Plant species selection shall benefit targeted wildlife species including pollinators.

Design dimensions of the planting shall be adequate for targeted wildlife species.

Additional Criteria for Improving Irrigation Efficiency

For sprinkler irrigation systems, the windbreak shall be taller than the spray height.

The windbreak shall not interfere with the operation of the irrigation system.

Additional Criteria to Reduce Energy Use

Orient the windbreak as close to perpendicular to the troublesome wind as possible

Use proper plant density to meet energy reduction needs.

Use plants with a potential height growth that will be taller than the structure or facility being protected.

CONSIDERATIONS

Consider enhancing aesthetics by using evergreen species or species with features such as showy flowers, brilliant foliage, or persistent colorful fruits.

When designing and locating a windbreak or shelterbelt, consider the impact upon the landowner's or public's view of the landscape.

Selection of plants for use in windbreaks should favor species or varieties tolerant to herbicides used in the area.

Plants that may be alternate hosts to undesirable pests should be avoided.

All plantings should complement natural features.

Tree or shrub rows should be oriented on or near the contour where water erosion is a concern.

Wildlife and pollinator needs should be considered when selecting or siting tree or shrub species. Species diversity, including use of native species, should be considered.

Species diversity, including use of native species, should be considered to avoid loss of function due to species-specific pests.

Consider the invasive potential when selecting plant species.

Windbreaks for odor and chemical control increase in effectiveness as the amount of foliage available for intercept increases. Multiple-row, wide plantings offer greater interception potential than do smaller plantings.

When using trees and shrubs for greenhouse gas reductions, prediction of carbon sequestration rates should be made using current, approved carbon sequestration modeling technology.

A shelterbelt can be used as a travel corridor to connect existing patches of wildlife habitat.

In cropping systems select windbreak and shelterbelt species that minimize adverse affects to crop growth (e.g. shade, allelopathy, competing root systems or root sprouts).

Locate windbreaks as near as possible to property boundaries to delineate ownership and minimize the amount of land removed from other productive uses where appropriate.

Windbreaks that also serve as noise screens should be:

- At least 65 percent dense.
- As tall as, and as close to the noise source as practicable.
- Twice as long as the distance from the noise source to the receiver.
- Not less than 65 feet wide for high-speed traffic noise.
- Not less than 20 feet wide for moderate speed traffic noise.
- Select species that are tolerant to noxious emissions.

Windbreaks that also serve as visual screens should be located as close to the observer as possible with a density, height and width to sufficiently block the view between the area of concern and the sensitive area.

PLANS AND SPECIFICATIONS

Plans and specifications for applying this practice shall be prepared for each site and recorded using the Pacific Islands Area Windbreak/Shelterbelt Establishment (380) Jobsheet.

OPERATION AND MAINTENANCE

All of the following actions shall be carried out to insure that this practice functions as intended throughout the practice lifespan. These actions include normal repetitive activities in the application and use of the practice (operation), and repair and upkeep of the practice (maintenance).

Replacement of dead trees or shrubs will be continued until the windbreak/shelterbelt is functional.

Supplemental water will be provided as needed.

Thin or prune the windbreak/shelterbelt to maintain its function.

Inspect trees and shrubs periodically and protect from adverse impacts including insects, diseases or competing vegetation. Refer to the standards for Integrated Pest Management (595) if pesticides will be employed and Herbaceous Weed Control (315) for weeds. The trees or shrubs will also be protected from fire and damage from livestock and wildlife.

Periodic applications of nutrients may be needed to maintain plant vigor.

REFERENCES

Bentrup, Gary 2008. Conservation buffers: design guidelines for buffers, corridors, and greenways. Gen. Tech. Rep. SRS-109. Asheville, NC: Department of Agriculture, Forest Service, Southern Research Station.

Brandle, J.R. etal. 1988. Windbreak technology. Agric. Ecosyst. Environ. Vol. 22-23.

NATURAL RESOURCES CONSERVATION SERVICE
PACIFIC ISLANDS AREA

STATEMENT OF WORK

WINDBREAK/SHELTERBELT ESTABLISHMENT (380)

These deliverables apply to this individual practice. For other planned practice deliverables refer to those specific Statements of Work.

DESIGN

All design documents shall be developed in accordance with the requirements of the NRCS Pacific Islands Area Field Office Technical Guide (FOTG) Section IV, Conservation Practice Standard.

Deliverables:

1. Design documents that demonstrate criteria in NRCS practice standard have been met and are compatible with planned and applied practices.
   a. Practice purpose(s) as identified in the conservation plan.
   b. List of required permits to be obtained by the client.
   c. Practice standard criteria-related computations and analyses to develop plans and specifications including but not limited to:
      i. Determination of adapted species of trees and shrubs, extent and position in row(s), and desired density for intended purpose(s).
      ii. The maximum design height (H) for the windbreak or shelterbelt shall be the expected height of the tallest row of trees or shrubs at age 20 for the given site.
      iii. Orientation of windbreaks/shelterbelts and, as applicable, spacing between windbreaks, to achieve intended purpose(s).
      iv. Protective measures for plants to provide desired function including access control.
      v. Additional provisions, as required, wind erosion control, shelter of structures and livestock, noise abatement, improvement of air quality, increasing carbon storage in plants and soil, providing wildlife habitat and travel corridors, and improving irrigation efficiency.
2. Written plans and specifications including sketches and drawings shall be provided to the client that adequately describes the requirements to install the practice and obtain necessary permits. The Pacific Islands Area Conservation Practice Jobsheet for this practice shall be used to provide the client with the requirements to install the practice on the treatment unit. The Jobsheet is available in Section IV of the Pacific Islands Area FOTG.
3. Documentation of needed operation and maintenance. The Pacific Islands Area Conservation Practice Jobsheet for this practice shall be used to provide the client with the requirements for the operation and maintenance of the practice on the treatment unit. The Jobsheet is available in Section IV of the Pacific Islands Area FOTG.
4. Certification that the design meets practice standard criteria and comply with applicable laws and regulations.
5. Design modifications during installation as required.

INSTALLATION

Deliverables

1. Pre-application conference with client.
2. Verification that client has obtained required permits.
3. Staking and layout according to plans and specifications including applicable layout notes.
4. Application guidance as needed.

5. Facilitate and implement required design modifications with client and original designer.
6. Advise client/NRCS on compliance issues with all federal, state, tribal, and local laws, regulations and NRCS policies during installation.
7. Certification that the application process and materials meet design and permit requirements.

CHECK OUT

Deliverables

1. Records of application.
   a. Extent of practice units applied.
   b. Actual plant materials used and applied.
2. Certification that the application meets NRCS standards and specifications and is in compliance with permits.
3. Progress reporting.

REFERENCES

- NRCS Pacific Islands Area Field Office Technical Guide (FOTG), Section IV, Pacific Islands Area Windbreak/Shelterbelt Establishment (380) – Conservation Practice Standard, and Conservation Practice Jobsheet.
- NRCS National Forestry Handbook (NFH), Part 636.4
- NRCS National Environmental Compliance Handbook
- NRCS Cultural Resources Procedures Handbook

NATURAL RESOURCES CONSERVATION SERVICE
PACIFIC ISLANDS AREA

CONSERVATION PRACTICE STANDARD

WASTE TREATMENT LAGOON

(No.)

CODE 359

DEFINITION

A waste treatment impoundment made by constructing an embankment and/or excavating a pit or dugout.

PURPOSE

To biologically treat waste, such as manure and wastewater, and thereby reduce pollution potential by serving as a treatment component of a waste management system.

CONDITIONS WHERE PRACTICE APPLIES

- Where the lagoon is a component of a planned agricultural waste management system.
- Where treatment is needed for organic wastes generated by agricultural production or processing.
- On any site where the lagoon can be constructed, operated and maintained without polluting air or water resources.
- To lagoons utilizing embankments with an effective height of 35 feet or less where damage resulting from failure would be limited to damage of farm buildings, agricultural land, or township and country roads.

CRITERIA

General Criteria for All Lagoons

Laws and Regulations. All Federal, state, and local laws, rules, and regulations governing the construction and use of waste treatment lagoons must be followed.

Location. To minimize the potential for contamination of streams, lagoons should be located outside of floodplains. However, if site restrictions require location within a floodplain, they shall be protected from inundation or damage from a 25-year flood event, or larger if required by laws, rules, and regulations. Lagoons shall be located so the potential impacts from breach of embankment, accidental release, and liner failure are minimized; and separation distances are such that prevailing winds and landscape elements such as building arrangement, landforms, and vegetation minimize odors and protect aesthetic values.

Lagoons should be located so they have as little drainage area as possible. If a lagoon has a drainage area, the volume of normal runoff during the treatment period and 25-year, 24-hour storm event runoff shall be included in the required volume of the lagoon.

The State of Hawaii, Department of Health requires waste facilities be located a distance of 1,000 feet from public drinking water resources and 50 feet from surface water resources. Lagoons shall not be located in wetlands. Other jurisdictions may have similar requirements.

Soils and Foundation. The lagoon shall be located in soils with an acceptable permeability that meets all applicable regulations, or the lagoon shall be lined. Information and guidance on controlling seepage from waste impoundments can be found in the Agricultural Waste Management Field Handbook (AWMFH), Appendix 10D.

The lagoon shall have a bottom elevation that is a minimum of 2 feet above the seasonal high water table unless special design features are incorporated that address buoyant forces, lagoon seepage rates, and non-encroachment of the water table by contaminants. The water table may be lowered by use of perimeter drains to meet this requirement.

Flexible Membranes. Flexible membrane liners shall meet or exceed the requirements of flexible membrane linings specified in Pond Sealing or Lining, Flexible Membrane (521A).

Required Volume. The lagoon shall have the capability of storing the following volumes:

- Volume of accumulated sludge for the period between sludge removal events;
- Minimum treatment volume (anaerobic lagoons only);
- Volume of manure, wastewater, and other wastes accumulated during the treatment period;
- Depth of normal precipitation less evaporation on the surface area (at the required volume level) of the lagoon during the treatment period;
- Depth of the 25-year, 24-hour storm precipitation on the surface area (at the required volume level) of the lagoon.

Treatment Period. The treatment period is the detention time between drawdown events. It shall be the greater of either 60 days; or the time required to provide the storage that allows environmentally safe utilization of waste considering the climate, crops, soil, and equipment requirements; or as required by local, state, and Federal regulations.

Waste Loading. Daily waste loading shall be based on the maximum daily loading considering all waste sources that will be treated by the lagoon. Reliable local information or laboratory test data should be used if available. If local information is not available Chapter 4 of the AWMFH may be used for estimating waste loading.

Embankments. The minimum elevation of the top of the settled embankment shall be 1 foot above the lagoon's required volume. This height shall be increased by the amount needed to ensure that the top elevation will be maintained after settlement. This increase shall be not less than 5 percent. The minimum top widths are shown in Table 1. The combined side slopes of the settled embankment shall not be less than 5 horizontal to 1 vertical, and neither slope shall be steeper than 2 horizontal to 1 vertical unless provisions are made to provide stability.

Table 1 – Minimum Top Widths

Total embankment Height, ft.	Top Width, ft.
15 or less	8
15 – 20	10
20 – 25	12
25 – 30	14
30 – 35	15

Excavations. Unless supported by a soil investigation, excavated side slopes shall be no steeper than 2 horizontal to 1 vertical.

Inlet. Inlets shall be of any permanent type designed to resist corrosion, plugging, and ultraviolet ray deterioration, while incorporating erosion protection as necessary. Inlets shall be provided with a water-sealed trap and vent, or similar device if there is a potential, based on design configuration, for gases to enter buildings or other confined spaces.

The inlet pipe should have a minimum diameter of 6 inches except that a minimum diameter of 4 inches may be used for milking center waste. The pipe should terminate a sufficient distance from the shoreline to insure good distribution. A cleanout shall be provided for removing obstructions.

Outlet. Outlets from the required volume shall be designed to resist corrosion and plugging. No outlet shall automatically discharge from the required volume of the lagoon.

Facility for Drawdown. Measures that facilitate safe drawdown of the liquid level in the lagoon shall be provided. Access areas and ramps used to withdraw waste shall have slopes that facilitate a safe operating environment. Docks, wells, pumping platforms, retaining walls, etc. shall permit drawdown without causing erosion or damage to liners.

Sludge Removal. Provision shall be made for periodic removal of accumulated sludge to preserve the treatment capacity of the lagoon.

A solids separator may be installed between the waste sources and the lagoon. This may be a concrete or earth structure that can be

emptied periodically. A minimum of two cells should be planned so that one can be dried and cleaned while the other is functioning.

Erosion Protection. Embankments and disturbed areas surrounding the lagoon shall be treated to control erosion. This includes the inside slopes of the lagoon as needed to protect the integrity of the liner.

Safety. Design shall include appropriate safety features to minimize the hazards of the lagoon. The lagoon shall be fenced around the perimeter and warning signs posted to prevent children and others from using it for other than its intended purpose.

Additional Criteria for Anaerobic Lagoons

Loading Rate. Anaerobic lagoons shall be designed to have a minimum treatment volume based on Volatile Solids (VS) loading per unit of volume. The maximum loading rate shall be 12 pounds of VS per 1,000 cubic feet per day.

Operating Levels. The maximum operating level shall be the lagoon level that provides the required volume less the 25-year, 24-hour storm event precipitation on the surface of the lagoon. The maximum drawdown level shall be the lagoon level that provides volume for the required minimum treatment volume plus the volume of accumulated sludge between sludge removal events. Permanent markers shall be installed at these elevations. The proper operating range of the lagoon is above the maximum drawdown level and below the maximum operating level. These markers shall be referenced and described in the O&M plan.

Depth Requirements. The minimum depth at maximum drawdown shall be 6 feet. If subsurface conditions prevent practicable construction to accommodate the minimum depth at maximum drawdown, a lesser depth may be used, if the volume requirements are met.

Additional Criteria for Naturally Aerobic Lagoons

Loading Rate. Naturally aerobic lagoons shall be designed to have a minimum treatment surface area as determined on the basis of daily BOD_5 loading per unit of lagoon surface. The required minimum treatment surface area shall be the surface area at maximum drawdown. The maximum loading rate shall be 50 pounds of BOD5 per acre per day.

Operating Levels. The maximum operating level shall be the lagoon level that provides the required volume less the 25-year, 24-hour storm event on the lagoon surface. The maximum drawdown level shall be the lagoon level that provides volume for the volume of manure, wastewater, and clean water accumulated during the treatment period plus the volume of accumulated sludge between sludge removal events. Permanent markers shall be installed at these elevations. The proper operating range of the lagoon is above the maximum drawdown level and below the maximum operating level. These markers shall be referenced and described in the Operation and Maintenance Guide.

Depth Requirements. The minimum depth at maximum drawdown shall be 2 feet. The maximum liquid level shall be 5 feet.

Additional Criteria for Mechanically Aerated Lagoons

Loading Rate. Mechanically aerated waste treatment lagoons' treatment function shall be designed on the basis of daily BOD_5 loading and aeration equipment manufacturer's performance data for oxygen transfer and mixing. Aeration equipment shall provide a minimum of 1 pound of oxygen for each pound of daily BOD_5 loading.

Operating Levels. The maximum operating level shall be the lagoon level that provides the required lagoon volume less the 25-year, 24-hour storm event precipitation and shall not exceed the site and aeration equipment limitations. A permanent marker or recorder shall be installed at this elevation. The proper operating range of the lagoon is below this elevation and above the minimum treatment elevation established by the manufacturer of the aeration equipment. This marker shall be referenced and described in the O&M plan.

CONSIDERATIONS

General

Lagoons should be located as close to the source of waste as possible.

Table 2- Potential Impact Categories from Breach of Embankment or Accidental Release

1. Surface water bodies -- perennial streams, lakes, wetlands, and estuaries
2. Critical habitat for threatened and endangered species
3. Riparian areas
4. Farmstead, or other areas of habitation
5. Off-farm property
6. Historical and/or archaeological sites or structures that meet the eligibility criteria for listing in the National Register of Historical Places

Solid/liquid separation treatment should be considered between the waste source and the lagoon to reduce loading.

The configuration of the lagoon should be based on the method of sludge removal and method of sealing.

Due consideration should be given to economics, the overall waste management system plan, and safety and health factors.

Considerations for Minimizing the Potential for and Impacts of Sudden Breach of Embankment or Accidental Release from the Required Volume

Features, safeguards, and/or management measures to minimize the risk of embankment failure or accidental release, or to minimize or mitigate impact of this type of failure should be considered when any of the categories listed in Table 2 might be significantly affected.

The following should be considered either singly or in combination to minimize the potential of or the consequences of sudden breach of embankments when one or more of the potential impact categories listed in Table 2 may be significantly affected:

- An auxiliary spillway
- Additional freeboard
- Storage volume for the wet year rather than normal year precipitation
- Reinforced embankment -- such as, additional top width, flattened and/or armored downstream side slopes
- Secondary containment
- Water level indicators or recorders

The following should be considered to minimize the potential for accidental release from the required volume through gravity outlets when one or more of the potential impact categories listed in Table 2 may be significantly affected:

- Outlet gate locks or locked gate housing
- Secondary containment
- Alarm system
- Another means of emptying the required volume

Considerations for Minimizing the Potential of Lagoon Liner Seepage

Consideration should be given to providing an additional measure of safety from lagoon seepage when any of the potential impact categories listed in Table 3 may be affected.

Table 3 - Potential Impact Categories for Liner Seepage

1. Any underlying aquifer is at a shallow depth and not confined
2. The vadose zone is rock
3. The aquifer is a domestic water supply or ecologically vital water supply
4. The site is located in an area of carbonate rock (limestone or dolomite)

Should any of the potential impact categories listed in Table 3 be affected, consideration should be given to the following:

- A clay liner designed in accordance with procedures of AWMFH, Appendix 10D with a thickness and coefficient of permeability so that specific discharge is less than 1 x 10^{-6} cm/sec (12.4 inches per year).
- A flexible membrane liner
- A geosynthetic clay liner (GCL) flexible membrane liner
- A concrete liner designed in accordance with slabs on grade criteria, Waste Storage Facility (313), for fabricated structures requiring water tightness.

Considerations for Improving Air Quality

To reduce emissions of greenhouse gases, ammonia, volatile organic compounds, and odor:

- Reduce the recommended loading rate for anaerobic lagoons to one-half the values given in AWMFH Figure 10-22.
- Use additional practices such as Anaerobic Digester (366), Roofs and Covers (367) and Composting Facility (317) in the waste management system.
- Liquid/solid separation prior to discharge to lagoon will reduce volatile solids (VS) loading resulting in reduced gaseous emissions and odors. Composting of solids will further reduce emissions.
- Design lagoons to be naturally aerobic or to allow mechanical aeration.

Adjusting pH below 7 may reduce ammonia emissions from the lagoon but may increase odor when waste is surface applied (See Waste Utilization, code 633).

PLANS AND SPECIFICATIONS

Designs (drawings and specifications) shall be prepared in accordance with the criteria of this standard and shall describe the requirements for applying the practice to achieve its intended use.

Drawings shall include:

- A plan layout of the pond, embankment, and adjacent area with topographic contours,
- Profile and cross section of the embankment and auxiliary spillway,
- Inlet and outlet pipeline details such as dimensions and material requirements,
- Quantities of materials required, such as: earth cut and fill yardage; yardage of concrete, pounds of steel reinforcement; and length of pipes, etc.

For ponds that require a lining, the lining requirements shall be incorporated into the drawing.

The drawings shall specify the recommended species, planting method, and fertilizer for protective vegetation on the embankment and other exposed areas.

OPERATION AND MAINTENANCE

The Pacific Islands Area operation and maintenance plan for this practice shall be developed for and reviewed with the client that is consistent with the purposes of the practice, its intended life, safety requirements, and the criteria for design. The plan shall contain the operational requirements for drawdown and the role of permanent markers. This shall include the requirement that waste be removed from the lagoon and utilized at locations, times, rates, and volume in accordance with the overall waste management system plan. In addition, the plan shall include a strategy for removal and disposition of waste with least environmental damage during the normal treatment period to the extent necessary to insure the lagoon's safe operation. This strategy shall also include the removal of unusual storm events.

Development of an emergency action plan should be considered for lagoons where there is a potential for significant impact from breach or accidental release. The plan shall include site-specific provisions for emergency actions that will minimize these impacts.

NATURAL RESOURCES CONSERVATION SERVICE
PACIFIC ISLANDS AREA

CONSERVATION PRACTICE SPECIFICATION

IRRIGATION PIPELINE (430)
(PLASTIC PIPE)

SCOPE

The work shall consist of furnishing and installing thermoplastic pipe and necessary appurtenances to the alignment, grades, and dimensions as shown on the drawings and/or staked in the field. The work also includes site preparation, earth fill, excavation, and any other applicable practice necessary for installation as shown on the drawings. This specification only applies to pipelines used as part of an irrigation system. Unless otherwise specified, the pipe shall conform to the requirements listed in this specification, NRCS-PI Irrigation Pipeline (430) Standard, and the requirements shown on the drawings.

SAFETY

Landowners or operators, sponsoring organizations, and contractors shall be liable for damage to utilities and damage resulting from disruption of service caused by construction activities. The Natural Resources Conservation Service makes no representation on the existence or non-existence of any utilities. Absence of utilities on the drawings is not assurance that no utilities are present at the site.

It is the responsibility of the landowner or operator to determine if there are buried or overhead utilities in the vicinity of the proposed work. They should take proper procedures to ensure that the utilities shall not be jeopardized and that equipment operators and others will not be injured during construction operations.

MATERIALS

This section covers the quality and requirements of Polyvinyl Chloride (PVC), corrugated Polyethylene (PE), High Density Polyethylene (HDPE), and Acrylonitrile-Butadiene-Styrene (ABS) plastic pipe, fittings, and joint materials.

Material/Polymer requirements. Pipe and fittings materials shall meet the minimum cell classification and material designation as stated in **Table 1.**

Pipe requirements. Manufactured pipe shall meet the applicable ASTM/AWWA standards listed in **Table 2.** Except for corrugated PE, all pipes shall be pressure-rated for water. ABS pipe shall be of solid wall construction.

Pipe shall be as uniform as commercially practicable in color, opaqueness, density, and other specified properties. It shall be free of visible cracks, holes, foreign inclusions, sunburn, bleaching, or other defects. The dimensions of the pipe shall be measured as prescribed in ASTM Standard D2122.

Wall thickness. The wall thickness for all pipe installed under this standard, regardless of pressure rating or type, shall not be less than 0.060 inches.

Pipe joints and fittings. All fittings shall meet or exceed the same strength, pressure, and dimension requirements as those of the pipe and shall be made of material that is recommended for use with the pipe. Joints and fittings shall meet the applicable ASTM specification and shall be used and installed according to the recommendations of the manufacturer.

Solvent for solvent cement joints shall conform to ASTM specifications D-2564 for PVC pipe and fittings and D-2235 for ABS pipe and fittings.

Fittings or belled ends for solvent cement joints shall have tapered sockets with socket lengths as per ASTM D2672. Sleeves for clamp-type joints shall provide a minimum of 4 inches overlap between the sleeve and the pipe or fitting.

Table 1 - Material Requirements

Material	Cell Class	Allowable Material Designation	Applicable Material Specification
Polyvinyl Chloride	12454	PVC1120	ASTM D1784
		PVC1220	
	14333	PVC2120	
Polyethylene	345464C or greater	PE3408 or greater	ASTM D3350 ASTM F2306 (corrugated PE)
Acrylonitrile-Butadiene-Styrene	20643 or greater	ABS1210 or greater	ASTM D3965

Table 2 - Applicable Pipe Standards

Material	PVC	PE	Corrugated PE	ABS
Applicable Specification	ASTM D1785 ASTM D2241 ASTM D2672 AWWA C900 AWWA C905	ASTM D2239 ASTM D3035 ASTM F714 ASTM F771 AWWA 906	ASTM F2306 AWWA 906	ASTM D1527

Rubber gasket joints. Rubber gasket joints shall conform to ASTM Specification D3139 for pressure pipe or D3212 for corrugated PE pipe. All rubber gaskets shall conform to ASTM F477. Gasket lubricant shall be suitable for use in water transmission applications. The gasket shall be the sole element depended upon to make the joint flexible and water tight. All surfaces of the joint upon or against which the gasket may bear, shall be smooth, free of cracks, fractures, or imperfections that could adversely affect the integrity of the joint.

Markings. Fitting markings shall include, as a minimum, the following information:

- Manufacturer's name or trademark
- Nominal size
- Pipe Schedule/pressure class/rating for water at 73 degrees F
- Materials name and designation (PVC1120, PE3408, etc)
- Recognized standard to which fitting is designed and manufactured

Pipe markings shall be repeated at a minimum interval of 5 ft along the pipe and shall include, in addition to fitting marking requirements, the following information:

- Specific production code including month and year
- Outside diameter base/system (IPS, PIP, etc)

INSTALLATION

Construction activities shall follow all OSHA standards and regulations. All work shall be neat and of a professional quality, as determined by the engineer.

Site preparation. Site preparation (mobilization and demobilization, clearing and grubbing, structure removal, pollution control, and water for construction) shall follow NRCS PI Supplemental Construction Specifications or others as appropriate.

Pipe storage. If pipe is stored outside for more than 15 days, it shall be covered by a durable, light-colored, opaque material, and vented to prevent heat buildup. Avoid awkward placement of pipe that could affect pipe integrity and strength.

HDPE pipe installed on the surface. Polyethylene plastic pipe, PE-3408 or better, up to 4-inch diameter, may be laid on the ground surface at locations where minimal hazards are imposed by fire, farm operations, traffic, vandalism, or theft. Snaking the pipe is necessary for surface pipes and an additional minimum 4% must be added to the length to accommodate the expansion and contraction. Surface pipe laid on steep slopes shall be anchored to control creep and resulting added stresses at intervals of no less than 200 feet. At vehicle crossings, burial, encasement of pipe, or other approved methods shall be used.

Depth of cover. Pipe shall be installed at sufficient depth below the ground surface to provide protection from hazards imposed by traffic crossings, farming operations, freezing temperatures, or soil cracking. The minimum depth of cover for pipe susceptible to any of these hazards shall be according to **Table 3.**

In areas where the pipe will not be susceptible to freezing and vehicular or cultivation hazards, and the soils do not crack appreciably when dry, the minimum depth of cover may be reduced to the values in **Table 4.**

Table 3 - Normal Minimum Cover Depth

Pipe diameter (in)	Depth of cover (in.)
½ through 2-1/2	18
3 through 5	24
6-18	30
More than 18	36

Table 4 - Non-Hazardous Minimum Cover Depth

Pipe diameter (in)	Depth of cover (in.)
½ through 1-1/2	6
2 through 3	12
4 through 6	18
More than 6	24

At locations where extra protection is needed such as vehicle crossings, encasement pipe or other approved methods shall be used.

In areas where burning is very likely, such as in sugarcane fields, the pipe shall be buried a minimum of 18 inches. Where peat or muck exists in their normal layered pattern, solvent-welded joints shall be used at all connections of PVC pipe. Where coarse sand or cement layers exist, rubber gasket joints may be used following normal bedding procedures.

In shallow trenches, extra fill may be placed over the pipeline to provide the minimum depth of cover. The top width of the fill shall be no less than 2 feet wider than the trench and the side slopes no steeper than 6H:1V. If extra protection is needed at vehicle crossings, encasement pipe or other approved methods may be used.

Minimum cover for corrugated PE is 12 inches. The maximum depth of cover for all plastic pipe sizes shall be 4 feet.

Trench construction. Provisions shall be made to insure safe working conditions where unstable soil, trench depth, or other conditions can be hazardous to personnel working in the trench.

The minimum width of the trench shall be wide enough to permit the pipe to be easily placed and joined and to allow the initial backfill material to be uniformly placed and compacted under the haunches and along the side of the pipe. The trench width shall depend upon the type of compaction of the backfill, and the width shall be the pipe diameter plus:

a. For water saturation - not less than 12 inches or more than 15 inches.
b. For mechanical compaction - not less than 24 inches or more than 36 inches.

If the trench is precision excavated and has a semicircular bottom that fits the pipe, the width shall not exceed the outside diameter of the pipe by more than 10 percent.

The trench bottom shall be uniform so that the pipe lies on the bottom without bridging. Clods, rocks, and uneven spots that provide non-uniform support or can damage the pipe or shall be removed.

If rocks or any other materials that can damage the pipe are encountered, the trench bottom shall be undercut a minimum of 4 inches below final grade and filled with bedding material consisting of sand or compacted fine-grained soils no greater than ½" diameter.

Pipelines having a diameter of ½ through 2-1/2 inches that are placed in areas not subject to vehicular loads and in soils that do not crack appreciably when dry, may be placed by using "plow-in" equipment instead of conventional trenching.

Pipe Placement. Care shall be taken to prevent permanent distortion and damage when handling the pipe. The pipe shall assume near-soil temperature before placing backfill. The pipe shall be uniformly and continuously supported over its entire length on firm stable material. Blocking or mounding shall not be used to bring the pipe to final grade.

If the pipe is assembled above ground, it should be lowered into the trench, taking care to not drop it or damage it against the trench walls.

Joints and connections. All joints and connections shall be installed to withstand the design maximum pressure for the pipeline without leakage. The inside of the pipe shall be free of any obstruction that may reduce its capacity below the design requirements.

For pipe with bell joints, bell holes shall be excavated in the bedding material, as needed, to allow for unobstructed assembly of the joint and to permit the body of the pipe to be in contact with the bedding material throughout its length.

The maximum bell joint deflection shall follow the manufacturer's recommendation. In curved sections, where joint deflection is greater than recommended, deflection couplings or elbows shall be used. A pipe section shall never be bent, deformed, blocked, or braced to hold a curve.

Allow heat fused and solvent-cemented joints to cool or cure for the minimum prescribed time before moving the pipe.

Fittings made of steel or other metals susceptible to corrosion shall be adequately protected by being wrapped with plastic tape or by being coated with a substance that has high corrosion-preventative qualities. If plastic tape is used, all surfaces shall be thoroughly cleaned and coated with a primer compatible with the tape before wrapping.

Thrust blocks. Thrust blocks shall be used at all major changes in alignment, under valves, intersections, and dead ends. Thrust blocks must be formed against a solid hand-excavated trench wall undamaged by mechanical equipment. They shall be constructed of concrete with a compressive strength of no less than 2000-psi and framed with wood or soil to restrain the freshly placed concrete. The space between the pipe and trench wall shall be filled with concrete to the height of the outside diameter of the pipe or as specified by the manufacturer. Allow sufficient time for concrete to cure before burying the thrust block or pressurizing the pipe.

Tracer wire. Where pipes are located close to utilities, roads, right-of-ways, in locations where development is anticipated, or as indicated in the drawings, tracing wire shall be installed. At a minimum, 14 gauge braided copper tracer wire shall be secured to the top of the pipes and shall surface at all ends and air vents. Wire shall be continuous or have an approved splice. Tracer tape is acceptable.

Water testing. The pipeline shall be tested for pressure strength, leakage, and proper functioning. The tests may be performed before backfilling or anytime after the pipeline is ready for service. Partial backfills needed to hold the pipe in place during testing shall be placed as specified in the **Initial backfill** section.

The line shall be slowly filled with water. Adequate provisions shall be made for air release during filling operations, taking care to bleed all entrapped air. The pressure shall be slowly built up to the maximum design working pressure of the system. While this pressure is maintained, all exposed pipe fittings, valves, hydrants, joints, appurtenances, and covered parts of the line shall be examined for leaks. Any leaks shall be repaired and the system retested.

The pipeline shall be tested to insure that it functions properly at design capacity. At or below design capacity, there shall be no objectionable flow conditions.

Initial backfill. Normally, hand, mechanical, or water packing methods may be used; however, all special backfilling recommendations of the pipe manufacturer shall be met.

The initial backfill material shall be soil or sand that is free from rocks or stones larger than 1 inch in diameter and earth clods greater than about 2 inches in diameter. Initial backfill shall extend 6 inches above the top of the pipe.

At the time of placement, the moisture content of the material shall be such that the required degree of compaction can be obtained with the backfill method to be used. The material shall be placed so that the pipe will not be displaced, deformed, or damaged.

If backfilling is done by hand or mechanical means, the initial fill shall be compacted firmly around and above the pipe as required to provide adequate lateral support to the pipe.

If the water packing method is used, to prevent floating the pipe, the pipeline first shall be filled with water and remain full until after the final backfill is complete. The initial backfill before saturation shall be of sufficient depth to insure complete coverage of the pipe after consolidation. Water packing is accomplished by adding enough water to diked reaches of the trench to thoroughly saturate the initial backfill without excessive pooling. The wetted fill shall be allowed to dry until firm before beginning the final backfill.

Final backfill. All special backfilling requirements of the pipe manufacturer shall be met.

The final backfill material shall be free of large rocks and other debris greater than 3 inches in diameter. The material shall be placed and spread in approximately uniform layers so that there will be no unfilled spaces in the backfill and the backfill will be level or slightly mounded with the natural ground or at the design grade required to provide the minimum depth of cover after settlement. Rolling equipment shall not be used to consolidate the final backfill until the specified minimum depth of cover has been placed.

Exposed PVC. Exposed PVC shall be specifically manufactured for use in above ground applications or shall be coated with a heavily pigmented latex or acrylic paint, chemically compatible with PVC. While color is not particularly important for UV protection, the use of light paint colors will reduce pipe temperature.

Above-ground pipe installation. Saddles and supports shall be installed and constructed as designed by the engineer and shall be approved prior to commencement of construction.

Vegetative cover. Permanent vegetation will be established following Conservation Practice Standard 342, Critical Area Planting.

CONSTRUCITON OPERATIONS AND WORKMANSHIP

Construction operations shall be carried out in such a manner and sequence that air and water pollution and erosion are minimized and held within legal limits.

The owner, operator, contractor, or other persons will conduct work and operations will conduct all work and operations in accordance with proper safety codes for the type of construction being performed with due regards to the safety of all persons and property.

All construction shall be performed in a workmanlike manner, and the job site shall have a neat appearance when finished.

QUALITY ASSURANCE AND GUARANTEE

The contractor shall contact the local NRCS office at least 24 hours in advance of any pipe that will be buried for quality assurance checks relating to pipe grade and appurtenances, bedding conditions, trench width and depth, and suitability of backfill material. Pipe and appurtenances that are of questionable quality (sun burnt PVC, gouged pipe, etc.) shall be subject to rejection at NRCS discretion.

The manufacturer or supplier of pipe materials shall supply a statement certifying that all pipe and materials have met the standards and specifications as described in this specification, as applicable.

The installing contractor shall certify that the installation complies with the requirements of this specification and NRCS Conservation Practice Standard 430. They shall furnish a written guarantee that protects the owner against defective workmanship and materials for not less than 1 year and that identifies the manufacturer and markings of the pipes used.

If requested by the engineer, a qualified testing laboratory shall certify with supporting test results that the pipe meets the requirements in this specification.

MEASUREMENT

The quantity of each size, type, and class of pipe shall be determined to the nearest foot by measurement of the laid length of pipe along the crown centerline of the conduit.

BASIS OF ACCEPTANCE

The acceptability of this practice shall be determined by inspections to insure compliance with all provision of this specification and to the drawings.

REFERENCE DOCUMENTS

American Society for Testing and Materials (ASTM)

ASTM D1527	Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Schedules 40 and 80
ASTM D1784	Standard Specification for Rigid PVC Compounds and Chlorinated PVC Compounds
ASTM D1785	Standard Specification for PVC Plastic Pipe, Schedules 40, 80, and 120
ASTM D2122	Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
ASTM D2235	Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings
ASTM D2239	Standard Specification for Polyethylene Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
ASTM D2241	Standard Specification for PVC Pressure-Rated Pipe (SDR Series)
ASTM D2466	Standard Specification for PVC Plastic Pipe Fittings, Schedule 40
ASTM D2467	Standard Specification for PVC Plastic Pipe Fittings, Schedule 80
ASTM D2564	Standard Specification for Solvent Cements for PVC Plastic Piping Systems
ASTM D2609	Standard Specification for Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe
ASTM D2672	Standard Specification for Joints for IPS PVC Pipe Using Solvent Cement
ASTM D2683	Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
ASTM D3035	Standard Specification for Polyethylene Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D3139	Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D3212	Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D3261	Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D3350	Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
ASTM D3965	Standard Specification for Rigid Acrylonitrile-Butadiene-Styrene (ABS) Materials for Pipe and Fittings
ASTM F477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F714	Standard Specification for Polyethylene Plastic Pipe (SDR-PR) Based on Outside Diameter
ASTM F771	Standard Specification for Polyethylene (PE) Thermoplastic High-Pressure Irrigation Pipeline Systems
ASTM F2306	Standard Specification for 12-in to 60-in Annular Corrugated Profile-Wall Polyethylene Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications

American Water Works Association (AWWA)

AWWA C900	Standard for PVC Pressure Pipe and Fabricated Fittings for Water Transmission and Distribution, 4-in though 12-in
AWWA C905	Standard for PVC Pressure Pipe and Fabricated Fittings for Water Transmission and Distribution, 14-in through 48-in
AWWA C906	Standard for PE Pressure Pipe and Fittings for Water Distribution and Transmission, 4-in through 63-in

NATURAL RESOURCES CONSERVATION SERVICE
PACIFIC ISLANDS AREA

CONSERVATION PRACTICE STANDARD

IRRIGATION SYSTEM, SPRINKLER

(Ac.)

CODE 442

DEFINITION

An irrigation system in which all necessary equipment and facilities are installed for efficiently applying water by means of nozzles operated under pressure.

PURPOSE

This practice may be applied as part of a resource management system to achieve one or more of the following purposes:

- Efficiently and uniformly apply irrigation water to maintain adequate soil water for the desired level of plant growth and production without causing excessive water loss, erosion, or water quality impairment.
- Climate control and/or modification.
- Applying chemicals, nutrients, and/or waste water.
- Leaching for control or reclamation of saline or sodic soils.
- Reduction in particulate matter emissions to improve air quality.
- Reduce energy use.

CONDITIONS WHERE PRACTICE APPLIES

The sprinkler method of water application is suited to most crops, irrigable lands, and climatic conditions where irrigated agriculture is feasible. Areas must be suitable for irrigation or sprinkler water application and have an adequate supply of suitable quality water available for the intended purpose(s).

This standard applies to the planning and design of the overall water application through sprinkler discharge systems. This standard pertains to the planning and functional design of all sprinkler components except for special structures, such as permanently installed main and lateral pipelines or pumping plants. Other components shall meet appropriate NRCS Conservation Practice Standards.

This standard does not include criteria for mini- or micro-sprinkler systems, which are covered by NRCS Conservation Practice Standard, Irrigation System, Microirrigation (441).

CRITERIA

General Criteria Applicable to All Purposes

The criteria for the design of components not addressed in NRCS practice standards shall be consistent with sound engineering principles.

Each sprinkler discharge system must be designed as an integral part of an overall plan of conservation land use and treatment for the intended purpose(s) based on the capabilities of the land and the needs of the operator. The selected system shall be based on a site evaluation, expected operating conditions, and verification that soils, topography, *and water quantity and quality* are suitable for the intended purpose(s).

***Water Meter**. All systems installed under this practice, shall have an approved water meter, such as from the local utility, as an integral part of the system.*

Depth of Application. Net depth of application shall meet criteria for the intended purpose, not exceeding the available soil water holding capacity *of the active root zone plus the leaching fraction*, and meeting the land user's management plan for the intended purpose.

Capacity. The sprinkler irrigation system shall be designed with adequate capacity to accomplish the primary purpose(s) of the system.

Design Application Rate. Rates shall be selected such that runoff, translocation, and unplanned deep percolation are minimized.

Additional conservation measures, such as furrow diking, dammer diking, in-furrow chiseling, conservation tillage or residue management shall be applied as needed and appropriate.

Distribution Patterns, Nozzle Spacing and Height. A combination of sprinkler spacing, nozzle size, and operating pressure that provides the design application rate and distribution shall be selected.

Coefficient of Uniformity (CU) data or distribution uniformity (DU) shall be used in selecting sprinkler spacing, nozzle size, and operating pressure. Definitions of each of these uniformity values can be found in the NRCS National Engineering Handbook, Part 652, Irrigation Guide.

Pipelines. The design of main lines, submains, and supply lines shall insure that required water quantities can be conveyed to all operating lateral lines at required pressures. For detailed criteria, see NRCS Conservation Practice Standard, Irrigation Pipeline (430).

Pump and Power Unit. Where required, pump and power units shall be adequate to efficiently operate the sprinkler system at design capacity and total dynamic head. For detailed criteria, see NRCS Conservation Practice Standard, Pumping Plant (533). *Certain systems may benefit from the use of variable frequency drives.*

Management Plan. An Irrigation Water Management plan, meeting NRCS Conservation Practice Standard, Irrigation Water Management (449), shall be developed for this practice, unless the purpose of the practice is waste water application. Where implemented for waste application, as a component of a Comprehensive Nutrient Management Plan (CNMP), a waste utilization plan and/or nutrient management plan shall be developed that meets the requirements of NRCS Conservation Practice Standards, Waste Utilization (633) and Nutrient Management (590), as appropriate.

Additional Criteria Applicable to Center Pivot or Linear-Move Sprinkler Systems

Design Capacity. Sprinkler systems shall be designed to have the capacity to meet the primary purpose. For the purpose of crop irrigation, sprinkler irrigation systems shall have either (1) a design capacity adequate to meet peak water demands of all irrigated crops in the design area, or (2) adequate capacity to meet requirements of selected irrigations during critical crop growth periods when less than full irrigation is planned.

In computing capacity requirements, allowance must be made for reasonable application water losses.

Distribution Patterns, Nozzle Spacing and Height. Pivot system (Heermann-Hein) or Linear (Christensen) CU shall not be less than 85% (76% DU), except as noted in criteria for a Low Energy Precision Application (LEPA) system. In lieu of the manufacturer's CU information, simulation modeling shall use Agricultural Research Service model Center Pivot Evaluation and Design (CPED) or similar modeling software. Manufacturer's information on nozzle packaging, allowing exclusion of the end gun and the first 12 percent of pivot length, not to exceed 250 feet, shall be considered acceptable documentation of system CU.

In the absence of CU data, sprinkler performance tables provided by the manufacturer shall be used in selecting nozzle size, operating pressure, and wetted diameter for the required sprinkler discharge. To the extent possible, low pressure spray nozzles shall be at uniform heights along the length of the lateral, with the exception of height adjustment to increase wetted diameter for runoff control. From a point midway between the first and second tower to the distal end of a center pivot, spray nozzle spacing along lateral lines shall not exceed 25% of the effective wetted diameter and impact sprinkler spacing shall not exceed 50 percent of the effective wetted diameter. The effective wetted diameter shall be determined from manufacturer's information for the nozzle height.

Lower elevation nozzle application systems, typically less than 7 feet from ground surface, that discharge water in the crop canopy for a considerable length of time during the growing season shall also meet the criteria of a Low Pressure in Canopy (LPIC) system as defined in this standard.

Additional Criteria Applicable to LEPA and Low Elevation Spray Application (LESA) Center Pivot or Linear-Move Sprinkler Systems

Distribution Patterns. For center pivot systems, nozzle discharge CU using the Heermann-Hein weighted area method shall be used in selecting sprinkler spacing, nozzle size, and operating pressure. Nozzle discharge CU shall not be less

than 94% of the calculated design flow rate needed at the discharge point. For linear systems, discharge shall be based on equivalent unit areas.

Nozzle Spacing. Nozzle spacing shall not be greater than two times the row spacing of the crop, not to exceed 80 inches.

Specific Additional Criteria for LEPA

Discharge Height. Water shall discharge through a drag sock or hose on the ground surface, or through a nozzle equipped with a bubble shield or pad at a uniform height not to exceed 18 inches.

Row Arrangement and Storage. LEPA systems are only applicable on crops planted with furrows or beds. LEPA systems shall have row patterns that match the lateral line movement (i.e., circular for center pivots). Water shall not be applied in the tower wheel track of a LEPA system. Runoff and translocation under LEPA systems shall be eliminated by providing surface basin storage such as furrow dikes, dammer dikes, or implanted reservoirs.

Slope. The slope for a LEPA system shall not exceed 1.0 percent on more than 50 percent of the field.

Systems that utilize bubble pads or shields, or drag hoses for a portion of the crop year and then spray nozzles at uniform height not exceeding 18 inches for a portion of the crop year shall meet LESA criteria.

Specific Additional Criteria for LESA

Discharge Height. LESA Systems shall discharge water through a spray nozzle at uniform heights not to exceed 18 inches.

Row Arrangement and Storage. LESA Systems are applicable on crops flat planted, drilled, or planted with furrows or beds. LESA Systems should employ some method of providing surface basin storage such as furrow dikes, dammer dikes, or implanted reservoirs, or farming practices such as conservation tillage, in-furrow chiseling, and/or residue management to prevent runoff.

Land Slope. The slope for LESA systems shall not exceed 3.0 percent on more than 50 percent of the field.

Additional Criteria Applicable to LPIC and Mid Elevation Spray Application (MESA) Center Pivot or Linear-Move Sprinkler Systems

Systems that utilize bubble pads or shields or drag hoses for a portion of the crop year and spray nozzles for a portion of the crop year not meeting all of the LEPA or LESA criteria shall meet LPIC criteria.

Distribution Patterns, Nozzle Spacing and Height. For row crops, when nozzles operate in canopy for 50 percent or more of the growing season, nozzle spacing shall not exceed every other crop row. In-canopy heights shall be such that areas of high leaf concentration are avoided (i.e., corn near the ear height (approximately 4 feet)). Local research and Extension Service information with applicable crops may serve as a guide for establishing appropriate nozzle spacing, height, and row arrangement.

CU (Heermann–Hein CU for center pivots) shall not be less than 90% for all LPIC and MESA Systems with nozzle heights less than 7 feet.

CU shall not be less than 85% (76% DU) for MESA Systems with nozzle heights 7 feet or greater.

Land Slope. The slope for LPIC and MESA systems shall not exceed 3.0 percent on more than 50 percent of the field for fine textured soils and not exceed 5 percent on more than 50 percent of the field on coarse textured soils.

Additional Criteria Applicable to Fixed-Solid-set, Big Gun and Periodic Move Sprinkler Systems

Design Capacity. Sprinkler irrigation systems shall have either (1) a design capacity adequate to meet peak water demands of all crops to be irrigated in the design area, or (2) adequate capacity to meet requirements of selected water applications during critical crop growth periods when less than full irrigation is planned. In computing capacity requirements, allowance must be made for reasonable application water losses.

Design Application Rate. The design application rate shall be within a range established by the minimum practical application rate under local climatic conditions, and the maximum application rate consistent with soil intake rate, slope, and conservation practices used on the land. If two or more sets of conditions exist in the design area, the lowest maximum application rate for areas of significant size shall apply.

Lateral Lines. Unless pressure reducers or regulators are installed at each outlet, or other pressure compensating or flow control devices are used, lateral lines shall be designed so that the pressure variation or flow variation at any sprinkler, resulting from friction head and elevation differential, does not exceed 20 percent of the design operating pressure or 10 percent of the design flow of the sprinklers, respectively.

Distribution Patterns and Spacing. A combination of sprinkler spacing, nozzle size, and operating pressure that provides the design application rate and distribution shall be selected.

If available, CU (or DU) data shall be used in selecting sprinkler spacing, nozzle size, and operating pressure. CU shall not be less than the following:

- 75 % (60% DU) for deep-rooted (4 feet or more) field and forage crops where fertilizers and pesticides are not applied through the system.
- 85 % (76% DU) for high-value or shallow-rooted crops and for any crop where fertilizer or pesticides are applied through the system.

In the absence of CU data, maximum lateral and nozzle spacing shall comply with the following criteria:

1. For low (2-35 pounds/square inch (psi))-, moderate (36-50 psi)-, and medium (51-75 psi)-pressure sprinkler nozzles, the spacing along lateral lines shall not exceed 50 percent of the wetted diameter, as given in the manufacturer's performance tables, when the sprinkler is operating at design pressure. The spacing of laterals along the main line shall not exceed 65 percent of this wetted diameter.

If winds that can affect the distribution pattern are likely during critical crop growth periods, spacing should be reduced to 60 percent for average velocities of 1 to 5 miles per hour (mph), to 50 percent for average velocities of 6 to 10 mph, and to 45 percent for average velocities greater than 10 mph.

2. For high-pressure and big gun type sprinklers (>75 psi), the maximum distance (diagonal) between two sprinklers on adjacent lateral lines shall not exceed two-thirds of the wetted diameter under favorable operating conditions

If winds that can affect the distribution pattern are likely during critical crop growth periods, the diagonal spacing should be reduced to 50 percent of the wetted diameter for average velocities of 5 to 10 mph and to 30 percent for average velocities greater than 10 mph. Guidance for towpath spacing of travelers in NRCS National Engineering Handbook (NEH), Part 623, Chapter 11, Sprinkler Irrigation, Table 11-31.

3. Sprinkler spacing requirements for orchards, including subtropical fruits:

a) Triangular pattern. The spacing along lateral lines shall not exceed 65 percent of the effective wetted diameter. The spacing of laterals along the main line shall not exceed 70 percent of the effective wetted diameter.

b) Square or rectangular pattern. The nozzle spacing along the lateral and the lateral spacing along the main line shall not exceed 65 percent of the effective wetted diameter at the design operating pressure.

c) Spacing between sprinklers and lateral lines shall be reduced by 2.5 percent for each mph over 3 mph average wind velocity normally occurring during planned hours of operation.

Risers. Except for under-tree operation, riser pipes used on lateral lines shall be high enough to prevent interference with the distribution pattern when the tallest crop is irrigated. Riser heights shall not be less than shown below:

Sprinkler discharge *(gallons/minute)*	Riser length *(inches)*
Less than 10	6
10-25	9
25-50	12
50-120	18
More than 120	36

Risers over 3 feet in height shall be anchored and stabilized.

Additional Criteria Applicable to Traveling Sprinkler Irrigation Systems

The towpath spacing shall follow the recommendations in NEH, Part 623, Chapter 11, Sprinkler Irrigation, Table 11-31.

Additional Criteria Applicable to Climate Control and/or Modification

Design Capacity. For temperature control, the sprinkler irrigation system shall have sufficient capacity to satisfy the evaporative demand on a minute-by-minute basis throughout the peak use period. NEH, Part 623, Chapter 2, Irrigation

Water Requirements, contains guidance on using sprinkler irrigation systems for temperature control.

For frost protection, the system shall be capable of applying the necessary rate, based on the minimum temperature, maximum anticipated wind speed, and relative humidity, in a uniform manner. The capacity shall be sufficient to supply the demand for the entire crop being protected. NEH, Part 623, Chapter 2, Irrigation Water Requirements, contains guidance on using sprinkler irrigation systems for frost protection.

Additional Criteria Applicable to Chemical, Nutrient and/or Waste Water Application

The installation and operation of a sprinkler irrigation system for the purpose of chemical or nutrient application (chemigation) shall comply with all federal, state and local laws, rules and regulations. This includes backflow and anti-siphon prevention measures. Additionally, surface waters shall also be protected from direct application.

Injectors (chemical, fertilizer or pesticides) and other automatic operating equipment shall be located adjacent to the pump and power unit and installed in accordance with state regulations, or lacking the same, in accordance with manufacturer's recommendation. The chemical injection device shall be within 1 percent of maximum injection rates and easily calibrated and adjustable for all chemicals at the required injection rate.

A reduced pressure principle backflow prevention assembly valve will be installed upstream of chemical injectors in accordance with the standard for the Conservation Practice Standard, Irrigation Pipeline (430).

Sprinkler irrigation systems used to apply waste shall be designed with sprinkler nozzles of sufficient size to prevent clogging. Treatment of the wastewater using solid separators, two stage lagoons, two-stage waste holding ponds, etc., may be needed to reduce percent solids.

Design Application Rate and Timing. Application rates shall meet the levels specified in General Criteria. Timing of chemical applications shall be the minimum length of time it takes to deliver the chemicals and flush the pipelines at rates specified by the label.

Coefficient of Uniformity. If available, CU (or DU) data shall be used in selecting sprinkler spacing, nozzle size, and operating pressure. The CU shall not be less than 70% for wastewater and not less than 85% (76% DU) for chemigation or fertigation. If CU data is not available, distribution patterns and spacing requirements shall be in keeping with the appropriate specific criteria of this standard.

Nutrient and Pest Management. Chemicals, fertilizers and liquid manure shall be applied in accordance with appropriate NRCS Conservation Practice Standards, Nutrient Management (590), Pest Management (595), Waste Utilization (633), and Manure Transfer (634). Chemical or nutrient application amounts shall not exceed these standards.

NEH, Part 623, Chapter 2, Irrigation Water Requirements, contains guidance on using sprinkler irrigation systems for chemigation.

Additional Criteria Applicable to Leaching

Design Application Rate and Depth. Application rates shall meet the levels specified in General Criteria. Design depth shall be determined as defined in NEH, Part 623, Chapter 2, Irrigation Water Requirements.

Management or Reclamation Plan. A plan shall be developed conforming to the requirements contained in NRCS Conservation Practice Standard, Salinity and Sodic Soil Management (610).

Additional Criteria Applicable to Reduction in Particulate Matter Emissions to Improve Air Quality

These criteria pertains to sprinkler systems used to improve air quality by controlling dust emissions from confined animal pen areas and other critical areas such as unpaved roads, staging areas, and equipment storage yards.

Installation of fixed solid set sprinklers or periodic move sprinkler systems for dust control shall conform to the criteria stated above, unless described by criteria in this section. The installation and operation of Sprinkler Systems for dust control on confined animal pen areas shall provide application coverage on the majority of pen areas occupied by livestock, except for feed bunk aprons. The quality of discharge water shall be pathogen free and fit for animal consumption.

Capacity and Application Rate. For dust control, the sprinkler irrigation system shall have sufficient capacity and operational flexibility to apply the design application depth every three days or less. When determining capacity requirements, allowance shall be made for reasonable water losses during application.

The minimum design application rate shall meet the maximum total daily wet soil evaporation rate, with allowances for moisture input to pen areas from animal manure and urine.

Open-lot management practices shall be applied that include scraping and removal of manure in pens between occupations, and shaping of the holding areas to prevent water ponding and chronic wet areas.

Over-application and excessive sprinkler overlap shall be avoided to minimize runoff and reduce odor and fly problems.

Water Amendments. Appropriately labeled chemicals for pest control or dust suppression may be applied through the sprinkler system when designed, installed and operated with appropriate backflow prevention and anti-siphon devices. When chemicals are applied through the sprinkler system, surface waters and livestock watering facilities shall be protected from direct application unless chemical labels indicate that direct application will not negatively impact animal health or water quality.

Distribution Patterns and Spacing. A combination of sprinkler spacing, nozzle size, and operating pressure that provides the design application rate and distribution pattern shall be selected.

Maximum spacing of sprinklers along laterals shall not be greater than 75 percent, and no closer than 50 percent of wetted diameter listed in manufacturer's performance tables. Spacing between lateral shall comply with the following criteria:

1. For medium (51-75 psi)-pressure sprinkler nozzles, the spacing of laterals along the main line shall be no more than 90 percent, and no closer than 70 percent of wetted diameter.
2. For high-pressure sprinklers (>75 psi), the maximum distance between two sprinklers on adjacent lateral lines shall not exceed 100% of wetted diameter.

If winds impact distribution patterns during critical dust emission periods, the system shall be equipped with timer overrides and have the flexibility to be operated manually during periods of lesser wind, such as late evening and early morning.

Risers. Riser pipes used in lateral lines shall be high enough to minimize interference with the distribution pattern. The risers shall be constructed in a manner that provides protection from corrosive soils, equipment damage, and livestock damage. Riser heights shall place the discharge sprinkler not less than 6 feet above ground surface. Risers shall be anchored and stabilized.

System Valves and Controllers. Due to high application rates inherent with large sprinkler nozzle diameters, an automatic irrigation control system shall be utilized for all nozzles greater than 0.5 inch diameter. The automated control system shall utilize electro-hydraulic valves facilitating automatic operation. The valves shall be of a size and quality consistent with standard engineering practice. The operating system shall provide the flexibility to change sprinkling duration in one-minute increments and have a minimum of six start times per-day to provide for adjustment for climate conditions.

Systems shall be equipped with a rain sensor connected to the control valve network set to prohibit system operation during rainfall events.

Manual zone isolation valves shall be incorporated to isolate laterals allowing partial system operation during periods of maintenance and repair.

In areas of uneven or sloping terrain a control valve or low-head drainage device shall be incorporated at each sprinkler to ensure that line drainage to the lowest sprinkler is minimized.

Additional Criteria Applicable to Reduce Energy Use

Provide analysis to demonstrate reduction of energy use from practice implementation.

Reduction of energy use is calculated as average annual or seasonal energy reduction compared to previous operating conditions.

CONSIDERATIONS

When planning this practice the following items should be considered, where applicable:

Application rates near the end of a center pivot may exceed soil intake rate. Light, frequent applications can reduce runoff problems, but may increase soil surface evaporation. Nozzle offsets or booms can be used to reduce peak application rates.

For low suspended nozzle application systems, row arrangement, nozzle spacing, discharge nozzle type and configuration, along with height all impact CU. System design and field management should complement each other to yield the highest CU. In general, circular rows for center pivot systems and straight rows for linear move systems provide higher CU's.

Some aspects of non-uniformity tend to average out throughout the irrigation season while others tend to accumulate. Factors that tend to average out during the irrigation season are climatic conditions and uneven travel speed for systems that start and stop. Factors that tend to accumulate during the irrigation season are nozzle discharge variances due to pressure or elevation differences, surface movement of water, and poor water distribution around field boundaries.

Consider the effects of a center pivot end gun operation on CU. A large end gun may reduce the average CU by 1 percent for each 1 percent of the area covered past the main system hardware.

Consider the on and off effects of center pivot corner arm units and end guns on overall sprinkler performance. Discharges reduce flow in the main tower, significantly lowering the CU.

Beneficial effects of conservation practices applied to limit surface redistribution of water and runoff may diminish over the irrigation season.

The velocity of prevailing winds and the timing of occurrence should be considered when planning a sprinkler system. Systems designed to operate in varied time increments aid in balancing the effects of day and night wind patterns.

Consider filtering or screening the irrigation water before it enters the system if it contains particulate matter, algae, or other material that could plug the sprinkler nozzles.

Drop tubes should be installed alternately on both sides of the mainline and when used in-crop they should have a flexible joint between the gooseneck pipes and the application device. Drops should be weighted or secured in windy areas.

Consider different sprinkler application depths and application rates with hand move and center pivot systems. With hand move systems, the application rates more nearly match the soil infiltration rate so that large irrigations can be applied and the number of hand moves reduced.

With an automated system, such as a center pivot, hand labor is not a major consideration and small applications at high rates are normal.

Fertilizer and chemical application amounts may vary from prior application methods and rates, due to precise applications possible with some sprinkler irrigation systems.

Management of sprinkler irrigation systems normally include utilizing soil water stored in the root zone, especially during critical crop growth stages.

Deflection of spans on center pivots and linear-move systems is common when the lateral is loaded (filled with water). This should be considered when determining nozzle heights. Wheel track depth will also affect nozzle height.

Water distribution is greatly affected by nozzle spacing and height for LPIC and MESA systems. In general, smaller, more closely spaced nozzles will yield a higher uniformity than larger, more widely spaced nozzles.

On center pivot or linear move systems, nozzles should be diverted away from wheel tracks to avoid rutting.

Low pressure systems (35 psi or less) are sensitive to small changes in nozzle pressure. Consider using pressure regulators on all low pressure systems where elevation differences, pumping depth variations, and end gun or corner arm operation can significantly change nozzle discharge and sprinkler uniformity. Also consider installing a pressure gauge at both ends of the sprinkler system to monitor system pressure.

Consider system effects on the water budget, especially the volume and rate of runoff, infiltration, evaporation, transpiration, deep percolation, and ground water recharge.

Consider system effects on erosion and movement of sediment, and soluble and sediment-attached substances carried by runoff.

Consider system effects on soil salinity, soil water or downstream water quality including subsurface drains. Crops may be more sensitive to salts applied to plant foliage during sprinkling than to similar water salinities applied by surface irrigation, subirrigation, and microirrigation. Information on foliar injury from saline water applied by sprinkler irrigation is contained in NEH, Part 623, Chapter 2, Irrigation Water Requirements. If the salt content of the irrigation water is high, other irrigation methods should be considered.

Where wastewater is used for irrigation, timing of irrigation based on prevailing winds should be considered to reduce odor. In areas of high visibility, irrigating at night should be considered. The use of wastewater may reduce the life of the system due to corrosion or abrasion.

When utilized for particulate matter reduction, check to assure adequate animal feeding operation water supplies are available to meet other operating needs, during sprinkler system operation.

Irregularly shaped pen areas that are impractical to treat with a sprinkler system and where potential dust sources may occur should be treated for dust control with tanker water trucks equipped with hoses, or nozzles designed to apply water at rates similar to an equivalent sprinkler system.

Open-feedlot management practices that minimize thickness of loose manure will reduce water demands for dust control, as well as, reduce wet areas and ponding that could increase ammonia emissions.

Water Quality. *Water quality will affect production and must be appropriate for the crop to be grown.*

Elevated levels of electrical conductivity (ECw) will effect production and is specific for each crop.

Elevated levels of Sodium (Na+) or Chloride (Cl-) can cause foliar injury as well.

Test irrigation water to ensure compatibility to the selected crops.

Suspended solids can cause accelerated wear of system components, resulting in decreased irrigation efficiency, and added maintenance expense.

PLANS AND SPECIFICATIONS

Designs (drawings and specifications) for constructing irrigation sprinkler systems shall be in keeping with this standard and shall describe the requirements for properly installing *and operating* the practice to achieve its intended purpose. *As a minimum, the design must include the following:*

- *A location map, showing the scale, north arrow, field number and size, water meter, and crop(s) to be grown.*
- *Depth of active root zone, soil water holding capacity at time of irrigation.*
- *Irrigation application time and rate and soil infiltration rate.*
- *Sprinkler type, nozzle size, operating pressure, flow rate, wetted diameter, and spacing along lateral line.*
- *Instruction on number of sprinklers to operate at one time.*
- *Lateral line diameter and spacing along the main line.*
- *Number and lengths of laterals lines;*
- *Pipe material, pressure rating, and system operating pressure.*
- *Pressure regulator(s) and pressure setting(s) (if needed).*
- *Back-flow prevention valves.*
- *An Irrigation Water Management plan, meeting the NRCS Conservation Practice Standard, Irrigation Water Management (449).*

Designs (drawings and specifications) for permanently installed main lines (Irrigation Pipeline, Code 430) may be incorporated into the sprinkler system design.

OPERATION AND MAINTENANCE

The Pacific Islands Area operation and maintenance plan *shall be prepared for and reviewed with the client, and* must provide specific instructions for operating and maintaining the system to insure that it functions properly. It should also provide information regarding periodic inspections and prompt repair or replacement of damaged components. The plan, at minimum, shall include provisions to address the following:

- Periodic checks and removal of debris and sediment as necessary from nozzles to assure proper operation.
- Inspection or testing of all pipeline and pumping plant components and appurtenances, as applicable.
- Regular testing of pressures and flow rates to assure proper operation.
- Periodic checks of all nozzles and spray heads for proper operation and wear.
- Routine maintenance of all mechanical components in accordance with the manufacturer's recommendations.
- Prior to retrofitting any electrically powered irrigation equipment, electrical service must be disconnected and the absence of stray electrical current verified.

REFERENCES

USDA-NRCS, National Engineering Handbook, Part 623, Chapter 2, Irrigation Water Requirements

USDA-NRCS, National Engineering Handbook, Part 623, Chapter 11, Sprinkler Irrigation

Sprinkle and Trickle Irrigation, Keller and Bliesner, 2000

Agricultural Salinity Assessment and Management, ASCE, 1990

NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

IRRIGATION WATER MANAGEMENT

(Ac.)
CODE 449

DEFINITION

The process of determining and controlling the volume, frequency and application rate of irrigation water in a planned, efficient manner.

PURPOSE

- Manage soil moisture to promote desired crop response
- Optimize use of available water supplies
- Minimize irrigation induced soil erosion
- Decrease non-point source pollution of surface and groundwater resources
- Manage salts in the crop root zone
- Manage air, soil, or plant micro-climate
- Proper and safe chemigation or fertigation
- Improve air quality by managing soil moisture to reduce particulate matter movement

CONDITIONS WHERE PRACTICE APPLIES

This practice is applicable to all irrigated lands.

An irrigation system adapted for site conditions (soil, slope, crop grown, climate, water quantity and quality, air quality, etc.) must be available and capable of efficiently applying water to meet the intended purpose(s).

CRITERIA

General Criteria Applicable to All Purposes

Irrigation water shall be applied in accordance with federal, state, and local rules, laws, and regulations. Water shall not be applied in excess of the needs to meet the intended purpose.

Measurement and determination of flow rate is a critical component of irrigation water management and shall be a part of all irrigation water management purposes.

The irrigator or decision-maker must possess the knowledge, skills, and capabilities of management coupled with a properly designed, efficient and functioning irrigation system to reasonably achieve the purposes of irrigation water management.

An "Irrigation Water Management Plan" shall be developed to assist the irrigator or decision-maker in the proper management and application of irrigation water.

Irrigator Skills and Capabilities. Proper irrigation scheduling, in both timing and amount, control of runoff, minimizing deep percolation, and the uniform application of water are of primary concern. The irrigator or decision-maker shall possess or obtain the knowledge and capability to accomplish the purposes which include:

A. General

1. How to determine when irrigation water should be applied, based on the rate of water used by crops and on the stages of plant growth and/or soil moisture monitoring.

2. How to determine the amount of water required for each irrigation, including any leaching needs.
3. How to recognize and control erosion caused by irrigation.
4. How to measure or determine the uniformity of application of an irrigation.
5. How to perform system maintenance to assure efficient operation.
6. Knowledge of "where the water goes" after it is applied considering soil surface and subsurface conditions, soil intake rates and permeability, crop root zones, and available water holding capacity.
7. How to manage salinity and shallow water tables through water management.
8. The capability to control the irrigation delivery.

B. Surface Systems

1. The relationship between advance rate, time of opportunity, intake rate, and other aspects of distribution uniformity and the amount of water infiltrated.
2. How to determine and control the amount of irrigation runoff.
3. How to adjust stream size, adjust irrigation time, or employ techniques such as "surge irrigation" to compensate for seasonal changes in intake rate or to improve efficiency of application.

C. Subsurface Systems

1. How to balance the relationship between water tables, leaching needs, and irrigation water requirements.
2. The relationship between the location of the subsurface system to normal farming operations.
3. How to locate and space the system to achieve uniformity of water application.
4. How to accomplish crop germination in arid climates and during dry periods.

D. Pressurized Systems

1. How to adjust the application rate and/or duration to apply the required amount of water.
2. How to recognize and control runoff.
3. How to identify and improve uniformity of water application.
4. How to account for surface storage due to residue and field slope in situations where sprinkler application rate exceeds soil intake rate.
5. How to identify and manage for weather conditions that adversely impact irrigation efficiency and uniformity of application.

System Capability. The irrigation system must be capable of applying water uniformly and efficiently and must provide the irrigator with adequate control over water application.

Additional Criteria to Manage Soil Moisture to Promote Desired Crop Response

The following principles shall be applied for various crop growth stages:

- The volume of water needed for each irrigation shall be based on plant available water-holding capacity of the soil for the crop rooting depth, management allowed soil water depletion, irrigation efficiency and water table contribution.
- The irrigation frequency shall be based on the volume of irrigation water needed and/or available to the crop, the rate of crop evapotranspiration, and effective precipitation.

- The application rate shall be based on the volume of water to be applied, the frequency of irrigation applications, soil infiltration and permeability characteristics, and the capacity of the irrigation system.

Appropriate field adjustments shall be made for seasonal variations and field variability.

Additional Criteria to Optimize Use of Water Supplies

Limited irrigation water supplies shall be managed to meet critical crop growth stages.

When water supplies are estimated to be insufficient to meet even the critical crop growth stage, the irrigator or decision-maker shall modify plant populations, crop and variety selection, and/or irrigated acres to match available or anticipated water supplies.

Additional Criteria to Minimize Irrigation-Induced Soil Erosion

Application rates shall be consistent with local field conditions for long-term productivity of the soil.

Additional Criteria to Decrease Non-Point Source Pollution of Surface and Groundwater Resources

Water application shall be at rates that minimize transport of sediment, nutrients and chemicals to surface waters and that minimize transport of nutrients and chemicals to groundwater.

Additional Criteria to Manage Salts in the Crop Root Zone

The irrigation application volume shall be increased by the amount required to maintain an appropriate salt balance in the soil profile.

The requirement shall be based on the leaching procedure contained in the National Engineering Handbook (NEH) Part 623, Chapter 2 and NEH, Part 652, chapters 3 and 13.

Additional Criteria for Proper and Safe Chemigation or Fertigation

Chemigation or fertigation shall be done in accordance with all local, state and federal laws.

The scheduling of nutrient and chemical application should coincide with the irrigation cycle in a manner that will not cause excess leaching of nutrients or chemicals below the root zone to the groundwater or to cause excess runoff to surface waters.

Chemigation or fertigation should not be applied if rainfall is imminent. Application of chemicals or nutrients will be limited to the minimum length of time required to deliver them and flush the pipelines. Irrigation application amount shall be limited to the amount necessary to apply the chemicals or nutrients to the soil depth recommended by label. The timing and rate of application shall be based on the pest, herbicide, or nutrient management plan.

The irrigation and delivery system shall be equipped with properly designed and operating valves and components to prevent backflows into the water source(s) and/or contamination of groundwater, surface water, or the soil.

CONSIDERATIONS

The following items should be considered when planning irrigation water management:

- Consideration should be given to managing precipitation effectiveness, crop residues, and reducing system losses.
- Consider potential for spray drift and odors when applying agricultural and municipal waste waters. Timing of irrigation should be based on prevailing winds to reduce odor. In areas of high visibility, irrigating at night should be considered.

- Consider potential for overspray from end guns onto public roads.
- Equipment modifications and/or soil amendments such as polyacrylamides and mulches should be considered to decrease erosion.
- Consider the quality of water and the potential impact to crop quality and plant development.
- Quality of irrigation water should be considered relative to its potential effect on the soil's physical and chemical properties, such as soil crusting, pH, permeability, salinity, and structure.
- Avoid traffic on wet soils to minimize soil compaction.
- Consider the effects that irrigation water has on wetlands, water related wildlife habitats, riparian areas, cultural resources, and recreation opportunities.
- Management of nutrients and pesticides.
- Schedule salt leaching events to coincide with low residual soil nutrients and pesticides.
- Water should be managed in such a manner as to not drift or come in direct contact with surrounding electrical lines, supplies, devices, controls, or components that would cause shorts in the same or the creation of an electrical safety hazard to humans or animals.
- Consideration should be given to electrical load control/interruptible power schedules, repair and maintenance downtime, and harvest downtime.
- Consider improving the irrigation system to increase distribution uniformity or application efficiency of irrigation water applications.

PLANS AND SPECIFICATIONS

Application of this standard may include job sheets or similar documents that specify the applicable requirements, system operations, and components necessary for applying and maintaining the practice to achieve its intended purpose(s).

OPERATION AND MAINTENANCE

The operation and maintenance (O&M) aspects applicable to this standard consist of evaluating available field soil moisture, changes in crop evapotranspiration rates and changes in soil intake rates and adjusting the volume, application rate, or frequency of water application to achieve the intended purpose(s). Other necessary O&M items are addressed in the physical component standards considered companions to this standard.

NATURAL RESOURCES CONSERVATION SERVICE
PACIFIC ISLANDS AREA

CONSERVATION PRACTICE STANDARD

POND SEALING OR LINING, FLEXIBLE MEMBRANE

(No.)
CODE 521A

DEFINITION

A manufactured hydraulic barrier consisting of a functionally continuous layer of synthetic or partially synthetic, flexible material.

PURPOSE

To restrict, impede, and control seepage of contaminants from water and waste impoundment structures for water conservation and environmental protection.

CONDITION WHERE PRACTICE APPLIES

On ponds and water storage structures that require treatment to control seepage rates within acceptable limits.

On earthen waste storage lagoons and other waste impoundment structures that require treatment to control seepage of contaminants from the storage structure.

CRITERIA

Design. Structures to be lined shall have been constructed to meet all applicable NRCS standards. All inlets, outlets, ramps, and other appurtenances may be installed before, during, or after the liner placement, but shall be done in a manner that does not damage or impair the proper operation of the liner.

Design and installation of the flexible membrane shall be in accordance with manufacturer recommendations. All flexible membrane installations shall be certified by the installer as meeting the material and installation requirements of the plans and specifications.

Manufacturer recommendations shall be followed with regard to protection from weather and exposure.

Minimum Criteria for Membranes

Type	Limiting Parameter	
	Wastewater	Clear Water
HDPE	40 mil	30 mil
LLDPE	40 mil	20 mil
PVC	30 mil	20 mil
GCL	0.75 lb./sq ft (bentonite)	
EPDM	45 mil	
PP (Reinforced)	36 mil	24 mil
PP (Un-reinforced)	40 mil	30 mil
RPE	NR	24 mil
CPSE	*30 mil*	*30 mil*

1 mil = 1/1000 of an inch
HDPE – High Density Polyethylene Geomembrane
LLDPE – Linear Low Density Polyethylene Geomembrane
PVC – Polyvinyl Chloride Geomembrane
GCL – Geosynthetic Clay Liner
EPDM – Synthetic Rubber Geomembrane *(butyl)*
PP – Polypropylene Geomembrane
RPE – Reinforced Polyethylene Geomembrane
NR – Not Recommended
CPSE – Chlorosulfonated Polyethylene (hypalon)

Cover Soil. PVC and GCL liners shall be covered with a minimum of 12 inches of soil. Cover soil may be used on other liners but is not required.

Cover soil shall be used as cover for liners when required for the proper performance,

protection and durability of the installation. Cover soils shall not contain sharp, angular stones or any objects that could damage the liner. Maximum allowable particle size of soil cover material shall be 3/8-in for geomembrane liners and ½-inch for geosynthetic clay liners, unless the liner is cushioned by an 8-ounce or greater needle punched, non-woven geotextile padding material. Cover materials shall be stable against slippage down the slope under all operational and exposure conditions.

Subgrade Preparation. Subgrade preparation shall conform to manufacturer recommendations. Subgrade materials shall not contain sharp, angular stones or any objects that could damage the liner or adversely affect its function.

Padding. A cushion or padding shall be placed beneath the liner if the subgrade particles contain sharp angular stones that could damage the liner or particles greater than 3/8-inch for geomembrane liners and ½-inch for geosynthetic clay liners. The padding or cushion may be an 8-ounce or greater non-woven geotextile or a soil meeting the particle size and shape requirements of the subgrade.

Anchorage. Liners shall be anchored to prevent uplift due to wind or slippage down the side slope.

Safety. Design shall include appropriate safety features to minimize the hazards of the structure. Warning signs, fences, ladders, ropes, bars, rails, and other devices shall be provided, as appropriate, to ensure the safety of humans and livestock. .

CONSIDERATIONS

Venting of wastewater pond liners not covered with soil is recommended unless other site conditions exist to allow dissipation of gas pressure from beneath the liner. One such condition is the presence of granular foundation soils (SW, GW or GP). A minimum vent spacing of 50 feet is recommended.

If high water tables could adversely affect the proper functioning of the structure, interceptor or relief-type drainage systems should be considered to control uplift pressures.

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared for specific field sites in accordance with this standard and shall describe the requirements for applying the practice to achieve its intended uses.

As a minimum, the plans and specifications shall provide the following:

1. Layout of the containment structure, collection points, waste transfer locations or pipelines, and topography of the site
2. Required liner properties, cushion materials, and pipeline materials
3. Subgrade details, including tolerances on smoothness of the finished grade
4. Details of liner installation, seaming requirements, and requirements for attachments and appurtenances
5. Quality control testing
6. Fence and signage requirements, if required.
7. *Area of lining*
8. *Thickness of cover*
9. *Anchoring trench dimensions and details*

OPERATION AND MAINTENANCE

The Pacific Islands Area Operation and Maintenance (O&M) Plan for the liner and structure shall be *reviewed and discussed with the client*. The plan shall be consistent with the purposes of the type of liner chosen, intended life, safety requirements and design criteria. The plan shall contain requirements including but not limited to:

1. Design capacity and liquid level of the structure.
2. A description of the normal operation, safety concerns and maintenance requirements.

3. Repair procedures.
4. Periodic inspection of the following:
   - Visible portions of the liner for tears punctures, or other damage;
   - Liner interface with inlets, outlets, ramps, or other appurtenances for damage;
   - Liquid level in the structure;
   - Ballooning of the liner indicating presence of gas beneath the liner.

REFERENCES

Quality Assurance and Quality Control for Waste Containment Facilities, EPA/1600/R-93/182, September 1993.

NATURAL RESOURCES CONSERVATION SERVICE
PACIFIC ISLANDS AREA

CONSERVATION PRACTICE STANDARD

NUTRIENT MANAGEMENT

(Ac.)

CODE 590

DEFINITION

Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments.

PURPOSE

- To budget, supply, and conserve nutrients for plant production.
- To minimize agricultural nonpoint source pollution of surface and groundwater resources.
- To properly utilize manure or organic by-products as a plant nutrient source.
- To protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates.
- To maintain or improve the physical, chemical, and biological condition of soil.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all lands where plant nutrients and soil amendments are applied. This standard does not apply to one-time nutrient applications to establish perennial crops.

CRITERIA

General Criteria Applicable to All Purposes

A nutrient budget for nitrogen, phosphorus, and potassium must be developed that considers all potential sources of nutrients including, but not limited to, green manures, legumes, crop residues, compost, animal manure, organic by-products, biosolids, waste water, organic matter, soil biological activity, commercial fertilizer, and irrigation water.

Enhanced efficiency fertilizers, used in the State must be defined by the Association of American Plant Food Control Officials (AAPFCO) and be accepted for use by the State fertilizer control official, or similar authority, with responsibility for verification of product guarantees, ingredients (by AAPFCO definition) and label claims.

To avoid salt damage, the rate and placement of applied nitrogen and potassium in starter fertilizer must be consistent with land-grant university guidelines, or industry practice recognized by the land-grant university.

For nutrient risk assessment policy and procedures see Title 190, General Manual (GM), Part 402, Nutrient Management, and Title 190, National Instruction (NI), Part 302, Nutrient Management Policy Implementation.

The following risk assessments will be completed on all Nutrient Management Plans:

1) Erosion Rates
2) Nitrogen Leaching Index
3) Phosphorus Index

The Nitrogen Leaching Index is located in Table 1. Use the guidance in the bottom of the table to plan mitigation to address leaching concerns. Planner can increase the index risk hazard based on field observations.

Table 1. Nitrogen Leaching Index

Annual Rainfall	Soil Hydrologic Group			
	A	B	C	D
>100"	H	H	M	M
50-100"	H	M	M	L
<50"	M	M	L	L

Low – No additional mitigation required
Mod – Timing of nitrogen applications must be applied to coincide with crop growing season
High – Timing of nitrogen applications must coincide with crop growing season and be split applied to prevent leaching

The NRCS-approved nutrient risk assessment for phosphorus must be completed on all fields. The Phosphorous Index in located in Appendix C. There is also an automated version in the Pacific Islands Area 590 jobsheet. Once soil test phosphorus exceeds 300 ppm or 600 lbs/ac no more phosphorus applications can be planned unless the land grant university is still making a recommendation for additional phosphorus.

Table 2. Phosphorus Index Interpretation

Risk Assessment	Phosphorus Index Value
Low	<30
Mod	30-90
High	>90

Low - phosphorus can be applied at rates greater than crop requirement not to exceed the nitrogen requirement for the succeeding crop if manure or other organic materials are used to supply nutrients

Mod - phosphorus can be applied not to exceed the crop requirement rate

High - phosphorus can be applied not to exceed the crop removal rate if the following requirements are met: A soil phosphorus drawdown strategy has been implemented, and a site assessment for nutrients and soil loss has been conducted to determine if mitigation practices are required to protect water quality. Any deviation from these high risk requirements must have the approval of the Chief of the NRCS.

Planners must use the current NRCS-approved soil erosion risk assessment tools to assess the risk of soil loss. Identified resource concerns must be addressed to meet current planning criteria (quality criteria).

On organic operations, the nutrient sources and management must be consistent with the USDA's National Organic Program.

Areas contained within minimum application setbacks (e.g., sinkholes, wellheads, gullies, ditches, or surface inlets) must receive nutrients consistent with the setback restrictions.

Applications of irrigation water must minimize the risk of nutrient loss to surface and groundwater.

Soil pH must be maintained in a range that enhances an adequate level for crop nutrient availability and utilization. Refer to State land-grant university documentation for guidance.

Soil, Manure, and Tissue Sampling and Laboratory Analyses (Testing).

Nutrient planning must be based on current land-grant university soil test analysis and recommendations. Manure and (where used as supplemental information) tissue test results shall be developed in accordance with land-grant university guidance, or industry practice, if recognized by the university.

Current soil tests are those that are no older than 3 years, but may be taken on an interval recommended by the land-grant university or as required by State code. The area represented by a soil test must be that acreage recommended by the land-grant university.

Where a conservation management unit (CMU) is used as the basis for a sampling unit, all acreage in the CMU must have similar soil type, cropping history, and management practice treatment.

The soil and tissue tests must include analyses pertinent to monitoring or amending the annual nutrient budget, e.g., pH, electrical conductivity (EC) and sodicity where salts are a concern, soil organic matter, phosphorus, potassium, or other nutrients and test for nitrogen where applicable. Follow land-grant university guidelines regarding required analyses.

Soil test analyses must be performed by laboratories successfully meeting the requirements and performance standards of the North American Proficiency Testing Program-

Performance Assessment Program (NAPT-PAP) under the auspices of the Soil Science Society of America (SSSA) and NRCS, or other NRCS-approved program that considers laboratory performance and proficiency to assure accuracy of soil test results. Alternate proficiency testing programs must have solid stakeholder (e.g., water quality control entity, NRCS State staff, growers, and others) support and be regional in scope.

Nutrient values of manure, organic by-products and biosolids must be determined prior to land application.

Manure analyses must include, at minimum, total nitrogen (N), ammonium N, total phosphorus (P) or P_2O_5, total potassium (K) or K_2O, and percent solids, or follow land-grant university guidance regarding required analyses.

Manure, organic by-products, and biosolids samples must be collected and analyzed at least annually, or more frequently if needed to account for operational changes (feed management, animal type, manure handling strategy, etc.) impacting manure nutrient concentrations. If no operational changes occur, less frequent manure testing is allowable where operations can document a stable level of nutrient concentrations for the preceding three consecutive years, unless federal, State, or local regulations require more frequent testing.

Samples must be collected, prepared, stored, and shipped, following land-grant university guidance or industry practice.

When planning for new or modified livestock operations, acceptable "book values" recognized by the NRCS (e.g., NRCS Agricultural Waste Management Field Handbook) and the land-grant university, or analyses from similar operations in the geographical area, may be used if they accurately estimate nutrient output from the proposed operation.

Manure testing analyses must be performed by laboratories successfully meeting the requirements and performance standards of the Manure Testing Laboratory Certification program (MTLCP) under the auspices of the Minnesota Department of Agriculture, or other NRCS-approved program that considers laboratory performance and proficiency to assure accurate manure test results.

Nutrient Application Rates.

Planned commercial fertilizer nutrient application rates for nitrogen, phosphorus, and potassium must not exceed land-grant university guidelines or industry practice when recognized by the university.

At a minimum, determination of rate must be based on crop/cropping sequence, current soil test results, realistic yield goals, and NRCS-approved nutrient risk assessments.

If the land-grant university does not provide specific guidance that meets these criteria, application rates must be based on plans that consider realistic yield goals and associated plant nutrient uptake rates.

Realistic yield goals must be established based on historical yield data, soil productivity information, climatic conditions, nutrient test results, level of management, and local research results considering comparable production conditions.

Estimates of yield response must consider factors such as poor soil quality, drainage, pH, salinity, etc., prior to assuming that nitrogen and/or phosphorus are deficient.

For new crops or varieties, industry-demonstrated yield, and nutrient utilization information may be used until land-grant university information is available.

Lower-than-recommended nutrient application rates are permissible if the grower's objectives are met.

Applications of biosolids, starter fertilizers, or pop-up fertilizers must be accounted for in the nutrient budget.

Nutrient Sources.

Nutrient sources utilized must be compatible with the application timing, tillage and planting system, soil properties, crop, crop rotation, soil organic content, and local climate to minimize risk to the environment.

Nutrient Application Timing and Placement.

Timing and placement of all nutrients must correspond as closely as practical with plant nutrient uptake (utilization by crops), and consider nutrient source, cropping system limitations, soil properties, weather conditions, drainage system, soil biology, and nutrient risk assessment results.

Nutrients must not be surface-applied if nutrient losses offsite are likely. This precludes spreading on:

- fields when the top 2 inches of soil are saturated from rainfall.

Additional Criteria to Minimize Agricultural Nonpoint Source Pollution of Surface and Groundwater

When there is a high risk of transport of nutrients, conservation practices must be coordinated to avoid, control, or trap manure and nutrients before they can leave the field by surface or subsurface drainage (e.g., taro loi fields). The number of applications and the application rates must also be considered to limit the transport of nutrients to discharged irrigation water. Nutrients must be applied with the right placement, in the right amount, at the right time, and from the right source to minimize nutrient losses to surface and groundwater. The following nutrient use efficiency strategies or technologies must be considered:

- slow and controlled release fertilizers
- nitrification and urease inhibitors
- enhanced efficiency fertilizers
- incorporation or injection
- timing and number of applications
- soil nitrate and organic N testing
- coordinate nutrient applications with optimum crop nutrient uptake
- Corn Stalk Nitrate Test (CSNT), Pre-Sidedress Nitrate Test (PSNT), and Pre-Plant Soil Nitrate Test (PPSN)
- tissue testing, chlorophyll meters, and spectral analysis technologies
- other land-grant university recommended technologies that improve nutrient use efficiency and minimize surface or groundwater resource concerns.

Additional Criteria Applicable to Properly Utilize Manure or Organic By-Products as a Plant Nutrient Source

When manures are applied, and soil salinity is a concern, salt concentrations must be monitored to prevent potential crop damage and/or reduced soil quality.

The total single application of liquid manure:

- must not exceed the soil's infiltration or water holding capacity
- be based on crop rooting depth
- must be adjusted to avoid runoff or loss to subsurface tile drains.

Crop production activities and nutrient use efficiency technologies must be coordinated to take advantage of mineralized plant-available nitrogen to minimize the potential for nitrogen losses due to denitrification or ammonia volatilization.

Manure or organic by-products may be applied on legumes at rates equal to the estimated removal of nitrogen in harvested plant biomass, not to exceed land grant university recommendations.

Manure may be applied at a rate equal to the recommended phosphorus application, or estimated phosphorus removal in harvested plant biomass for the crop rotation, or multiple years in the crop sequence at one time. When such applications are made, the application rate must not exceed the acceptable phosphorus risk assessment criteria, must not exceed the recommended nitrogen application rate during the year of application or harvest cycle, and no additional phosphorus must be applied in the current year and any additional years for which the single application of phosphorus is supplying nutrients.

Additional Criteria to Protect Air Quality by Reducing Odors, Nitrogen Emissions and the Formation of Atmospheric Particulates

To address air quality concerns caused by odor, nitrogen, sulfur, and/or particulate emissions; the source, timing, amount, and placement of nutrients must be adjusted to minimize the negative impact of these emissions on the environment and human health. One or more of the following may be used:

- slow or controlled release fertilizers
- nitrification inhibitors
- urease inhibitors
- nutrient enhancement technologies
- incorporation
- injection
- stabilized nitrogen fertilizers

- residue and tillage management
- no-till or strip-till
- other technologies that minimize the impact of these emissions

Do not apply poultry litter, manure, or organic by-products of similar dryness/density when there is a high probability that wind will blow the material offsite.

Additional Criteria to Improve or Maintain the Physical, Chemical, and Biological Condition of the Soil to Enhance Soil Quality for Crop Production and Environmental Protection

Time the application of nutrients to avoid periods when field activities will result in soil compaction.

In areas where salinity is a concern, select nutrient sources that minimize the buildup of soil salts.

Inoculate the soil with appropriate Rhizobia bacterial when legumes are not forming adequate nodules for nitrogen fixation or other beneficial microbes for improved nutrient cycling.

There must also be a positive trend to the Soil Condition Index score

CONSIDERATIONS

Elevated soil test phosphorus levels are detrimental to soil biota. Soil test phosphorus levels should not exceed State-approved soil test thresholds established to protect the environment.

Use no-till/strip-till in combination with cover crops to sequester nutrients, increase soil organic matter, increase aggregate stability, reduce compaction, improve infiltration, and enhance soil biological activity to improve nutrient use efficiency.

Use nutrient management strategies such as cover crops, crop rotations, and crop rotations with perennials to improve nutrient cycling and reduce energy inputs.

Use variable-rate nitrogen application based on expected crop yields, soil variability, soil nitrate or organic N supply levels, or chlorophyll concentration.

Use variable-rate nitrogen, phosphorus, and potassium application rates based on site-specific variability in crop yield, soil characteristics, soil test values, and other soil productivity factors.

Develop site-specific yield maps using a yield monitoring system. Use the data to further diagnose low- and high- yield areas, or zones, and make the necessary management changes. See Title 190, Agronomy Technical Note (TN) 190.AGR.3, Precision Nutrient Management Planning.

Use manure management conservation practices to manage manure nutrients to limit losses prior to nutrient utilization.

Apply manure at a rate that will result in an "improving" Soil Conditioning Index (SCI) without exceeding acceptable risk of nitrogen or phosphorus loss.

Use legume crops and cover crops to provide nitrogen through biological fixation and nutrient recycling.

Modify animal feed diets to reduce the nutrient content of manure following guidance contained in Conservation Practice Standard (CPS) Code 592, Feed Management.

Soil test information should be no older than 1 year when developing new plans.

Excessive levels of some nutrients can cause induced deficiencies of other nutrients, e.g., high soil test phosphorus levels can result in zinc deficiency in corn.

Use soil tests, plant tissue analyses, and field observations to check for secondary plant nutrient deficiencies or toxicity that may impact plant growth or availability of the primary nutrients.

Use the adaptive nutrient management learning process to improve nutrient use efficiency on farms as outlined in the NRCS' National Nutrient Policy in GM 190, Part 402, Nutrient Management.

Potassium should not be applied in situations where an excess (greater than soil test potassium recommendation) causes nutrient imbalances in crops or forages.

Workers should be protected from and avoid unnecessary contact with plant nutrient sources. Extra caution must be taken when handling anhydrous ammonia or when dealing with organic wastes stored in unventilated enclosures.

Material generated from cleaning nutrient application equipment should be utilized in an environmentally safe manner. Excess material should be collected and stored or field applied in an appropriate manner.

Nutrient containers should be recycled in compliance with State and local guidelines or regulations.

Considerations to Minimize Agricultural Nonpoint Source Pollution of Surface and Groundwater.

Use conservation practices that slow runoff, reduce erosion, and increase infiltration, e.g., filter strip, contour farming, or contour buffer strips. These practices can also reduce the loss of nitrates or soluble phosphorus.

Use application methods and timing strategies that reduce the risk of nutrient transport by ground and surface waters, such as:

- split applications of nitrogen to deliver nutrients during periods of maximum crop utilization,
- banded applications of nitrogen and/or phosphorus to improve nutrient availability,
- drainage water management to reduce nutrient discharge through drainage systems, and
- incorporation of surface-applied manures or organic by-products if precipitation capable of producing runoff or erosion is forecast within the time of planned application.

Use the agricultural chemical storage facility conservation practice to protect air, soil, and water quality.

Use bioreactors and multistage drainage strategies when approved by the land-grant university.

Considerations to Protect Air Quality by Reducing Nitrogen and/or Particulate Emissions to the Atmosphere.

Avoid applying manure and other by-products upwind of inhabited areas.

Use high-efficiency irrigation technologies (e.g., reduced-pressure drop nozzles for center pivots) to reduce the potential for nutrient losses.

PLANS AND SPECIFICATIONS

The following components must be included in the nutrient management plan using the Pacific Islands Area jobsheet for this practice:

- aerial site photograph(s)/imagery or site map(s), and a soil survey map of the site,
- soil information including: soil type surface texture, pH, drainage class, permeability, available water capacity, depth to water table, restrictive features, and flooding and/or ponding frequency, (Print the Map Unit Description from Soil Data Mart for this information)
- location of designated sensitive areas and the associated nutrient application restrictions and setbacks,
- for manure applications, location of nearby residences, or other locations where humans may be present on a regular basis, and any identified meteorological (e.g., prevailing winds at different times of the year), or topographical influences that may affect the transport of odors to those locations,
- results of approved risk assessment tools for nitrogen, phosphorus, and erosion losses,
- documentation establishing that the application site presents low risk for phosphorus transport to local water when phosphorus is applied in excess of crop requirement.
- current and/or planned plant production sequence or crop rotation,
- soil, water, compost, manure, organic by-product, and plant tissue sample analyses applicable to the plan,
- when soil phosphorus levels are increasing, include a discussion of the risk associated with phosphorus accumulation and a proposed phosphorus draw-down strategy,
- realistic yield goals for the crops,
- complete nutrient budget for nitrogen, phosphorus, and potassium for the plant production sequence or crop rotation,
- listing and quantification of all nutrient sources and form,
- all enhanced efficiency fertilizer products that are planned for use,

- in accordance with the nitrogen and phosphorus risk assessment tool(s), specify the recommended nutrient application source, timing, amount (except for precision/variable rate applications specify method used to determine rate), and placement of plant nutrients for each field or management unit, and
- guidance for implementation, operation and maintenance, and recordkeeping.

In addition, the following components must be included in a precision/variable rate nutrient management plan:

- Document the geo-referenced field boundary and data collected that was processed and analyzed as a GIS layer or layers to generate nutrient or soil amendment recommendations.
- Document the nutrient recommendation guidance and recommendation equations used to convert the GIS base data layer or layers to a nutrient source material recommendation GIS layer or layers.
- Document if a variable rate nutrient or soil amendment application was made.
- Provide application records per management zone or as applied map within individual field boundaries (or electronic records) documenting source, timing, method, and rate of all applications that resulted from use of the precision agriculture process for nutrient or soil amendment applications.
- Maintain the electronic records of the GIS data layers and nutrient applications for at least 5 years.

If increases in soil phosphorus levels are expected (i.e., when N-based rates are used), the nutrient management plan must document:

- the soil phosphorus levels at which it is desirable to convert to phosphorus based planning,
- the potential plan for soil test phosphorus drawdown from the production and harvesting of crops, and

- management activities or techniques used to reduce the potential for phosphorus transport and loss,
- for AFOs, a quantification of manure produced in excess of crop nutrient requirements, and
- a long-term strategy and proposed implementation timeline for reducing soil P to levels that protect water quality,

OPERATION AND MAINTENANCE

Conduct periodic plan reviews to determine if adjustments or modifications to the plan are needed. At a minimum, plans must be reviewed and revised, as needed with each soil test cycle, changes in manure volume or analysis, crops, or crop management.

Fields receiving animal manures and/or biosolids must be monitored for the accumulation of heavy metals and phosphorus in accordance with land- grant university guidance and State law.

Significant changes in animal numbers, management, and feed management will necessitate additional manure analyses to establish a revised average nutrient content.

Calibrate application equipment to ensure accurate distribution of material at planned rates.

Document the nutrient application rate. When the applied rate differs from the planned rate, provide appropriate documentation for the change.

Records must be maintained for at least 5 years to document plan implementation and maintenance. As applicable, records include:

- soil, plant tissue, water, manure, and organic by-product analyses resulting in recommendations for nutrient application,
- quantities, analyses and sources of nutrients applied,
- dates, and method(s) of nutrient applications, source of nutrients, and rates of application,
- weather conditions and soil moisture at the time of application; lapsed time to manure incorporation; rainfall or irrigation event,

- crops planted, planting and harvest dates, yields, nutrient analyses of harvested biomass, and crop residues removed,
- dates of plan review, name of reviewer, and recommended changes resulting from the review, and
- all enhanced efficiency fertilizer products used.

Additional records for precision/variable rate sites must include:

- maps identifying the variable application source, timing, amount, and placement of all plant nutrients applied, and
- GPS-based yield maps for crops where yields can be digitally collected.

The Pacific Islands Area jobsheet for this practice shall be used to record the operation and maintenance of the practice on the treatment unit, and reviewed with the client.

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Sims, J.T. (ed.) 2005. Phosphorus: Agriculture and the environment. Agron. Monogr. no. 46. ASA, CSSA, and SSSA, Madison, WI.

Stevenson, F.J. (ed.) 1982. Nitrogen in agricultural soils. Agron. Series 22. ASA, CSSA, and SSSA, Madison, WI.

U.S. Department of Agriculture, Natural Resources Conservation Service. 2010. Agronomy Technical Note, (TN) 190-AGR-3, Precision Nutrient Management Planning. Washington, DC.

U.S. Department of Agriculture, Natural Resources Conservation Service. 2011. Title 190, General Manual, (GM), Part 402, Nutrient Management. Washington, DC.

U.S. Department of Agriculture, Natural Resources Conservation Service. 2011. Title 190, National Instruction (NI), Part 302, Nutrient Management Policy Implementation. Washington, DC.

Appendix A. Common Nutrient Management Conversions

To convert column 1 to column 2, multiply by	Column 1	Column 2	To convert column 2 to column 1, multiply by
1.20	K	K_2O	0.83
2.29	P	P_2O_5	0.44
0.891	kg/ha	lbs/ac	1.12
8.34	gallon water	lbs	0.12
325,851	ac foot water	gallons	0.000003068
43,560	lb/ft^2	lbs/ac	0.00002295

Appendix B. Helpful Nutrient Management Websites

NPK Crop Removal Rates
Soil Data Mart
Proper Soil Sampling Procedures
University of Hawaii Soil Testing Lab
University of Guam Soil Testing Lab

Appendix C: Phosphorus Index

Phosphorus Index Risk Assessment for PIA

Client Name

Tract Number

Phosphorus Index Factors	Factor Wt	Risk Factor 0	2	4	6	8	Risk Factor x Factor wt
Soil Test Data (ppm P) Cutoff for P applications is 300 ppm P, unless the LGU is still recommending P	5	0-25	26-50	51-100	101-200	201-300	
Water Erosion Rate (tons/ac/yr)	5	1 or less	2	3	4	5 or more	
Wind Erosion Rate (tons/ac/yr)	3	1 or less	2	3	4	5 or more	
P_2O_5 Application Rate	2	None	<Recommended	=Recommended	>Recommended	[redacted]	
Time between P application and incorporation (days)	2	<2	2-5	6-9	10-14	>14	
Frequency of flooding (years)	2	Very Rare	Rare	Occasional	Frequent	Very Frequent	
Surface Runoff Class	1	Very Low	Low	Medium	High	Very High	
Distance to Surface Water Drainage (edge of field - feet)	-1	<50	50-150	151-300	301-500	>500	
Sediment Trapping Measures (% of field addressed)	-1	0	1-25	26-50	51-75	>75	
Sediment Trapping Practices Meeting NRCS Standards (% of field addressed)	-3	0	1-25	26-50	51-75	>75	
						Index Sum	

NATURAL RESOURCES CONSERVATION SERVICE
PACIFIC ISLANDS AREA

STATEMENT OF WORK

NUTRIENT MANAGEMENT (590)

These deliverables apply to this individual practice. For other planned practice deliverables refer to those specific Statements of Work.

DESIGN

All design documents shall be developed in accordance with the requirements of the NRCS Pacific Islands Area Field Office Technical Guide (FOTG) Section IV, Conservation Practice Standard.

Deliverables:

1. Design documents that demonstrate criteria in NRCS practice standard have been met and are compatible with planned and applied practices.
   a. Practice purpose(s) as identified in the conservation plan.
   b. List of required permits to be obtained by the client.
   c. List all required and/or facilitating practices.
   d. Practice standard criteria-related computations and analyses to develop plans and specifications including but not limited to:
      i. Results of applicable sampling, analyses, and tests provided by the client (e.g soil and tissue).
      ii. Realistic yield goals for the crop(s) to receive nutrient applications.
      iii. Planned nutrient and soil amendment application rates, methods, and timing of application in balance with the nutrient budget.
      iv. Site risk assessments for erosion rates, nitrogen leaching index, and phosphorus index will be completed on all nutrient management plans.
      v. Other requirements applicable to manure or organic materials, non-point source pollution, soil condition, and air quality.
2. Written plans and specifications including sketches and drawings shall be provided to the client that adequately describes the requirements to install the practice and obtain necessary permits. Plans and specifications shall be developed in accordance with the conservation practice standard Nutrient Management (Code 590). The Pacific Islands Area Conservation Practice Jobsheet for this practice shall be used to provide the client with the requirements to install the practice on the treatment unit. The Jobsheet is available in Section IV of the Pacific Islands Area FOTG.
3. Operation and maintenance plan. The Pacific Islands Area Conservation Practice Jobsheet for this practice shall be used to provide the client with the requirements for the operation and maintenance of the practice on the treatment unit. The Jobsheet is available in Section IV of the Pacific Islands Area FOTG.
4. Certification that the design meets practice standard criteria and comply with applicable laws and regulations
5. Design modifications during application as required

INSTALLATION

Deliverables

1. Pre-application conference with client.
2. Verification that client has obtained required permits.
3. Location of and communication of setback requirements for wetlands, water bodies, streams, and other nutrient-sensitive areas.

4. Application guidance as needed.
5. Facilitate and implement required design modifications with client and original designer.
6. Advise client/NRCS on compliance issues with all federal, state, tribal, and local laws, regulations and NRCS policies during application.
7. Certification that the application process and materials meets design and permit requirements.

CHECK OUT

Deliverables

1. Records of application.
   a. Extent of practice units applied.
   b. Actual materials used.
2. Guidance for record keeping (implementation records maintained by the producer or agent)
   a. Records of crops produced, planting and harvest dates, yields, residue management.
   b. Records of recurring soil tests, and other tests (e.g. manure, plant tissue, water) used to implement the plan.
   c. Records of recommended nutrient application rates.
   d. Records of nutrient applications including quantities, analyses, and sources of nutrients applied; dates and methods of application.
   e. Records of recurring review of the plan including the dates or review, individual performing the review, and recommendations that resulted from the review.
3. Certification that the application meets NRCS standards and specifications and is in compliance with permits.
4. Progress reporting.

REFERENCES

- NRCS Pacific Islands Area Field Office Technical Guide (FOTG), Section IV, Pacific Islands Area Nutrient Management (590) – Conservation Practice Standard, and Conservation Practice Jobsheet.
- NRCS General Manual Title 450, Part 401.03 (Technical Guides, Policy and Responsibilities) and Title 190, Part 402 (Ecological Sciences, Nutrient Management, Policy)
- NRCS National Planning Procedures Handbook (NPPH) (CNMP Technical Guidance)
- NRCS National Agronomy Manual (NAM) Section 503
- NRCS National Engineering Handbook (NEH), Part 651 Agricultural Waste Management Field Handbook (AWMFH), Chapter 4 – Agricultural Waste Characteristics
- NRCS National Environmental Compliance Handbook
- NRCS Cultural Resources Procedures Handbook

NATURAL RESOURCES CONSERVATION SERVICE
PACIFIC ISLANDS AREA

CONSERVATION PRACTICE STANDARD

WASTE UTILIZATION

(Ac.)
CODE 633

DEFINITION

Using agricultural wastes such as manure and wastewater or other organic residues.

PURPOSE

- Protect water quality
- Protect air quality
- Provide fertility for crop, forage, fiber production and forest products
- Improve or maintain soil structure
- Provide feedstock for livestock
- Provide a source of energy

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where agricultural wastes including animal manure and contaminated water from livestock and poultry operations; solids and wastewater from municipal treatment plants; and agricultural processing residues are generated, and/or utilized.

CRITERIA

General Criteria Applicable to All Purposes

All federal, state and local laws, rules and regulations governing waste management, pollution abatement, health and safety shall be strictly adhered to. The owner or operator shall be responsible for securing all required permits or approvals related to waste utilization, and for operating and maintaining any components in accordance with applicable laws and regulations.

Use of agricultural wastes shall be based on at least one analysis of the material during the time it is to be used. In the case of daily spreading, the waste shall be sampled and analyzed at least once each year. As a minimum, the waste analysis should identify nutrient and specific ion concentrations. Where the metal content of municipal wastewater, sludge, septage and other agricultural waste is of a concern, the analysis shall also include determining the concentration of metals in the material.

When agricultural wastes are land applied, application rates shall be consistent with the requirements of the NRCS conservation practice standard for Nutrient Management (590).

Where manure is to be spread on land not owned or controlled by the producer, *record keeping*, as a minimum, shall document the amount of manure to be transferred, *the nutrient content of the manure, the date of transfer*, and who will be responsible for the environmentally acceptable use of the waste. *Minimum quantities to document are three cubic yards of wet solids and 5,000 gallons of liquid waste.*

Records of the use of wastes shall be kept a minimum of five years as discussed in OPERATION AND MAINTENANCE, below.

Additional Criteria to Protect Water Quality

All agricultural waste shall be utilized in a manner that minimizes the opportunity for contamination of surface and ground water supplies.

Agricultural waste shall not be land-applied on soils that are frequently flooded, as defined by the National Cooperative Soil Survey, during the period when flooding is expected.

When liquid wastes are applied, the application rate shall not exceed the infiltration rate of the soil, and the amount of waste applied shall not exceed the moisture holding capacity of the soil profile at the time of application. Wastes shall not be applied to saturated soil if the potential risk for runoff exists. The basis for the decision to apply waste under these conditions shall be documented in the *comprehensive nutrient* management plan.

Additional Criteria to Protect Air Quality

Incorporate surface applications of solid forms of manure or other organic by-products into the soil within 24 hours of application to minimize emissions and to reduce odors.

When applying liquid forms of manure with irrigation equipment select application conditions where there is high humidity, little/no wind blowing, a forthcoming rainfall event and/or other conditions that will minimize volatilization losses into the atmosphere. The basis for applying manure under these conditions shall be documented in the nutrient management plan.

Handle and apply poultry litter or other dry types of animal manure or other organic by-products when weather conditions are calm and there is less potential for blowing and emission of particulates in the atmosphere. The basis for applying manure under these conditions shall be documented in the nutrient management plan.

When sub-surface applied using an injection system, waste shall be placed at a depth and applied at a rate that minimizes leaks onto the soil surface, while minimizing disturbance to the soil surface and plant community.

All materials shall be handled in a manner to minimize the generation of particulate matter, odors and greenhouse gases.

Additional Criteria for Providing Fertility for Crop, Forage and Fiber Production and Forest Products

Where agricultural wastes are utilized to provide fertility for crop, forage, fiber production and forest products, the practice standard Nutrient Management (590) shall be followed.

Where municipal wastewater and solids are applied to agricultural lands as a nutrient source, the single application or lifetime limits of heavy metals shall not be exceeded. The concentration of salts shall not exceed the level that will impair seed germination or plant growth.

Additional Criteria for Improving or Maintaining Soil Structure

Wastes shall be applied at rates not to exceed the crop nutrient requirements or salt concentrations as stated above.

Residue management practices shall be used for maintenance of soil structure.

Additional Criteria for Providing Feedstock for Livestock

Agricultural wastes to be used for feedstock shall be handled in a manner to minimize contamination and preserve its feed value. Chicken litter stored for this purpose shall be covered. A qualified animal nutritionist shall develop rations that utilize wastes.

Additional Criteria for Providing a Source of Energy

Use of agricultural waste for energy production shall be an integral part of the overall waste management system.

All energy producing components of the system shall be included in the waste management plan and provisions for utilization of residues of energy production identified.

Where the residues of energy production are to be land-applied for crop nutrient use or soil conditioning, the criteria listed above shall apply.

CONSIDERATIONS

The effect of Waste Utilization on the water budget should be considered, particularly where a shallow ground water table is present or in areas prone to runoff. Limit waste application to the volume of liquid that can be stored in the root zone.

Agricultural wastes contain pathogens and other disease-causing organisms. Wastes should be utilized in a manner that minimizes their disease potential.

Priority areas for land application of wastes should be on gentle slopes located as far as possible from waterways. When wastes are applied on more sloping land or land adjacent to waterways, other conservation practices should be installed to reduce the potential for offsite transport of waste.

It is preferable to apply wastes on pastures and hayland soon after cutting or grazing before re-growth has occurred.

Minimize environmental impact of land-applied waste by limiting the quantity of waste applied to the rates determined using the practice standard Nutrient Management (590) for all waste utilization.

Consider the net effect of waste utilization on greenhouse gas emissions and carbon sequestration.

PLANS AND SPECIFICATIONS

Plans and specifications for Waste Utilization shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. The *comprehensive nutrient management plan* is to account for the utilization or other disposal of all animal wastes produced, and all waste application areas shall be clearly indicated on a plan map.

OPERATION AND MAINTENANCE

Records shall be kept for a period of five years or longer, and include when appropriate:

- Quantity of manure and other agricultural waste produced and their nutrient content.
- Soil test results.
- Dates and amounts of waste application where land applied, and the dates and amounts of waste removed from the system due to feeding, energy production or export from the operation.
- Describe climatic conditions during waste application such as: time of day, temperature, humidity, wind speed, wind direction and other factors as necessary.
- Waste application methods.
- Crops grown and yields (both yield goals and measured yield).
- Other tests, such as determining the nutrient content of the harvested product.
- Calibration of application equipment.

The operation and maintenance plan shall include the dates of periodic inspections and maintenance of equipment and facilities used in waste utilization. The plan should include what is to be inspected or maintained, and a general time frame for making necessary repairs.

Exhibit 8

GOODSILL ANDERSON QUINN & STIFEL
A LIMITED LIABILITY LAW PARTNERSHIP LLP

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August 11, 2014

VIA EMAIL

Sina Pruder, P.E.
Chief
Wastewater Branch
Environmental Management Division
Department of Health
919 Ala Moana Blvd., Room 309
Honolulu, HI 96814

Re: Comments re Hawaii Dairy Farms' Waste Management Plan, dated July 23, 2014

Dear Ms. Pruder:

I am writing on behalf of Kawailoa Development LLP ("Kawailoa") regarding Hawai'i Dairy Farms' Waste Management Plan ("Plan"), dated July 23, 2014, for its proposed dairy farm ("Dairy") in Māhā'ulepū, Kaua'i.

Kawailoa is the owner of the Grand Hyatt Kaua'i and the Poipu Bay Golf Course. Kawailoa has a substantial interest in the Plan as both the Grand Hyatt Kaua'i and the Poipu Bay Golf Course will be directly affected by the operations of the Dairy. The project boundary of the Dairy will be less than a mile from the boundary of the Poipu Bay Golf Course and a mere mile and a half from the boundary of the Grand Hyatt Kaua'i.

A. Overview. This project will be of significant public interest. Not only will the project affect the over 1,000 employees at the Grand Hyatt Kaua'i and Poipu Bay Golf Course, but adverse consequences resulting from the Dairy's operations will be a concern for all who visit, live or work in the Poipu and Koloa area. The operations of the Dairy have already been acknowledged by the Dairy to be a Concentrated Animal Feeding Operation ("CAFO"), and at 2,000 cows, or even 699 cows (Hawai'i Dairy Farms' purported first phase), the Dairy will be one of the largest and most concentrated in the State. As the U.S. Environmental Protection Agency ("EPA") has stated, "The concentrations of waste from these animals increase the potential to impact air, water, and land quality." Each cow, it should be noted, "produces an average of 143 lbs. of manure per day." *See*, page 42 of the Plan. The 2,000 cows will therefore

produce a total of 286,000 lbs. of manure per day. Given such potential impacts, a careful and deliberate review of the Plan is imperative.

Kawailoa offers its comments in two parts. First, preliminary comments and observations by industry experts as to specific sections of the Plan are attached to this letter. Second, general comments relating to the processes and the overall scope of review are included in the body of this letter. We hope that the comments, both general and specific, will be helpful and will assist the Department of Health ("Department").

B. **Comments by Experts**. Preliminary comments of Dr. Deanne Meyer are attached.

Dr. Meyer is a Research Scientist and Cooperative Extension Specialist in the Department of Animal Science at the University of California, Davis (UC Davis). She holds a B.S. in Animal Science and an M.S. in Dairy Science from UC Davis and a Ph.D. in Animal Science from the University of Florida, Gainesville. Dr. Meyer's research analyzes production, collection, storage, transportation, and utilization of manure management waste stream(s) on livestock facilities with an emphasis on commercial dairies. She consults with both dairy operators and with agency regulators. Her CV is attached to her comments.

Because of the shortness of time to provide comments, Kawailoa expressly reserves the right to supplement the comments of Dr. Meyer. We must emphasize that the comments of Dr. Meyer are preliminary and may be supplemented. Furthermore, comments from additional experts are anticipated.

By way of background, a copy of the Plan was received on July 25, 2014.[1] Since then, there have been only ten business days for the experts to review the lengthy Plan. (Although prior versions of the Plan have existed, those prior versions have not been helpful in the review of this Plan. The prior versions have not been made publicly available except with wholesale and substantial redactions of material sections. Moreover, the Plan released on July 25, 2014 appears to be significantly revised from prior versions.)

Until Wednesday, August 6, 2014, Kawailoa did not realize that a due date of August 11, 2014 had been established for comments.[2] The experts submitting comments have worked diligently, but have been on previously scheduled travel in addition to facing the time challenges related to the scope of this review. Some experts have simply not been available and will not available for several more weeks. We intend to send the Department complete comments as soon as they are received from our experts. We request that the Department consider these comments, in their entirety.

[1] Hawai'i Dairy Farms' project was first announced over a half year ago. The Dairy has had at least that long of a period to develop the Plan and to consider its impacts.
[2] Although Kawailoa understood that the due date for comments initially was set for Friday, August 8, 2014, State offices were closed on such date.

C. **General Comments**.

1. **Chapter 343**. This project is subject to Hawai'i Revised Statutes ("HRS") Chapter 343. HRS Chapter 343 requires that when a project proposes any "wastewater treatment unit," an environmental assessment must be prepared "at the earliest practicable time to determine whether an environmental impact statement shall be required." HRS § 343-5(a)-(b). There is no agricultural exemption applicable to the Dairy. The term "wastewater treatment unit" is defined in Hawai'i Administrative Rules ("HAR") Chapter 11-62 and does not exempt animal waste. Hawai'i Dairy Farms ("HDF") will operate a wastewater treatment facility in order to treat the cow manure generated by its milking cows.

HDF has not prepared an environmental assessment for its proposed wastewater treatment unit and its dairy farm and therefore may not proceed with its project until it does so. The Department should likewise not proceed with decision-making on a project that has not complied with Chapter 343.

2. **Storm Water Permit**. Construction of the Dairy has already commenced without a storm water permit for such construction activities. HAR § 11-55-04 requires that before beginning construction activities that disturb one or more acres of land, a person shall submit a complete National Pollutant Discharge Elimination System ("NPDES") permit application and provide notice of intent at least 180 days before construction begins. Since the construction activities have involved far in excess of one acre of property and since a storm water permit has not been obtained, all construction activities must cease immediately.

3. **Kaua'i County Board of Water Supply**. It would be appropriate that the Department exercise its discretion to require that the Dairy's wastewater system be approved in writing by the Kaua'i Board of Water Supply, pursuant to HAR § 11-62-6(k). The Kaua'i Board of Water Supply is not only suited to evaluate the impacts to Kauai's drinking water sources, but is the agency most directly interested in assuring that the drinking water sources on Kauai not be impacted by the Dairy. The entire island of Kaua'i is a critical wastewater disposal area, HAR § 11-62 Appendix E, and the dairy farm is proposing a unique, highly intensive agricultural use.

4. **Wastewater Treatment Permits**. Under a number of existing administrative rules of the Department, permits are necessary and should be required for the Dairy's wastewater treatment works. *See*, HAR § 11-62-50(a)(5), HAR § 11-62-50(b)(5), HAR § 11-62-50(d)(6) and/or HAR § 11-62-50(e).

5. **Public Meeting**. The Department has the authority to hold, and Kawailoa requests a public meeting prior to its decision regarding the Plan. HAR § 11-62-10. There are numerous reasons for a public meeting, which individually, as well as collectively, are compelling.

The primary and overarching reason for the public forum is that the dairy farm is in a <u>location</u> of great public importance. The Māhā'ulepū area holds such natural and cultural

significance that the National Park Service ("NPS") conducted a reconnaissance survey for potential inclusion in the national park system. *See* NPS Reconnaissance Survey, attached as Exhibit B. Impacts from the dairy to the natural and cultural resources have caused extensive public debate. It would be ironic that such a major use by the Dairy of an area that is worth preserving and protecting, so much so as to be potentially included in the National Park System, not be the subject of at least a public meeting by the Department.

The Dairy will discharge its effluent directly to waters of the United States. Māhā'ulepū valley contains "waters of the United States" as defined under the Clean Water Act ("CWA"), 33 U.S.C. § 1251 *et seq.*, and discharge into these waters is prohibited. According to the Hawai'i Clean Water Branch Water Quality Map, two streams run through the middle of Māhā'ulepū valley and discharge into the ocean. *See* Water Quality Map, attached as Exhibit C.

The NPS reconnaissance survey (Exhibit B) notes that landowner Grove Farm "operates a water system that includes wells, ditches, tunnels and reservoirs." Exhibit B at 29. Māhā'ulepū Reservoir, at the back of the valley, is part of that system. *Id.* Although Māhā'ulepū valley's streams and wetlands have been modified, their remnants remain and visibly expand during wetter periods. *Id.* The valley's water bodies provide habitat for endangered species, such as koloa and nēnē. *Id.* at 19.

The former Wai'ōpili stream—largely subsumed by the ditch system within the cultivated area at Māhā'ulepū —emerges in a more natural form near Makauwahi Cave, where it joins forces with a natural spring and Kapunakea pond. *Id.* at 29. This wetland juncture attracts waterbirds and serves as nursery habitat for native fish. *Id.* It is also linked hydrologically to the Makauwahi Cave complex, a critical habitat for endangered anthropods. *Id.*

Research and restoration have been ongoing in the Wai'ōpili stream/Kapunakea pond area since 1992. *Id.* at 30. On 15 acres leased from Grove Farm, volunteers have been restoring native grassland and riparian areas. *Id.* A statewide wetland strategy calls for continuation of these efforts, and protection of "this unique area in perpetuity through conservation easements, cooperative agreements with the landowner, and/or direct acquisition." *Id.* (quoting Pacific Coast Joint Venture, Strategic Plan for Wetland Conservation in Hawai'i (March 2005)). Whether the result of streams, wetlands or ponds, it is clear that Māhā'ulepū valley contains "waters of the United States" pursuant to 40 CFR §122.2.

State water quality data designates the two streams in Māhā'ulepū valley as Class 2. *See* Exhibit C.

> The objective of class 2 waters is to protect their use for recreational purposes, the support and propagation of aquatic life, agricultural and industrial water supplies, shipping, and navigation. The uses to be protected in this class of waters are all uses compatible with the protection and propagation of fish, shellfish, and wildlife, and with recreation in and on these waters. <u>These</u>

> waters shall not act as receiving waters for any discharge which has not received the best degree of treatment or control compatible with the criteria established for this class. No new treated sewage discharges shall be permitted within estuaries.

HAR § 11-54-3(b)(2) (emphasis added). Underscoring the above, no new industrial discharges within estuaries are permitted, with the exception of: (1) discharges covered by an NPDES general permit in accordance with 40 CFR § 122.28 and HAR § 11-55; and (2) stormwater discharges associated with industrial activities which meet water quality criteria as specified in HAR §§ 11-54-4(a) and 11-55. *Id.*

The two streams in Māhā'ulepū valley converge and flow through a Class 1 Critical Habitat, the Māhā'ulepū Coast, before discharging into the ocean. *See* Exhibit C.

> It is the objective of class 1 waters that these waters remain in their natural state as nearly as possible with an absolute minimum of pollution from any human-caused source. To the extent possible, the wilderness character of these areas shall be protected. Waste discharge into these waters is prohibited, except as provided in section 11-54-4(e). Any conduct which results in a demonstrable increase in levels of point or nonpoint source contamination in class 1 waters is prohibited.

HAR 11-54-3(b)(1) (emphasis added).

D. Conclusion.

It is not enough for the Dairy to simply assert without more that there will be no discharge. The Māhā'ulepū area, including the ground water and nearby Class 1 waters, are pristine and irreplaceable, and any discharge will cause irreparable damage. After-the-fact remedies will be wholly lacking and unsatisfactory.

It is HDF that proposes a highly intensive use of the land. The operations and condition of the Dairy alone will directly affect both the quality and quantity of runoff water that inevitably will find its way into the streams, wetlands and ocean or seep into the groundwater table. It is therefore highly appropriate that HDF bear the burden to demonstrate in detail that there is no risk of polluting the area. HDF has not so demonstrated. Its Plan is not adequate and should be rejected by the Department.

Thank you for your attention to this matter. Please do not hesitate to contact me with any questions regarding these comments.

Sincerely,

Lisa Woods Munger

LWM

cc: Edward Bohlen, Esq.
Becky Mitschele, EPA Region 9, NPDES Permits Office
Jun Fukada, Kawailoa Development LLP

Enclosures:
Exhibit A, Expert's CV and Comments on Hawai'i Dairy Farms' Waste Management Plan
Exhibit B, National Park Service Reconnaissance Survey
Exhibit C, Hawai'i State Water Quality Map and Key

Meyer, Deanne
University of California, Davis
Dr. Deanne Meyer is a Research Scientist and Cooperative Extension Specialist in the Department of Animal Science at the University of California, Davis (UC Davis). She holds a B.S. in Animal Science from UC Davis (1983) and an M.S .in Dairy Science (1986) and a Ph.D. (1989) in Animal Science from the University of Florida, Gainesville. She minored in Food and Resources Economics (M.S.) and Farming Systems and Agricultural and Extension Education (Ph.D.). Dr. Meyer's research analyzes production, collection, storage, transportation, and utilization of manure management waste stream(s) on livestock facilities with an emphasis on commercial dairies. Research has focused on nutrient flows into, through and out of dairy operations including: content of manure solids and liquids, water use, efficiency of mechanical and gravity flow separator devices, analyses of other treatment technologies, nutrient distribution during land applications, and ammonia volatilization and PM10 emissions. Based on her experiences in research and policy development related to atmospheric emissions she has served twice as panel manager for USDA NIFA Air Quality grant review process. She maintains an active collaboration with San Joaquin Air District Staff since initial development of Volatile Organic Compound (VOC) dairy cattle emission rates (2005) to assist with understanding mitigation measures for implementation by dairy operators. Dr. Meyer worked with colleagues to reformat Table D384.1 Manure Characteristics Standard for the American Society of Agricultural and Biological Engineers. These landmark modifications (2005) allowed an end user to include biological input (dietary parameters) to estimate manure and nutrient excretion and not solely rely on body weight. This was the first major revision to the Table D384.1 since its inception. Dr. Meyer has served on numerous advisory committees working with Federal, State, and Regional regulatory agencies to better understand potential for nutrients from dairy production operations to be emitted to soil, ground or surface water, or air. Dr. Meyer was a primary contributor to Livestock and Poultry subcommittee responsible for white paper for USDA NRCS Agricultural Air Quality Task Force, Recommended Units and Supporting Data for Standardized Reporting of Air Emissions from Animal Agriculture (2010) and is currently serving on US EPA Scientific Advisory Board Animal Feeding Operation Emissions Panel. Dr. Meyer maintains an active outreach program to educate dairy operators and professionals in water and air regulatory compliance requirements. Through this process she regularly interacts with stakeholders and regulatory staff to provide scientific input and better understand needs of each agency.

Exhibit A

August 11, 2014
Dr. Deanne Meyer

Comments on Hawai‘i Dairy Farms’ Waste Management Plan

Hawai‘i Dairy Farms’ Waste Management Plan (“Plan”), dated July 23, 2014, contains incomplete and/or contradictory information. Significantly, the Plan fails to address herd size and composition, average expected milk production, potential nutrients available for land application, reasonable expectation for crop yields in the early years, stocking rate, confirmation that the settling pond will or won’t be aerated, reasonable recovery of estimated nitrogen excretion, reasonable initial frequency and protocols for manure sampling, the need to import more than 80% of nitrogen applied to pasture, the high fertilization rates compared to sugar cane production, the minimum feedback analysis to determine if nutrient applications met or exceeded crop needs and how to modify accordingly to be protective of water resources. The Plan also contains numerous inconsistencies and contradictory information, such as herd size (both number of animals and weight of cows), use of terminology (effluent, solids, manure), and that storage ponds will have next to no odor then describe odor mitigations for the storage pond. The Plan, as it currently stands, is highly problematic because insufficient information is provided to determine if nutrient management of effluent, solids and manure will be consistent with pasture needs and production and protective of water resources and how long term importation of nutrients to the facility (fertilizer and feed) will impact existing natural resources and surrounding landscape. The Plan identifies that all facilities and infrastructure presented in the application are for 2000 cows. Yet, it is unclear when the base number of 699 or 2000 cows is used. The Hawai‘i Department of Health (“Department”) should reject the Plan because it cannot properly form a decision on the Plan’s sufficiency until all of these issues are resolved. My comments on the Plan are as follows:

1. The Plan does not properly count the number of animals. The Plan cannot be approved if the number of animals is unknown.
    a. First, the Plan does not identify exactly how many animals will fall into each category: (1) dry cows (pregnant, not lactating); (2) lactating cows; (3) bulls; or (4) replacement heifers. How many total animals will be at the property?
    b. Second, there is a discrepancy between the number of milking cows and the number of mature cows. They are not interchangeable; from a regulatory perspective, mature cows consist of all cows that have calved at least once.
    c. Third, the Plan also fails to describe consistently how many cows will be in a mob. This will determine how many mobs are present and how much time is needed to get each mob to and from the milking parlor twice each day. If there are too many mobs the animals will not be able to be milking even if capacity is present in the parlor. It may take up to 30 minutes per mob for animals to commute to or from the milking parlor for the distant mobs.

   It is unclear if the dairy will have 699 milking cows, or 699 milking and dry cows. Unless seasonal calving occurs, approximately 85% of cows are lactating and 15% are dry (pregnant and not lactating). Anticipated number and age of support stock (day old calves through first calving) must be defined. Animals are responsible for excreting manure and associated nutrients that must be accounted for/included in the Plan as well as generating process water from the milking parlor or calf shed.

2. The Plan fails to identify the estimated milk production and nutrient loading per day from one cow or from the anticipated number of animals. This is important because milk production drives feed intake. Nutrients consumed in feed that are not incorporated into milk, body growth (during the first and second lactations) or the growing fetus (when cows are pregnant) will be excreted. These excreted nutrients will be the basis for the nutrients excreted by lactating cows that must be accounted for/included in the Plan.

3. The Plan fails to address the stocking rate. This is critical information because the ratio of animals per unit surface area will impact soil compaction and therefore impact water infiltration rate and water runoff. Additionally, stocking rate should be determined based on forage productivity and quality. Estimated yields and forage composition should be used to determine stocking rate. The historic use of the land indicates soils are of low fertility and maximum or average forage production should not be planned for during the early stages of use. Recommendations for nitrogen fertilization on sandy soils growing sugarcane are near 180 pounds. The plant biomass grown will be much greater in this project with suggested nitrogen fertilization rates above 700 lbs per acre (requiring large importation of nitrogen into the watershed).

4. The Plan does not address what happens to the daily wash water used to wash down the feed area of the calf shed. This water and associated nutrients must be accounted for in pond storage and effluent irrigation uses.

5. The Plan does not address what happens to calves once they leave the calf shed. This is significant because once calves are moved to open paddocks, those paddocks are not available for grazing for the milk herd. The excrement from calves must be accounted for in nutrient management calculations.

6. The Plan does not identify a maximum distance for cattle walking in a day. It indicates that a mob will graze in an individual paddock for a day. For the outlying paddocks this is considerable distance to walk to and from twice a day. Additionally, many of the perimeter paddocks have greater slope which will require more energy for animals to graze. This is significant because the greater walking distance and slope will affect the efficiency of energy utilization by animals in a mob.

7. The Plan does not provide information on the water holding capacity of various soils. This information is required in order to properly evaluate the Plan because water holding capacity of soil and soil porosity impact how fast water will infiltrate through the soil profile to the underlying water table. Irrigation or rainfall on porous soil will result in water leaching through the soil profile (moving from the surface of the soil through the soil). The moving front of leaching water will carry nitrate nitrogen (nitrate does not stick to soil particles) with it. This nitrogen will ultimately reach groundwater if it is not denitrified by microbial processes during transit.

8. The Plan does not give a description (slope) for the “Ke” Kalihi soil type. Steeper slopes require more energy for animals to graze. Steeper slopes will likely have increased runoff during intense rain events.

9. The animal cemetery is located in soil with 6 to 12% slope. Run-on will need to be diverted to not inundate the cemetery and result in leaching to groundwater. A riverine is adjacent to the paddock with the cemetery. Management of the riverine to be sure it doesn’t flow onto the cemetery is important. Physically digging the defined trenches for mortality may be challenging in sloping soils. Managing rainfall will be critical to minimize ponding of rain water and prevent deep percolation.

10. According to the Plan, the perimeter of the property has greater slopes. This is problematic because runoff will likely be greater from these areas and the runoff will be directed through other paddocks. Intense rain events resulting in runoff that goes through the paddocks will collect freshly excreted feces and relocate it. Manure will likely be discharged with runoff off-site. The Plan does not address where this runoff will flow. However, according to the Department of Health, Clean Water Branch’s water quality map, there is a ditch that flows next to the taro farm, which connects to a water body that flows directly to the ocean.

11. The Figure 9 farm map legend does not provide definitions for the following: truck turn around, cow walkways/races, concrete holding yards and gravel farm races, calf sheds, effluent and sludge pumps and distribution system, irrigation water storage and distribution system, potable well and transmission main to milking parlor, potable water tank for milking parlor and livestock consumption, livestock water distribution system, feed silos or individual wastewater system. In particular, the dairy calf shed is going to be problematic because there is wash water generated from daily cleaning of the feeding area and this does not appear to be accounted for in pond design calculations. Also, there is no discussion on how the bedding area of the calf shed will be cleaned and sanitized between animals. Additionally, it is not clear if two sheds would be sufficient space for the maximum build out of 2000 cows.

12. In-parlor feeding by definition will result in dust presence and accumulation. In-parlor or supplemental feeding is done to provide needed nutrients that are not provided by pasture consumption. Accumulated dust feed particles will provide substrate for flies and require labor and water to remove. Fly management is important to minimize nuisance issues for employees and minimize health issues for cows. Perhaps use of water to remove dust is accounted for in the 30,000 gallons a day identified as dairy facility water (primarily for wash water). However, only 10,667 gallons of process water from machine wash, yard wash, and water usage appear to be in the calculation for the settling and storage pond system.

13. The amount of time devoted to milking cannot be determined as described. If only one mob is in the holding area/parlor at a time, there must be considerable down time as described between mobs for one mob to return and another mob to come up to be milked. Paddock rotation must be known to determine if all mobs will be milked successfully.

The long transit times may translate to more manure deposited on cow runs (where no plants are growing) versus in pasture (where nutrients may be used by growing plants).

14. The information given regarding the potable water systems is incomplete because it is not clear if the potable water is used as drinking water for all the animals on the farm, including the non-milking cows and replacement animals. This is significant because potable water must be available daily for all animals and to clean milk harvesting equipment. The water use budget must be calculated with all categories and number of animals considered.

15. The discussion on irrigation setbacks is incomplete because it does not address such significant issues as whether the GPS will correct for wind speeds and directions during irrigations. This information is required to properly evaluate the Plan because during irrigation, with effluent, if no correction is made for wind speed and direction, drift of applied water a conduit to US Waters or directly to US Waters could occur and is not legal. Drift is the unintentional off-target application due in this case to wind movement.

16. The Plan’s effluent pond calculations are highly problematic and contradictory because it indicates the dairy facility including the wastewater treatment ponds and other infrastructure will be sized and constructed for the Phase 2 capacity of 2,000 cows. However, the calculations in this report are based on the Phase 1 capacity of 699 cows. The facility cannot be sized for 2000 cows if the calculations are based on 699 cows. Is the 2000 number referring to all the cows on the farm or just milking cows?

17. The values given for the total wastewater volume and potable water demand for the dairy facility are inconsistent because the total wastewater volume for 699 cows from the machine wash, yard wash, and other milking activity is 10,667 gallons per day (“gpd”) plus other farm uses. See Figure 18, Water Flow Schematic. This value does not agree with “Total potable water demand for the dairy facility (primarily for wash water) is approximately 0.03 millions of gallons per day (MGD).” Located on page 25, Paragraph 1. If other farm uses are an additional 20,000 gpd of water they should be used in the calculations. Figure 18 identifies there are other farm uses and only indicated the estimated volume of water and estimated manure generated during milking to in the flow schematic. Further clarification regarding all material entering the settling or effluent ponds is necessary in order to adequately determine if pond size is sufficient for holding and required storage for storm events.

18. The description of the settling pond is problematic because the intent of a settling pond is to settle larger and/or denser particles. Yet, the description includes use of a stirrer to break up the solids. The larger sized particles are retained in the settled solids, along with some smaller trapped particles. However, solids (what remains after moisture is removed; solubles and very fine suspended solids, as well as other solids) will transfer to the storage pond.

19. The description of the secondary containment area for overflow from the storage pond is problematic because by definition it would allow dumping or emptying of the storage

pond to land without implementing the nutrient budget. This dumping of waste into an area that will likely not support crop growth is against the intent of the EPA's CAFO Rule. The Plan fails to describe how the water will be managed if the secondary containment area is utilized. Additionally, the Plan fails to address whether a portable pump will be used after an extreme rain event to relocate water back to the storage pond. If not, the Plan needs to address how the material will be handled in order to prevent leaching or runoff of nutrients. A contingency plan is needed so if the secondary containment area is utilized environmental impact will be minimized. The secondary containment would need to hold the discharged material, rainfall, and be managed to withstand intense weather conditions for an unknown duration. It would likely have to have freeboard similar to the storage pond.

20. The Plan fails to address how weeds and plant material will be managed around the fence that surrounds the settling and effluent storage ponds. Weed management is critical to maintain structural integrity of ponds and minimize windblown weed seeds from entering the effluent and subsequently be applied to paddocks during irrigations. As weeds die, they may become debris on the surface of the pond and interfere with pump function.

21. The Plan inadequately discusses how the farm's structures will ensure human and livestock safety. Many manure storage ponds/structures are deemed confined spaces and must meet appropriate safety requirements to fulfill OSHA. The description of the pond lining is highly problematic because there is nothing to assure joint integrity. The Plan fails to address the expected life of the lining. The expected life of storage ponds is 20 years, as identified in the operation and maintenance worksheet on page 94. Maintaining joint integrity is essential to keep the pond from leaking into underlying area. More information must be provided in the Plan before decisions can be made on this application.

22. The Plan's description on pond sealing, lining and flexible membrane is incomplete because there is no concise discussion regarding prevention of whaling. In soils prone to gaseous release whaling can occur. This is when the liner traps gas between the soil and the liner. The liner inflates (stretches out of shape) and displaces capacity for storage. Releasing the gas without puncturing the liner is a challenge. Even if gas is removed the liner will not return to its proper location, since it is stretched. In other instances, when liners aren't installed properly they can slough resulting in the liner sagging into the structure (pulling away from the anchor). Any reconfiguration of the liner shape will make pond clean-out difficult.

23. The Plan fails to include calculations to identify how much irrigation land will be reduced when setbacks are taken into account. That is, calculations should be provided to identify how many acres will not be irrigated as a result of the various setbacks in each of the irrigation units. The 378 acres at the farm is equal to 7 areas*54 acres/area. The calculation to identify reduction of irrigation land by setback acreage needs to be shown. Summary information is provided in Table 6. Paddocks are identified in Table 7 (page 18). They add up to 517.29 acres. Table 9 identifies 378 acres are irrigated through pivot

systems; 82 acres irrigated through drip; 57 acres not irrigated (perimeter lands with greater slopes; beyond the reach of the pivot and not uniformly shaped).

a. In addition, Table 6 currently lists total non-irrigated land within the irrigation area. It appears that this number was subtracted from the size of the area. The final value was divided by 7 sections, resulting in 54 acres each. The amount of water and fertilizer needed by each area is a function of the area size. If one area is larger or smaller than another nutrient and water applications must be modified appropriately.

24. The Plan fails to properly prepare for upcoming storm events. EPA will not condone emptying ponds due to upcoming storm events. If material is emptied on land, there will be a higher probability of effluent contaminated runoff. The CAFO Rule does not acknowledge cataclysmic storm events. Were a 25-yr, 24-hr storm event to hit, the only legal discharge for NPDES permit holders is the water collected beyond the 25-yr 24-hr storm event rainfall. 10.4 inches is the estimated storm event. Clearly, given the topography, animals will need to be moved to higher ground and anything in the way at lower elevations may not exist after the storm event.

25. The Plan does not include an adequate description of the laboratory that will provide soil fertility recommendations to support the farm's nutrient applications. In particular, the Plan fails to provide the types of certifications performed at the laboratory. This is problematic because analytic methods used for various types of waste streams may or may not be sufficient for dairy manure slurry or effluent or plant tissue testing.

26. The Plan fails to adequately ensure that the recommended nutrient application rates are protective of ground and surface water resources. Comparing planned nutrient applications to a Standard does not insure anything. In addition, it is not clear why there is a reference to the Standard for purposes of Phosphorus indexing. The phosphorus index is an index value that identifies if there are sufficient or insufficient amounts of phosphorus in soil (is it ok to apply phosphorus—yes or no; not how much phosphorus should be applied). This is inconsistent because having a Plan and implementing the Plan are two separate concepts. It is important to have a feedback mechanism to evaluate if the targets of the Plan were achieved and if they were not, what modification(s) need to occur and what potential environmental ramifications may occur as a result of the Plan.

27. The Plan contains unrealistic yield expectations certainly for the early years of implementation. The Plan thus cannot be properly evaluated because Plan evaluation relies on reasonable estimates of yield expectations (how much nutrient is removed) and that allows the application of nutrients based on removal rates. If, as the Plan states, the historical uses of the farm have left the soils depleted of the essential nutrients required for crop growth, it is highly unlikely that such poor soil will begin Kikuyu production at 20 ton of dry matter per year. Reasonable estimates of yield must be used. For every ton of dry matter at 22% crude protein (crude protein is approximately 6.25% nitrogen) an additional 70.4 pounds of nitrogen is removed per acre [2,000 lbs x 22 lbs crude protein per 100 lbs of dry matter x 6.25 lbs nitrogen/ 100 lbs of Crude Protein]. This extra removal justifies the application of more nitrogen to the field. There is **no** compelling

evidence in the document to believe 20 tons of dry matter would be reasonable early on, even with heavy fertilization rates. This is especially true for the perimeter paddocks that are not irrigated as well as Block F that is subject to flooding. As identified previously, it is imperative to have reasonable yield goals. When excess nitrogen is applied to land it may be emitted as ammonium (atmospheric), or the organic form may be allowed to mineralize to ammonium. Ammonium may adsorb to negatively charged soil particles or if conditions are favorable, it may be nitrified to nitrate, a very mobile form of nitrogen. It is important to maintain reasonable yield goals. To begin with a 20 dry ton/acre yield goal is unusual given the stated poor quality of the soil. When nitrogen is applied to meet higher yield expectations and these yields are not achieved the excess nitrogen is likely lost to the environment. The difference of applying nitrogen for a yield that doesn't occur, results in potentially huge imports of nitrogen fertilizer that will be lost to the environment. Ammonium volatilized into the atmosphere will be deposited to earth downwind (on soil or surface water). This increases the amount of nitrogen quantity in the landscape. Significant amount of greenhouse gases are released during the production of fertilizer.

28. The Plan is misleading and contains many inconsistencies which make it impossible for the Department to thoroughly evaluate it.
    a. For example, the inconsistency in use of effluent and sludge adds considerable and unnecessary confusion. Effluent as described is only the material leaving the storage pond (second stage pond) for irrigation purposes. Sludge refers to material from within the settling pond. Manure is the excrement from cattle (feces and urine).
    b. Another example is found in Section 8, Nutrient Management with subsection 8.2 Pasture-Based Dairy. The following is on page 57 in paragraph 3: *The effluent is highly diluted, to the extent that it will have next to no odor in the storage pond and certainly no odor at the farm boundary. The settling pond will also be aerated to help mitigate odor. To help further mitigate any odors arising from the facility a Windbreak/Shelterbelt (i.e. a multiple row planting of trees) will be established along the prevailing wind pattern of the pond. This design will follow the guidance of NRCS Conservation Plan Standard 380 Windbreak/Shelterbelt Establishment.* These sentences do not belong under a heading of Nutrient Management. Having 1% solids concentration in a storage pond does not guarantee no odor. This is the first mention that the settling pond will be aerated. There is no further discussion of aeration, aside from it occurring in NRCS Standard. Neither Figure 21 nor 22 have any indication of aeration mechanism. There is no mention in Section 7.2 Effluent Ponds about aeration. Figure 17 "Dairy Facility Site Plan" has no indication of windbreak/shelterbelt location. There is virtually no space west of the settling pond for a shelterbelt. This information should be under an independent heading of odor management in Section 7.2. If aeration is going to be used, more detailed information is needed to determine if it will be sufficient. Keep in mind that depending on the type of aeration technique used, ammonia may be volatilized to the atmosphere (with subsequent return to ground uncontrolled). This may not be desirable of it returns into a pristine waterway where very small concentrations of added ammonium may make an impact on aquatic habitat.

    c. Another example is on Page 59. The Plan states: *As the cattle excrete on the Kikuyu thatch, it is incorporated into what is effectively an organic net. Due to the high moisture and moderate temperatures, the microbial activity in the thatch is very high and the effluent will be largely broken down by microbial activity within 24 hours. The effluent is less than 20% of the daily nutrient needs, and therefore readily absorbed in Kikuyu.* Fecal matter (organic nitrogen) will likely remain on the plant or thatch until sufficient rainfall or irrigation water washes it to the ground. Organic nitrogen will not be readily absorbed in Kikuyu. The ammonium fraction of the waste stream may be adsorbed into the plant. Organic nitrogen has a much slower release (mineralization) time and although it may not be readily available for plant growth, if discharged off site it may have import on mineralization near aquatic species (ammonium toxicity).
    d. Generalities lacking specific detail provide no insight to farm oversight and management. Page 59 states: *Site specific soil moisture will be monitored, in real time, to ensure irrigation water, liquid effluent and cattle are not applied to soils when conditions are suboptimal.* Cattle are not applied to soil. They are given access to a paddock. No definition is provided for suboptimal. What happens if cattle were supposed to go onto a paddock that has suboptimal conditions? Where should the cattle go (need a contingency plan). What happens to the quality of the pasture that isn't consumed? What criteria will be used to identify when suboptimal conditions no longer exist?
    e. In Table 9, the drip irrigation area is 82 acres. However, in Figure 23 Nutrient Management Map Block H, the drip irrigation area is 81 acres.
    f. Another inconsistency relates to body size of the cows. Page 42 identifies that *the kiwi-cross cow's weight is about 1,210 lbs.* Page 90 under 8.10.1 Nutritional Requirements states: *The nutritional requirements are based on an approximately 1,000 lb animal producing 5.3 gal of milk per day.* The amount of potable water required for 699 livestock animals is 20,000 gallons per day. It's not clear how many animals drink this water or their stage of production. Hence, it's not possible to estimate milk production by using average water intake. Closely identifying body weight and milk production are critical. Milk production and body weight drive feed intake, and therefore quantity of manure excreted daily as well as total quantity of nutrients excreted daily.
    g. Another example is the amount of dry matter consumed from pasture per day. A mob of animals (105 to 150 cows when there are 699 cows in residence; 300 when there are 2000 cows) will graze one paddock in one day. According to the Plan, the paddock size ranges from 4 to 5 acres. If 115 cows graze a 5 acre paddock the amount of space available for 1 cow to graze is 5 ac/paddock ÷ 115 cows/paddock=.04 ac/cow. At a yield expectation of 20 tons of dry matter per acre per year this amounts to .04 ac/cow x 20 tons dry matter/ac/yr x 2000 lbs/ton ÷ 365 days/year = 4.4 lbs dry matter per cow per day. Page 90 identified the Kikuyu intake as 14 kg dry matter a day (14 kg x 2.2 lbs/kg=30.8 lbs dry matter per day). According to the Plan, cows will consume pasture from .04 acres and consume far less than recommended nutrient requirements identified as 30.8 lbs dry matter per day.

h. According to calculations on page 82, the Kikuyu growth rate of 120.5 lbs dry matter/ac/day x 365 days a year is an annual yield of 22 tons (not the previously defined 20 tons). Protein listed here is 22 to 23%. This is inconsistent with 20% identified on page 90. The assumption is that one only applies the nitrogen needed by the plant for growth. This is not the standard method for making fertilizer recommendations. Nitrogen is a leaky system. For many fertilizer applications more than 100% of the nitrogen needed by the plant is applied. The 'leaky' part of nitrogen is unmanaged and unaccounted for and may enter the environment as N2 gas, nitrate (leached), ammonia (atmospheric emissions), or other forms of nitrogen.

i. The tables on pages 85 to 86 representing phosphorus and potassium appear to be in the elemental form not at P2O5 or K2O. This is inconsistent with tables on pages 72 and 73. One standard method of discussion should be used. Likely this would be the elemental forms as the analysis for phosphorous and potassium excretion will yield elemental forms.

j. The manure analysis on page 88 demonstrates the inconsistent use of nomenclature. As discussed previously, manure is the feces and urine as excreted. Yet, the material may include other wastes. Manure in the general sense may include bedding and is referred to as solid manure. Manure diluted with water is referred to as liquid manure. In this document the term effluent (indicating material from the storage pond) is used. The term "solids" is used for the pumpable material removed from the settling pond. Use of definitions in ASAE Standard S292.5 Uniform Terminology for Rural Waste Management should help reduce confusion in terminology used in the Plan.

29. The Plan fails to account for nitrogen ("N"). This is unacceptable because N lost to the environments in undesirable forms may result in environmental impact. According to the Plan, the total N applied from animals is 81,224.8 (40.6 tons). Assuming this comes from 699 milking cows the value is low. If any manure from any other age group is allegedly in the liquid effluent, sludge or excreted on pasture, the recovered value is extremely low. Logically, one would compare application values to potential excretion values to ground truth the applied values. Information in "8.10.1 Nutritional requirements" was used to estimate excretion. The protein daily requirement of 18% for 5.3 gallons of milk is very high. The US National Research Council Nutrient Requirements for Dairy Cattle recommends concentrations closer to 14 or 15% for the given average daily milk production. At 18% protein concentration 3240 g of protein are identified as required. Divide this number by 6.25 (composition of N in crude protein) to estimate 518 g of N intake per day. N in milk is estimated 5.3 gal x 8.6 lb/gal x 3.2% protein /6.25 *454 = 106 g of N in milk per day. Intake – product is a rough estimate of excretion. 518-106= 412 grams per head per day (g/hd/day) excreted. Estimated N excretion rate for the herd is 412 g/hd/d x 365 d/yr x 699 hd ÷ 1000 g/kg x 2.2 lb / kg ÷ 2000 lbs/ton = 115.6 tons of N excreted/yr (for 699 cows; 330.8 tons of N excreted/year for 2000 cows). **Only 35.1% of the estimated excreted N is accounted for in the nutrient mass balance (unnumbered table on page 73).** This is quite low for a pasture based system. Biological processes involved in the N cycle make it unlikely that recovery of 100% of excreted N occur on an animal operation. In a pasture based facility, one expects much of the N to be land applied by animals as very small losses of N occur between defecation

or urination by the animal and contact of feces or urine on the soil surface. Much more than one-half of the excreted N would be land applied directly. There are calves in the calf shed and it is unknown if/where replacement heifers and bulls reside. The numerator of applied nutrients would not change. However, the denominator of how much N was excreted would change. Therefore recovery, already low, would actually be lower. Unaccounted for N is escaping into the environment in an unmanaged fashion. According to the Table on page 73 only 20.8% of the N needs of the crop will come from manure. Therefore 79.2% will come from commercial fertilizer. **A minimum of 154 tons of fertilizer will be imported into the watershed. More is likely imported as nitrogen application is seldom equal to nitrogen removal given the leaky nature of the N cycle.**

a. An alternative method to estimate excretion is by use of the American Society of Agricultural and Biological Engineers Standard D384.2. Data from cattle in the US fed within 113% of daily requirements were used to develop regression equations to estimate manure and nutrient excretion. Equation 16 is one method to estimate nitrogen excretion: Nitrogen excreted (g)/hd/d= (milk (kg) x 4.204) +283.300. For this example, 20.7 kg (calculated as 5.3 gal/hd/d x 8.6 lb/gal ÷ 2.2 lbs/kg) x 4.204) +283.3 = **374 g/hd/day.** This 374 g/hd/day value is less than the 412 g/hd/day value because the equation is based off results from diets that were formulated closer to recommended concentrations**. The difference of 38 g/hd/day over 699 or 2000 animals in one year 10.6 to 30.5 tons per year of additional estimated nitrogen excreted.** The fate of this extra nitrogen excreted in the environment is unknown.

b. In addition, an analysis of the effluent needs to be done to determine if the nitrogen form can be absorbed by the plant leaves. Organic N will not absorb into the plant (the fraction responsible for the coloration of the effluent). Ammonium may absorb into the plant. It is likely that organic nitrogen (manure solids) that sticks to plant tissue will be washed off during a rain event or subsequent irrigation event.

30. The discussion of Block F (paddocks 215 to 226) is inadequate. The short and long term ability to apply nutrients to this block and mob graze is questionable given its predisposition to flooding (and subsequent movement of nutrients off site). This will include excretion by cattle, unless they cease grazing on these paddocks.

31. The Plan cannot be evaluated where it is missing vital information in its data presentation. On page 73 of the Plan, the column heading units for N, P2O5, and K2O of applied/ac/yr are misleading. The units appear to be pounds per acre per year or total pounds per acre (for the subtotal rows).

a. Neither the Table nor the Figure on pages 74 through 76 has titles. Additionally there are no units in the table or the figure on pages 74 and 75.

b. Table 15 needs to identify that the letters represent Blocks. The table in the middle of the page needs a number and title. It contradicts the information presented in the table that precedes it.

c. The values in the table on page 84 need to be defined.

32. The discussion of the effluent application schedule in light of rain is inadequate because if 5 application events are delivered to one block at one application event, then the quantity of nutrients delivered will be 400% of a normal irrigation. What changes will occur in subsequent nutrient applications? If this occurs, then subsequent application events of effluent or fertilizer need to be modified to some extent.

33. The manure sampling frequency is insufficient for initial analyses for year round applications. Initial sampling for a facility with no data should be far more frequent than annually to determine the variability in nutrient concentration. If samples come back consistent then an annual sample is appropriate. If variability is present (most likely) then more frequent sampling is needed and data should be incorporated into nutrient management.

34. In addition, the Plan cannot be approved when the sampling procedures are inadequate. The Operations and Management Worksheet for Manure Sampling Protocol represents what was presented in the Plan and is insufficient to obtain representative samples and incomplete in that it does not define analytes for analyses. Regarding liquid effluent manure sampling, taking multiple grab samples from an existing storage structure may or may not represent the actual material applied during land application. If material is agitated prior to application then the sample should be taken while agitation is occurring. Taking grab samples from the same depth serves no purpose as they are composited. However, if the grab sample is taken with a dipper tool, the contents of any sample container may or may not represent the actual material going to the field. When a dipper is inserted below the water surface and material fills the container, retrieval of the dipper from the water may displace contents (leaving behind more dense particles). This is not a recommended sampling method and may not yield a representative sample. The term sub-sample should be replaced with grab sample. Multiple grab samples may be composited. A sub-sample of that may be extracted. It is unclear why grab samples will be mixed and what analysis will be conducted in the field under swirling conditions. Analytical needs should be identified.
    a. Regarding "solid" (sludge) manure sampling, the material in the settling pond does not dewater. This material does not have characteristics of solid manure (it will not stack). It will behave as a liquid or a slurry. The method of sampling should be consistent with effluent sampling. The sampling protocol described in the Plan is inconsistent with the Effluent sludge management Operation and Maintenance Worksheet that suggests individuals go on a boat onto the pond to retrieve sludge samples. Freezer bags are not unbreakable and should not be used for something that has high moisture. Analytical needs should be identified.

35. The Plan's description of feed management is inadequate because it relies on very high intake of dry matter from pasture, long walking distances (when in distant paddocks), and high protein composition. There is no question that regular analysis of feeds is valuable to incorporate into diet formulation when feeds with high variability are used. However, in a pasture based system it is unclear what reformulation will occur. More grain can be provided to a point to increase energy content of the diet. Nutrient composition of pasture will not be modified when only one species of forage is intended to be grown.

The animals will eat what is present. The primary way to modify intake of nutrients is to reduce time exposed to pasture. However, as currently defined, it appears that the cows will have insufficient intake of pasture [the identified 30.8 lbs of dry matter intake daily is well above calculated dry matter intake given the number of animals in a mob, average acres per paddock, and the annual dry matter yield per acre]. If the nutrient ratios of the pasture are not what is needed for the animals (excess nutrients provided) the animals will excrete more nutrients than desired. If the pasture nutrient content is deficient then potentially mineral supplement may be provided to animals.

36. The Animal Mortality Management Plan (in appendices) should include an estimate of normal mortality (percent of herd per month) and episodic mortality (in case of disease outbreak). The worksheet has some unusual language: "The burial pit will be a minimum of 2 feet wide with length necessary to accomplish mortality." It is unclear what is being accomplished. How many animals can be accommodated in 4,400 ft sq area? If a pit is only2' wide and 3' separation is needed between pits, a double line of pits with a single 3' separation would be 628' long if only 4,400 ft sq of land is used for the cemetery. How long will it take to fill the cemetery to capacity? What is the burial plan after the cemetery is filled? How many animals can be accommodated in this area? Is a separation required between carcasses? What happens when catastrophic losses occur (during flood, hurricane, disease outbreak, bad feed)? The cemetery is proposed in an area of greater slope than many of the paddocks. Extreme care will need to occur to divert runoff from the neighboring landscape around the cemetery (so it doesn't run-on to the area of the cemetery) and minimize infiltration in the area of the cemetery. How accessible will this area be given the frequency of rainfall? What contingency plans will be in place to handle mortality during wet, rainy conditions, when it may not be possible to excavate and bury animals?

<u>Conclusion</u>

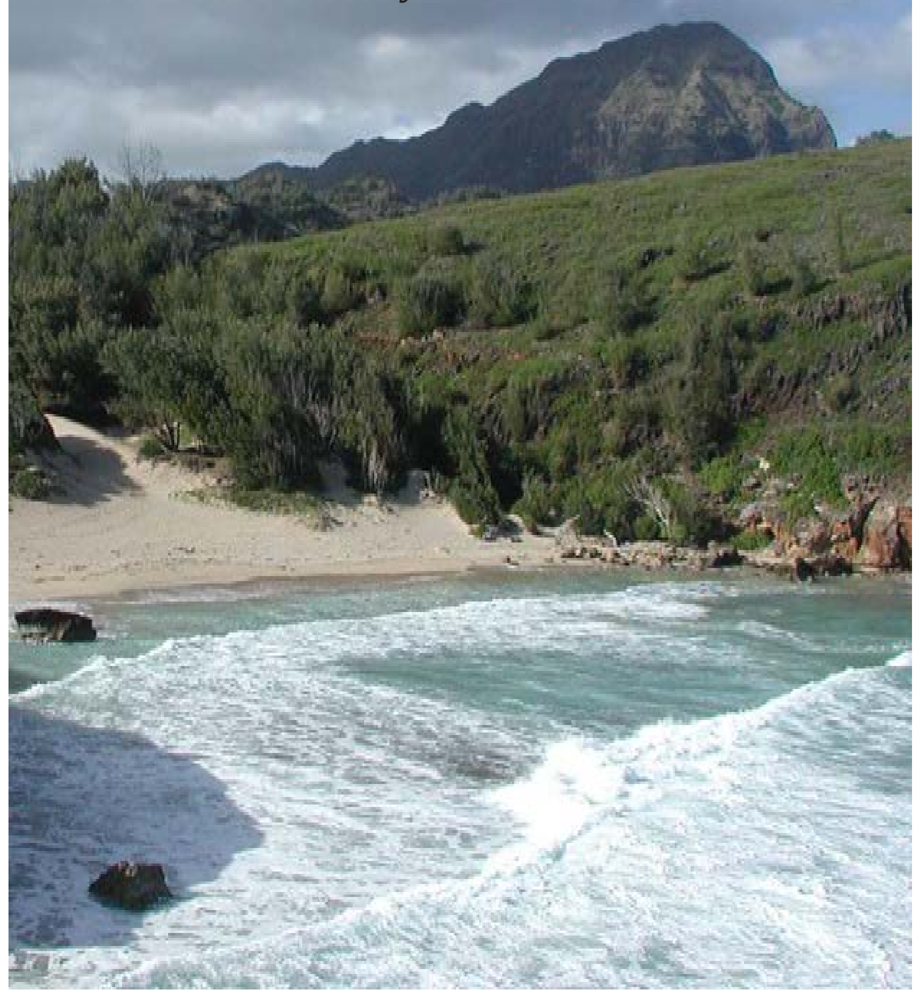
The Plan, as it currently stands, cannot be approved by the Department because it is incomplete and inconsistent, and lacks necessary nutrient and water accumulation calculations to determine if it is appropriate. It is in my professional opinion that such vital components are lacking in sufficiency and specificity to determine if adequate waste and nutrient management may occur. At a minimum these include: actual animal population (including weight of each population category, average daily milk production, estimated excretions, estimates of mortality by population category), process waters contributing to the waste stream (from calf sheds, milking parlor, and any other location), consistent use of terminology, proposed nutrient budgets for paddocks of differing slopes and field conditions (with and without irrigation; with flooding), explanation for unreasonably low recovery of nitrogen from manure, detailed management of settling pond (aerated?, stirred daily even if not pumped?), potential impact to the watershed of markedly higher fertilization requirements for Kikuyu compared to the previous crop (sugarcane) and a check and balance system in place to evaluate nutrient applications and removals and modify as needed.

Exhibit B

National Park Service
U.S. Department of the Interior

Pacific West Region, Honolulu Office
February 2008

Māhāʻulepū, Island of Kauaʻi
Reconnaissance Survey



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1 SUMMARY

At the request of Senator Daniel K. Inouye, in 2006 the National Park Service agreed to conduct a reconnaissance survey of Māhā‘ulepū and nearby areas on the island of Kaua‘i, the oldest major inhabited island in the state of Hawai‘i.

Māhā‘ulepū is an ahupua‘a (historic Hawaiian land division) and watershed running from the Hā‘upu mountain range to the shoreline on Kaua‘i’s southeast coast. It sits at the heart of a larger undeveloped 9-mile coastal span that separates the county seat of Līhu‘e from the resort town of Po‘ipū. Natural and cultural resources in this area provide respite and recreation for residents and visitors, and are the focus of this study.

Resources of particular interest in this locale include the undeveloped shoreline corridor from Makawehi northeastward through Māhā‘ulepū and Kīpū Kai to Nāwiliwili Bay; the Hulē‘ia National Wildlife Refuge and historic Alekoko Fishpond along Hulē‘ia Stream; and parts of the Hā‘upu mountain range overlooking these areas. These natural and cultural assets are mostly privately owned, and are mostly designated as conservation district by the state of Hawai‘i. They exist within a broader landscape of vast, private agricultural lands currently used for farming and ranching.

In accord with established NPS planning criteria, this report examines these natural and cultural resources to provide a preliminary evaluation of their significance, and a preliminary evaluation of the suitability and feasibility of helping to protect them within the framework of the national park system. These evaluations are based on limited site visits, research and consultations conducted by staff of the NPS Pacific West Region Honolulu Office in 2007, and are neither final nor definitive. They serve as background material for Senator Inouye as he considers whether to seek Congressional authorization for a full-fledged study of resource protection alternatives for Māhā‘ulepū and surrounding areas.

This reconnaissance survey report provides the following preliminary evaluations of the study area:

- The study area shoreline corridor, Hā‘upu mountain range and Hulē‘ia Stream are deemed nationally significant on the basis of natural and cultural resources including geologic landforms, rare species and habitats, and features central to stories of native Hawaiian and United States history. Collectively these areas comprise a relatively unspoiled and increasingly threatened coastal landscape that provides unique opportunities for public enjoyment, interpretation and scientific study.
- Resources in these areas represent themes and types suitable for protection within the framework of the national park system, and not otherwise adequately protected in the state or nation. Volcanic features of the study area represent a stage and range of geologic development of the Hawaiian high islands that is not featured at other Hawai‘i parks. Landforms and fossils of the Māhā‘ulepū coast illustrate the reality of global climate and sea level change, as well as the impacts of human settlement on native ecosystems. An extensive and undeveloped Hawai‘i shoreline within easy reach of population centers, such as that found in the study area, is a rare and rapidly vanishing

- type of recreational resource prized by U.S. citizens and international visitors as well as Hawai‘i residents. Protection and management of this resource type is currently inadequate at federal, state and local levels.
- The study area's significant natural and cultural resources are of a collective size and configuration to be feasibly managed for resource protection and public enjoyment at reasonable cost, provided that NPS, affected landowners, and interested state and local entities work in ongoing partnership to identify and reduce resource threats, manage access, and ensure long-term protection of the area's overall scenic quality.

Based on these preliminary evaluations, the National Park Service Pacific West Region recommends that a Special Resource Study be authorized under the stipulations of Public Law 105-391, so long as it focuses on non-traditional management alternatives that a) involve local partners and b) include options for continued farm and ranch operations on private agricultural lands.

2 BACKGROUND OF THE STUDY

In 2006, Senator Daniel K. Inouye asked the National Park Service (NPS) to conduct a reconnaissance survey on the Hawaiian island of Kaua‘i, in order to provide a preliminary evaluation of the resources of Māhā‘ulepū and surrounding areas for potential inclusion in the national park system. NPS agreed to conduct the study in the next fiscal year, and began its work in February 2007.

A team of NPS staff conducted a field visit to the study area March 19-21, 2007. The team included Frank Hayes, Pacific Area Director; Keith Dunbar, Chief of Planning for the Pacific West Region; Dr. Larry Basch, Marine Biologist/Science Advisor; Darcy Hu, Ecologist; and Helen Felsing, Planner.

The visit included guided tours of the Makawehi-Pā‘ā dunes trail, Māhā‘ulepū shoreline, Māhā‘ulepū Valley, Makauwahi Cave Reserve, and Kīpū Kai, plus a brief stop at Alekoko Fishpond and Hulē‘ia National Wildlife Refuge. NPS held off-site meetings with the state's Kaua‘i District archeologist and wildlife manager, the board of directors of nonprofit Mālama Māhā‘ulepū, and the managers of Makauwahi Cave Reserve. Field notes and photographs from the visit were combined with follow-up research and consultations to prepare this report.

For sharing their knowledge of the study area and facilitating access to it, we thank representatives of Grove Farm, National Tropical Botanical Garden, Grand Hyatt Kaua‘i, Mālama Māhā‘ulepū, TEOK Investigations, Hulē‘ia National Wildlife Refuge, and Kīpū Ranch (Waterhouse Trust and caretakers). Mahalo also to Thomas Kaiakapu and Nancy McMahon of the Kaua‘i District office of the Hawai‘i Department of Land and Natural Resources for sharing their valuable time and information.

2.1 Purpose and Scope of an NPS Reconnaissance Survey

Special Resource Studies for potential new units of the national park system may be conducted by the NPS only with specific authorization of Congress. However, Congress does permit the NPS to conduct preliminary resource assessments and gather data on potential study areas or sites. The term "reconnaissance survey" has been used to describe this type of assessment.

A reconnaissance survey examines the natural and cultural resources in a study area to provide a preliminary evaluation of their significance, and a preliminary evaluation of the suitability and feasibility of helping to protect them within the framework of the national park system. Unlike a Special Resource Study, the reconnaissance survey does not explore management alternatives. Its findings and recommendations are centered on whether or not a full Special Resource Study is warranted.

If according to the reconnaissance survey a study area appears potentially eligible for inclusion in the NPS system, then NPS may recommend that a full-scale Special Resource Study be authorized by Congress. The Special Resource Study process is an extensive one, designed to involve the public and affected parties; further examine significance, suitability, and feasibility; and identify and evaluate potential resource protection strategies, boundaries, and management alternatives.

2.2 NPS Evaluation Criteria

To be eligible for favorable consideration as a unit of the national park system, a study area must possess nationally significant natural or cultural resources. It must be a suitable and feasible addition to the system, and should be shown to require direct NPS management instead of protection by some other governmental agency or the private sector. These criteria are further described below.

2.2.1 Criterion 1: National Significance

Significance evaluation is based on the qualities of the natural and cultural resources present in the study area. Recreational resources, while an important component of most NPS units, are not evaluated independently for their significance. NPS considers a natural or cultural resource nationally significant if it meets four standards: 1) It is an outstanding example of a particular type of resource; 2) it possesses exceptional value or quality illustrating or interpreting the natural or cultural themes of our nation's heritage, 3) it offers superlative opportunities public enjoyment or scientific study; and 4) it retains a high degree of integrity as a true, accurate, and relatively unspoiled example of the resource. Appendix 6.1 provides examples of types of natural and cultural resources NPS may consider significant.

2.2.2 Criterion 2: Suitability

To be considered suitable, an area must represent a type of recreational resource or natural or cultural theme that is not already adequately represented in the National Park System, and not comparably represented and protected for public enjoyment by another land-managing entity. Adequacy of representation is determined on a case-by-case basis by comparing the proposed area to other units in the National Park System for differences or similarities in the opportunities for public enjoyment, and in the type, quality, quantity, or combination of resources present.

2.2.3 Criterion 3: Feasibility

To be considered feasible, an area's natural systems and/or historic settings must be of sufficient size and appropriate configuration to ensure long-term protection of the resources and to accommodate public use. The area must have potential for efficient administration at a reasonable cost. Other important feasibility factors include landownership, acquisition costs, access, threats to the resource, and staff or development requirements.

2.2.4 Criterion 4: Management Options

Even if a study area's resources are deemed significant, feasible and suitable for addition to the National Park System, management by the NPS will not usually be recommended if

other entities—such as state or local government or the private sector—can provide adequate protection and management. As a preliminary document, a reconnaissance survey does not address potential management options, however; these are explored only if and when a Special Resource Study is conducted.

3 OVERVIEW OF THE STUDY AREA

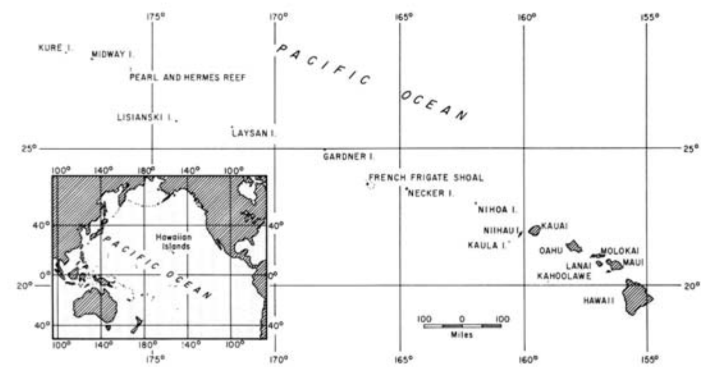
3.1 Regional Context

Hawai'i is unique in our nation—it is the only state that is not part of the North American continent, and the only one made up of volcanic islands. Situated midway between the American and Asian continents, it spans 1500 miles of sea and encompasses nearly as much ocean as land within its boundaries. The isolated Hawaiian archipelago was one of the last places on earth to be occupied by people.

Entirely volcanic in origin, the state's 132 isles range from the tiny reefs and shoals of the Northwestern Hawaiian Islands to the 4,038-square-mile "Big Island" of Hawai'i at the southeastern end of the chain. Their varying sizes reflect different stages in a shared and ongoing volcanic process.

For each island that process begins by eruption over the Hawaiian magmatic hot spot (located today beneath the ocean just east of Hawai'i). Through buildup from successive eruptions, an island emerges from the sea. At the same time it drifts slowly westward—away from the hot spot—along with the underlying Pacific Tectonic Plate. As an island's distance from the hot spot increases, eruptions cease, and it slowly subsides into the sea.

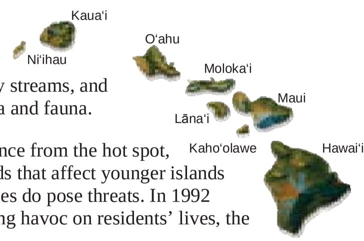
Drifting west at about 3.5 inches per year, all the islands of Hawai'i will eventually—in millions of years—be drawn back into the earth at the subduction zone where the Pacific plate collides with the plate of the Asian continent.



HAWAIIAN ARCHIPELAGO

Hawai‘i’s human population concentrates on the eight main islands that were most recently formed. Lined up in just a 350-mile stretch at the southeastern end of the archipelago, these populated high islands make up all but three square miles of the state’s 6400 square miles of land.

The Māhā‘ulepū study area is located on Kaua‘i, the oldest and westernmost of the main high islands. At 5 million years of age, Kaua‘i’s volcanic slopes are deeply carved by streams, and its forests host Hawai‘i’s richest array of flora and fauna.



Because of its Kaua‘i’s relative age and distance from the hot spot, it escapes the seismic activity and lava hazards that affect younger islands in the chain. However, tsunamis and hurricanes do pose threats. In 1992 Hurricane Iniki devastated the island, wreaking havoc on residents’ lives, the local economy, and fragile native ecosystems.

Historically, Kaua‘i’s economy was based in agriculture, and its lifestyle today remains rural and relaxed. As development escalates throughout the state, however, visitors increasingly seek the haven of Kaua‘i’s lush environment, scenic beauty and tranquility. The island’s 63,000 residents coexist with a daily visitor population of about 21,000. From 2005 to 2006, Kaua‘i’s annual visitor count rose 10.4%, to over 1.2 million people (DBEDT 2007b). Today new commercial and residential developments are changing both the landscape and the people. These provide needed jobs, but also generate tension about the pace and direction of change on the island.

Of the larger main islands (Kaua‘i, Hawai‘i, Maui, Moloka‘i and O‘ahu), Kaua‘i is the only one that is not home to a unit of the national park system. In the 1960s an NPS study for a national park on the island’s rugged northwest Nā Pali coast and Waimea Canyon met intense local resistance; no NPS designation was pursued.

Māhā‘ulepū, a focus area for this reconnaissance survey, was evaluated in an NPS Natural Landmarks Survey of the Hawaiian Islands in 1981. That survey concluded that “the lands of Māhā‘ulepū are among the most interesting areas in the State both geologically and biologically.” It gave the area a priority ranking of 1, applied to areas that “include outstanding and/or unique examples of geological and ecosystem features characteristic of the Hawaiian Islands and which encompass several such features.” (NPS 1981)

3.2 Geography and Climate

The study area encompasses approximately 12 square miles on Kaua‘i’s southeast coast (see Study Area map). Its *makai* or seaward side spans the 9-mile coastal corridor between the county seat of Līhu‘e and the resort town of Po‘ipū, and is bracketed by the bays of Keoneloa and Nāwiliwili. Its inland edge arcs around Māhā‘ulepū valley, across Hā‘upu Ridge and through Kīpu to include Hulē‘ia National Wildlife Refuge and Alekoko Fishpond at Hulē‘ia Stream. These boundaries are tentative ones established only for purposes of this report and should be reconsidered in consultation with local landowners if and when a more detailed study is authorized by Congress.

The Hā‘upu (Hoary Head) mountain ridge runs east-west across the study area. Land south of the ridge is part of the county’s Hanamā‘ulu-Po‘ipū planning district, which extends from the ridgeline across forests, fields, and old plantation towns to the fast-growing resort area of Po‘ipū. Study area land north of the ridge lies in the planning district of Līhu‘e; this district includes Līhu‘e town—Kaua‘i’s county seat, population center and business hub—and adjacent Nāwiliwili Harbor, a deepwater port for cargo and cruise ships.

Weather and climate in the study area typify the mild and locally variable conditions for which Hawai‘i is famous. At Māhā‘ulepū, in the lee of the Hā‘upu mountains, rainfall averages 53 inches a year. Average temperatures range from 72-86°F in the hottest months (August and September) and 64-80°F in cool January and February (WRCC 2007). Wetter and cooler conditions prevail north of Hā‘upu ridge, where moisture-laden northeast trade winds are slowed by the nearly 3,000-ft mountain before sweeping over and around to Māhā‘ulepū. Along the coast the trade winds run roughly parallel to the shore, shaping the dunes from Kīpū Kai to Makawehi.

Resources of particular interest in the study area lie along the entire shoreline corridor, Hulē‘ia Stream, and the Hā‘upu mountain range. While large open agricultural areas at Māhā‘ulepū and Kīpū are encompassed by the study area boundary and may contain relevant natural and cultural resources, their primary importance to this study lies in their potential impact upon adjacent natural areas.

The shoreline corridor begins at Makawehi Point, where a trail across the Pā‘ā dunes affords pedestrian access from the Po‘ipu resort area to Punahoa Point and Māhā‘ulepū Beach. From there the accessible shoreline continues north to Ha‘ula at the foot of the Hā‘upu range. Known as the **Māhā‘ulepū coast**, this popular recreation area features crescents of sandy beach, a variety of coastal vegetation, windblown modern dunes, and a fossil-rich lithified dune system that forms fantastic cliffs, points and pinnacles overlooking the water. A privately-owned rutted dirt road affords daytime vehicular access to the Māhā‘ulepū coast from Punahoa Point north to Hā‘ula Bay.

Beyond Hā‘ula is the private coastal property of **Kīpū Kai**, a spectacular and secluded valley isolated from its surroundings by the eastern arms of the Hā‘upu range. Kīpū Kai’s two-mile shoreline consists of four beaches separated by low rocky points, set against a backdrop of coastal wetland, green pastures, a perennial stream and soaring cliffs. Public access by land is not allowed. Kīpū Kai teems with birdlife, including many native species, and the coastal marine resources appear to be in pristine condition.

Towering above Kīpū Kai valley is the **Hā‘upu** mountain range, which runs inland nearly eleven miles to Knudsen Gap. The eastern half of the range, dominated by the ancient volcanic caldera of Mt. Hā‘upu, lies within the study area. Rising dramatically between the Kōloa and Līhu‘e basins, Mt. Hā‘upu serves as an orientation point from land and sea, and plays a key role in native Hawaiian myths and legends. Native plant communities high on

Hāʻupu ridge provide nesting areas for endangered birds, and serve as critical habitat for some of the last remaining specimens of endemic Hawaiian flora.

The seaward end of the Hāʻupu mountain range at **Niumalu**, north of Kīpū Kai, terminates in headlands by Nāwiliwili Bay. It includes three ancient volcanic cones—Kalanipuʻu, Keōpāweo, and Hōkūnui—with elevations up to over 1600 feet. Its makai face is a broad and steep sea cliff indented by small valleys, and its inland face descends to Hulēʻia Stream. This undeveloped land lacks public access, is mostly zoned for conservation, and is privately owned except for a small state-owned strip above Nāwiliwili Harbor. It includes dense forest along the Hulēʻia Stream corridor; freshwater springs and streams; designated Critical Habitat for endangered plant species; and expansive open areas of non-native scrub and grassland. In the evening, large numbers of seabirds stream into this area.

The verdant **Hulēʻia Stream corridor** at Hulēʻia National Wildlife Refuge and Alekoko Fishpond marks the northern extent of the study area. Flat valley land by the stream was historically used for growing taro, rice and other foods; today it is regrown with natural vegetation and provides important habitat for endangered birds. Hulēʻia Stream waters and adjacent private forests serve as settings for kayaking and hiking tours, and afford awe-inspiring views of the Hāʻupu mountain range that forms the backbone of the study area.

3.3 Land Use and Ownership

Hawaiʻi's State Land Use Commission classifies all real estate into one of four land use designations: Conservation, Agricultural, Rural and Urban. Counties establish more detailed designations and zonings, but these conform to the range of allowable uses under each designation by the state.

In Hawaiʻi, conservation lands are further designated into subzones according to environmental sensitivity; all subzones place strong limits on use, and most uses must be approved by a permit from the state's Board of Land and Natural Resources. Most of the conservation lands in the study area fall into the two strongest subzones.

All of the land in the study area is designated and zoned for agriculture or conservation, and except for a few homes and farm or ranch structures, it remains undeveloped. The conservation lands are found in a narrow strip along the Māhāʻulepū coast, across most of Hāʻupu ridge, and around part of Hulēʻia Stream. Broad agricultural lands occur on both sides of the Hāʻupu range and at Kīpū Kai. (See Regional Land Use map).

The vast majority of the study area is privately owned (see Study Area Landowners map). Grove Farm, one of the oldest and largest landowners in the state, holds all of the parcels that comprise Māhāʻulepū valley and coast (except for a small home lot at Māhāʻulepū Beach and a county-owned water reservoir just inland of Makawehi). Grove Farm was founded in 1864 by George N. Wilcox. Historically a sugar plantation, during the late 20th century it transitioned into real estate development, and ceased sugar production in the 1990s. Around the same time, Grove Farm unsuccessfully sought development permits for coastal land at Māhāʻulepū.

In 2000, the Wilcox family sold Grove Farm to Steve Case of America Online. Today the corporation is involved in major residential and commercial developments in Līhuʻe. In recent years it has leased portions of its Māhāʻulepū land for various individual and business purposes, including crops, pasturage, a commercial stable, a sand quarry, and a nonprofit research and restoration project at Makauwahi cave. Grove Farm allows daytime vehicle access through the valley to a dirt road that skirts the shoreline, with a gated entry that is locked at night. This beach access is used by both residents and visitors.

While acknowledging the potential development value of the Māhāʻulepū valley and shoreline, Grove Farm managers say they intend to utilize the valley as an agricultural park with its own branding, and that they have no current plans for resort or residential development there, or along the shoreline. Cultivation of taro has already begun. The long-term conceptual plans for the agricultural park include a possible interpretive pedestrian path around the valley, where hundreds of acres will be dedicated to traditional Hawaiian taro-growing, native Hawaiian healing plants, organic greens, fruit orchards, and other 'grow what you eat' crops.

A second major private property is Kīpū Kai, a 1,117-acre coastal valley owned by the long-time heirs of Jack Waterhouse, and legally slated to be turned over to the state as a wilderness park upon their passing. Its scenic setting has served as a movie location, and until 2006, a cattle ranch. Today resident caretakers live on site, and Waterhouse family and friends vacation in the old Waterhouse home. Residents and commercial tour operators approach this scenic hideaway by boat to play, fish and gather *limu* (edible seaweed) in the nearshore waters; foot traffic is not allowed above the high tide line. It is unclear how the family will sustain the land in the near term under a growing tax burden, and details remain unsettled as to how the state will protect Kīpū Kai's resources in the long term.

North of Kīpū Kai, in the area known as Niumalu, is a nearly 1400-acre private property that overlooks the ocean, Nāwiliwili Bay and Hulēʻia Stream. Owned by California resident Donn R. Campion, this land remains undeveloped and unused. Though its conservation zoning allows for construction of a single residence, none has been built. The owner placed the property on the real estate market in 2004; no sale occurred. Access to the Niumalu tract is afforded through the adjacent private Kīpū Ranch.

Kīpū Ranch was purchased by William Hyde Rice in 1881 and has remained in the Rice family, operated first as sugar plantation and then as cattle ranch. The Kīpū property ascends from Hulēʻia to the Hāʻupu ridge above Kīpū Kai and Māhāʻulepū, and is zoned for agriculture except on upper portions of the ridge. Uses of the land today include not only cattle ranching, but also ecotourism. Tour operators offer kayak and hiking trips that begin at Hulēʻia and then venture inland to Kīpū's pastures and forested slopes. The ranch is home to a variety of non-native wildlife introduced by the Rice family. An ATV operation on site provides guided adventures throughout the Kīpū property. Approximately three-fourths of the ranch lies within our reconnaissance survey study area.

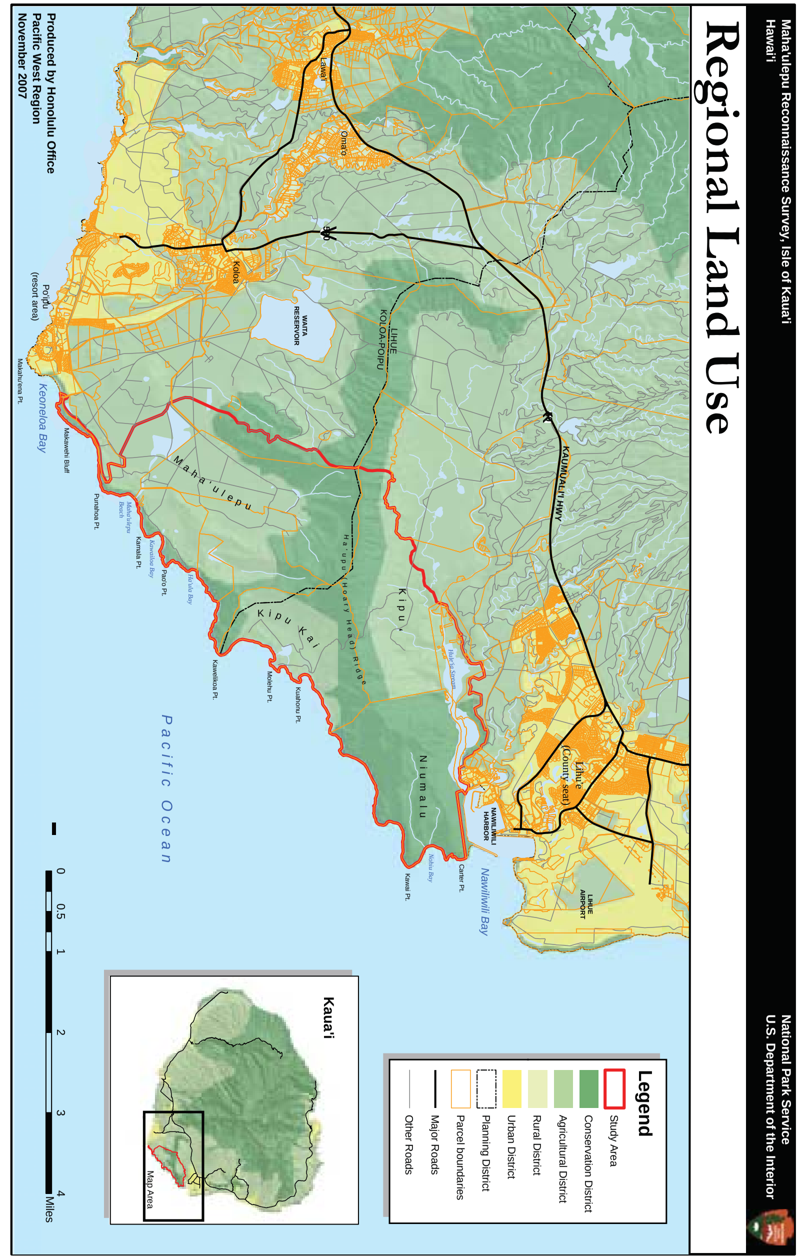
The final major private property in the study area is made up of the Alekoko Fishpond and an adjacent segment of Hulēʻia Stream. These two parcels totaling just over 100 acres belong to the O`ahu-based Okada Trucking firm. The pond is designated as conservation land and is listed on the State and National Register of Historic Places. Although public access is prohibited, stream users occasionally enter the pond by kayak. In 2005, the owners attempted unsuccessfully to sell this property.

Adjacent and upstream to the fishpond is the only major public land in the study area, the U.S. Fish and Wildlife Service’s Hulēʻia National Wildlife Refuge. The refuge was established in 1973 as a managed wetland to provide habitat for Hawaiʻi’s endangered waterfowl. It occupies four parcels including both conservation and agricultural land. Like the fishpond, the refuge prohibits public access, but in the absence of on-site enforcement some informal recreation use occurs. A state-owned roadside overlook affords a scenic view of the fishpond and wildlife refuge against the backdrop of the Hāʻupu mountain range.

Owner	Parcels	GIS Acres
Grove Farm	6	3477
W.H. Rice	2	1476
D.R. Campion	3	1400
Waterhouse Trust	1	1117
U.S. Fish and Wildlife Service	4	237
Okada	2	102
Small privately owned parcels	13	17
Total acreage		*7826*

3.4 Maps

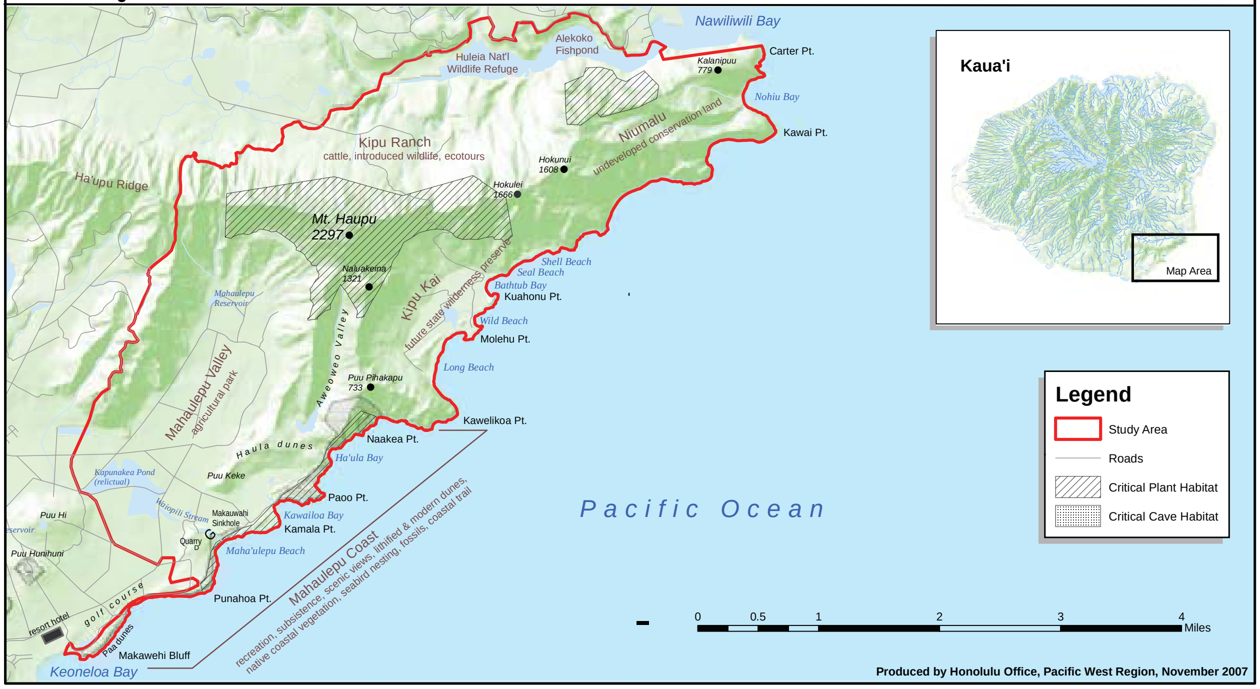
Study area maps follow.



Maha'ulepu Reconnaissance Survey, Isle of Kaua'i
Hawai'i

National Park Service
U.S. Department of the Interior

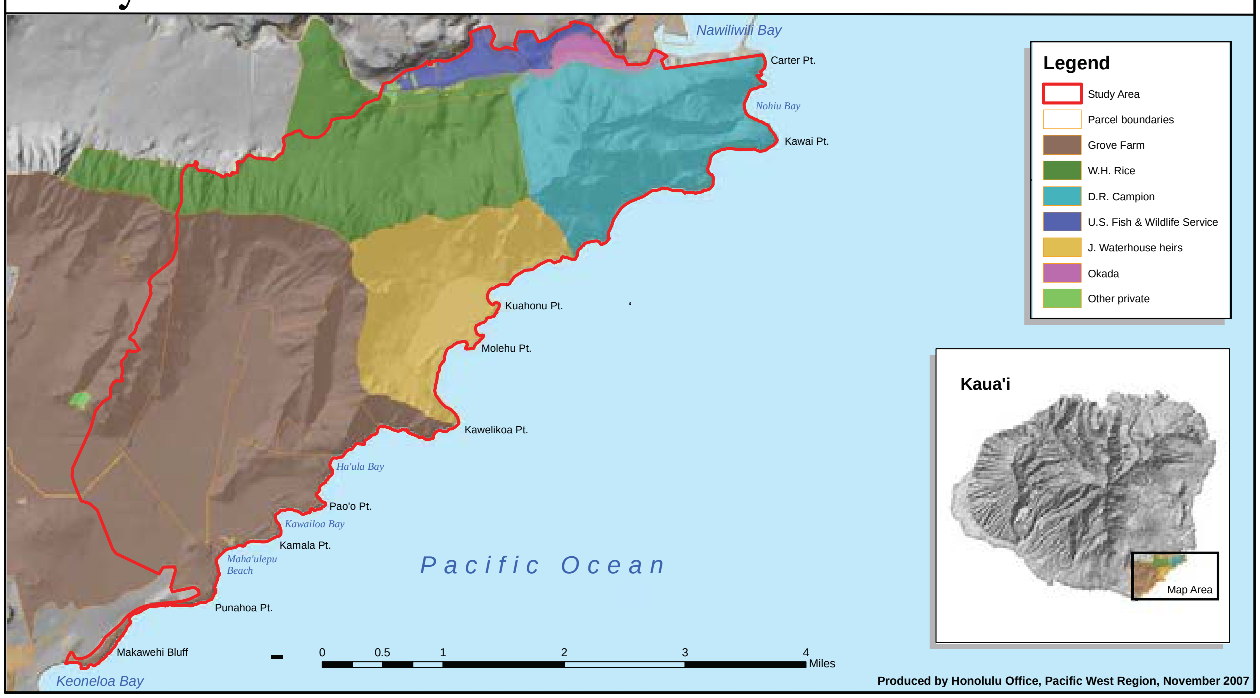
Study Area Features



Maha'ulepu Reconnaissance Survey, Isle of Kaua'i
Hawai'i

National Park Service
U.S. Department of the Interior

Study Area Landowners



4 STUDY AREA RESOURCES

4.1 Geological Resources

As the oldest of the state's main islands, Kaua‘i features the widest age range of geologic landforms that illustrate the birth of the Hawaiian archipelago. Within the study area, this full age span of high-island volcanics can be seen at one time. The study area also displays a visible geologic record of global sea level changes over the last 300,000 years, and a 10,000-year fossil trove of Hawai‘i lifeforms.

Waimea Basalts

The Hā‘upu mountains that cross the the study area are made up of the most ancient volcanic series in the high islands, the Waimea Canyon Basalts. These formed during the shield-building stage of the Kaua‘i volcano, as eruptions gradually built up its sides and widened its base. Most of the Hā‘upu range is part of the ancient Nāpali member of the Waimea series, dating from 4.35 to 5.1 million years old. The caldera of Mt. Hā‘upu is the separate Hā‘upu member, which remains undated. (Blay & Siemens 2004)

Waimea basalts comprise most of the Hā‘upu mountain range, and can be readily seen in the slopes and sea cliffs of Kawelikoa Point, at the northeast end of the Māhā‘ulepū coast near Hā‘ula Bay.

Kōloa Volcanics

Māhā‘ulepū lands below Hā‘upu ridge are part of the Kōloa series that cloaks most of the east half of Kaua‘i. It formed as the Kaua‘i volcano ceased major eruption and began to erode, with occasional small eruptions at lava domes, cinder cones and spatter cones. These produced a layer of lava that, though not large in mass, nevertheless covered a large area. Kōloa volcanics within the study area at Māhā‘ulepū include both underlying lava and visible vents, ranging from .5 to 2.0 million years in age (Blay & Siemens 2004).

Lithified Dunes

The Māhā‘ulepū coast features a remarkable array of lithified dune features that lie atop the much older Kōloa and Waimea Canyon lavas. First formed when sea level was about 60 feet lower than today, they accumulated over the last 350,000 years, and are still dynamically changing. Extending from below sea level to as high as 500 feet above it, their layers reflect global cycles of glaciation and sea level change. Transitions between layers are marked by depositional and erosional soils that settled there during glacial periods, when sea level dropped and the shoreline lay as much as a mile farther out than it does today. The dunes contain plant and animal fossils that tell the stories of their time.

The dunes vary in their degree of consolidation and weathering according to age. The oldest and most thoroughly cemented layer, the Punahoa member, occurs near Hā‘ula and Papamō‘i and covers most of Punahoa Point. It is laced by caves and contains fossils of land snails and plant roots. Mid-range layers (Pāo‘o and Makawehi members) are moderately or well cemented, with fossils of land crab burrows and plant roots. The loosely cemented Pā‘ā dunes that run northeast from Makawehi Pt. toward Punahoa comprise the youngest Māhā‘ulepū member. Formed 4,000-6,000 years ago, they contain numerous fossils including land crabs, crab burrows, plant roots, land snails and birds. (Blay & Siemens 2004)

Caliche limestone dunes at Pāo‘o Point

The Māhā‘ulepū formation is an exceptionally rich ground for avian and other fossils. According to Smithsonian Institute researchers, the majority of significant avifauna fossils found in Hawai‘i were collected along this coast. Many were documented in the 1970s and 1980s, a period when the dunes were active and shifting, exposing pockets of fossils, including bones from three species of goose, a long-legged owl, and a flightless rail. Though vegetation has since partially stabilized the dunes, portions of loose limestone still sometimes break off to reveal new and startling fossil finds. (James 2007)

An adjacent limestone cave/sinkhole that is part of the lithified dune system lies just inland of Punahoa Point. Paleoecologists excavating there have discovered an unparalleled array of plant and animal fossils and human remains from both pre- and post-contact Hawai‘i; these are described later in this section (see Makauwahi Cave, below and in Section 4.6) Fossils were also found at a sand quarry site next to the cave.

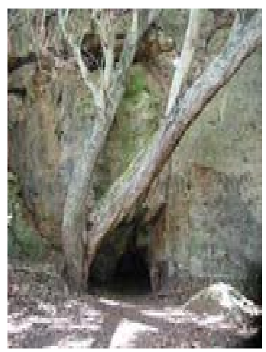
Modern Dunes and Recent Sedimentary Deposits

Loose sand deposited during the last 2000 years overlies all the geologic units in the Māhā‘ulepū Formation. Modern dunes of up to 50 ft occur at Hā’ula, Papamoi, and Kāmala, as well as farther up the coast at Kīpū Kai. They are partially stabilized by vegetation, but continue to be reshaped by the trade winds that sweep the coast. ‘Āweoweo, a tall fossil sand dune atop basement rock north of Hā‘ula, is reported to be the longest, largest burial dune in the Pacific. It consists of partly lithified gray hydromorphic soils that were transported from the Yangtse River valley, China by high altitude winds (Blay 2007).

Beaches along the study area are comprised of recent sedimentary deposits, either in the form of loose sand or bedded calcareous sandstone (beachrock). Geologically recent deposits also formed the alluvial soils in the study area at Hulē‘ia river valley, and around the base of the Hā‘upu range at Kīpū Ranch, Māhā‘ulepū valley, and Kīpū Kai.

Makauwahi Cave and Sinkhole

A large limestone cave system, hollowed out by groundwater, permeates the dunes of the Māhā‘ulepū Formation. The best known part of this cave system is the Makauwahi cave and sinkhole, located on Grove Farm property just inland of Punahoa Point. It is the state’s only solution limestone cave (OSP 1992), and has been described as “the largest limestone cave complex, the richest fossil site and the oldest dated ecological site in the Hawaiian Islands.” (Hoopaja 2006). Discoveries at Makauwahi were featured in public television’s 2001 NOVA series on worldwide species extinction.



A small opening in a limestone bluff affords entrance to the sinkhole.

In the early Holocene, the Makauwahi Cave was entirely roofed and had a dry floor. But as sea levels rose the nearby ocean increasingly breached the cave. About 7,000 years ago the roof at the center of the cave collapsed, forming a sinkhole open to the sky, and internal collapses sealed the cave off from the sea. Groundwater filled the cave and created a lake. During the millennia that followed, natural soils, sand, bones, plant remains, shells, and human artifacts and debris from the surrounding area swept into the sinkhole lake, building up thick layers of a peat-like substance that eventually turned the lake into a swamp. (Burney & Kikuchi 2006)

Today the sediments are 10 meters deep at the sinkhole’s center, and the sinkhole floor sits 1-2 meters above sea level. A coating of silty clay—deposited mostly during the 20th century—cloaks the earlier peat-like strata. The water table, fed by underground springs, sits just below the clay surface. The sinkhole’s sheer walls range in height from 6 to 25 meters, forming an irregular opening to the sky that measures 30-35 meters across. (Burney *et al.* 2001)

Cave passages connect to the north and south ends of the sinkhole. The south passage leads to culturally sensitive areas and is protected from public access. The north passage, where researchers and visitors enter the cave, has a crawl-in entrance through a sheer limestone bluff bordering Wai‘ōpili Stream.

The sinkhole walls range in height from 6 to 25 meters.

Sediment layers in the cave chronicle Hawai‘i environment, lifeforms and geological events from 10,000 years ago up to the present. The site is exceptional partly because of its excellent stratification, and also because of its unusual degree of preservation of materials that normally perish. The peat’s neutral pH, created by the combination of fresh water and limestone, allows for preservation of minute pollen grains as well as bones and shells; one fossilized but intact yam was even uncovered. “This is like a giant pickling jar. Leaves, whole tree trunks, extinct land snail shells, bird bones, seeds, fish with scales still on—they're all remarkably preserved" (Burney D, quoted in Hoopaja 2006)

To protect this unique resource and make it available for research, the private landowner leases the sinkhole and 17 acres around it to the nonprofit Makauwahi Cave Reserve. Research at the site began in 1992 and first received federal funding in 1996. Sponsors have included National Science Foundation, NOAA, National Tropical Botanical Garden, Fordham University, the Smithsonian Institution, USDA, Kaua'i Community College, and the National Geographic Society.

Researchers have collected cores throughout the site; described ten stratigraphic units based on age, sediment, and the fossils and artifacts found; and excavated in three pits to depths as much as 5 meters below the water table. To date, they have documented findings from over 200 cubic meters of sediment. According to the lead researchers on site, "Nearly 10,000 years of sedimentary record … has been analyzed for vertebrate bones, invertebrate shells, plant macrofossils, pollen, diatoms, sedimentology, and in the upper layers, human artifacts." Their finds, often cited in journals and featured in public media, are documented in Burney and Kikuchi (2001) and Burney *et al.* (2001), and are summarized below.

Fossil bird bones from Makauwahi cave and sinkhole.

Excavations at Makauwahi have uncovered fossils of 45 species of birds. Fully half of these are extinct, and seven or eight are species not previously documented by science. They include a long-legged owl that ate fellow birds; a newly discovered extinct species of bat; flightless grazing birds the size of turkeys; a moa nalo (lost fowl) with a jaw like a turtle; and a tiny duck that fed at night and had eyes set unusually far back on its head. Other finds are nesting boobies, gulls, several forest birds, and the endangered Laysan duck, which still exists elsewhere in the Hawaiian archipelago but was not previously known to inhabit Kaua'i.

Plant fossils uncovered at Makauwahi are equally surprising. The cave strata yield seeds and pollen of many plant species which today are rare and seen only at higher elevations, and which were previously assumed to be suited only to Hawai'i's cooler, wetter upland and mountain areas. Their appearance in significant numbers in core samples from Makauwahi is leading scientists to reconsider these assumptions, and to examine the possibility for extensive native plant restoration efforts in coastal areas.

Other finds include 14 species of extinct land snails, seen in large numbers in lower cave layers but entirely absent in later strata. Their disappearance correlates with the arrival of the Pacific rat, which is believed to have landed in the islands with the first Polynesians. Earliest evidence of rats in the cave layers is dated at 1039-1241 A.D.

Hawai'i's native species disappear from Makauwahi's successive sediment layers in stages that reveal much about human interaction with the island environment. Arrival of people, rats and pigs corresponds with rapid disappearance of large snails, large flightless birds, and certain plants. A second stage of species loss ensues as Polynesian settlers alter the landscape, eat some native species, and introduce new ones. Extinction proceeds apace when Europeans arrive: they introduce goats and cattle, import new species for agriculture, rapidly use forest resources, and alter the landscape in ways that dramatically contribute to erosion and lowland sedimentation.

Even today, a drama of potential extinction is playing out at Makauwahi and other caves in the Māhā'ulepū Formation. The cave system is designated Critical Habitat for the Kaua'i cave wolf spider (*Adelocosa anops*) and the Kaua'i cave amphipod (*Spelaeorchestia Hanamā'uluna*). Only a few known populations of these species remain; all are small, and all occur in Makauwahi or its immediate vicinity. The U.S. Fish and Wildlife Service is helping to fund plant restorations atop the cave area, in order to foster the native plants whose roots extend downward to the cave ceilings, potentially serving as food for the endangered arthropods (Henry 2007).

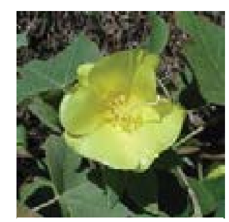
4.2 Vegetation

Hawai'i's geographic isolation and varied volcanic habitats combined to support evolution of unique flora. Nine-tenths of the state's approximately 1500 indigenous plants grow nowhere else in the world. Because they are adapted to such localized conditions, Hawai'i's endemic plants are especially vulnerable to extinction as human population expands, development encroaches, and competition from introduced species increases.

Within the study area, both the undeveloped shoreline and the upper reaches of Hā'upu ridge provide haven for a variety of native Hawaiian flora, including many rare and endemic species that have been identified as Species of Greatest Conservation Need by the state of Hawai'i. Extensive portions of ridge and shoreline are designated as Critical Habitat for federally-listed endangered species (see Study Area Features map). In the valleys and on the lower slopes of the Hā'upu range, non-native species dominate.

4.2.1 Coastal Vegetation

Hawai'i's native coastal strand vegetation—an array of plants unique in the world—has been destroyed or seriously degraded on beaches throughout the state's inhabited islands. Along the shoreline of the study area, the fact that public access is relatively limited and adjacent land remains undeveloped provides some protection for this plant community. A wide variety of native coastal flora still grows here, despite the extensive presence of non-natives such as ironwood and koa haole.



Ma'o, Hawaiian cotton (Gossypium tomentosum)

NPS staff noted coastal strand vegetation from Makawehi to

Hā'ula and at Kīpū Kai, with the greatest concentration of native species seen from Pā'o'o Point northward. U.S. Fish and Wildlife Service has designated Critical Habitat along the entire Māhā'ulepū shoreline for the endangered 'ohai *(Sesbania tomentosa).*

Other endemics (species found only in Hawai'i) include Hawaiian cotton *(Gossypium tomentosum)*; beach spurge *(Chamaesyce degeneri)*; pa'uohi'iaka *(Jacquemontia ovalifolia)*; koki'o *(Kokia Kaua'iensis)*; nehe *(Lipochaeta integrifolia)*; ma'oli'oli *(Schiedea* sp.*)*; noni tree *(Morinda citrifolia);* the tree *Munroidendron racemosum*; two species of loulu *(Pritchardia* cf *minor*, *Pritchardia elmerrobinsoni)*; and the Hawaiian caper *(Capparus sandwichiana)* and hinahina kahakai *(Nama sandwicensis)*, both designated as USFWS Species of Concern.

Pohuehue, beach morning-glory (Ipomea pes-caprae)

Indigenous species (native to Hawai'i but also found elsewhere) include two species of pohuehue (morning-glory); naio (false sandalwood); hala (screwpine); 'akulikuli (sea purslane); 'ilima; milo (portia tree); and 'uhaloa. Common non-natives near the shoreline are beach pea, tree heliotrope, and niu (coconut palm).

Koko, beach spurge (Chamaesyce degeneri)

One item of special note is *Ruppia martima*, an indigenous seagrass recorded in the north end of the study area. Although not seen by NPS, according to staff of the National Tropical Botanical Garden, this is one of three previously known Kaua'i populations of this species, and it is likely that is the only one still persisting. It is characterized by NTBG staff as the "nicest presentation of [the species]" (Burney and Flynn 2007).

'Ilima (Sida fallax)

Coastal strand species sighted or reliably reported during the survey appear in Appendix 6.2.1. One non-coastal tree, the native leguminous wiliwili, appears in the list. While not a coastal strand species, it was found quite near the beach in a remote spot. This merits attention due to the recently introduced Erythrina gall wasp that has attacked most wild wiliwili in the state.

4.2.2 Upper Elevation

NPS staff did not visit upland sites during the reconnaissance survey visit, but botanist Ken Wood, a conservation biologist for the National Tropical Botanical Garden, compiled records of native flora and fauna on and around the summit region of Mt. Hā'upu (1800-2300 ft elevation) during a recent research trip. He describes an impressive inventory of native vascular plant species in this isolated ecosystem (Wood 2005).

*Matting ferns such as uluhe (*Dicranopteris linearis) *and uluhe lau nui (*Diplopterygium pinnatum*) mix with a scattering of trees, primarily 'ōhi'a (*Metrosideros polymorpha*), on Hā'upu's east slope and upper summit.*

Throughout the Mt. Hā'upu summit area, native vegetation still dominates in a mostly open landscape of shrubs, ferns, and scattered trees. The estimated amount of native vegetation varies by location—from 60% on the summit and east slopes to as much as 85% on the precipitous north face. (Wood 2005).

The summit hosts at least 112 native plant species (Wood 2005). Of these, nearly ninety are endemic to Hawai'i. Over two dozen are endemic to Kaua'i only, and some are restricted to just Mt. Hā'upu.

Wood singled out seventeen endemic vascular plants on Mt. Hā'upu that merit especially urgent conservation efforts due to their rarity (Appendix 6.2.2). Among them are three of Hawai'i's Genetic Safety Net species—those of which fewer than fifty individuals are known to remain alive in the wild. They include *Schiedea perlmanii*, *Tetraplasandra bisattenuata* ('ohe'ohe), and *Delissea rhytidosperma.* The thirteen Schiedea on Hā'upu are the only known living examples of their species. A group of thirty 'ohe'ohe trees found by Wood provides cause for celebration: until recently, only two individuals of this single-island endemic were known to exist.

Delissea rhytidosperma, a Genetic Safety Net species.

Three of the plants identified by Wood on Hā'upu may be previously unknown species. Another, *Pittosporum gayanum*, is a unique Hā'upu form of the hō'awa tree that appears to hold horticultural promise (Wood 2005). USFWS has designated six species known on Hā'upu as endangered, one as threatened and six as Species of Concern. Parts of Hā'upu ridge are designated Critical Habitat for eleven endemic plant species.

4.3 Terrestrial Wildlife

4.3.1 Birds

NPS staff recorded nine native bird species while on the reconnaissance and documented another seven via research or by interviews with local biologists. Of the total, seven are endemic at the species or sub specific level, five are indigenous, and the remaining four are migratory birds that winter in Hawai‘i. Five of the seven endemic species are designated by USFWS as Endangered, and one as Threatened.

The endemic Endangered birds known in the study area are the Hawaiian coot (‘alae ke‘oke‘o), common moorhen (‘alae ‘ula), Hawaiian duck (koloa); Hawaiian stilt (ae‘o); and Hawaiian goose (nēnē). All but the coot and the nēnē were observed by NPS during the site visit.

Nēnē, Hawaiian goose

Koloa maoli, Hawaiian duck

Habitat for these species is scattered throughout the study area. Manmade reservoirs at Waitā, Pu‘u Hi and Māhā‘ulepū provide a year-round attraction, as do the golf course ponds at the adjacent Grand Hyatt resort. Intermittent streams and wetlands at Māhā‘ulepū and Kīpū Kai also provide habitat. Bottomlands at Kīpū Kai were the site of a deliberate reintroduction of nēnē several decades ago; the increasing numbers of nēnē now seen on south Kaua‘i outside Kīpū Kai are believed to be descendent populations from that group. According to a state source, nēnē, koloa and other waterfowl frequent the taro lease land in Māhā‘ulepū valley, and a broad natural depression in the valley that fills with water after heavy rain draws many waterbirds. Sixty koloa individuals were counted during one such event (Kaiakapu 2007).

The most extensive habitat for waterbirds in the study area is at the Hulē‘ia National Wildlife Refuge. Hulē‘ia was established in 1973 to provide open, productive wetland and is considered a Core Wetland in the USFWS Recovery Plan for Hawai‘i’s Endangered coot, moorhen, duck and stilt (USFWS 2005). It provides breeding habitat to all four of these Hawaiian waterbirds plus the indigenous black-crowned night-heron. Two endemic birds characteristic of open country also nest on the refuge: the endangered nēnē and the pueo. Migratory water fowl and shorebirds are common seasonal inhabitants.

Newell’s shearwater, a Threatened endemic species, nests in the study area on Hā‘upu ridge. A known nesting site recognized in the USFWS Recovery Plan for the Newell’s

Shearwater is at Kaluahonu, northeast of Waitā Reservoir (USFWS 1983) by the west edge of the study area. Biologists who spend research time on Mt. Hā‘upu report hearing approximately 100-120 individuals arriving in summit areas around 8pm and departing back to sea in the early mornings between 3 and 5 am. Based on audial observations they believe that most of these birds were headed to the Kaluahonu area, but that perhaps 15-20 pairs were nesting nearer their summit camp (Wood 2005).

‘A‘o, Newell’s shearwater

The endemic short-eared or Hawaiian owl (pueo) was reported by a biologist and seen by NPS during the survey; both sightings occurred on or near the east end of the Hā‘upu ridge (Wood 2005).

Pueo, Hawaiian owl

Five indigenous species are known by NPS to frequent the study area: the black-crowned night heron, white-tailed tropicbird, great frigatebird, wedge-tailed shearwater, and red-tailed tropicbird. The black-crowned night heron finds breeding habitat at Hulē‘ia NWR and was spotted during the survey. Biologists describe frigatebird sightings at Māhā‘ulepū and on Mt. Hā‘upu, where seven individuals were seen flying together (Wood 2005). Researchers at the Makauwahi Cave Reserve and on Mt. Hā‘upu report repeated sightings of white-tailed tropic birds (Burney 2007, Wood 2005) and NPS staff saw several during the reconnaissance survey.

Koa‘e kea, white-tailed tropicbird

Wedge-tailed shearwaters regularly nest in the nooks and crannies of the Māhā‘ulepū coast, and red-tailed tropicbirds are also known to nest there. However, in recent years feral and domestic dogs wreaked havoc on accessible nests in this popular area (Kaiakapu 2007, Zaun 2007). Presumably successful nesting still occurs along sea cliffs in the northeastern part of the study area where access is limited.

Four migratory species that winter in Hawai‘i and return to the arctic to breed were noted in the study area. We observed three of these: the Pacific golden plover, ruddy turnstone, and wandering tattler. The fourth migrant, the sanderling, has been reported by residents (MM 2004). Additional migratory shorebirds probably frequent the coastline occasionally, and other seabird species likely transit the coast. A state study notes that seabirds use the coastal sea cliffs and foothills for nesting and loafing (OSP 1992).

We neither observed nor learned of any native passerines in the study area. In a 2005 record of birds seen on the summit of Mt. Hāʻupu during botanical research, biologists reported two introduced passerine species (hwamei and Japanese white-eye), but no native ones (Wood 2005). As is common on all the main Hawaiian islands, songbird habitat along this coast has been severely altered or eliminated, and disease-bearing alien mosquitoes that infect the passerines are presumably present at least seasonally at all elevations.

The extensive limestone formations of the Māhāʻulepū coast are an exceptionally rich ground for avian fossils. Fossilized bird bones from three species of goose, a long-legged owl, and a flightless rail were recovered from the lithified dunes, and fossilized bird prints from an extinct bird, possibly one of the moa nalo species, were recently found. Nesting boobies (possibly shrub-nesting red-footed boobies) are known from fossil remains recovered from the Makauwahi Cave Reserve.

The seldom-accessed Niumalu portion of the study area, which was not visited by NPS, is a potential location for seabird sightings and research. A website for Hawaiʻi birders describes Ninini Point—outside the study area but directly across Hulēʻia Stream from Niumalu—as "probably the best seawatching site in Hawaiʻi," with thousands of birds observable under good conditions (e.g., mornings in spring through fall, with northeast tradewinds):

> Most of the birds offshore will be Wedge-tailed Shearwaters and Red-footed Boobies, but large gatherings of Newell's Shearwaters and smaller groups of Hawaiian Petrels can also be seen. Brown Boobies (below) are regularly seen as are Sooty Terns, Black and Brown Noddies, Laysan and Black-footed Albatross and less frequently Tropicbirds and Frigatebirds. Groups of 100 or more Newell's Shearwaters and 50+ Hawaiian Petrels have been recorded as well as many other migrant seabirds. Sooty Shearwater is regular in the Spring, usually in small numbers but over 500 were recorded in one evening in 1999. Other migrants and vagrant seabirds recorded here have included Masked Booby, Mottled Petrel, Short-tailed Shearwater, Ring-billed and Laughing Gulls, Grey-backed Tern, Common Tern and White Tern. Bristle-thighed Curlews have been reported several times passing the Point during the spring and fall and are always worth keeping an eye, and ear, out for. Ruddy Turnstone and Sanderling are sometimes seen on the rocks here and a Dunlin was seen nearby in 1997. Barn Owls regularly hunt the nearby airfield and often fly low over the Point whilst searching for prey, such as mice and rats. Short-eared Owls (or Pueo) are less regular at the Point but are seen occasionally…(Birding Hawaiʻi 2007).

Appendix 6.2.3 provides a species list of native birds identified by NPS in the study area. It includes nine species seen on the March 2007 site visit and seven noted during interviews or by research.

4.3.2 Terrestrial Invertebrates

The study area hosts two notable and extremely rare terrestrial invertebrates: the Kauaʻi cave wolf spider (*Adelocosa anops*) and the Kauaʻi cave amphipod (*Spelaeorchestia Hanamāʻuluna*). In 2000, both the spider and the amphipod were federally listed by USFWS as endangered species. All known populations occur in the Kōloa basin on Kauaʻi, within a 4-square-mile area (CBD 2007) that lies partly within the study area.

Kauaʻi cave wolf spider

The Kauaʻi cave wolf spider—sometimes called the "no-eyed, big-eyed wolf spider"—grows to about 1.5 inches. It has so completely adapted to deep, dark moist caves that it has no eyes. The spider uses venom to capture small prey—including the Kauaʻi cave amphipod—but is harmless to humans. The Kauaʻi cave amphipod, also sightless, is a smaller shrimp-like creature (~.4 inch). It eats decomposing matter, mostly plant parts and roots, found in the caves.

At least three-fourths of the historic habitat for these two species has been "rendered uninhabitable by development projects" (CBD 2007). Both species have been reduced to a few small populations; exact numbers remain unknown. Researchers say the spider is seen regularly in only one cave with a population of 16 to 28 individuals (USFWS 2005).

The cave-laced corridor along the Māhāʻulepū coast of the study area, from Makawehi Point to Kawelikoa Point, is designated by USFWS as Critical Habitat for both of these endangered species. At Makauwahi cave and sinkhole, located within the study area near Punahoa Point, the USFWS is funding plant restoration atop the cave system in order to foster the native plants whose roots extend downward to the cave ceilings and serve as food for the endangered arthropods (Henry 2007).

NPS uncovered little additional information on terrestrial invertebrates in the study area. Results are pending from a recent study (Wood 2005)in which botanists from the National Tropical Botanical Garden observed, recorded and collected specimens of arthropods and molluscs on and around the summit of Mt. Hāʻupu. Specimens were sent to Bishop Museum for further identification. Results will provide a window into species distribution and diversity within Hāʻupu's native plant communities.

4.4 Marine Resources

This section summarizes the large marine vertebrates, fishes, algae, and marine invertebrates in the study area that were noted by NPS during the survey and reported by reliable sources. The NPS site visit included hiking and observations along the entire shoreline from Makawehi to Hā’ula, and a separate excursion to Kīpū Kai. We were unable to access the steep coastal cliffs of Niumalu on the private property that extends from Kīpū Kai north to Nāwiliwili Harbor. Observations were necessarily limited by time, as well as by rough ocean conditions. Staff took notes, GPS points, and photographs; no specimens were collected. We recorded about 80 marine species across all taxonomic groups.

The study area coast is exposed to strong tradewinds and turbulent surf, and lacks any major well-protected bays. The geomorphology of its undulating shoreline offers a variety of habitats for hardy marine life. Above Hā’ula, around Kīpū Kai, and northward to Nāwiliwili Harbor the stratified basalts of the Hā‘upu mountain range terminate in cliffs and headlands that drop precipitously to the sea. Below Hā‘ula along the Māhā‘ulepū coast, the ancient lithified dunes that overlay basalt bedrock are eroded into elaborate cliffs, caves and pinnacles angled over the water.

The cliffs and headlands are separated by small bays, coves or shelves, often with nearshore rock reef benches or boulders that partly protect the shallow waters. White carbonate sand or cobble beaches and basalt benches occupy the intertidal zones (olivine sand occurs in one location). Modern loose sand dunes back many of the beaches and storm-deposited colonies of aged coral rubble are occasionally found high up on shore.

Tidepools in the basalt benches serve as important nursery habitats for marine invertebrates and fishes. The most extensive tidepool complexes we saw during the site visit are at Makawehi and Kīpū Kai. NPS staff observed juveniles of several marine species at both locations, with the greatest diversity occurring at Kīpū Kai.

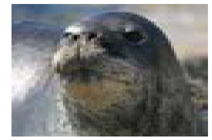
Limited information is available on the study area’s subtidal composition and bathymetry, except for a few sample sites. Below the cliffs by Hā‘ula Bay, the nearshore bottom is consolidated reef and beachrock with some sediment, and the offshore bottom is sand; depth drops to 50 feet within 0.3 miles. At Makawehi, the bottom is basalt with a thin veneer of non-reefal marine life, and depth drops to 50 feet within 0.2 miles.

Compared to other Hawai‘i shorelines near population areas, the coastal marine habitats of the study area appear relatively unmodified and undisturbed by humans. To date these habitats—and the species they harbor—remain largely unstudied, probably because of rough ocean conditions combined with restricted access.

4.4.1 Large Marine Vertebrates

The beaches and nearshore waters of the study area are home to three important large marine vertebrates: the endangered Hawaiian monk seal, known in Hawaiian as ‘īlio holo i ka uaua (*Monachus schauinslandi*); the endangered humpback whale or kohala (*Megaptera

novaeangliae); and the threatened green sea turtle or honu (*Chelonia mydas*). All three were sighted during NPS’s March 2007 visit.



Hawaiian Monk Seal

Endangered Hawaiian monk seals regularly haul out on the beaches of the study area to bask. During the brief NPS field reconnaissance we observed adult seals resting onshore at Kawailoa Beach and at Kīpū Kai. Successful monk seal puppings occurred at Māhā‘ulepū in 2000 and 2007, at nearby Po‘ipu Beach in 2000 and 2001, and at Kīpū Kai in 2006.

The Hawaiian monk seal is one of only two mammals endemic to Hawai‘i, and the most endangered marine mammal unique to U.S. waters (KMSWP 2007). In 1976 it was declared depleted under the Marine Mammal Protection Act, and endangered under the Endangered Species Act. Despite these protections, seal populations plummeted. An estimated 1200 Hawaiian monk seals remain alive today; experts predict there will be fewer than 1000 within five years (NOAA 2007b).

Ninety percent of the surviving Hawaiian monk seals live around the tiny unoccupied islets of the northwestern Hawaiian archipelago. However, within this group few juveniles are living to reproductive age. By contrast, the much smaller group of seals that inhabits the main islands is slowly growing.

Hawaiian monk seal seen basking during March 2007 NPS site visit.

About 25 seals are known to live around Kaua‘i (KMSWP 2007). They feed on fish, eels, lobsters and octopi in the nearshore waters, and haul onto shore to bask. Females look for safe, gently sloping beaches by shallow water where they can give birth. They stay onshore to nurse their young for about six weeks, and the pup generally lingers at the birth beach for another month or two after weaning. Kaua‘i is considered the hot spot for seals in the main islands (Eagle 2007).

Monk seals in the study area and elsewhere attract crowds: a healthy adult seal weighs in at an impressive 400 to 600 pounds, and a pup grows from 25 to 200 pounds or so during its six weeks of nursing. The Kaua‘i Monk Seal Watch Program monitors seal use of island beaches. Its volunteers establish cordons and round-the-clock watches to protect ill seals or mothers and pups from disturbance. (KSMWP 2007)

Monk seal occurrences within the study area take on increasing significance as the overall population continues declining at about 4 percent each year. The updated Recovery Plan for the Hawaiian Monk Seal, released in August 2007, states that the species “is headed to extinction if urgent action is not taken.” Its recovery strategy calls for actions to ensure continued growth of the seal population in the main Hawaiian Islands. (NOAA 2007b)

Green Sea Turtles

Residents report green sea turtles basking and nesting on sandy beaches in the study area and foraging in nearshore waters. During the site visit NPS staff spotted green sea turtles swimming at Kīpū Kai.

Green sea turtles swim in warm seas around the world, but the undisturbed environments they require as major breeding sites and the untrammeled sandy beaches they need as nesting areas are becoming increasingly rare. In 1978, the species was listed as Threatened under the Endangered Species Act in all areas under U.S. jurisdiction. Despite this protection the Pacific population is continuing to decline overall. No major breeding sites remain in the Pacific. (NOAA 1998)

Nine out of ten green sea turtle nests in Hawai‘i occur in the remote northwestern end of the archipelago. Growing turtles range hundreds of miles, however, to find foraging grounds. They feed in shallow waters, mainly on algae and sea grasses, and bask on open beaches. To nest and give birth, they return to the beach where they were born.

Increasingly, green sea turtles frequent the waters and beaches of Hawai‘i’s main islands, including Kaua‘i. Within the state the species appears to be making a comeback. At the same time, these Hawai‘i turtles are plagued by fibropapilloma tumors. Because of this affliction, plus mortality from poaching and gillnet capture throughout the Pacific, officials say the conservation future for the species is “seriously compromised.” (NOAA 1998)

Humpback Whale

According to a summary of humpback whale sightings recorded in 2002-2005, the Māhā‘ulepū coast featured Kaua‘i’s best spot for whale-watching (NOAA 2006). On the March 2007 site visit, late in whale season, NPS noted three humpback whales in waters offshore of the study area.

Each winter about 5,000 humpback whales migrate to Hawai‘i from their Alaska feeding grounds to mate, calve and nurse their young. After centuries of population decline by whaling, in the 1970s this massive marine mammal—adults reach over 40 tons—was declared endangered under the Endangered Species Act and depleted under the Marine Mammal Protection Act. Today the species is slowly making a comeback. Hawai‘i is the only state in the nation where humpbacks reproduce.

During annual whale counts—an extensive volunteer effort coordinated by NOAA—observers record whale presence and surface activity at sites around the islands. Four sites in or immediately adjacent to the study area coast are included in the annual count: Ninini Lighthouse at Nāwiliwili Bay, Hā’ula Bay and Makawehi dunes at Māhā‘ulepū, and Makahūena Point just south of Māhā‘ulepū (NOAA 2006).

Preliminary results for 2007 show the Māhā‘ulepū coast area (Hā’ula, Makawehi and Makahūena sites) with the three highest whale sighting counts on Kaua‘i (NOAA 2007).

4.4.2 Fishes

Kaua‘i residents describe the nearshore waters of the study area as a “prime fishing area.” Telltale pipes for holding fishing poles are embedded at favored sites along the shoreline. Fish abundance is also implied by the presence of monk seals—the seals feed on reef fish as well as octopus, lobster, and eel.

Fish fauna offshore of the study area appear similar to those seen at other shallow water sites throughout the Hawaiian archipelago. Snorkel fish surveys by trained volunteers for the Reef Environmental Education Foundation recorded 24 species of fish at Kawailoa Bay (Māhā‘ulepū), and 43 species at Kīpū Kai. During the site visit NPS noted eight marine species, and an additional eight appeared in records kept by proprietors at Kīpū Kai.

In study area tidepools we saw the zebra rockskipper blenny, as well as juveniles of several families found commonly in Hawaiian intertidal pools and shallow nearshore rock reefs. One brackish-water fish, the Western mosquitofish (*Gambusia affinis*) was seen in the *mulivai* (brackish water wetland) at Kīpū Kai.

A species list of fishes seen by NPS or reliably reported by others appears in Appendix 6.2.4. It should be noted that we were not able to observe or reliably confirm fish species of Hulē‘ia Stream or Nāwiliwili Bay during the reconnaissance survey.

4.4.3 Algae

NPS observed and identified 23 algal taxa from shore and at wading depth during our brief site visit. Based on the locations we saw, algal and benthic invertebrate cover appear to be in equilibrium throughout the study area. We saw no invasive or alien algae. A 2007 limu inventory along the Māhā‘ulepū coast by a local biologist reportedly noted small amounts of invasive hypnea but an otherwise diverse and healthy array of species.

The only indication of algal overgrowth observed by NPS is on shallow, gently sloping rocky intertidal benches, where cover is dominated by limu kala (*Sargassum echino-carpum)* or a diverse assemblage of foliose and turf algae. Where limu kala dominates, other algal species present include *Asparagopsis taxiformis*, *Dictyota sandvicensis*, *Dictyosphaeria cavernosa*, *Laurencia* sp., *Padina* sp., *Turbinaria ornata*, *Ahnfeltiopsis coccinea*, and *Wrangelia elegantissima*. On large boulders exposed to strong waves, crustose coralline red algae are particularly abundant.

Limu is a valued food source in Hawaiʻi. Caretakers of Kīpū Kai report that during low tides Kauaʻi residents arrive by boat to glean for limu kohu (*Asparagopsis taxiformis*) and other edible algae. Evidence of excessive harvesting and poor harvesting of limu kohu is reported along the Māhāʻulepū coast.

A species list of algae sighted by NPS during the survey appears below in Appendix 6.2.5. The list reflects the survey's limited scope and should not be considered comprehensive.

4.4.4 Marine Invertebrates

Marine invertebrates noted by NPS during the site visit included nine corals, a relatively rare sea anemone, and 29 other macroinvertebrates.

Occurring as widely scattered colonies on basalt, all corals observed had the encrusting, mound, or robust branching morphologies characteristic of species adapted for life on high energy exposed coasts. Corals seen in the study area's wave-protected embayments reflect good water quality, and presumably low levels of runoff and sedimentation from adjacent undeveloped lands. While the number of coral species we saw is fairly low for shallow coastal areas in the Hawaiian Islands, we believe this reflects more the limits on observation (time, sea conditions) than a depauperate coral fauna.

We recorded eight species of stony coral, one zoanthid soft coral, and the relatively rare Mann's anemone (*Cladactella manni)*, the largest intertidal sea anemone in Hawai'i. The most commonly encountered corals across all sites were encrusting *Porites lobata.* More protected areas like Long Beach and Mōlehu Point at Kīpū Kai hosted a slightly broader range of species: *Porites lobata*, *Pocillopora meandrina*, *Montipora flabellata* and the zoanthid soft coral *Palythoa caesia.* Small recruits of *Pocillopora meandrina* were common on the tidal bench at Long Beach.

Mann's anemone (cladactella manni), *Hawaiʻi's largest intertidal sea anemone.*

Similar patterns of coral colonization may occur in nearshore subtidal depths, but we were not able to confirm this. It has been reported that a small fringing reef exists off Kuahonu Point (Fletcher et al. 2002), and that an intact reef of *Porites compressa* is located off Kawailoa Point (OSP 1992).

Towed-diver surveys conducted offshore of the study area by NOAA in 2005/2006 recorded relatively low coral cover, seldom over 10%. The notable exception was at depths of 20-30 feet between Pāoʻo Point and Kamala Point, where they noted cover of 20-30% with medium to high habitat complexity. (Asher 2007)

Non-coral macroinvertebrates noted during the NPS site visit were typical for rocky intertidal waters in Hawaiʻi. Molluscs were most prevalent: we saw ʻopihi (*Cellana exarata)*, false ʻopihi (*Siphonaria normalis)*, reticulated clam (*Periglypta reticulate*), and 15 species of snails including cone shells, cowries, tube snails, nerites, periwinkles, Hawaiian turbans and others. At Makawehi Point, nearest to populated areas, evidence of ʻopihi appeared as old middens containing small shells. In the remoter northeast coast of the study area we saw abundant live ʻopihi up to 7 cm in size.

After molluscs, the next most abundant marine invertebrates sighted by NPS were echinoderms: we identified four species of urchins and two sea cucumbers. Other species noted were the spaghetti worm (*Loimia medusa*), spiny lobster (*Panulirus* sp. [molt]) and three types of crab. Shingle urchins (*Colobocentrotus atratus*) and a'ama crabs (*Grapsus tenuicrustatus*) are abundant at some places, especially Pakamoi and Kīpū Kai. A full list of marine invertebrates recorded during the site visit appears in Appendix 6.2.6.

4.5 Hydrological Resources

The study area lands encompass portions of five Kauaʻi watersheds: Hulēʻia, Puali, and Nāwiliwili in the area north of the Hāʻupu ridge; Kīpū Kai at the ridge's east end; and Māhāʻulepū from the ridgeline southeast to the coast. Collectively these watersheds feature one perennial stream at Hulēʻia; intermittent streams at Māhāʻulepū, Kīpū Kai, and Niumalu; a mosaic of varied wetland habitats; and two major freshwater aquifers.

Hulēʻia

Lowlands of the Hulēʻia, Pūʻali and Nāwiliwili watersheds converge at Hulēʻia Stream, the only perennial stream within the study area. The Hawaiʻi Stream Assessment (DLNR 1990) identifies it as one of eight "Outstanding Riparian Resources" on the island of Kauaʻi, noting the presence of recovery habitat, four species of threatened or endangered birds, and a significant amount of palustrine wetland. The stream's aquatic resources are also rated outstanding: a native indicator species, ʻoʻopu nākea (awaous stamineus), and six other native aquatic species were observed during the 1990 survey. Threats identified during the assessment included invasive hau, California grass, and pigs.

Hulēʻia is partially protected due to the presence of the National Wildlife Refuge, which was established in 1973 to provide wetland habitats for Hawaiian waterbirds. The refuge is designated a Core Wetland by the USFWS. Currently it is managed to control invasive vegetation species through disking and water-level manipulation. Proposed future activities include improved water delivery, mangrove removal at the adjacent fishpond (PCJV 2005) and wetland restoration (FWS/DU 2005). However, limits on funding and staff appear to have curtailed any active planning for such improvements.

The lower reach of Hulēʻia Stream leading into Nāwiliwili Bay is listed as impaired due to turbidity and nitrite/nitrate levels. This area—rated in the 1990 stream assessment as an "Outstanding" recreational resource—is heavily used by residents and tourist for water-based recreation, and is now the target of state and local monitoring and restoration efforts (UH Manoa 2007).

Kīpū Kai

Kīpū Kai watershed descends from the eastern ridges of the Hāʻupu mountain range to the ocean. During periods of heavy rain, waterfalls course down the steep coastal pali. A freshwater spring surfaces near the ridge and an intermittent stream flows through the valley. The Hawaiʻi Stream Assessment recognizes Kīpū Kai stream for its "Substantial" riparian and recreational resources, and documents the presence of four species of threatened and endangered birds.

Since access to this watershed is tightly controlled, its water resources have not been well-studied. NPS staff who visited the site report a brackish water wetland or muliwai behind the beach at Kīpū Kai. With sufficient rain it flows directly to the ocean by a channel and concrete mākāhā, and also joins with the nearby intermittent stream. The muliwai contains the aquatic grass *Ruppia maritima* and the introduced Western mosquitofish, and provides a secluded and protected habitat for Hawaiʻi's threatened and endangered waterfowl.

Māhāʻulepū

The portion of Māhāʻulepū watershed that lies within the study area stretches from the Hāʻupu ridgeline southward through Māhāʻulepū valley and eastward to the coast.

Agricultural operations began in the mid-1800s in Māhāʻulepū valley; its intermittent streams and wetlands were long ago modified for irrigation purposes. The landowner Grove Farm operates a water system that includes wells, ditches, tunnels and reservoirs. Māhāʻulepū Reservoir, at the back of the valley, is part of that system. Both it and the County-owned Puʻu Hi reservoir (at the very southern end of the study area) serve as important attractors for Hawaiʻi waterfowl. Irrigated taro loʻi in the valley provide additional waterbird habitat. A broad natural depression in the valley also fills with water after heavy rains and temporarily draws waterbirds in large numbers.

Though Māhāʻulepū valley's streams and wetlands were modified, their remnants remain; these expand and become especially visible during wetter periods. The former Waiʻōpili stream—largely subsumed by the ditch system within the cultivated area at Māhāʻulepū—emerges in more natural form near Makauwahi Cave at the south end of the study area, where it joins forces with a natural spring and a remnant of the once much larger Kapunakea Pond. This wetland juncture attracts waterbirds and serves as nursery habitat for native fish. It is linked hydrologically to the important Makauwahi Cave complex, a critical habitat for endangered arthropods that rely on seepage of nutrient-rich water.

Waiʻōpili Stream at Māhāʻulepū Beach

Research and restoration have been ongoing in Waiʻōpili Stream/Kapunakea Pond area since 1992. On fifteen acres leased from Grove Farm, volunteers are restoring native grassland and riparian areas. A statewide wetland strategy calls for continuation of these efforts, and protection of "this unique area in perpetuity through conservation easements, cooperative agreements with the landowner, and/or direct acquisition." (PCJV 2005).

Along the Māhāʻulepū watershed coastline, other small wetland ecosystems fed by rain and groundwater lie just inland of the dunes. These, too, attract native waterfowl; biologists believe they once supported larger populations, and have excellent restoration potential.

Resource specialists told NPS that Māhāʻulepū and Kīpū Kai, in combination with Hulēʻia, provide a much-needed mosaic of varied wetland habitats that should be protected and restored to be reliably available for endangered Hawaiian waterbirds.

Groundwater

Rain is Kauaʻi's sole source of water. Rainfall not lost to runoff or evaporation seeps into the lava flows that make up the island, forming freshwater aquifers. In the study area this seepage is generally slow, since the types of lava found here are relatively impermeable overall. However, they do contain some spaces where water collects to form underground aquifers. Large amounts of fresh water perch in the Kōloa volcanics atop denser layers of soil, ash or lava. Fresh basal groundwater occurs in the basalt lavas that comprise most of Hāʻupu ridge, and scattered springs emerge around the base of the mountain range. County of Kauaʻi and major landowners, including Grove Farm, collect and distribute fresh water from area streams and basal sources through ditches, wells, tunnels and reservoirs. Two separate aquifers—Kōloa and Hanamāʻulu—supply the water system in the study area.

Because of the limited permeability of lavas in the study area, few freshwater springs discharge into the ocean. In the permeable limestone dunes along the coast, the basal water is brackish.

4.6 Cultural Resources

Scholars say Polynesians seafarers in canoes discovered Hawaiʻi over a millennium ago, possibly as early as 300 AD. Cultural resources in the study area tell the story of Hawaiʻi's subsequent transformation by human settlement—from the first Polynesian settlers, to the wave of later immigrants who launched the ranching and plantation era, to the mixed communities and modern agriculture and tourism operations in place today.

The whole coast of the study area was populated by native Hawaiians when the first westerner, explorer Captain James Cook, sailed through Kauaʻi waters to land in Waimea in 1778 (McMahon 2007). At that time Hawaiians distributed their settlements and shared land and resources through a system of land divisions known as *ahupuaʻa*. Boundaries of ahupuaʻa were delineated to maximize occupants' access to a range of natural resources needed for sustenance—from nearshore reefs to upland forests.

Cook's arrival set the stage for an influx of newcomers from around the world and catalyzed a dramatic transformation of Hawaiʻi's land use and demographics. Cook introduced cattle to the islands; a gift to the government, they quickly multiplied and spread across the landscape. Whaling ships, traders and missionary expeditions soon brought new immigrants from America, Asia and Europe. In the decades from the 1830s to 1870s the native Hawaiian population declined by over half, largely due to introduced diseases. An American land ownership framework replaced Hawaiian ways of managing resources and a western-style economy rapidly took hold, enabling ambitious immigrants to acquire major landholdings.

By 1850, American entrepreneurs launched large-scale sugar plantations in southeast Kauaʻi. Their efforts heralded the beginning of Hawaiʻi's plantation era, which lasted into the late 20th century. Over that same period, the Hawaiian kingdom fell to United States political interests. With the 1893 overthrow of Queen Liliʻuokalani, the islands were claimed as a United States Territory; in 1959, Hawaiʻi became our nation's fiftieth state.

In the study area today, a range of natural and cultural resources reflect the state's evolution through the periods of Hawaiian settlement and expansion, Western contact, and plantation life.

4.6.1 Hawaiian Settlement and Expansion

The lands examined in this reconnaissance study encompass portions of five different traditional Hawaiian ahupuaʻa: Haiku, Kīpū , Niumalu, Kīpū Kai, and Māhāʻulepū. Changes in these ahupuaʻa as a result of modern agriculture, ranching or natural events buried many sites and features from the period of native Hawaiian settlement and expansion. Most which remain are on private land, where archeological investigation is likely to occur only if the owner seeks development permits.

According to the state's archeologist, basic sites in the region are known and some burial reinterments have occurred, but generally speaking, researchers have not done extensive fieldwork in the study area (McMahon 2007). Notable documented cultural resources which are rooted in the period of native Hawaiian settlement and expansion—and which remain visible today—are described below.

Hulēʻia Valley

Hulēʻia Valley—the land designated today as Hulēʻia National Wildlife Refuge—was natural breadbasket for early Hawaiians on Kauaʻi. Rich in the resources that sustained native settlers, its lands formed the lowland junction of three ahupuaʻa: Kīpū, Niumalu, and Haiku.

In the drier portions of the valley, people grew ʻ*ulu* (breadfruit), *wauke* (mulberry, for making tapa cloth),*ʻawa* (for ceremonial drink), and other crops. In wetter areas near streams, they shaped *loʻi* (irrigated pond fields) for cultivating the staple *kalo* (taro). Records indicate that by the early 1800s, and probably well before, the valley hosted a healthy agricultural community with native Hawaiian homes, fields, and at least 113 separate taro loʻi. (FWS 2005)

With the changes in land use laws and demographics in the mid-19th century, however, taro patches soon became "a rarity among the profusion of rice fields." Westerners purchased large agricultural acreages, and Grove Farm—still a major landowner in the study area today—began cultivating sugar in Hulēʻia valley. (FWS 2005)

Archeologists have documented an entire loʻi and *ʻauwai* (ditch) system on the valley floor; agricultural terraces delineated by boulders in the valley's western end; conical depressions in rock that appear to be prehistoric native Hawaiian bait cups (for preparing fish bait); and two *loʻi* (taro paddy) complexes created within the last decade by FWS lessees. In site investigations they also identified or recovered Hawaiian artifacts including basalt flakes and a polished basalt scraper. Researchers recommend studies of exposed soil profiles if excavation is undertaken as part of future wetland restoration at the Hulēʻia National Wildlife Refuge.

Alekoko Fishpond

Makai of the Hulēʻia National Wildlife Refuge is Alekoko Fishpond, a native Hawaiian aquaculture site that dates to approximately 1200 AD. Alekoko—sometimes known as

Menehune Fishpond— is listed on the National Register of Historic Places and widely recognized as one of the most important cultural features on Kaua‘i.

While aquaculture existed in other island cultures, prehistoric Hawai‘i’s aquaculture endeavors were far more extensive and innovative than elsewhere in the Pacific. In hundreds of ponds throughout the islands Hawaiians raised and harvested fish—mainly *awa* (milkfish) and *‘anae* (mullet)—and other products. Though usually ponds were built along the ocean shoreline, in some places they were located inland to take advantage of stream waters. Of the 65 fishponds known on Kaua’i, at least nine were located on Hulē‘ia Stream (Cockett 2001). Inland freshwater ponds were known as *loko wai.*

Some ponds were simply natural enclosures, but most were constructed laboriously from rocks. A unique feature of many Hawai‘i ponds was the *mākāhā*, or sluice grate, which improved the pond from a tide-dependent fishtrap into an aquatic arena that could be controlled, regardless of tide, to manage movement of fish between the pond and adjacent stream or ocean waters.

The success of Hawai‘i ponds made them a treasured resource for Hawai‘i’s royalty:

> By the end of the 18th century, more than 300 fishponds were conspicuously owned by the high chiefs. Accessibility to these ponds and their products was limited to the elite minority of the native population—the chiefs and priests. Ownership of one or more fishponds was one of the ultimate, high-status symbols in the status-conscious Hawaiian culture…

Hulē‘ia Stream and Alekoko Fishpond

Alekoko is a royal fishpond of the *loko wai* type. It is the largest manmade inland fishpond in the state (McMahon 2007), and was built using cut stones, a technique rarely employed by ancient Hawaiians. Its extensive rock wall embankments remain, hidden by mangrove, and the mākāhā openings still exist. Although listed on the National Register, the pond has not been fully studied; it is privately owned and access is restricted to viewing from a nearby state-owned overlook. Alekoko is not used today for fish production: water diversion upstream and breakwater jetties downstream altered the rate of flow, and sediments have increased the water turbidity.

A statewide study of Hawaiian fishponds for NPS in 1975 identified remnant Hawaiian fishponds “worthy of preservation as part of the cultural heritage of the State of Hawai‘i and the United States of America.” Highest value was given to ponds “judged to have deviated least from their conditions when in operation.” The study authors rated Alekoko fifth out of 56 extant royal Hawaiian fishponds for its potential restorability. The state’s aquatic resources biologist on Kaua‘i says the pond could serve as a research site and be restored as “an incredible teaching and demonstration resource for Hawaiian aquaculture.”

Since the NPS study, mangrove has overgrown and interpenetrated the fishpond walls, posing an increased challenge for restoration. Study authors noted in 1975 that the extent of mangrove invasion strongly affects a pond’s potential, since “mangrove removal may involve cranes and underwater sawing. In removing mangrove roots grown into man-made pond walls, the walls would have to be wrecked and rebuilt.” Recently more sophisticated mangrove-removal machinery has become available, however. Opinions of experts we spoke with vary widely as to whether restoration of Alekoko is feasible.

Makauwahi Cave and Sinkhole

Makauwahi cave and sinkhole, discussed in section 4.1 for its paleoecological importance, is equally important for the light it sheds on Hawai‘i’s human story. According to scientists working at the site, it contains “in a single stratigraphic sequence an encapsulated view of the full span of human occupation, including the millennia preceding human arrival, earliest human evidence, subsequent population increase and cultural change, European contact, and modern transformation” (Burney and Kikuchi 2006).

Due to its neutral pH environment, Makauwahi’s fossil and artifact finds are exceptionally well preserved. Its sinkhole walls surround an ordered column of sediment layers that tell a nearly unbroken tale of conditions on Kaua‘i, from before the arrival of people through the changes wrought by a millennium of human activity. Researchers are piecing together new and detailed views of Kaua‘i’s past based on analysis of the cave’s sediments, combined with oral and archival sources.

They have identified consistencies between local oral traditions dating back to the 1300s and data retrieved from the cave’s hidden layers. In sediments from the historic period over the last two centuries, their finds show consistency not only with oral accounts, but also with historic maps, drawings, photographs, and Land Court Award records (Burney and Kikuchi 2006).

Bones of the Pacific rat, believed to have arrived in Hawai‘i with Polynesian voyagers, are dated at 1039-1241 A.D. in the cave and provide the earliest evidence of people in its immediate vicinity. Sediment layers above the first rat bones show an increasing abundance and diversity of whole or partial human artifacts. Documented by Burney and Kikuchi (2006), they include:

- tools such as files, picks, scrapers, and adzes
- fishing gear including hooks, octopus lures, and stone weights
- game stones, sling stones, and hammerstones
- gourds and a wide range of food remnants
- fiber cordage
- wooden fragments of canoes, paddles and tool handles
- a stone stool and evidence of a platform
- ornaments, including drilled shells and a drilled, polished basalt mirror pendant.

The increase in human artifacts through successive layers corresponds with a decrease in native flora and fauna. Some species abruptly vanish when humans arrive, while others gradually decline in size over the centuries and eventually disappear, especially after European contact. In the 1800s and 1900s, as feral animals and agriculture strip nearby land, the number of native plants and birds drops dramatically.

Discoveries at Makauwahi lend weight to an ongoing discussion among scholars about the ways in which Polynesian settlers may have significantly altered the landscape and native biota of Hawai‘i, even prior to European arrival.

Archeological finds at Makauwahi cave and sinkhole to date are from only three excavation pits; presumably many future discoveries remain hidden in the cave sediments. Burney and Kikuchi (2006) note that the cave strata “provide an ongoing record of human activity near the site [that] can be thought of as not just an ‘album of snapshots’ of past life, but perhaps, in combination with the oral histories and early documents, maps, and pictures … a sort of epic movie of human ecology stretching over a thousand years.”

Mt. Hā‘upu

A notable landmark in the study area, Mt. Hā‘upu, is of special meaning to native Hawaiians. In 1998, proposals to build a communications tower on Hā‘upu Ridge prompted the state’s Office of Hawaiian Affairs to document the cultural importance of Mt. Hā‘upu. In a 3-week period they collected information from elders, traditional religious practitioners, teachers of hula and chant, and historians. Their results were summarized in a written appeal to the Federal Communications Commission (OHA 1998) that successfully stopped plans to erect the tower. Points they outlined in the appeal are noted and quoted below.

In Hawaiian culture, a “sacred familial union” joins people to the land.

> “If a time arises when the ‘āina is threatened, we, as Hawaiians, will be there, not by choice, but by our deep aloha to protect our fellow family member. No amount of Western influence, cultural assimilation, or persuasion can sever this relationship between Hawaiians and the land, for the land is our kin.” (OHA 1998)

In this reality, Hā‘upu ridge is a *wahi kapu* (sacred place).

> “Hā‘upu is our kin, descendant of Papa [Earth mother] and Wakea [Sky father], and older sibling of the Hawaiian people. This is the main underlying reason why we, as Hawaiians, hold Hā‘upu sacred in our hearts.” (OHA 1998)

Hā‘upu is said to be named after a warrior demi-god who tore a large rock (*pohaku*) from Kaua‘i and threw it across the channel to kill an enemy chief on O‘ahu, forming the islet there known as Pohaku o Kaua‘i. Hā‘upu in the Hawaiian language means a sudden recollection; the mountain is known for its ability to jolt a memory, or alternatively, open a view to the future. A small heiau atop Mt. Hā‘upu is dedicated to Laka, the goddess of hula, whose *kinolau* (embodied form) lives in the wild and sacred plants of the upland forest that are used by hula practitioners. Both the heiau and the wooded area at Hā‘upu’s summit are known by the place name Keolewa, which appears in a variety of prayers, chants and oral traditions. (OHA 1998)

Hā‘upu Ridge is revered as a meeting place where the powerful fire-goddess Pele made passionate love with the demi-god Kamapua‘a. The Kōloa region south of the ridge was controlled by Pele; its dry and rocky landscape reflects her harsh, impatient and dominant personality. The lusher Līhu‘e side of the ridge was home to the pig god Kamapua‘a, who is associated with “taro, fertility and the creation of fertile springs necessary to sustain life,” and who is known to excel as a lover. According to tradition,

> "Pele and Kamapua'a are believed to have been involved in a tumultuous love affair with each other in the vicinity of Hā'upu and the topography of the area is believed to have been shaped by the fury of their love-making…Hā'upu Ridge is the dividing line between the two areas controlled by Pele and Kamapua'a and Hawaiian religious practitioners believe these gods continue to dwell there. In times of drought, the fertile and lush domain of Kamapua'a is said to be inhabited by Pele, whereas in times of heavy rains the dry and arid domain of Pele is said to be inhabited by Kamapua'a. It is at these times that their love affairs are believed to continue." (OHA 1998)

Ku and Hina, the earliest Hawaiian god and goddess, reside on Hā'upu Ridge. They are patron gods of fishermen and "the special protectors of all the generations of Hawaiians whose ancestors came from Kahiki [Tahiti]." Ku and Hina also represent the male and female procreative powers; their images, seen in rock formations atop the mountain, are a focal point for Hawaiian cultural and religious practitioners. (OHA 1998)

Hawaiian proverbs and poetical sayings reflect Hā'upu's cultural importance. The phrase *Hā'upu mauna kilohana i ka la'i* (Hā'upu, a mountain outstanding in the calm) honors the mountain itself, and is also a description for someone who achieves outstanding things. Mary Kawena Pukui's *Olelo No Eau* includes seven sayings centered on Hā'upu, a relatively large number for a place that is not a habitation site. (OHA 1998)

Visible from as far as sixty miles at sea, Mt. Hā'upu was an important navigational landmark for traditional Hawaiian fishermen in canoes. Hawaiian fishermen today use modern navigation technology, but continue to look to the mountain as both a physical and spiritual guide. (OHA 1998)

Wai'ōpili Heiau

Wai'ōpili Heiau is located near Makauwahi cave, on the land leased from Grove Farm for a sand quarry operation. In a 1974 surface survey archeologists recognized the heiau as "undoubtedly the most important site" known at that time along the southeast Kaua'i coast, and rated it in the state's "Valuable" category—i.e., significant sites in excellent condition that are good examples of a feature type. They recommended the heiau be "stabilized and/or restored" and described its unique qualities:

> This temple is only one of 4 major heiau, in good condition, which still exist between Hanapepe and Māhā'ulepū (in fact, if one were to continue up the east coast of the island of Kaua'i the next comparable temple would be those in and around the State Park at Wailua)…The large pahoehoe slabs used in the construction of the south wall is unique as is the stone "tower" near the corner of the south and west walls. Wai'ōpili is also the only remaining temple in the ahupua'a of Māhā'ulepū. (Ching et al 1974)

Quarry operations were already underway when the site was examined in 1974. The walls and interior of the heiau were readily seen, but the unique tower formation, noted as substantial by previous archeologists 40 years earlier, had been reduced to "a pile of lava," apparently as a result of quarry operations pushing against the heiau (Ching et al 1974).

Twenty years later conditions had worsened: a 1992 state study noted commented that the heiau was "sitting directly underneath the rock crusher" (OSP 1992). Archeologists and residents who have visited the quarry recently say the heiau is difficult to see but appears to have been further degraded.

Several local sources told NPS that the quarry operator is preparing to close the current site in the near future and move operations to a second permitted site above Hā'ula Bay. According to the state's archeologist on Kaua'i, quarry permit conditions require the operator to revegetate the existing site and restore Wai'ōpili Heiau upon shifting locations.

Burials

The coastal sand dunes of the study area are all known to contain Hawaiian burials. 'Āweoweo, a tall dune north of Hā'ula, is reported to be the longest, largest burial dune in the Pacific. Excavation and grading for the Hyatt hotel, adjacent to the study area, uncovered human remains in the Makawehi dunes. Burials occasionally erode out of other coastal dunes in the study area, and some have been found in study area caves. Newly discovered burials are protected and reinterred through protocols established by the local Native Hawaiian Burial Council.

Little is definitively known about the numerous dune burials. From the early to late 1800s, written accounts refer to great numbers of bones visible in the dunes of Pā'ā and Māhā'ulepū. In 1867, entrepreneur Sanford Dole wrote a letter describing the scene:

> Over this whole extent of sand beaches and hills, human bones are thickly scattered….Ten years ago they were much more numerous than now. The wind is constantly uncovering the skeletons, and when exposed, they are quickly destroyed by the weather and the feet of cattle…[Formerly] it was easy to find perfect skeletons in the exact position in which they were buried. This is now impossible and even perfect crania are becoming more scarce with every year. In olden times the natives often made use of the soft sand beaches for sepulture, but the immense number that is buried here forbids the idea that it was any common burying place. The present generation of natives know nothing definite on the subject. (Ching et al 1974, citing Wyman 1868)

Some 19th century Hawaiians told questioners that the dunes were simply easy places to accomplish common burials. Others said the burials were the result of a great battle in which Kaua'i warriors defeated invading forces. One version placed the battle in the 13th century; the best-known versions—still popular today—describe it as a 1796 battle in which the warriors of Kaua'i's chief, Kamuali'i, defeated Kamehameha's warriors from O'ahu (Ching 1974). To date, none of these battle legends have been confirmed archeologically (McMahon 2007).

Petroglyphs

Known petroglyphs in the study area occur on Māhā'ulepū beach; on privately-owned coastal lands between Hā'ula and Nāwiliwili Bay; and on Grove Farm agricultural lands in Māhā'ulepū valley.

Petroglyphs on rock ledges underlying Māhā‘ulepū beach are occasionally exposed by high tide and waves.

At Māhā‘ulepū beach and at Keoneloa Bay just outside the study area, dozens of petroglyphs and carvings decorate expanses of rock that are usually buried deep in sand, but occasionally exposed by high tides and waves. The markings range up to six feet in length and show historic influences mixed with ancient designs (Clark 1990). Their origin is unknown. In the late 1800s, elders from the area reported the petroglyphs had "always" been there (Ching et al 1974). Rocks in the shallow water at Māhā‘ulepū Beach exhibit grooves made by the sharpening of adzes. Underwater archeology may reveal additional features of interest.

Inland, in the upper reaches of Māhā‘ulepū Valley, is a mystifying petroglyph boulder measuring nearly 4 meters across. It features approximately twenty carved figures, and on its top are two cup-like carved holes; the larger of the two is 4" deep and 1 ft in diameter, and is connected to the edge of the boulder by a shallow carved groove. Researchers have speculated on the meaning and purpose of this configuration—some think it may symbolize or even map a stream and/or spring, and others suggest that it might have served a sacrificial purpose. The actual function and meaning are entirely unknown. (Ching et al 1974; McMahon 2007; KCC 1973)

Other Archeological features

Through ship's logs and drawings, historians know that Kaua‘i's southeast coast was well populated by Hawaiians when Captain Cook arrived in 1778. Unfortunately, the village complexes he saw did not survive the two centuries of social and physical upheaval that

followed. An archeological surface survey in coastal portions of Māhā‘ulepū in 1974 noted "…many of the sites within the study area were destroyed, otherwise obliterated, or in an advanced stage of deterioration…a reflection of the changing land use patterns of the region" (Ching et al 1974).

Surface sites and features that do remain are mostly scattered and isolated. They include shelter caves, remnants of rock walls and house sites. Three heiau are preserved on the Hyatt hotel property abutting the south end of the study area. An 1896 map by Monsarratt shows house lots and salt ponds near Wai‘ōpili Stream and Kapunakea Pond, but evidence of these has been destroyed or obscured, and even the stream and pond have been drastically altered by agricultural operations.

On private properties in the north end of the study area a range of sites and features are reported to exist. These include burials, village and house sites, heiau, rock walls, middens, agricultural terraces, taro lo‘i, a clay-mining cave, and a fishpond site. Hunters tell of a place in Niumalu that is said to be the house and burial site of a princess from the island of Hawai‘i.

Some of these have been documented and a few were viewed by NPS staff during the site visit, but overall the documentation to date has not been thorough. Given the habitation dates revealed at Makauwahi Cave, and the known existence of coastal villages in the study area through the 18th century, a more thorough survey and excavation would likely yield new finds and insights.

4.6.2 First Western Contact

The ocean off Māhā‘ulepū was the location of the first documented contact between native Hawaiians and people of the Western world on January 19, 1778. Captain James Cook recorded the rendezvous in his diary (as cited in MM 2004):

> January 19, 1778…I stood for the East end of the second island [Kaua‘i] …the nearest part about two leagues distant. At this time we were in some doubt whether or not the land was inhabited, this doubt was soon cleared up, by seeing some canoes coming off from shore towards the Ships, I immediately brought about to give them time to come up, there were three and four men in each and we were agreeably surprised to find them of the same nation as the people of Otahiete [Tahiti] and the other islands we had lately visited…

This fateful meeting marked the first economic encounter between two vastly different cultures. A brief flurry of trade between the Hawaiians in canoes and the Westerners in ships marked the first exchange in the series of economic transactions that would eventually transform Hawai‘i's people, laws, and landscape:

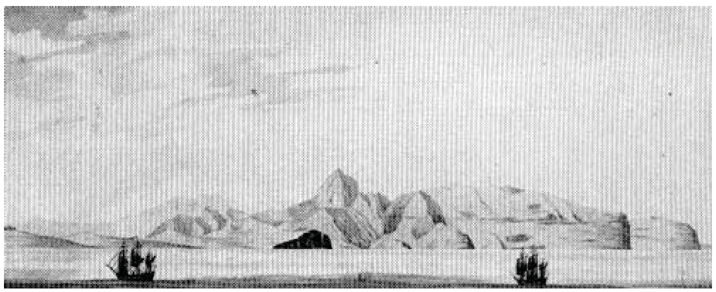
> …It required but little address to get them to come along side, but we could not prevail upon any one to come on board; they exchanged a few fish they had in the Canoes for any thing we offered them, but valued nails, or iron above every other thing; they only weapons they had were a few stones in

> some of the Canoes and these they threw overboard when they found they were not wanted.

Lack of a good anchorage led Cook to proceed around the island to Waimea, but as he skirted Kaua‘i’s southeast coast, he described the view across Kōloa and Māhā‘ulepū to the Hā‘upu Ridge, with its steep stratified basalt headlands at Kīpū Kai and Niumalu:

> …The land on this side of the island rises in a gentle slope from the sea shore to the foot of the Mountains that are in the middle of the island, except in one place, near the East end where they rise directly from the sea; here they seemed to be formed of nothing but stone which lay in horizontal stratus.

The first drawing of Hawai‘i by a European is William Ellis’ depiction of the Māhā‘ulepū Coast, with Mt. Hā‘upu as its focal point (Ainakumuwai 2001).



4.6.3 Plantation and Ranching Era

Scattered physical remnants of plantation life are visible in and around the study area. Kōloa Plantation—the 19th century owner of Māhā‘ulepū lands that now belong to Grove Farm—gave birth to Hawai‘i’s commercial sugar industry. Remnants of the company’s first mill are in nearby Kōloa town, and a second mill constructed in 1912 stands on Grove Farm property just outside Māhā‘ulepū Valley.

Kīpū Ranch and Grove Farm—two agricultural entities that shaped Hawai‘i’s historic plantation and ranching era—still manage active operations on lands within the study area, with some historic facilities remaining in use. At Kīpū Kai, cattle operations ended just two years ago.

The histories of these properties illustrate Hawai‘i’s transformation since the early 1800s—the troubled transition to a Western-style land ownership system; the acquisition of vast acreages by American missionary families; the diversion of water to support commercial sugar crops; the tide of imported laborers needed to maintain production; and the mid-20th century decline of plantation life as laborers left the fields for other work opportunities.

They stop just short of the modern chapter in the story—the wave of subdivision and development that has recently broken up many of the state’s vast and historic agricultural holdings.

Kipu Ranch abandoned sugar in 1942 and narrowed its focus to cattle ranching. The Rice family, owner of the land since 1872, continues cattle operations today. In recent years the ranch trimmed staff, replaced horses with ATVs, launched an ecotour operation, and served as a location for Hollywood movies. (Yamanaka and Rice 1998)

Grove Farm stopped actively cultivating sugar in the 1970s. A lessee grew sugar on Grove’s Koloa lands for twenty more years—1996 marked their final harvest and the closure of the historic Koloa Mill just outside Māhā‘ulepū Valley (Yamanaka 2000). Over the last two decades, Grove Farm engaged in extensive real estate development outside the study area, but its Māhā‘ulepū valley land remained in crops and pasture.

In their current state, both Kīpū Ranch and Grove Farm offer windows into Hawai‘i’s past. Interestingly, both are invested in business strategies that highlight that past. Kipu Ranch offers ecotours emphasizing the ranch’s history, while Grove Farm plans interpretive features focused on local agriculture.

4.7 Recreation and Community Use

Despite the study area’s location between the population centers of Līhu‘e and Po‘ipū, no public lands within it are managed for recreation purposes. However, residents and tourists enjoy both informal and commercial recreation along the study area shoreline, in the adjacent ocean, on Hulē‘ia Stream, and on some of the privately-owned lands. Community uses include traditional cultural activities such as fishing, hunting and gathering.

Shoreline

The Māhā‘ulepū and Kīpū Kai shorelines have long served as secluded recreation places for local residents. Lately a growing tourist presence has added to the mix; over one-third of the petition-signers in a community initiative to protect Māhā‘ulepū’s shoreline resources identified themselves as visitors to the island (MM 2007).

The study area shoreline is accessible at its south end via a footpath leading from Keoneloa Bay and the Hyatt hotel along the Makawehi/Pā‘ā dunes. Businesses and community groups jointly prepared an interpretive guide for this trail and sponsor occasional guided walks from the hotel to Punahoa Point.

Grove Farm allows daytime vehicle access through its property to a rutted road that parallels the Māhā‘ulepū coast from Punahoa Point to Hā’ula Bay. Punahoa Point is a popular place to fish for ulua, pāpio, and ‘ō‘io; pipes for holding poles are permanently anchored into the rock here and at other high points along the shoreline. Māhā‘ulepū Beach is favored for windsurfing and kite surfing, and its long white stretch of sand appeals to sunbathers and walkers. Kāmala Point Beach, Kawailoa Bay and Hā‘ula Beach are all popular swimming spots. A commercial stable just inland of Punahoa Point provides horseback riding tours along the shoreline.

The Māhā'ulepū coast offers varied and readily accessible recreation opportunities in a wilderness type atmosphere.

The entire four-mile stretch from Makawehi Point to Hā'ula offers a scenic hike in a wilderness atmosphere with no visible development except a single house at Māhā'ulepū Beach. A narrow and rutted dirt road reaches most of the way to Hā'ula; at favored spots it can be packed with vehicles on weekends and holidays, when local families converge for daytime and overnight fishing, spearfishing and camping.

Kīpū Kai encompasses five separately named beach areas, but these are not accessible to the public by land, and foot travel is allowed only below the high tide line. The single road that leads over the ridges of the Ha'upu Range into Kīpū Kai is private property and blocked by gates. Most visitors arrive by boat or kayak.

Most of the public recreation at Kīpū Kai occurs at Long Beach, which is suitable for swimming, snorkeling, bodysurfing, bodyboarding, surfing, fishing, and beachcombing. A small cove in the arc of Mōlehu Point at the north end of Long Beach is a popular snorkel site for tour boats. By agreement between commercial boat operators and Kīpū Kai landowners, onshore tour activities are confined to the adjacent beach area, below the high tide line (Clark 1990). On the smaller and rockier beaches beyond Long Beach, residents often arrive by boat to harvest edible algae (e.g. limu kohu) and capture shallow reef fish and octopus (he'e or tako).

The study area coast lacks well-sheltered harbors and is exposed to strong waves, currents and tradewinds, so boat-based ocean uses are often limited by rough sea conditions. During calm periods, however, small vessels from nearby Nāwiliwili Bay or Kukui'ula Bay (west of Po'ipū) fish offshore. Charter boats and commercial kayak, dive, snorkeling and sightseeing craft skirt the study area shoreline and enter coves along the way when conditions allow, particularly in winter when high surf precludes tours along the Nā Pali coast. Ocean-based tours to Kīpū Kai—where public access by land is not allowed—are increasingly popular.

Hulē'ia Stream and Kīpū Ranch

The waters of Hulē'ia Stream are a peaceful kayaking spot for local residents and independent tourists. Local outfitters also offer guided kayak tours along two miles of the sheltered Hulē'ia waterway, through scenic forests that are often used as film locations for adventure movies. Paddlers glide past Alekoko Fishpond and through the Hulē'ia National Wildlife Refuge, then hike through the forest to waterfalls and swimming holes. One kayak tour operator, by agreement with the landowner, leads hikes into Kīpū Ranch that feature a covered wagon tour, a treehouse picnic, and a zipline ride across a waterfall.

Kīpū Ranch is also the site of commercial ATV tours. Sponsors tout the varied terrain through forests and along Hulē'ia Stream; opportunities to learn about Hawaiian culture; stops at Hollywood movie locations; encounters with cattle, wild pigs, and game birds; and spectacular "ocean, mountain and jungle" views, including a look at the private and inaccessible valley of Kīpū Kai.

Hā'upu Ridge

Hā'upu Ridge was formerly a popular hunting area accessible to the public. Due to growing vandalism, poaching, and risk of fire on the ridge and adjacent land, owners now allow access only by permission.

4.8 Resource Threats

Human Land Use and Activities

Changing land uses and activities pose current and potential threats to important natural and cultural resources within the study area.

An active sand quarry excavation operates adjacent to Makauwahi cave and sinkhole—so close that one small cave opening in the west sinkhole wall rises diagonally only about 50 feet before it ends in a surface collapse at the edge of the quarry (Burney and Kikuchi 2006). Heavy equipment in use at the quarry can sometimes be felt within the cave environment, causing fear of potential rockfall or collapse. A heiau on the quarry site has already suffered significant damage. A future quarry site farther north at 'Āweoweo may potentially impact dune burials.

Kaua'i's endangered arthropods in the study area are especially vulnerable to impacts from quarrying and other activity on the marginal agricultural soils overlying their cave habitats. Grading, fill, and excavation result in disturbance, compaction or blockage of the subterranean cracks where these species find refuge during drought. Blocked areas break up the cave system into separate areas, isolating the already small populations and increasing their risk of extinction.

Endangered birds rely on a mix of natural and manmade resources in the study area that are readily subject to change. At Kīpū Kai—the release site for a small population of nēnē that grew and catalyzed resurgence of nēne on Kaua‘i—the mowed and grazed grassy areas favored by nēne have been substantially reduced since the cessation of cattle operations in the valley. On Hā‘upu ridge, pig predation and fire risk are ongoing threats to the Newell's shearwater nesting habitat. Potential development in the shearwater's land-sea flight path also poses a threat if it results in increased lighting, which disorients and downs birds in transit.

Recreational use of the study area shoreline is growing in tandem with Kaua‘i's resident and visitor populations. Along the accessible Māhā‘ulepū coast, user conflicts are common; and at relatively inaccessible Kīpū Kai, trustees express concerns about the increasing arrivals by boat. Neither site is currently managed to assess and monitor coastal-marine resources or actively manage use. Without active management, shoreline cultural and natural assets run the risk of damage from overuse before they have even been well studied. If activities get out of hand at Māhā‘ulepū, Grove Farm could choose to block access through its property, effectively limiting public use of an important recreational resource.

A potential threat to resources is future development on the private lands that are now designated for agriculture, and that are intertwined with important natural and cultural elements in the study area. Past proposals by Grove Farm, for example, included luxury resorts, large home sites, businesses, and a marina along the Māhā‘ulepū coast. Kīpū Ranch lands hold obvious value for potential development. A 2004 sales brochure for the Campion property at Niumalu suggests the buyer could apply to "change zoning for a commercial type development" and notes that "when this application was approved obviously the value would multiply."

Despite current owner intentions to keep lands in agriculture, without permanent legal protection, their redesignation and development remain possible. Such development would destroy the scenic integrity of the study area, exacerbate competition for shoreline use, and potentially cause unacceptable impacts on adjacent natural areas.

Invasive Alien Plant Species

Non-native species dominate parts of the study area, and threaten or encroach on significant resources on the shoreline, at Hulē‘ia, and on Hā‘upu ridge. Once established, some of these aliens are difficult to remove.

At Alekoko Fishpond, red mangrove completely covers the pond's rock walls. Study area coastal lands are invaded by ironwood, Christmas berry, koa haole, kiawe, false kamani and prickly pear. At Kīpū Kai, NPS staff noted one small patch of a *Canavalia*, or beach pea; fruit or flowers are needed to confirm the identification. This species was not recorded from Kaua'i in the *Manual of the Flowering Plants of Hawai'i* (Wagner et al. 1990), and thus has likely been introduced in the past decade (L. Pratt, pers. comm.).

Albizia, guinea grass and java plum are major invasives on parts of Hā‘upu Ridge. Non-natives such as rose myrtle, passion flower, cat's claw, and thimbleberry have also gained a foothold; some of these are able to spread quickly through the forest understory, competing for habitat with Hā‘upu's rare native species (Wood 2005). In the absence of active management, alien invasives can eventually destroy native plant communities within the study area.

A species list of introduced plant and animal threats identified during the reconnaissance survey appears in Appendix 6.3.

Grazers and Predators

Pigs and goats seriously threaten native habitat in the study area. After Grove Farm ceased sugar operations and began leasing out crop and pasture at Māhā‘ulepū, they closed hunters' access to Hā‘upu ridge through their property. Habitat degradation and destruction by feral pigs, always a problem, has since grown unchecked. Large numbers of feral goats also clamber across the slopes of the Hā‘upu range. During the reconnaissance survey site visit, NPS staff counted 89 goats on the ridge between Kīpū Kai and Niumalu.

Ungulate disturbance destroys native vegetation, increases erosion, and provides fertile ground for invasive species. Throughout Hawai‘i, feral ungulates are ravaging native ecosystems. The study area is no exception. Ungulate control on Hā‘upu ridge is a critical need.

Dogs, both domestic and feral, threaten populations of native seabirds on the study area coast. Dogs are blamed for killing remnant or nascent Wedge-tailed Shearwater colonies along the coast (Kaiakapu 2007, Blaich 2007). Dogs have killed nesting albatrosses and nēnē elsewhere and threaten all ground-nesting birds. Feral dog removal and domestic dog control are sensitive social issues—ones that demand attention if native species in the study area are to be protected.

Rats pose a special threat in the forests of Hā‘upu, where they can wreak havoc on small and vulnerable populations of endemic plants by eating precious seeds. Rats are a persistent pest in agricultural areas and a threat to nesting birds.

Non-native predatory birds in the study area include the barn owl, which has been recorded preying on both Newell's shearwaters (Ainley et al. 1997) and Hawaiian stilts; and the cattle egret, which may take young of endemic waterbirds (USFWS 2005) and compete with native waterbirds for food (Hawaii Audubon Society 2005).

Of particular positive note, Kaua'i is the largest island in the state that appears free of the mongoose, a voracious eater of bird eggs and chicks. Likely in part because of its absence, Kaua'i remains the stronghold of the threatened Newell's ahearwater (‘a'o) and is home of a growing nēnē population, especially in and around the study area. Isolated individual mongoose sightings have been reported on the island; an established mongoose population would be a serious threat to the study area and all of Kaua‘i.

Environmental Events

Environmental events such as hurricanes, fires, tsunamis and landslides are potential study area threats that can not only wreak direct havoc, but also set into motion long-term landscape changes—such as erosion and alien plant invasion—that gradually degrade and destroy native habitats. State officials report that two hurricanes in recent decades damaged Newell’s Shearwater habitat on Hāʻupu ridge, and allowed invasives to spread across newly-eroded slopes. Kīpū Kai representatives say the mountainsides above their valley were lushly vegetated before the hurricanes. By the time of the NPS site visit, the slopes were bare and roamed by goats, and a small recent landslide was apparent on the upper part of the access road.

The entire study area shoreline is highly vulnerable to storms and hurricanes. Long-term coastal erosion hazard is high at Māhāʻulepū Beach and moderately high at Kawailoa Bay, Hāʻula, Kīpū Kai beaches, and the southern portion of Niumalu. (KC 2003)

Located far from the Hawaiʻi magmatic hot spot, the study area is not at direct risk from volcanic or seismic events. However, potential tsunami hazard intensity is considered high along the Māhāʻulepū coast between Punahoa Point and Hāʻupu Bay, and at Long Beach in Kīpū Kai. These moderately sloped areas are also vulnerable to coastal stream flooding from seasonal rainfall (KC 2003).

4.9 Resource Protections

Besides the National Wildlife Refuge designation at Hulēʻia, the strongest existing resource protection mechanism applied in the study area is state designation of Conservation lands along the shoreline corridor and much of Hāʻupu ridge (See Regional Land Use Map). Most of these lands fall into the state’s two strongest Conservation subzones, which place strong limits on use, and which require state permits for most uses (DLNR 2005b).

Federal Critical Habitat designations along the Māhāʻulepū shoreline and portions of Hāʻupu ridge provide minimal protection. A Critical Habitat designation does not affect situations where a federal agency is not involved—for example, a landowner project on private land that involves no federal funding or permit. Similarly, Alekoko Fishpond’s listing on the National Register of Historic Places only modestly assists in its protection: under federal law, private property owners can do anything they wish with their National Register-listed property provided that no federal license, permit, or funding is involved.

Several state planning documents related to tourism, recreation, and historic trails emphasize the importance of recreational access and resource protection along this coast, especially in light of increasing public use (OSP 1992). These documents establish ideals and goals that are not reflected in enforceable policy. They do not necessarily result in actual resource protection or maintenance of existing public access.

In 1992, Hawaiʻi ’s Office of State Planning conducted a land use review that recognized Māhāʻulepū’s “combination of outstanding coastal recreational areas, native coastal strand

vegetation and significant physiographic, archaeologic and scenic resources.” Anticipating future development pressure, it said “measures will need to be taken to assure that the sensitive resources here will be protected.” Suggested ways to achieve that protection included transfer of development rights and purchase of easements (OSP 1992).

The 2000 update of the Kauaʻi County General Plan—a direction-setting policy document that precedes and guides zoning regulations—discusses important resources in the study area (KC 2000). In Section 6.3, Līhuʻe, it notes the value of the Hāʻupu mountains, Alekoko Fishpond, Hulēʻia, Kīpū Kai, and the Niumalu coastline; establishes policy to ensure that future urban development on bluffs above the fishpond is placed out of sight from the fishpond overlook; and envisions a future in which Hulēʻia Stream and valley are well-managed, and the scenic qualities of Hāʻupu ridge are preserved.

General Plan policy statements in Section 6.4, Hanamāʻulu-Poʻipū, promote a community-based approach to protecting Māhāʻulepū resources:

> Involve the community in planning for the future of Māhāʻulepū. Planning should take into consideration various interests and factors, including but not limited to: the long-term need for managing Māhāʻulepū lands to preserve their significant natural and cultural features; the owner’s desire to develop revenue-producing uses in a way that is sensitive to the area’s unique qualities; the need to secure permanent public access to the shoreline; and the potential to create a coastal park.
>
> …This area needs a community-based planning effort that engages the landowner and local community interests, drawing upon the County government, the State DLNR, and various professional experts, as needed. Options for the area include some development in exchange for a park and/or preservation areas; or purchase of the land for a State park.

In 2001 the Kauaʻi County Council approved a resolution to work with the state to preserve the entire Māhāʻulepū ahupuaʻa (Sommer 2001a), and the State Legislature passed a concurrent resolution saying “This body supports a collaborative planning effort to explore options that would make it possible to preserve the irreplaceable natural and cultural resources of Māhāʻulepū, and to sustain the special experience of this place” (HI 2001). Hawaiʻi’s Governor declared his intent to add Māhāʻulepū to an envisioned statewide “string of pearls”, made up of wilderness parks with minimal infrastructure and no commercial activity (TenBruggencate 2001). The Governor met with Grove Farm owners, but could not strike a satisfactory deal to acquire the land.

Kauaʻi County’s Open Space Commission, an advisory group that gathers public input and recommends priorities for allocation of the county’s Open Space Fund, names Māhāʻulepū as one of the island’s ten “Priority Sites for Acquisition.” Since little money is allocated to the fund—coffers amounted to $1.2 million at the beginning of 2007—actual acquisition in the near future via this funding source appears unlikely. (KC 2006)

5 CONCLUSIONS OF THE STUDY

5.1 Preliminary Evaluations Based on NPS Criteria

Based on the reconnaissance survey site visit, research and consultations in 2007, the NPS Pacific West Region Honolulu Office provides the following preliminary evaluations of the national significance of the study area resources, and the suitability and feasibility of helping to protect them within the framework of the national park system.

5.1.1 Significance

> *A natural or cultural resource is considered nationally significant if it is an outstanding example of a particular type of resource; possesses exceptional value or quality illustrating or interpreting the natural or cultural themes of our nation's heritage; offers superlative opportunities public enjoyment or scientific study; and retains a high degree of integrity as a true, accurate, and relatively unspoiled example of the resource.*

Within the Māhā'ulepū reconnaissance survey study area, the resources of the Māhā'ulepū coast, Makauwahi Cave, Kīpū Kai, Hā'upu range, and Hulē'ia Stream are deemed nationally significant. These areas encompass unique geologic landforms and fossils, rare species and habitats, and storied sites important to native Hawaiian and United States history. Together they comprise a relatively unspoiled landscape that affords exceptional opportunities for interpretation, enjoyment and study.

The lithified dune system of the Māhā'ulepū coast is a rare remnant of a landscape type that has almost vanished in Hawai'i due to human settlement and development. Its visible layers reveal the story of global sea level changes—and accompanying changes in landscape—over the last 300,000 years. The dunes and Makauwahi cave harbor an abundance of rare and extinct plant and animal fossils including 45 species of extinct birds. Sediment layers sealed within Makauwahi sinkhole afford a unique sequential look at Hawai'i biota over a span of 10,000 years. Māhā'ulepū dunes and underlying caves, especially Makauwahi, have been the site of significant natural resource discoveries over the last two decades, and are the ongoing focus of international scientific interest.

The volcanic vents of the Kōloa plain, ancient layered basalts of Hā'upu Ridge, and dunes of Māhā'ulepū are manifestations of geologic processes dating from the birth of the high Hawaiian islands to the present—an observable age range available only on Kaua'i, the state's geologically oldest high island.

Habitats of the study area provide critical refuge for endemic Hawaiian plant and animal species whose survival is in jeopardy.

- The only known living examples of two endangered arthropods—the Kaua'i cave wolf spider and the Kaua'i cave amphipod —cling to life in the confines of caves on the Māhā'ulepū coast.

- Mt. Hā'upu's summit hosts nearly ninety plant species endemic to Hawai'i, including more than two dozen endemic to Kaua'i only, and some restricted to just Mt. Hā'upu. USFWS has designated six species as endangered, one as threatened and six as Species of Concern. Parts of Hā'upu ridge are designated Critical Habitat for eleven endemic plant species.
- The endangered and nearly extinct Hawaiian monk seal rests and nurses its pups on study area beaches.
- Hawai'i's four endemic endangered waterfowl—the Hawaiian duck, stilt, coot and moorhen—breed at Hulē'ia and other protected sites, and feed at remnant wetlands and manmade water features throughout the study area.
- The endemic endangered nēnē, or Hawaiian goose, is making a comeback on Kaua'i thanks in part to breeding habitat at Kīpū Kai and foraging opportunities at study area sites.
- Newell's shearwater, a Threatened endemic species, nests on Hā'upu ridge.
- Native coastal strand vegetation includes thirteen endemic plant species at increasing risk of disappearance due to continuing shoreline development throughout Hawai'i. The Māhā'ulepū coastal corridor is designated Critical Habitat for the endangered 'ohai (*Sesbania tomentosa).*

By definition, these endemic species—found in Hawai'i and nowhere else—have always been uncommon. Today, they depend on habitats in the study area for their continued survival on earth.

Relatively intact native plant communities, made up mostly of endemic and indigenous species, persist in the coastal strand vegetation and on the upper reaches of Hā'upu ridge. Indigenous and migrant birds roost and nest at Hulē'ia, Niumalu, Kīpū Kai, and undisturbed sites along the Māhā'ulepū coast.

Dramatic topography and unusual contrasts in form create a study area landscape with outstanding scenic qualities. Mt. Hā'upu and its arms rise majestically out of the Kōloa plain, a green beacon visible from all directions. Along the Māhā'ulepū shoreline, the weathered seacliffs, dunes and limestone crannies offer an intriguing window into the past, and the lateral coastal vista remains entirely undeveloped. Untrammeled beaches and a backdrop of green help establish the feeling of a remote wilderness, despite the study area's accessible location between two population centers

Nationally significant cultural resources within the study area are Mt. Hā'upu, Makauwahi Cave, and Alekoko Fishpond; other sites may prove significant upon further investigation. Mt. Hā'upu is a revered *wahi kapu*, or sacred place, within native Hawaiian culture. Ku and Hina—the earliest Hawaiian god and goddess, the patron gods of fishermen, and the embodiments of procreative power—reside on Hā'upu Ridge. A notable landmark and navigation aid for seafarers, Hā'upu features in the first documented sighting of Hawai'i by a westerner, Captain James Cook. The first European drawing of Hawai'i is of the Māhā'ulepū Coast, with Mt. Hā'upu as its focal point.

Makauwahi cave's uniquely well-preserved fossils and artifacts tell a nearly continuous tale of Hawai'i people on the land over the last millennium. Remnants of tools, ornaments, food, craft supplies and fishing gear provide a record of human activity; fossilized seeds, shells, bones and organic debris reveal a changing mix of native and nonnative plants and animals; and sediment strata speak of environmental events that shaped both land and people. In combination with oral and archival sources, the finds at Makauwahi Cave shed new light on Hawai‘i’s human story, and chronicle the transformation of Hawai‘i’s landscape and biota through a thousand years of dynamic cultural change.

Alekoko Fishpond, an aquaculture site built by early Hawaiians around 1200 A.D., was recognized by NPS over thirty years ago as “worthy of preservation as part of the cultural heritage of the State of Hawai‘i and the United States of America.” Hawai‘i’s prehistoric manmade ponds were the most extensive and innovative in the Pacific; the best ones were held by royalty as both a symbol of status and a source of food. Among the examples that survive today, Alekoko is a rare example of a royal pond located on a stream, rather than at the ocean, and it is the largest inland manmade historic fishpond in Hawai‘i. Alekoko remains worthy of preservation as part of the state and national heritage, provided that overgrown mangrove can be removed from its rock walls without undue damage.

Bracketed between two population centers, the study area nevertheless still embraces significant places with relative resource integrity, against a backdrop of current and historic agricultural lands. Poised at the brink of the 21st century but not yet urbanized, this span of undeveloped coast offers unique opportunities for understanding the dynamic forces that shaped Hawai‘i—volcanic birth, sea level changes, human settlement and expansion, and native ecosystems struggling to survive the impacts of people and natural events. The Māhā‘ulepū coast in particular affords excellent venues not only for interpretation and education, but also for outdoor recreation. Other significant sites such as Alekoko Fishpond, Kīpū Kai, Hā‘upu ridge, and Makauwahi cave merit extensive further scientific study, and careful management to assure appropriate use.

5.1.2 Suitability

To be considered suitable, an area must represent a natural or cultural theme or type of recreational resource that is not already adequately represented in the National Park System or is not comparably represented and protected for public enjoyment by another land-managing entity. Adequacy of representation is determined on a case-by-case basis by comparing the proposed area to other units in the National Park System for differences or similarities in the character, quality, quantity, or combination of resources, and opportunities for public enjoyment.

Significant resources in the study area represent themes and types that are suitable for protection within the framework of the national park system, and are not otherwise adequately protected in the state or nation. Volcanic features of the study area represent a stage and range of geologic development of the Hawaiian high islands not available at other Hawai‘i parks. Landforms and fossils of the Māhā‘ulepū coast illustrate the reality of global climate and sea level change, as well as the impacts of human settlement on native ecosystems. An extensive and undeveloped Hawai‘i shoreline within easy reach of population centers, such as that found in the study area, is a rare and rapidly vanishing type

of recreational resource prized by U.S. citizens and international visitors as well as Hawai‘i residents. Protection and management of this resource type is currently inadequate at federal, state and local levels.

5.1.3 Feasibility

To be considered feasible, an area's natural systems and/or historic settings must be of sufficient size and appropriate configuration to ensure long-term protection of the resources and to accommodate public use. The area must have potential for efficient administration at a reasonable cost. Other important feasibility factors include landownership, acquisition costs, access, threats to the resource, and staff or development requirements.

The study area’s significant resources are of a collective size and configuration that would be feasible to manage for protection and public enjoyment, provided that NPS, affected landowners, and local and state stakeholders collaborate to identify and reduce threats, manage access, and ensure long-term protection of the area’s overall scenic quality. To manage costs, NPS would need to emphasize partnerships and minimize outright land acquisition.

Because sensitive conservation areas are mingled with active agricultural land throughout the study area, future activities on agricultural land could cause major impacts on significant resources. In addition, vehicular public access to the Māhā‘ulepū coast—the portion of the study area best suited for public recreation—depends on roadways through private land. Successful resource protection and management will depend on willing cooperation by all parties.

The National Park Service manages a variety of designated units including parks, recreation areas, seashores, national historic sites, monuments, reserves and preserves. In some cases, enabling legislation for a designated NPS unit provides for continued private land ownership, ongoing community uses, and sharing of management costs and responsibilities via agency or community partnerships.

For example, Ebey’s Landing National Historic Reserve includes extensive private land, with NPS holding some 3500 acres in easement to retain historic agricultural lands and exclude rural subdivisions. Craters of the Moon National Monument and Preserve allows for hunting and grazing on Preserve acreage. City of Rocks National Reserve encompasses private land within its boundary, where NPS holds conservation easements and grazing is permitted. In potential units where nonprofit land trusts can secure conservation easements on agricultural lands and/or certain significant natural and cultural resources, NPS can focus on the remaining significant resources that would benefit most from NPS management.

Scrutiny of such options and how they might apply to the current study area is beyond the scope of this reconnaissance survey. If a Special Resource Study is conducted, it would identify, examine and compare alternatives that appear to hold promise.

5.2 Other Findings

Notable partners have been involved in research, management, or resource protection within the study area, or have expressed interest in involvement. Besides the landowners, they include local land trusts, Trust for Public Land, The Nature Conservancy, National Tropical Botanical Garden, Mālama Māhāʻulepū, Sierra Club, Smithsonian Institution, National Geographic Society, Bishop Museum, County of Kauaʻi, Kauaʻi Community College, and State of Hawaiʻi Department of Land and Natural Resources.

Since the development of the Hyatt Resort by the south end of the study area in the 1980s, residents and government officials have expressed ongoing concern about the potential for further development that would impact resources and affect public use of the Māhāʻulepū coast. To some extent discussion has become polarized, with preservation advocates and landowners viewing each other through a cloud of mutual suspicion and wariness, and shaping their communications with each other based on that view. Great potential exists for creative management of resources within the study area, but a constructive framework for stakeholder discussion is needed.

It is also worth noting that since 2002, Hawaiʻi Congressional officials on behalf of Hawaiʻi residents asked the National Park Service to conduct reconnaissance surveys on three southeast shores of Hawaiian islands: at Keoneʻōʻio on Maui, Kaʻū on Hawaiʻi, and Māhāʻulepū on Kauaʻi. In general, these coasts are relatively dry, traditionally rural and lacking in infrastructure; they are the last major bastions of undeveloped, unmanaged accessible shoreline in Hawaiʻi.

In all three instances, residents unsuccessfully sought state and local protections, and then expressed interest in the concept of a National Seashore, in the hope that such a designation would protect the resources in perpetuity and allow for continued community uses. The request for federal protection is an index of fear that Hawaiʻi residents express about growing tourism, population and development, and a concomitant loss of access to coastal wilderness.

Hawaiʻi serves as a multi-island playground for the nation and the world, hosting nearly 7.6 million visitors per year, but its tax base depends on a statewide resident population of only 1.3 million people (USC 2007). Local and state financial resources may be insufficient to protect sensitive Hawaii seashores from development.

5.3 Recommendation

The National Park Service Pacific West Region recommends that a Special Resource Study be authorized under the stipulations of Public Law 105-391, so long as it focuses on non-traditional management alternatives that a) involve local partners and b) include options for continued farm and ranch operations on private agricultural lands.

6 APPENDICES

6.1 How NPS Evaluates Significance of Resources

Natural resource significance may be associated with the following types of sites:

- an outstanding site that illustrates the characteristics of a landform or biotic area that is still widespread;
- a rare remnant natural landscape or biotic area of a type that was once widespread but is now vanishing due to human settlement and development;
- a landform or biotic area that has always been extremely uncommon in the region or nation;
- a site that possesses exceptional diversity of ecological components (species, communities, or habitats) or geological features (landforms, observable manifestations of geologic processes);
- a site that contains biotic species or communities whose natural distribution at that location makes them unusual (for example, a relatively large population at the limit of its range or an isolated population);
- a site that harbors a concentrated population of a rare plant or animal species, particularly one officially recognized as threatened or endangered;
- a critical refuge that is necessary for the continued survival of a species;
- a site that contains rare or unusually abundant fossil deposits;
- an area that has outstanding scenic qualities such as dramatic topographic features, unusual contrasts in landforms or vegetation, spectacular vistas, or other special landscape features;
- a site that is an invaluable ecological or geological benchmark due to an extensive and long-term record of research and scientific discovery.

Cultural resource significance may be attributed to districts, sites, structures, or objects that possess exceptional value or quality in illustrating or interpreting our heritage and that possess a high degree of integrity of location, design, setting, materials, workmanship, feeling, and association. Specific examples include:

- a resource that is associated with events that have made a significant contribution to and are identified with, or that outstandingly represent the broad national patterns of United States history and from which an understanding and appreciation of those patterns may be gained;
- a resource that is importantly associated with the lives of persons nationally significant in the history of the United States;
- a resource that embodies distinguishing characteristics of an architectural type specimen, exceptionally valuable for study of a period, style, or method of construction, or represents a significant, distinctive and exceptional entity whose components may lack individual distinction;
- a resource that is composed of integral parts of the environment not sufficiently significant by reason of historical association or artistic merit to warrant individual

recognition but collectively composes an entity of exceptional historical or artistic significance, or outstandingly commemorates or illustrates a way of life or culture;

- a resource that has yielded or may be likely to yield information of major scientific importance by revealing new cultures, or by shedding light upon periods of occupation over large areas of the United States.

Many units of the national park system have been established to recognize their important role in providing recreational opportunities. The potential for public use and enjoyment is an important consideration in evaluating potential new additions to the National Park System. However, recreational values are not evaluated independently from the natural and cultural resources that provide the settings for recreational activities.

6.2 Study Area Species Lists

The species lists shown below are based on NPS observations, limited research, and reliable reports from local researchers, government officials, and residents. Locations of specific sightings are intentionally omitted.

6.2.1 Coastal Vegetation

Since staff had limited time to explore or botanize, this list should not be considered to cover all species present or their full range of distribution.

E=Endemic (found in Hawaii and nowhere else); I=Indigenous (native to Hawai‘i but not endemic); A=Alien; SOC= federal Species of Concern (USFWS); END=federally listed Endangered Species; GCN=State of Hawai‘i Species of Greatest Conservation Need.

Scientific Name	Common / Hawaiian Name	Family	Status
Boerhavia repens?	Alena, anena, nena	Nyctaginaceae	I
Capparis sandwichiana	Hawaiian caper, maiapilo	Capparaceae	E, SOC, GCN
Chamaesyce degeneri	beach spurge, koko, 'akoko	Euphorbiaceae	E
Cocos nucifera	coconut palm, niu	Arecaceae	A
Cordia subcordata	kou	Boraginaceae	I
Dodonaea viscosa	'a'ali'i	Sapindaceae	I, GCN
Erythrina sandwicensis	Wiliwili	Fabaceae	E, GCN
Gossypium tomentosum	Hawaiian cotton, ma'o, uluhulu	Malvaceae	E, GCN
Heliotropium anomalum var. *argenteum*	Beach heliotrope, hinahina, hinahina ku kahakai	Boraginaceae	I , GCN
Ipomea indica	Morning glory koali ‘awa	Convolvulaceae	I
Ipomea pes-caprae	Beach morning glory, pohuehue	Convolvulaceae	I, GCN
Jacquemontia ovalifolia subsp. *Sandwicensis*	Pa'u o Hi'iaka	Convolvulaceae	E
Kokia Kaua'iensis	koki'o	Malvaceae	E, GCN
?Lipochaeta integrifolia	nehe, ko'oko'olau	Asteraceae	E, GCN
Morinda citrifolia	noni tree, noni kuahiwi	Rubiaceae	E
Munroidendron racemosum	tree	Araliaceae	E, GCN
Myoporum sandwicense	false sandalwood, naio	Myoporaceae	I, GCN
Osteomeles anthyllidifolia	u'ulei	Rosaceae	I, GCN

Pandanus tectorius	screwpine, hala	Pandanaceae	I, GCN
Pritchardia cf *minor*	loulu	Arecaceae	E
Pritchardia elmerrobinsoni	Ni'ihau lolou palm, loulu	Arecaceae	E
Ruppia martima	ditchgrass, widgeon grass	Potamogetonaceae	I
Scaevola taccada	Beach naupaka, naupaka kahakai	Goodeniacea	I
Schiedea sp.	ma'oli'oli	Caryophyllaceae	E
**Sesbania tomentosa*	‘ohai	Fabaceae	E , END, GCN
Sesuvium portulacastrum	Sea purslane, ‘akulikuli	Aizoaceae	I, GCN
Sida fallax	‘Ilima, ‘ilima ku kahakai, ‘ilima papa	Malvaceae	I, GCN
Thespesia populnea	portia tree, milo	Malvaceae	I
Tournefortia argentea	tree heliotrope	Boraginaceae	A
Waltheria indica	‘uhaloa	Sterculiaceae	I

* Federally designated Critical Habitat along Māhā‘ulepū coastal corridor. Not seen during survey.

6.2.2 Notable Rare Plants of Hā‘upu

Of 112 native plant species identified on the summit of Mt. Hā‘upu during research in 2005, botanist Ken Wood identified a subset of endemic vascular plants which urgently need action to carry out conservation collections, due to their rarity. Shown below, they are taken from Wood’s *Summary Report of Botanical Research, Hā‘upu Summit, Kaua`i, Hawai‘i (550—700 m [1800—2297 ft] elevation), August 2005.*

E=Endemic (found in Hawaii and nowhere else); I=Indigenous (native to Hawai‘i but not endemic); A=Alien; SOC= federal Species of Concern (USFWS); END=federally listed Endangered Species; GCN=State of Hawai‘i Species of Greatest Conservation Need; GSN=State of Hawai‘i Genetic Safety Net species.

Species	Common / Hawaiian Name	Family	Status
Bonamia menziesii		Convolvulaceae	E, END, GCN
Delissea rhytidosperma		Campanulaceae	E, SIE, END, GCN, GSN
Dubautia laxa subsp *pseudoplantaginea* [New sp.?]	na‘ena‘e, pua melemele	Asteraceae	E [New sp.?]
Hedyotis fluviatilis	kamapua‘a, pilo	Rubiaceae	E, SOC
Hedyotis sp. nov. [unnamed]		Rubiaceae	?
Hibiscus kokio	koki‘o ‘ula, mākū	Malvaceae	E, SOC
Isodendrion longifolium	aupaka	Violaceae	E,T, GCN
Lepidium orbiculare	‘ānaunau	Brassicaceae	E,SIE
Lipochaeta micrantha var. *exigua*	nehe	Asteraceae	E,SIE,END
Lobelia Ni‘ihauensis		Campanulaceae	E,END
Lobelia sp. [new sp.?]		Campanulaceae	E [new sp.?]
Munroidendron racemosum		Araliaceae	SIE, GCN
Myrsine linearifolia	kōlea	Myrsinaceae	E,V,SIE, GCN
Peucedanum sandwicense	makou.	Apiaceae	E,T, GCN
Pittosporum gayanum	hō‘awa	Pittosporaceae	E, SIE
Schiedea perlmanii		Caryophyllaceae	E,SIE, END, GCN
Tetraplasandra bisattenuata	‘ohe mauka	Araliaceae	E, SIE,SOC, GCN, GSN

6.2.3 Native Birds

This list includes nine native bird species noted on the March 2007 NPS site visit, plus seven others documented during interviews or from research. It should not be considered a definitive list of all native bird species in the study area.

E = endemic at the species or subspecific level; I = indigenous; M = migrant; T = federally listed Threatened Species; END = federally listed Endangered Species.

Species	Common / Hawaiian Name	Family	Status
Anas wyvilliana	Hawaiian Duck, Hanamā‘ulu	Anatidae	E, END
Arenaria interpres	Ruddy Turnstone, ‘Akekeke	Scolopacidae	M
Asio flammeus sandwichensis	Short-eared or Hawaiian Owl	Strigidae	E
Branta sandvicensis	Hawaiian Goose, Nēnē	Anatidae	E, END
Calidris alba	Sanderling, Hunakai	Scolopacidae	M
Fregeta minor palmerstoni	Great Frigatebird, ‘Iwa	Fregatidae	I
Fulica alai	Hawaiian Coot, ‘Alae keo’keo	Rallidae	E, END
Gallinula chloropus sandvicensis	Common Moorhen, ‘Alae ‘ula		E, END
Heteroscelus incanus	Wandering Tattler, ‘Ulili	Scolopacidae	M
Himantopus mexicanus knudseni	Hawaiian Stilt, Ae’o	Recurvirostridae	E, END
Nycticorax nycticorax hoactli	Black-crowned Night-heron, ‘Auku’u	Ardeiidae	I
Phaethon lepturus dorotheae	White-tailed Tropicbird, Koa’e kea	Phaethontidae	I
Phaethon rubricauda melanorhynchos	Red-tailed Tropicbird, Koa’e ‘ula	Phaethontidae	I
Pluvialis fulva	Pacific Golden Plover, Kolea	Charadridae	M
Puffinus auricularis newelli	Newell’s Shearwater, ‘A’o	Procellidae	E, T
Puffinus pacificus	Wedge-tailed Shearwater, ‘Ua’u kani	Procellidae	I

6.2.4 Marine Fishes

Fishes shown here are taken from three sources: NPS observations during the site visit; recorded observations at Kipu Kai and Māhā‘ulepū by trained volunteers for Reef Environmental Education Foundation (REEF); and information from David Waterhouse of Kipu Kai, based on fish catches noted in Kipu Kai guestbooks.

Species	Common / Hawaiian Name	Family
Abudefduf abdominalis	Hawaiian Sergeant, mamo	Pomacentridae
Abudefduf sordidus	Blackspot Sergeant, kupipi	Pomacentridae
Acanthurus achilles	Achilles Tang, paku‘iku‘i	Acanthuridae
Acanthurus nigrofuscus	brown surgeonfish, ma’i’i’i	Acanthuridae
Acanthurus nigroris	Bluelined Surgeonfish, maiko	Acanthuridae
Acanthurus olivaceus	Orangeband Surgeonfish, na‘ena‘e	Acanthuridae
Acanthurus triostegus	convict tang, manini	Acanthuridae
Aetobatus narinari	Spotted Eagle Ray, hihimanu	Myliobatidae
Arothron meleagris	Guineafowl Puffer, moa	Tetraodontidae
Aulostomus chinensis	Trumpetfish, nunu	Aulostomidae
Cantherhines sandwichiensis	Squaretail Filefish, o‘ili lepa	Monacanthidae
Canthigaster jactator	Hawaiian Whitespotted Toby	Tetraodontidae
Caranx ignobilis	giant trevally, ulua aukea	Carangidae

Caranx melampygus	bluefin trevally, omilu	Carangidae
Caranx ignobilis	juvenile giant trevally, papio	Carangidae
Chaetodon sp.	butterfly fish, kikakapu	Chaetodontidae
Chaetodon auriga	Threadfin Butterflyfish, kikakapu	Chaetodontidae
Chaetodon fremblii	Bluestripe Butterflyfish kikakapu,	Chaetodontidae
Chaetodon lunula	Raccoon Butterflyfish, kikakapu	Chaetodontidae
Chaetodon miliaris	Milletseed Butterflyfish, lau wiliwili	Chaetodontidae
Chaetodon multicinctus	Multiband Butterflyfish, kikakapu	Chaetodontidae
Chaetodon quadrimaculatus	Fourspot Butterflyfish, lauhau	Chaetodontidae
Chaetodon unimaculatus	Teardrop Butterflyfish, kikakapu	Chaetodontidae
Chlorurus sordidus	Bullethead Parrotfish, uhu	Scaridae
Chromis vanderbilti	Blackfin Chomis	Pomacetridae
Cirrhitops fasciatus	Redbarred Hawkfish, pilikoa	Cirrhitidae
Coris gaimardi	Yellowtail Coris, hinalea ‘akilolo	Labridae
Dascyllus albisella	Hawaiian Dascyllus	Pomacetridae
Echidna nebulosa (juvenile)	snowflake eel, puhi kappa	Muraenidae
Gambusia affinis	Western mosquitofish (Introduced)	Poeciliidae
Gomphosus varius	Bird Wrasse, hinalea i‘iwi	Labridae
Gymnothorax undulatus	undulated moray, puhi	Muraenidae
Holacanthus arcuatus	Bandit Angelfish	Pomacanthidae
Istiblennius zebra	zebra rockskipper, pao’o	Blenniidae
Kuhlia sandvicensis	Hawaiian flagtail, aholehole	Kuhliidae
Kyphosus sp.	Gray/Highfin/Lowfin Chub, nenue	Kyphosidae
Labroides phthirophagus	Hawaiian Cleaner Wrasse	Labridae
Lutjanus fulvus	Blacktail Snapper, to‘ao	Lutjanidae
Lutjanus kasmira	Bluestripe Snapper, ta‘ape	Lutjanidae
Melichthys niger	Black Durgonm humuhumu ele ele	Balistidae
Melichthys vidua	Pinktail Durgon, humuhumuhi‘ukole	Balistidae
Monotaxis grandoculis	Bigeye Emperor, mu	Lethrinidae
Mugil cephalis	mullet (juvenile), ‘ama‘ama	Mugilidae
Mulloidichthys flavolineatus	Yellowstripe Goatfish, weke‘a	Mullidae
Mulloidichthys vanicolensis	Yellowfin Goatfish, wele ‘ula	Mullidae
Myripristis berndti	Bigscale Soldierfish, ‘u‘u	Holocentridae
Naso lituratus	Orangespine Unicornfish, umaumalei	Acanthuridae
Naso unicornis	bluespine unicornfish, kala	Acanthuridae
Oplegnathus punctatus	Spotted Knifejaw	Oplegnathidae
Ostracion meleagris	Spotted Boxfish, moa	Ostraciidae
Paracirrhites arcatus	Arc-Eye Hawkfish, piliko‘a	Cirrhitidae
Paracirrhites forsteri	Blackside Hawkfish, hilu piliko‘a	Cirrhitidae
Parupeneus bifasciatus	Doublebar Goatfish	Mullidae
Parupeneus multifasciatus	Manybar Goatfish, moano	Mullidae
Plectroglyphidodon johnstonianus	Blue-eye Damselfish	Pomacetridae
Polydactylus sexfilis	6-fingered threadfin, moi	Polynemidae
Priacanthus meeki	Hawaiian Bigeye, ‘‘Āweoweo	
Pseudocheilinus octotaenia	Eightstripe Wrasse	Labridae
Rhinecanthus rectangulus	Reef Triggerfish, humuhumu nukunuku apua‘a	Balistidae
Selar crumenopthalmus	bigeye scad, akule	Carangidae
Seriola dumerili	greater amberjack, kahala	Carangidae
Stegastes fasciolatus	South Pacific Gregory	Pomacetridae
Sufflamen bursa	Lei Triggerfish, humuhumu lei	Balistidae
Thalassoma duperrey	Saddle Wrasse, hinalea lauwili	Labridae
Thalassoma trilobatum	Christmas Wrasse, ‘awela	Labridae
Zanclus cornutus	Moorish Idol, kihikihi	Zanclidae

6.2.5 Algae

Species	Common / Hawaiian Name	Family
Asparagopsis taxiformis	limu kohu, limu lipehe	Bonnemaisoniaceae
?*Centroceras* cf. *clavulatum*		Ceramiaceae
Cladophora sp.	green filamentous algae	Cladophoraceae
Codium arabicum	limu 'a 'ala'ula	Codiaceae
Dasya iridescens	iridescent red algae	Dasyaceae
Dictyota sp.		Dictyotaceae
Dictyota sandvicensis		Dictyotaceae
Halimeda discoidea	green calcareous algae	Halimedaceae
Dictyosphaeria cavernosa	green bubble algae	Siphonocladaceae
Colpomenia sinuosa	brown bubble algae	Scytosiphonaceae
Laurencia cf. *mcdermidiae*		Rhodomelaceae
Martensia fragilis	fragile red algae	Delessariaceae
Asteronema breviarticulatum	intertidal brown filimentous algae	Scytothamnaceae
Padina sp.		Dictyotaceae
Peysonnellia sp.	crustose red algae	Peysonneliaceae
Galaxaura sp.		Galaxauraceae
Sargassum echinocarpum	limu kala	Sargassaceae
Turbinaria ornata		Sargassaceae
Ahnfeltiopsis coccinea	limu 'aki'aki	Phyllophoraceae
Wrangelia elegantissima		Ceramiaceae
?*Haliptilon subulatum*		Corallinaceae
?*Stenopeltis gracilis*	red calcareous algae	Liagoraceae
Lithophyllum sp.	red coralline algae, crustose coralline algae	Corallinaceae

6.2.6 Marine Invertebrates

Species	Common / Hawaiian Name	Family
Corals (Cnidaria)		
Cladactella manni	Mann's anemone	Actiniidae
Palythoa caesia	soft coral, limu make o Hana	Zoantharia
Fungia sp. skeleton juveniless	solitary coral, 'ako'ako'a kohe	Fungiidae
Montipora capitata	rice coral, 'ako'ako'a, ko'a	Acroporidae
Montipora cf. *flabellata*	blue rice coral, ako'ako'a, ko'a	Acroporidae
Pocillopora sp.	'ako'ako'a, ko'a, puna kea	Pocilloporidae
Pocillopora meandrina	cauliflower coral, 'ako'ako'a, ko'a	Pocilloporidae
Pocillopora edouxi	cauliflower coral, ako'ako'a, ko'a	Pocilloporidae
Porites evermanni	mound coral, pohaku puna	Poritidae
Porites lobata	mound coral, pohaku puna	Poritidae
Worms (Annelida)		
Loimia medusa	spaghetti worm	
Molluscs (Mollusca):		
Cassis cornutus	conch snail, pu puhi	Cassididae
Cellana exarata	black-foot limpet, 'opihi makaiauli	Patellidae
Conus sp.	cone snail, pupu 'ala	Conidae
Cypraea spp,	cowry, leho	Cypraeidae
Cypraea granulata	cowry, leho 'okala, leho opu 'upu'u	Cypraeidae
Dendropoma gregaria	tube snail, kauna'oa	Vermetidae

Drupa morum	snail, makaloa	Thaididae
Drupa ricina	snail, makaloa	Thaididae
Hipponix foliaceus	hoof snail	Hipponicidae
Littoraria pintado	periwinkle snail, pipipi kolea	Littorinidae
Nerita picea	black nerite snail, pipipi	Neritidae
Nerita polita	polished nerite, kupe'e	Neritidae
Periglypta reticulata	reticulated clam	Veneridae
Purpura aperta	snail	Muricidae
Serpulorbis sp.	tube snail, kauna'oa	Vermetidae
Serpulorbis variabilis	tube snail, kauna'oa	Vermetidae
Siphonaria normalis	false 'opihi, 'opihi-'awa	Siphonariidae
Turbo sandwicensis	Hawaiian turban, 'alilea, pupu mahina	Turbinidae
Crustaceans (Arthropoda)		
Calcinus sp.	hermit crab, unauna	Diogenidae
Grapsus tenuicrustatus	rock crab, 'a'ama	Grapsidae
Ocypode pallidula	pallid ghost crab, 'ohiki	Ocypodidae
Panulirus sp. (molt)	spiny lobster, ula	Palinuridae
Echinoderms (Echinodermata)		
Brissus latecarinatus	keeled heart urchin, ha'uke'uke kaupali	Brissidae
Colobocentrotus atratus	shield urchin,	Echinometridae
Echinometra sp.	boring sea urchin, 'ina kea	Echinometridae
Heterocentrotus mammillatus	pencil urchin, ha'uke'uke 'ula'ula	Echinometridae
Actinopyga mauritiana	white-spotted sea cucumber, loli	Holothuriidae
Holothuria atra	black sea cucumber, loli okuhi kuhi	Holothuriidae

6.2.7 Introduced Plant and Animal Threats

Threats as observed by NPS staff or reported by researchers or state wildlife officials.

Scientific Name	Common / Hawaiian Name	Family
?*Canavaliea sericea*	Beach pea, silky jackbean	Fabaceae
?*Verbesina enceloides*	golden crown-beard	
Albizia sp.	Albizia	Fabaceae
Caesalpinia decapetala	Cat's claw, Puakelekino	Fabaceae
Casuarina equisetifolia	Ironwood, p'āina	Casuarinaceae
Leucaena leucocephala	Koa haole, ekoa	Fabaceae
Opuntia sp	prickly pear cactus, panini, papipi	Cactaceae
Paederia foetida (*P. scandens*)	(coffee family), Maile pilau	Rubiaceae
Panicum maximum	Guinea grass	Poaceae
Passiflora laurifolia	Yellow water lemon, passion flower	Passifloraceae
Prosopis sp. Prosopis pallida	mesquite, Kiawe	Fabaceae
Psidium cattleianu	Strawberry guava, Waiawi, 'ula'ula	Myrtaceae
Psidium guajava	Guava, Kuawa	Myrtaceae
Rhizophora mangle	Red mangrove	Rhizophoraceae
Rhodomyrtus tomentosa	Downy rose myrtle	Myrtaceae
Rubus rosifolius	Thimbleberry, Olaa	Rosaceae
Schinus terebinthifolius	Christmas berry, naniohilo, wilelaiki	Anacardiaceae
Syzygium cumini	Java plum	Myrtaceae
Terminalia catappa	false kamani tree, kamani haole	Combretaceae
Capra hircus	Feral goats	Bovidae
Rattus sp.	Rats	Muridae
Sus scrofa	Feral pigs	Suidae

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4.1	11	Waimea basalts	NPS – Larry Basch
4.1	12	Lithified dunes (2)	NPS – Larry Basch
4.1	13	Cave opening	NPS – Larry Basch
4.1	14	Sinkhole walls	NPS – Larry Basch
4.1	15	Fossil bird bones	NPS – Larry Basch
4.2.1	16	Hawaiian cotton	NPS – Larry Basch
4.2.1	17	ʻIlima, Koko, Pohuehue (3)	NPS – Larry Basch
4.2.2	18	Uluhe, uluhe lau nui, ʻōhiʻa (3)	Forest & Kim Starr
4.2.2	18	*Delissea rhytidosperma*	State of Hawaiʻi DLNR
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4.6.2	41	Ellis drawing of Hāʻupu	Hawaiʻi State Arhives
4.7	42	Horse ride, Māhāʻulepū coast (2)	NPS – Larry Basch

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U.S. Department of the Interior

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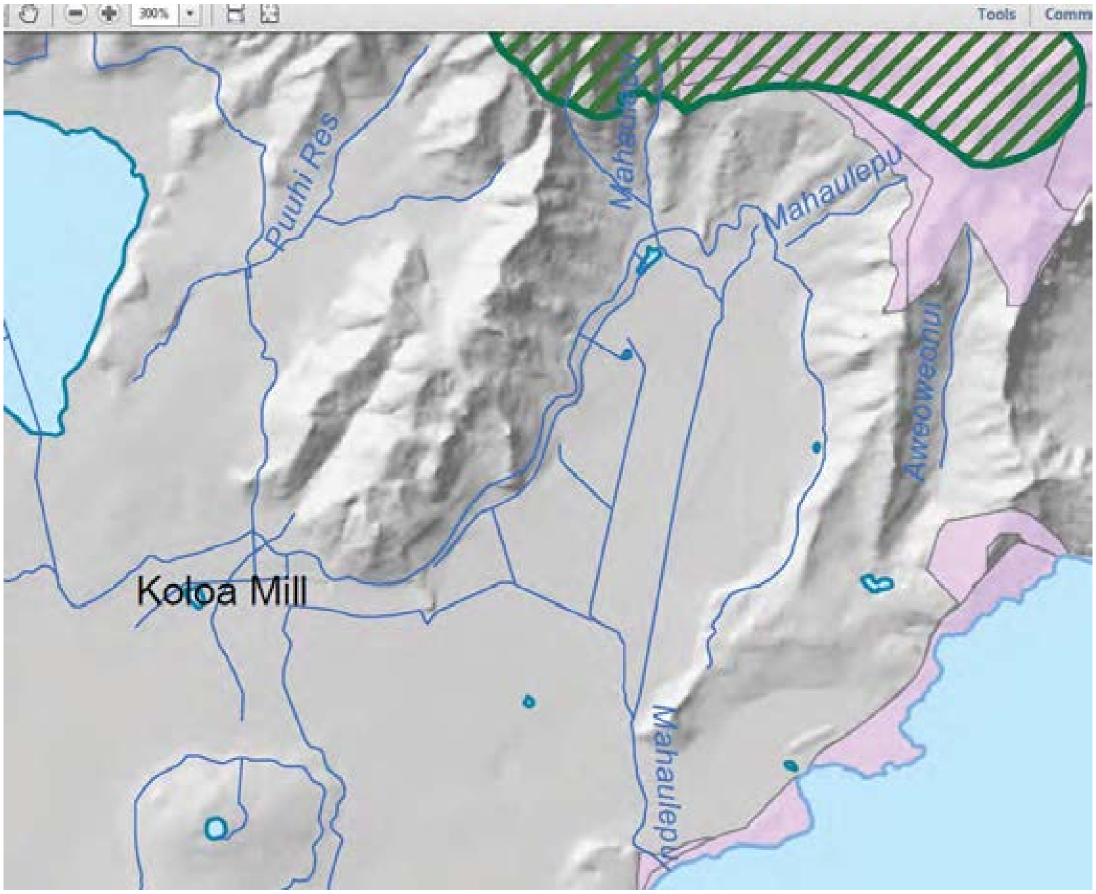
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Exhibit C

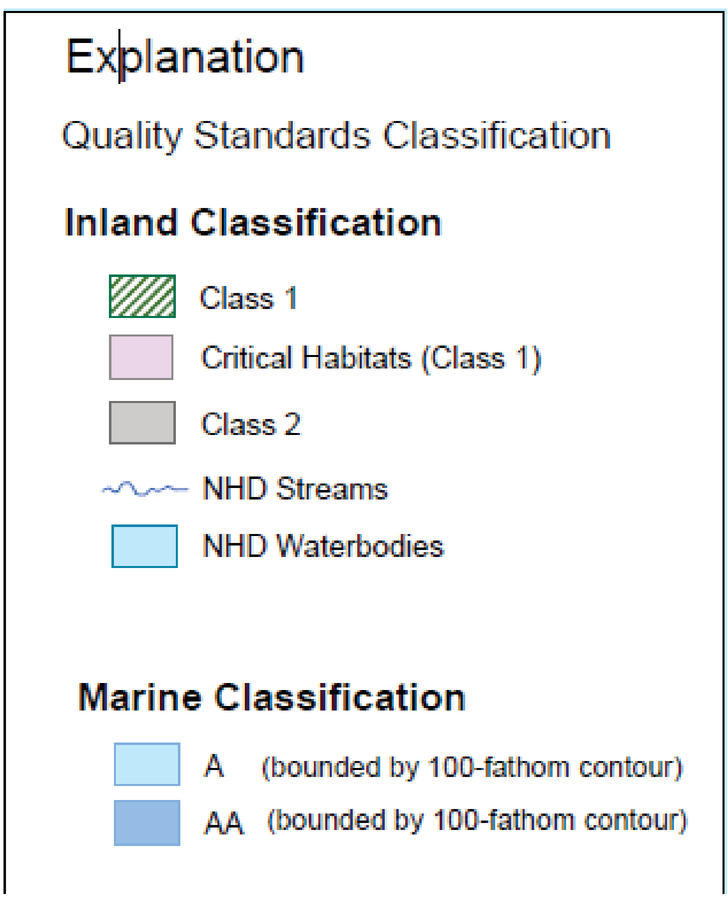
Explanation
Quality Standards Classification
Inland Classification
Class 1
Critical Habitats (Class 1)
Class 2
NHD Streams
NHD Waterbodies
Marine Classification
A (bounded by 100-fathom contour)
AA (bounded by 100-fathom contour)

Exhibit 9

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August 21, 2014

VIA EMAIL

Sina Pruder, P.E.
Chief
Wastewater Branch
Environmental Management Division
Department of Health
919 Ala Moana Blvd., Room 309
Honolulu, HI 96814

Re: Additional Comments re Hawaii Dairy Farms' Waste Management Plan, dated July 23, 2014

Dear Ms. Pruder:

This letter supplements our letter of August 11, 2014. In our prior letter, we presented preliminary comments on behalf of Kawailoa Development LLP ("Kawailoa") regarding Hawai'i Dairy Farms' Waste Management Plan ("Plan"), dated July 23, 2014, for its proposed dairy farm ("Dairy") in Māhā'ulepū, Kaua'i.

At the time that we submitted our first set of comments, some of our experts were simply not available due to previously scheduled travel commitments. The comments that are now submitted with this letter are in addition to those submitted earlier.

Comments of Mark Madison.

Preliminary comments of Mark Madison of CH2M HILL are attached as Exhibit B. CH2M HILL is a global engineering and consulting firm. Mr. Madison is an agricultural, environmental and civil engineer, and senior project manager with CH2M HILL. He holds a B.S. in Agricultural Engineering from Oregon State. Mr. Madison specializes in managing soil, water, plants, and nutrient relationships for wastewater reuse, wetlands treatment, and agricultural production. His CV is attached as Exhibit A.

We appreciate that the Department of Health ("Department") has allowed and will consider all comments by our experts. Mr. Madison's comments serve to underscore the

importance of comments from the public on this proposed project. As set forth in his comments, the current Plan does not address the significant non-point source discharges from dairy operations, including run-off and groundwater recharge. The current Plan does not use appropriate technology, let alone the best available technology. The current Plan does not address the effect of the Dairy's operations on Kaua'i County water wells, shown on page 9 of the Plan.

The wells are significant because according to a water quality report by the Kaua'i Department of Water, at least two sources of drinking water, Koloa Wells F and C, are close to the Dairy's boundaries. The water quality report is attached as Exhibit C. Although the Plan states on page 8 that the Koloa F well is "located over ½ mile away from the dairy facility site," using the scale of the map on page 9, Koloa F appears to be less than 750 feet from the adjacent grazing paddocks and Koloa C appears to be approximately 750 feet from the farm. Without mention of the proximity to the dairy farm itself, it is disingenuous to imply, as Hawai'i Dairy Farms ("HDF") has done, that the community drinking water wells will not be subject to contamination.

Scope of the Plan.

The planned size of the Dairy is 2,000 cows. The projected size of the Dairy when fully operational is not conditional or speculative; it is clearly and expressly stated by HDF in its Plan: "Hawaii Dairy Farms LLC (HDF) intends to ultimately develop a 2,000-cow dairy in the Mahaulepu Valley at Grove Farm on the island of Kauai." However, HDF now proposes to develop the project in two phases: "Phase 1 will have no more than 699 cows, and Phase 2 will have up to 2,000 cows." While the Plan purports to be for the first phase, it actually seeks approval of the same facilities that will be used in Phase 2. In other words, all of the buildings, ponds, wastewater systems, pastures, irrigation system, graves, etc. are exactly the same. As approval is sought for full build-out, the impacts of the dairy at full build-out must be studied now. Critically, in this Plan, HDF makes no commitment to return to DOH for additional approvals before there are 700 or more cows. The fact that HDF is treating this application as the first of a series of similar applications, without full disclosure of planned impacts, should be reason enough to deny the application.

Conclusion.

Hawai'i Dairy Farms has not made full disclosure of its operations or the consequences therefrom. The Plan contains incomplete, inconsistent and contradictory information, and fails to address significant issues that have a direct impact on the environment of the Māhā'ulepū area, including wells, ground water and nearby Class 1 waters. The HRS Chapter 343 process would allow the public to have an opportunity to identify these critical issues, would allow HDF to respond to them and would inform the Department's decision-making. Hawai'i Dairy Farms does not come close to meeting its burden of demonstrating that no pollution or harmful environment degradation will occur. The Plan should therefore be rejected by the Department.

Thank you for your attention to this matter. Please do not hesitate to contact me with any questions regarding these comments.

Sincerely,

Lisa Woods Munger

LWM

cc: Edward Bohlen, Esq.
Becky Mitschele, EPA Region 9, NPDES Permits Office
Jun Fukada, Kawailoa Development LLP

Enclosures:
Exhibit A, Mark Madison's CV
Exhibit B, Mark Madison's Comments on Hawai'i Dairy Farms' Waste Management Plan
Exhibit C, Kaua'i Department of Water's Water Quality Report
Exhibit D, Custom Soil Resource Report for Island of Kauai, Hawaii, USDA and NRCS (with Mark Madison's comments)
Exhibit E, Custom Soil Resource Report for Island of Kauai, Hawaii, USDA and NRCS (original version)

Exhibit A

Mark F Madison
Agricultural Engineer

Education

B.S., Agricultural Engineering, Oregon State University, 1979
A.S., Production Agriculture (Irrigation Emphasis), Blue Mountain Community College, 1975

Professional Registrations

Professional Engineer (Agricultural, Environmental, Civil): Oregon, 1983 (No. 12178); Washington, 1985 (No. 022457)
CH2M HILL Certified Project Manager: 1995
Certified Water Rights Examiner, Oregon, 1992 (No. 325)

Distinguishing Qualifications

- Principal technologist with 34 years experience studying, designing, and building irrigation, land application, and natural treatment systems
- Specialized expertise in successful use of tree plantations for phytoremediation, biosolids, and wastewater management
- Specializes in drip, micro-spray, and sprinkler irrigation modeling, design optimization, field testing, and performance monitoring
- Managed design of the worlds' largest contiguous drip irrigation system (16,000 acres) and the world's largest saline water subsurface drip irrigation system (2,500 acres)
- Helped write new wastewater reuse regulations for the Oregon Department of Environmental Quality (DEQ)
- National expert in design of constructed wetlands for wastewater quality improvement that also have mitigation credits
- Managed five national award-winning projects; four in effluent reuse and one in irrigation technology

Relevant Experience

Mr. Madison is an agricultural, environmental, and civil engineer and senior project manager with CH2M HILL's Water Business Group in Rio de Janeiro, Brasil. He specializes in managing soil, water, plants, and nutrient relationships for wastewater reuse, wetlands treatment, and agricultural production. His experience includes site investigation, data collection, modeling, model calibration, design, construction, management, operations, and monitoring and maintenance of irrigation, reuse systems, wetlands and uplands phytoremediation systems. Mr. Madison served on the State of Oregon (USA)Department of Environmental Quality (DEQ) task force that wrote new municipal wastewater reuse regulations. He also served on a task force with the Oregon Department of Water Resources that developed a water marketing law and on a DEQ task force that wrote new industrial reuse regulations. Mr. Madison is an internationally known expert in irrigation, water reuse, and constructed treatment wetlands.

Representative Projects

International

Technology leader; Terracal Food and Biofuels Farm Development; Guadalupe, Brasil. Worked in the Terracal office for over a year assisting the client in the planning, permitting, and conceptual design of a major food and bioenergy farm. The farm will occupy 35 thousand hectares of non-irrigated land in the State of Piaui near Guadalupe and plans to develop the farm with drip and pivot irrigation. The area will be irrigated for the cultivation of cocoa on 3,000 hectares, sugar cane on 27,300 hectares, and tomatoes on 4,700 hectares-the tomatoes will be in rotation with the cane. Terracal is investing R$ 1.5 billion in the integrated agricultural and industrial processing project to produce ethanol, electricity, sugar, tomato paste, and cocoa. The industrial complex will cover 350 hectares and have three processing plants and multiple warehouses. The sugar mill will grind 3.4 million tons of sugar cane per year and the cane fiber will be fuel for the 135 MW co-generation power plant. The tomato paste plant will render 525 thousand tons of tomatoes per year. The cocoa processing plant will produce 10.5 million tons of cocoa beans annually. The project included development of an agricultural plan, graphical schedule of phasing and construction sequencing, LiDAR survey procurement and oversight, preparing terms of reference for an intensive soil survey and conceptual design of all major facilities of the irrigation system.

Team leader and Resident Engineer; Mahawili System B Irrigation Project; Puntaranus, Sri Lanka. Team leader and resident engineer for this project funded by USAID and the Sri Lankan government. CH2M HILL designed, managed construction, and performed startup operations for the 40,000-hectare irrigation system that included a concrete-lined main canal up to 20 meters wide and 5 meters deep. The canal system has several 5-meter drop sections as it traverses the relatively uneven topography of the lower Mahawili River valley. The canal system construction included sections of blasted cuts in granite bedrock, as well as significant fills and inverted siphons. The sloped canal system has radial gates and re-regulation reservoirs to match supply to demands without operational spills. Distribution canals are unlined earthen canals and were constructed primarily by local farmers that are served by each canal. The irrigation system serves approximately 20,000 subsistence farmers, each with about one hectare of rice paddy and one hectare of upland crops. The startup operations team managed the irrigation system to deliver water through three crop growing seasons. CH2M HILL trained the local water management engineering and technical staff in system operations and monitoring and established maintenance procedures. Our water management training included establishment and training of local farmer user groups on each distribution canal who monitor their own water use and control the main canal turnout gates to their distribution canal and the on-farm water control structures. The on-farm irrigation systems are all gravity flow surface irrigation and shallow flooding with tail-water reused on adjacent fields or returned to re-regulation reservoirs or lower canals.

Project Manager; Kwajalein Atoll Irrigation Pipeline Rehabilitation; U.S. Army; Island of Kwajalein. Managed an island-wide pipeline rehabilitation project for the island of Kwajalein. The project included evaluating and rehabilitating all pipelines in the non-potable irrigation system, potable water system and sewer system for the city of 3,000 people and the military base facilities that support the "Star Wars Missile Defense System" research. The project included master planning and basic field investigations including flow and pressure tests and leak detection, design, construction management, and acceptance testing. Hydraulic models of the systems were developed with EPANET and calibrated with field testing. Pipe segments that were verified to have high friction losses or leaks were sampled and analyzed to determine the integrity of the pipe material so that an appropriate rehabilitation method could be selected for it. Pipeline rehabilitation included the following technologies and construction methods: HDPE slip lining inside cast iron pipe, concrete pipe, and steel pipe; cement mortar lining in-situ in cast iron pipe and steel pipe; pipe replacement with PVC, ductile iron, and lined and coated steel. The irrigation system pipeline rehabilitation work occurred while the system was not in use. The irrigation system was expanded to include a complete new irrigation system on a golf course. The drinking water system was rehabilitated in phases while the system was in service with the use of temporary surface piping to bypass the segments that were under construction. The sewer system rehabilitation also occurred while the system was in service by use of temporary bypass piping and pumping to sewers in adjacent streets. The irrigation system uses all of the treated effluent from the WWTP and delivers it for irrigation as well as toilet flushing to conserve fresh water. The project dramatically improved the island wide water security and sustainability.

Task Manager; Municipal Water System Master Plan and Pipeline Rehabilitation; City of Lviv; Lviv, Ukraine. Lviv is working to restore continuous drinking water service to over one million residents. The break-up of the former Soviet Union left a void in infrastructure maintenance while regions and cities organized agencies to manage critical facilities. The water supply system in Lviv consists of old cracked concrete pipe, cast iron pipe with leaking lead joints, unlined corroded steel pipe, and galvanized steel for the smallest diameter pipe. At the beginning of this project, water was only available for 12 hours per day for most residents who had enjoyed continuous service only a few years before. The water system master plan recommended an aggressive program of pipe replacement supplemented with a massive rehabilitation program to extend the useful life of failing pipelines. Worked on the hydraulic modeling for the master plan and helped develop the city's first comprehensive computer model using EPANET. Performed site investigations and collected samples of pipeline material for integrity analysis. It was determined that most of the leaking concrete, cast iron, and unlined steel pipelines could be restored with cement mortar lining in-situ. A U.S. contractor and all necessary lining machinery and supplies were imported and worked under Mr. Madison's direction to rehabilitate over 100,000 feet of pipeline. The machinery was transferred to the Lviv Municipal Water Service Company, which continues to line additional failing pipelines throughout the city.

Task Leader; Rainwater Harvesting and Reuse Irrigation for Water Independence; U.S. Embassy; Freetown, Sierra Leone. Led site investigation and concept development for capturing rainwater from building roof tops and storing and treating to provide 100 percent of the domestic water needs of the 280-person U.S. Embassy. Evaluated landscape irrigation system and wastewater treatment plant upgrades to enable reuse irrigation to replace 100 percent of the irrigation water needs within the compound to result in no discharge of effluent. Water shortages in Sierra Leone prompted the Embassy to remove itself from the water supply grid and to stop discharging effluent which was potentially being used as drinking water by locals. Task leader for final design of the project which has become an example of water independence for U.S. Embassies and overseas buildings. Assisted the State Department Office of Overseas Building Operations to modify their specifications and standards to allow rainwater harvesting for drinking water and to encourage effluent reuse for landscape irrigation to reduce the impact of US facilities in foreign countries.

Technologist; Landfill Leachate Irrigation on Poplar Trees; Kumi Landfill; South Korea. Provided technical input into the design of a drip irrigation system to apply landfill leachate to a poplar tree reuse site in South Korea. The highly loaded site is lined to capture percolation water for recycle to treat the maximum amount of Leachate on the available space. Irrigation includes subsurface drip, filtration, and conveyance piping.

Technologist; Phytoremediation of Chemical Processing Plant Site; Dow Chemical; Sarnia, Canada. Designed and provided construction oversight for a phytoremediation site using five species of trees and several planting methods for a chemical processing brown field site. Trees were planted in bore holes up to 10 feet deep and drip irrigated to grow roots into the groundwater for plume control.

QA/QC Reviewer; Post Military Exercise Restoration and Remediation Program; U.S. Army; Al Khobar, Saudi Arabia. Developed concepts for irrigation of desert vegetation in seed beds to reestablish native plants in areas disturbed by military vehicles. Alternatives for water supply include deep wells, tank trucks delivering to reservoirs, and tank trucks directly connecting to the irrigation pipeline. The irrigation system is widely spaced surface and subsurface drip designed with very low application rates to provide water for establishing native plants in seed bank strips perpendicular to wind for natural seed dispersion.

Technologist; Constructed Wetland for Wildlife Habitat and Water Quality Improvement; ICI Canada Inc.; Sarnia, Canada. Converted the former 60-acre gypsum processing prefiltration pond into a pond/wetland system by leveling portions of the former pond bottom, excavating deep zones perpendicular to the flow, installing gravity flow level control structures and underground distribution piping, and adding features, such as wetland shelves and islands. The primary treatment function of the wetlands is to remove phosphorus and gypsum residuals from the industrial process water. The wetland outlet is to the St. Clair River.

Irrigation

Project Manager; Potlatch Corporation Hybrid Poplar Farm; Boardman, Oregon. Managed all engineering assistance to Potlatch Corporation when they purchased the Eastern Oregon Farming Company and Pacific Northwest Farming Company landholdings in Boardman, Oregon, to develop a 22,000-acre hybrid poplar tree plantation. Developed a dynamic hydraulic network model of the irrigation pumping and distribution system (total system demand of 186,000 gallons per minute) on EPANET and calibrated using operational data from the supervisory control and data acquisition (SCADA) system. This model was used to evaluate instantaneous demand from the points of diversion under different distribution system configurations and operational scenarios, evaluate required facility upgrades, and evaluate energy savings due to facility modifications. The design and construction management of the irrigation system for the poplar plantation rehabilitated the 50 miles of existing pipelines 24 inches in diameter up to 72 inches in diameter with cement mortar lining. PVC pipe was used to expand the system to more than 200 miles of pipeline. The application system was converted from center pivot sprinkler irrigation to drip irrigation. Energy savings from pipeline upgrades and replacements and pump station modifications were verified with this model to authorize payments to Potlatch Corporation from the Bonneville Power Administration Waterwise Program. The project won Engineering Excellence award from the Consulting Engineers Council.

Project Manager; Irrigation System Modification; Boeing Company; Boardman Farms, Oregon. Managed study and upgrade design of the 28,000 acre Boeing Farm irrigation system. Used farm records, design data, field data, and farm and irrigation managers' working knowledge of the system to develop an EPANET computer model of the irrigation system. The model was used to evaluate potential energy-saving modifications of the irrigation system and its operation. The goal of the engineering investigation was to identify cost-effective system modifications that would substantially reduce the energy requirements for irrigation at the Boeing Farm. Modifications were identified to reduce the annual power bill by about 30 percent. The study recommended scheduling irrigation to reduce over-irrigation and to take greater advantage of off-peak power costs. It also recommended adjusting cropping patterns so that a variety of crops grown in the normal rotation would be located on each lateral to reduce the effects of peak water demand by any one crop. The work included design of rehabilitation and betterment upgrades to the irrigation system.

Project Manager; Fresh Water and Wastewater Irrigation System Development; Madison Ranches; Echo, Oregon. As CH2M HILL project manager, provided engineering design services for development of a combined freshwater and wastewater irrigation system at his family's farm—Madison Ranches. Madison Ranches received a water right from the Columbia River to irrigate 10,000 acres. The project, to develop the first 6,000 acres for irrigation, began in 1990 and irrigation was phased in over 10 years. Madison Ranches uses an existing river supply from the Columbia Improvement District. A major relift pump station was built on the district's irrigation canal to pump into the farm's penstock. A looped pipeline design was developed to provide greater flexibility of operation. The 10 miles of new pipeline system includes steel, HDPE, and PVC materials and a canal under crossing and a bore and jack casing under crossing of the I-84 freeway. The farm irrigation system also includes four wells and three creek diversions. The irrigation system incorporates the use of wastewater from the Lamb Weston potato processing plant and cooling water from the 440 MW Hermiston Generating gas fired power plant. Isolation valves allow the center pivot circles to use fresh water from the irrigation canals or groundwater aquifers, wastewater from the Lamb Weston plant and power plant, or a combination of fresh water and wastewater. CH2M HILL provided engineering design services for all pipeline and pump station design. Provided specification of all irrigation sprinklers and equipment, coordinated the design with crop rotations and wastewater reuse scheduling, and assisted Lamb Weston and Hermiston Generating in obtaining DEQ permits to apply their wastewater on 6,000 acres of the Madison Ranches.

Project Manager; Irrigation System Improvements; Sandpiper Farms Inc.; Paterson, Washington. Sandpiper Farms irrigates 5,000 acres with five 1,500-horsepower (hp) pumps lifting water from the Columbia River. Managed the team that evaluated the irrigation system and pump plant design as part of a master plan to reduce energy consumption as a participant of the Bonneville Power Administration's Water Wise conservation program. A hydraulic model of the system was developed to simulate various modifications and identify bottlenecks in the piping system. The selected option for pump station renovation involved modifying two of the 1,500-hp pumps to draw 1,200 hp and installing a variable speed drive on a third 1,500-hp unit. Other options provided similar energy savings, but the variable-speed drive option was chosen because it could automatically adjust to changes in flow and pressure requirements—greatly simplifying system management. Operations of a peaking reservoir were also evaluated. Pipeline modifications, including expansion of the service area, were modeled, and CH2M HILL prepared preliminary designs. Improvements to the pumping and water distribution systems reduced the power required to deliver the same volume of water by approximately 25 percent. The total project engineering and equipment cost was paid back in two years through substantial energy savings.

Project Manager; Irrigation System Efficiency Assessment and Improvement Study; Hawman Farms; Hermiston, Oregon. Managed an irrigation system efficiency assessment and improvement study of the 2,500-acre Hawman Farms located near Hermiston. The work included developing a master plan recommending alternatives that would reduce energy requirements of the pumping and water distribution system. The irrigation system consists of two pump stations used to lift the water from the McNary pool of the Columbia River over 650 feet vertically. The network of pipes includes pipe diameters ranging from 30- to 4-inches. Most of the large-diameter main line was cement-mortar-lined, and some laterals were replaced with PVC pipe to rehabilitate failing sections of the system and to improve flow as part of the plan's recommendations. A computer model created to simulate the operation of the irrigation system used farm records, as well as design and test data. This model was then used to investigate alternatives for reducing energy costs and sizing new pipelines. The recommended improvements reduced the pumping energy requirements by 19 percent. The primary recommendations were to install new PVC laterals, cement mortar line large unlined steel pipe, install a small booster pump station, repair the booster pumps so that they produce original design pressure at the existing flow rates with better efficiency, modify the river pumps to produce less pressure to match the modified system requirements after all system improvements have been implemented, and manage the system with irrigation scheduling so that minimum peaking of water demand occurs.

Project Manager; Eastern Oregon Farming Company; Boardman, Oregon. Managed the CH2M HILL team that redesigned an existing 10,500-acre pivot irrigation system to improve operating efficiencies. The system was originally designed to use 23,350 horsepower (hp) located in five pump stations. The redesigned system required only 17,000 hp to deliver an adequate volume of water, resulting in a peak hp reduction of 30 percent over the original design. Operator training in irrigation scheduling, water management, and efficient system operations further reduced the energy consumption. After the system modifications, the farm irrigated the same acreage with approximately 50 percent less energy than was required before system modifications and operation improvements. The total cost of the project, including engineering and equipment modification, was equal to the amount of the energy savings in the first year.

The redesign recommended irrigation scheduling, lower sprinkler operating pressure, improved pipe, valve, and manifold designs, and major pump station modifications. CH2M HILL also provided specifications for pump modifications, and testing and inspection for installation and startup. A model was developed and used to command the farm microcomputer to access data from a local weather station and recommend an irrigation schedule for each field. CH2M HILL and Eastern Oregon Farming Company were jointly awarded The Irrigation Association's National Award for Water and Energy Conservation.

Irrigation Technology Lead; Owens Lake Dust Mitigation Program; Los Angeles Department of Water and Power; Inyo County; California. Managed design of a system for drip-irrigated saltgrass production. Project required site investigation, irrigation projections for salt management, monitoring, and designing a buried drip irrigation system over 4.75 square miles of dry lakebed. Developed water demands for shallow flooding and drip-irrigated saltgrass dust control measures for water resource planning, using local climate and soils data and plant growth and salt response criteria to generate project water requirements. Final water demand estimates were used to size a water conveyance system serving a 16.5-square-mile area and a separate conveyance system serving a 22-square-mile area. Also developed conceptual design and design-build-operate bid documents for the irrigation and drainage components of a 13.5-square-mile shallow flooding dust control project. Provided design review throughout final design and construction phases. Worked as part of a multiagency research team developing objectives and refining plot designs for efficient reclamation of saline sodic soils and establishment of saltgrass on the lakebed.

Project Manager; Pacific Islands Phytoremediation Project; U.S. Army Corps of Engineers; Hickam Air Force Base, Honolulu, Hawaii. Managed developing water balance and designing and installing an irrigation system, primarily a drip irrigation system, with one spray-irrigated plot of native trees and shrubs. The project was delivered as design/build. The project included a research component with the University of Hawaii to determine which native plants were most effective in phytoremediation of petroleum products that resulted in the University being awarded a patent. The plants were installed with 5 innovative planting methods to place the roots in petroleum contaminated soil above and below the sea water aquifer. The project continues to remediate the site of a tank farm leak.

Technology Lead; Drip Irrigation System Design;Black Rock Ranch; Moxee, Washington. Designed a drip irrigation system complete with filters and pump stations for 500 acres of apple orchards at Black Rock Ranch near Moxee, Washington.

Project Manager; Rehabilitation and Betterment of Irrigation Facilities; Crown Zellerbach; Boardman, Oregon. Evaluated an 8,000-acre sprinkler irrigation system for rehabilitation and conversion to drip irrigation. The evaluation included disassembly, inspection, and reassembly of a 6,000-hp pump station, and corrosion evaluation of penstocks and main lines. Corrective action was recommended for removal and prevention of a sand bar that had formed around the pump station. A computer model was used to evaluate the performance of the existing distribution system when converted to supply drip irrigation.

Tree Reuse Systems

Project Manager; Poplar Tree Water Reuse Demonstration System; City of Woodburn; Woodburn, Oregon. Designed, built, and operated a four-acre demonstration site at the city's wastewater treatment plant to establish design criteria for a 320-acre full-scale poplar tree water reuse system installation. This demonstration site was the first poplar tree effluent irrigation site in Oregon and was used to establish the agronomic irrigation rate for poplar in a joint research project with Oregon State University. The prototype installation features land application of effluent from the secondary treatment system using an irrigation system with low-pressure, mini-sprinklers to irrigate the tree/grass ecosystem. Design variables tested at the site include various drip, sprinkler, and spray irrigation, poplar tree varieties, tree planting densities, and irrigation loading rates. The monitoring effort includes climatic data, soil moisture measurements throughout the tree rooting zone, quantity and quality of wastewater, quality of soil water, plant tissue analyses, and soil analyses for nutrients and waste stream constituents. This innovative project won an Honors Award for Engineering Excellence from the American Consulting Engineers Council.

Project Manager; Full-Scale Poplar Tree Water Reuse System; City of Woodburn; Woodburn, Oregon. The full-scale system was completed at a cost nearly 50 percent less than tertiary treatment or conventional reuse. Evaluated use of food processor wastewater for irrigation to reduce the peak loadings discharged to the city's wastewater treatment plant (WWTP). The evaluation included meetings with food processors, cooperative farmers, and WWTP staff to coordinate reuse objectives. Potential application sites were evaluated to determine acceptable loading rates and management practices. Also prepared a feasibility analysis and design, construction management, and permitting for the project. The new total maximum daily load (TMDL) for the Pudding River limits dry season effluent discharge. The reuse system includes 84 acres of trees, a pump station, and other improvements.

Technology Lead; Poplar Tree Water Reuse Demonstration System; Oremet Titanium; Albany, Oregon. Worked with Oremet, city of Albany, and the Oregon DEQ to design, install, manage, and monitor a five-acre poplar tree water reuse demonstration system. Identified criteria for developing an approximately 70-acre tree reuse site to consume the water and nutrients in the industrial waste during the growing season. Salts are stored in the soil during summer and collected in a drainage network in the winter months when the soil is saturated. This drainage water is discharged through the existing wetlands system during high flow periods of Oak Creek, allowing Oremet to be in compliance with the modified National Pollutant Discharge Elimination System (NPDES) permit. The five-acre demonstration site has automated micro-spray irrigation, drip irrigation, and a 10 foot deep drainage network.

Project Manager; Wastewater Effluent Reuse on Poplar Trees; Weyerhaeuser; Klamath Falls, Oregon. Designed, installed, managed, monitored, and analyzed a prototype installation featuring land application of effluent from Weyerhaeuser's industrial wastewater treatment system to determine design variables for a larger-scale system for effluent reuse. Variables tested at the site include various poplar tree varieties, tree planting densities, and irrigation loading rates and management techniques. The monitoring effort included climatic data, soil moisture measurements throughout the tree rooting zone, wastewater quantity and quality, soil water quality, plant tissue analyses, and soil analyses for nutrients and waste stream constituents.

Project Manager; Poplar Tree Irrigation System—Riverbend Landfill; Waste Management, McMinnville, Oregon. Designed the irrigation system for 55 acres of poplar trees planted at the landfill. The trees, soil, and microorganisms effectively remove nutrients and other contaminants from up to 12.6 million gallons of leachate annually. The project uses under-the-tree precision sprinkler heads and drip irrigation to irrigate the ground evenly to prevent runoff and promote adequate infiltration. The sprinkler heads discharge large droplets of water, rather than a finely atomized spray, to minimize the volatilization of leachate and reduce odors. A fully automated monitoring system allows Waste

Management to effectively manage the leachate generated annually at the site with zero discharge. This project won the National Engineering Excellence Award from the Consulting Engineers Council of Oregon and the American Consulting Engineers Council.

QA/QC Reviewer; Hardwood Trees Effluent Reuse Evaluation; Georgia-Pacific Paper Mill; Palatka, Florida. Evaluated potential for using hardwood trees to treat wastewater effluent from the mill. Conducted pilot studies to determine effectiveness of growing engineered short-rotation, intensive-culture hardwood trees for uptake of nutrients and increased water use.

Wetland Treatment Systems

Project Manager; Talking Water Gardens Low-Energy Passive Effluent Cooling Project; Albany, Oregon. CH2M HILL evaluated the potential temperature reduction capabilities of a constructed wetland and developed an explicit energy balance model for evaluating constructed wetlands and successfully calibrated the model to flow and temperature data collected from another constructed wetland. The wetland system is the nation's first constructed wetlands designed to further treat a unique combination of treated municipal wastewater and industrial effluent, and resulted in the first design model developed specifically for designing constructed wetlands for water cooling. The wetlands polish the water to remove metals and nutrients to levels that allow river discharge as well as discharge through the bottom on the wetland into shallow groundwater that provides hyporheic discharge to the adjacent lakes through springs and seeps to provide cool water to the lakes. The wetland system functions to educate and inform the public (the "talking waters") and the regulatory community about the benefits of wetlands treatment to reduce thermal loads and other pollutants. The wetlands are designed for phosphorus, nitrogen, sediment, and temperature reduction of warm effluent from the Albany-Millersburg WWTF and a large rare metals processor. The project was awarded federal stimulus funding. The constructed wetlands will treat an unusual mix of 26 different effluent constituents that were proven to have a synergetic treatment benefit when tested in pilot scale wetlands. This project won the National Grand Conceptor Award from the American Academy of Environmental Engineers.

Principal Engineer; Owens Lake Dust Mitigation and Wetlands Project; Los Angeles Department of Water and Power; Keeler, California. Principal engineer for planning, design, services during construction, and operations support for restoration of approximately 50 acres of shoreline saturated alkaline meadow wetlands and fresh water spring mounds or moist alkaline meadow wetlands. The project included development of flood and drip irrigation systems over more than 12,000 acres to mitigate dust emissions from the dry lakebed surface while protecting and enhancing existing wetlands and sensitive Snowy Plover nesting habitat areas. Served as the principal engineer for design, services during construction, startup, and operations support. Approximately 300 acres of the drip irrigated salt grass meadow is being managed and monitored as mitigation dry alkaline meadow wetlands. All of the wetlands plants are being propagated from seed of native plants collected in the immediate vicinity and replicated on a seed farm developed by the project.

Technology Lead; Natural Treatment System for Phosphorus Removal; RUSA; Roseburg, Oregon. Provided technology input to develop the first large-scale natural treatment system to remove phosphorus from municipal effluent to below 0.05mg/L. The 340-acre farm owned by RUSA is now a treatment process unit of the wastewater treatment facility and uses constructed wetlands, agronomic rate and high rate irrigation, and 60 acres of restored natural wetlands for infiltration of effluent into clay soils that bind phosphorus. The treatment process discharges clean water into an ephemeral stream from the hyporheic zone along both sides of the stream with more than three miles of diffuse stream bed springs. The treatment process removes about 100 pounds per day of phosphorus from effluent that was previously discharged to the South Umpqua River. The treatment process includes natural wetlands and is a landmark project in that the restoration of the natural wetlands with effluent provides mitigation credits for the uplift in ecosystem function and treatment benefits.

Project Manager; Wetland Treatment Demonstration Project; Pope & Talbot; Halsey, Oregon. Managed the design, construction, and startup services. Project was developed in partnership with Oregon State University as a field laboratory for the demonstration of wetland treatment technology and ongoing research. The system includes a pump station, water control structures, and ten separate wetlands with variable flow rates and plant management regimes. One cell is a subsurface flow wetland with rock media. The system reuses paper mill effluent and polishes it before river discharge. This project is the oldest research wetlands in the state of Oregon.

Project Manager; Demonstration Natural Reclamation System (NRS); City of Salem; Salem, Oregon. Designed a wetland treatment demonstration project that compares three NRS technologies: overland flow wet meadow wetlands, vertical flow subsurface wetlands, and surface flow wetlands. Goals of the demonstration project include summer temperature, phosphorus, and ammonia reduction, creating new wetland habitat for wildlife, and improving water quality. The project also is providing a new source of class A agricultural and golf course reuse water, in conjunction with the Title 16 U.S. Bureau of Reclamation program which funded 25 percent of the construction cost. The class A reuse water is produced by adding alum, sedimentation, filtration, and disinfection in series after the wetlands treatment system. This system has been in operation for 10 years and has the most robust data set in Oregon on operations and water quality.

Technology Lead; Wetlands for Phosphorus Removal; City of Boise; Boise, Idaho. Developed a Wastewater Facilities Plan Amendment that evaluated constructed wetlands for cooling, effluent polishing, and phosphorus removal for the West Boise wastewater reclamation facility. Developed and evaluated innovative treatments of wastewater, including constructed treatment wetlands for secondary effluent with hyporheic discharge and soil treatment to allow no surface discharge.

Senior Technologist QA/QC Reviewer; Facilities Plan through Final Design; Treatment Wetlands and Poplar Tree Irrigation Expansion; City of Woodburn; Woodburn, Oregon. Feasibility evaluation and design of constructed treatment wetlands for phosphorus and ammonia removal and cooling as a final filter after the wastewater treatment plant. The 27 acres of constructed wetlands in the flood plain provide effluent polishing before river discharge from May through October and are designed to be flooded each winter without damage. Permitted and designed the 40-acre second phase of expansion for the poplar irrigation site.

Task Leader; Treatment Wetland System Feasibility Review; South Suburban Sanitary District; Klamath Falls, Oregon. Feasibility review/conceptual design for treatment wetland construction next to municipal wastewater treatment facilities to polish effluent before river discharge. Surface flow treatment wetlands were evaluated to further remove nutrients and naturalize the effluent before river discharge.

Technology Leader; Wetland PreDesign; Clean Water Services; Hillsboro, Oregon. Sited, designed, and provided field investigation oversight for a 350-acre wetland for water cooling and phosphorus and ammonia removal in a water-quality limited basin. The predesign included meeting with stakeholders and regulators to address permit and public acceptance issues. The site is located in a two-year floodplain and discharges into the Tualatin River. A peat filter cell is used to enhance metals removal and is followed by a series of treatment wetlands to further filter, polish, and cool the water.

Technology Leader; Tualatin River Wetlands Mitigation; Hillsboro Landfill; Waste Management, Inc; Hillsboro, Oregon. Delineation of river floodplain wetlands before their phased filling by a landfill expansion, with wet-lands restoration and creation as mitigation, design, construction oversight, and monitoring. Developed 25 acres of constructed wetlands for stormwater treatment and mitigation for expanding the landfill. The wetlands system included a 100-acre-foot stormwater detention pond and four wetlands cells for specific habitat and treatment. The project improved the water quality of the Tualatin River and augmented summer flows in the water quality and quantity limited watershed.

Project Manager; Sycan Marsh Restoration; The Nature Conservancy; Beattie, Oregon. Managed design and construction services to facilitate the restoration of the original hydrology and native plant communities of the 25,000-acre Sycan Marsh in the headwaters of the Klamath River Basin. Included construction of three large water control structures in the 800 cfs Sycan River. Tasks included landowner coordination, site survey, hydrology and soils evaluations, hydraulic modeling, hydraulic control structure design, services during construction, and post-construction and system performance evaluation.

Principal Engineer; Williamson River; River Delta Restoration Alternatives; Oregon. Principal engineer for evaluation of alternatives to restore the Williamson River Delta in Klamath Lake to historic wetland conditions for endangered species fish spawning and rearing. Evaluated impacts of flooding, sedimentation, and agriculture on water quality and habitat values.

Project Manager; River Diversion Structure Assessment; The Nature Conservancy; John Day River, Oregon. Managed impacts assessment of a river diversion structure and field assessment of structure and impacts on river channel. Developed alternatives for structure removal.

Biosolids Land Application

Technology Leader; Wastewater Irrigation System, Idaho State Penitentiary Farm; Boise, Idaho. Provided site evaluation and designed a system to develop barren land for agricultural production. Project used municipal wastewater for irrigation and biosolids application for soil amendment and fertilization.

Technology Leader; Lagoon Biosolids Utilization Plan; City of Portland; Portland, Oregon. Developed the plan that provided characterization and inventory of the 63,000 dry tons of biosolids to be used. Developed alternatives and cost estimates for removing biosolids from the lagoon, transportation, and land application. Recommended uses included land application on food-chain crops, non-food-chain crops, and reclamation sites for various qualities of biosolids. Prepared specifications and contract documents and assisted the City to solicit bidders.

Technology Leader; Boise Twenty Mile South Farm Biosolids Reuse Project; Boise City, Idaho. Principal technologist for farmland biosolids application from two wastewater treatment plants. Included developing a Biosolids Management Plan, determining the best type of irrigation system for the farm and establishing operating criteria, and designing the irrigation system. Initially, biosolids applications were thickened liquid from an interim post digestion thickening facility. Dewatered biosolids cake has been applied since 1996, when the permanent dewatering facility came on line. Currently 1,000 acres receive biosolids. This project won the Consulting Engineers of Idaho Engineering Excellence Award.

Task Leader; Biosolids Land Application Program; Blue Plains Wastewater Treatment Plant; Washington, D.C. Determined land requirements for a 20-year program of biosolids land application. The plant land-applies 130 dry tons per day now and will expand to 200 dry tons per day in 20 years. The project included working with regulatory agencies, land application contractors, and biosolids generators to evaluate existing programs and make recommendations for ongoing land application.

Task Leader; Biosolids Land Application and Lime Stabilization; City of Rochester; Rochester, Minnesota. Prepared specifications and contract documents for lime stabilization and land application of municipal biosolids. The purpose of the documents was to retain a contractor to augment the city's ongoing land application program. This required careful coordination at the treatment plant and the city's land application farm. The contractor was also required to develop additional application sites, as well as stabilize, transport, and land-apply biosolids.

Technologist; Biosolids Land Application; City of Manhattan; Manhattan, Kansas. Due to operational difficulties, including over-application of biosolids, the city evaluated the potential for implementing irrigation capabilities at its biosolids farm. If implemented, irrigation would help maintain steady crop growth, providing flexibility for farm use. With the planned improvements, which include procuring or leasing additional land for biosolids application, the city can continue to use the biosolids farm for land application throughout the identified planning horizon.

Technologist; Biosolids Land Application; Cities of Minneapolis and St. Paul, Minnesota. Developed a computer program to recommend and size various systems and equipment for land application of biosolids.

Technologist; Biosolids Land Application; Water Environment Services;Clackamas County, Oregon. Designed transportation and land application systems to use municipal biosolids for agricultural production. Evaluated expansion of the biosolids program to include dewatered biosolids and transportation to arid regions of the state for winter application.

Technologist; Biosolids Land Application; City of Seattle; Seattle, Washington. Evaluated sites and designed storage, transportation, and application systems used to apply municipal biosolids from the city to forest lands.

Technologist; Biosolids Application for Agricultural Use, Multiple Clients. Designed land application and livestock feeding systems to use food processing waste streams and biosolids for agricultural production for Ore-Ida in Ontario, Oregon; Wise Foods in Berwick, Pennsylvania; and Frito Lay in Frankfurt, Indiana. Also completed conceptual layout, design, and construction supervision for all-weather transportation and livestock feeding facilities to use cheese whey from the country's largest mozzarella cheese plant in Waverly, New York.

Wastewater Reuse Systems

Technology Lead; Wastewater Irrigation Site Improvements—Forest Grove Wastewater Treatment Plant; Clean Water Services; Washington County, Oregon. Developed a conceptual plan for recycled wastewater irrigation site improvements. The plan recommended tree plantings for a forested perimeter buffer strip, demonstration plots, site expansion, and irrigation system improvements. Also assisted with developing wastewater facilities plan and treated wastewater reuse master plan, primarily identifying user needs and concerns. Participated in user interviews, surveys, and public meetings.

Project Manager; Wastewater Reuse Irrigation System; City of Madras; Madras, Oregon. Developed wastewater reuse irrigation system for a golf course and 1,200 acres of irrigated area. Helped develop the reuse plan and get DEQ permits for the project. CH2M HILL improved the plant to produce Class A for reuse.

Project Manager; Wastewater Reuse Feasibility Study; City of Hermiston; Hermiston, Oregon. Led CH2M HILL's team in evaluating the option of improving treatment plant capacity for phosphorus and other nutrient removal to meet impending discharge standards for the river at low flow during the summer months. Alternatives evaluated included reuse of wastewater for land application and crop production to eliminate or significantly reduce river discharge during dry months, or constructing additional treatment facilities to meet TMDL discharge standards. The land application system allowed the existing facility to continue to operate in compliance for an additional 10 years.

Project Manager; Wastewater Reuse Irrigation System; Lamb-Weston, Inc.; Hermiston, Oregon. Prepared a feasibility study, hydraulic model, and design of a 5,500-acre wastewater reuse irrigation system. Also provided construction observation startup assistance and performance monitoring and obtained DEQ wastewater reuse permits for the project. The reuse system includes improvements at the 3-million-gallon-per-day (mgd) WWTP for greater solids and nutrient removal, four pump stations, more than 20 miles of pipeline, irrigation systems, a freeway crossing, and a canal crossing. The system is designed for year-round operation. The new reuse system coordinates with the existing 750-acre reuse farm for agronomic loading rates on all sites.

Technology Lead; Municipal Reuse Irrigation System; Acoma Pueblo; Acoma, New Mexico. Led master planning, site investigation, and design team for this two-year project to provide a low-cost, low-maintenance reuse system to handle sewage flows from the existing community and handle expected growth in the area. The Acoma Pueblo sewage treatment, storage, and evaporation lagoons were unable to adequately handle existing sewage flows. The wastewater master plan identified land application of the wastewater to a nearby field as an acceptable alternative for reusing the wastewater and reducing the volume of water that must be evaporated from the lagoons. CH2M HILL designed and provided construction services for the pump station, mainline, and irrigation piping. The pipeline design included directional drilling to install HDPE piping under a river and irrigation canal and a bore and jack crossing under the main highway. The irrigation system piping was HDPE and PVC.

Stormwater and Drainage

Technologist; Watershed Storm Sewer System; Arlington, Texas. Designed a complete storm sewer system for a 50-acre paved industrial site and surrounding watershed for a 6-inch-per-hour design storm. Design included overland flow routing, detention, and collection of surface water and downspouts into a network of graduated-size storm sewers up to 54 inches in diameter. Also designed an open channel and structures for final discharge from the site.

Technologist; Industrial Stormwater and Transmission System; Tualatin, Oregon. Designed a stormwater collection and transmission system for a 40-acre industrial development. The system included inlets, gravity pipe, pressure pipe, open channels, culverts, and a detention pond. The system is designed to accommodate expansion of the site up to 160 acres without replacing existing facilities.

Technologist; Surface Drainage Control Plans, Wyoming and Oregon Sites. Developed a surface drainage control plan including runoff detention and routing, erosion control, and disturbed area stabilization for a large surface coal mine in Antelope, Wyoming. Prepared a similar plan that included rerouting of a stream for a future landfill site in the Oregon Coast Range.

Water Management Plans

Project Manager; Sycan Marsh Water Management Plan; The Nature Conservancy; Beatty, Oregon. Performed extensive site investigations, including aerial inspection and ground survey, of the 25,000-acre Sycan marsh. Existing structures and channels were inspected to determine how they could be modified and used in the Water Management Plan. The objective of the plan was to improve nesting habitat for Sand Hill Cranes in the spring by maintaining a proper water depth and to allow dewatering after the nesting period to produce the maximum amount of grass for livestock feed during the summer and fall. Project required developing hydrology and flow data and detailed maps. Installed and monitored gauging stations in five streams that feed the marsh. Maps and applications were prepared for filing of water rights.

Maduru Ova System B Irrigation Project, Sri Lanka. Team leader and water management engineer for 15 months on a USAID-funded project to provide technical services for the irrigation system. The project involves 28,000 hectares of irrigable land. It is the only concrete-lined canal system in Sri Lanka and includes 120 kilometers (km) of lined canal with a capacity up to 65 cubic meters per second and 2,100 km of unlined distribution and field canals. The sloped canal system is manually operated and requires careful monitoring, operation, and maintenance to perform properly. The System B project established, equipped, organized, and trained the local staff to assume responsibility for water management, operation, and maintenance. It also established a unit to monitor operating efficiency.

Water Supply

Project Manager; Water System Optimization Analysis; Maui Electric Company (MECO) and County of Maui; Maui, Hawaii. Evaluated the county's upcountry water system to identify alternatives for operations optimization that could reduce peak demands. The study identified a potential savings in peak energy use of 1.1 megawatts. Trained MECO staff in computer modeling and analysis of large water systems. Together developed a detailed computer model of the complex water system to simulate existing and proposed system operations. The model was used to develop a plan for off-peak pumping and reservoir operation to reduce peak period electrical demand and increase the water system delivery capacity. The water supply system that was modeled includes approximately 75 reservoirs, 20 pumps, and many miles of pipeline serving multiple-pressure zones from near sea level to more than 4,000 feet elevation. A plan was recommended to integrate the management of the water and energy systems for the benefit of both MECO and the county's Department of Water Supply.

Resident Engineer; Upper Kula Water Treatment Plant Construction; Maui, Hawaii. Resident engineer during construction of the 1.7-mgd plant. Construction services provided included onsite design modifications, progress monitoring, as-built drawings, an operations and maintenance manual, and construction observation. Construction included new facilities and rehabilitation of an existing 3-million-gallon steel tank and 8.5-million-gallon rubber-lined reservoir.

Technologist; Water Well Construction Inspection; Rockwood Water District; Portland, Oregon. Provided construction inspection for the drilling of water supply wells for the district and for quality control during pipe manufacturing for several large projects.

Technologist; Water Supply and Fish Handling System; Rocky Reach Dam, Columbia River, Oregon. Supervised design and construction of a water supply and fish handling system for fish mortality studies at Rocky Reach Dam on the Columbia River.

Hazardous Waste Management

Lead Technologist; Hazardous Waste Treatment Facility Closure Permit and Cleanup; Waste Management; Arlington, Oregon. Prepared the closure plan, post-closure plan, and financial requirements for the Resource Conservation and Recovery Act (RCRA), Part B permit application for a hazardous waste treatment and disposal facility. Facilities covered by the permit include hazardous waste landfills, surface impoundments, land treatment areas, an incinerator, drum decant and storage facilities, tanks, and all associated equipment and support buildings. Also developed a conceptual plan and operating procedures for a large-scale land treatment system that included soil amendment, moisture control, application, and monitoring systems based on site investigations. The closure plan included detailed design of a closure cap and a revegetation program.

Technologist; Agricultural Waste Drainage Land Application Feasibility Study; Westlands Irrigation District; San Joaquin Valley, California. Performed site investigations and compiled hydrological data to evaluate the feasibility of land application of agricultural drainage water in the valley, which contains high concentrations of boron and selenium. Developed water balance to size storage, blending, and land application systems and provided conceptual designs.

Technology Leader; Land Farm Hazardous Waste Treatment and Permit; Texaco; Anacortes, Washington. Provided site evaluation and prepared the land treatment demonstrations, land treatment program, and land farm design measures and operating practices for the RCRA, Part B permit application for a hazardous waste treatment land farm for an oil refinery. Also developed provisions for unsaturated zone monitoring and a detection monitoring program. Project included rehabilitating an existing land farm and adding another land farm to the treatment system.

Technologist; Contaminated Steel Tank Rehabilitation, Confidential Client. Resident engineer for rehabilitating a 3-million-gallon steel tank previously painted with lead-based paint. The sand blast grit contaminated by the lead paint was by definition a hazardous waste. Followed RCRA regulations in sampling and analyzing the waste. The sand blast grit was tested and approved as a raw product for manufacturing concrete and was collected and used for construction of a parking area. The site was cleanly closed at a relatively low cost.

Wastewater Facility Plans

Senior Consultant; Waipio Wastewater Pump Station Upgrade; City and County of Honolulu; Honolulu, Hawaii. Senior consultant for review of the Waipio Wastewater Pump Station Upgrade project that considered expansion of an existing pump station from 2.5 mgd to 4.3 mgd. Alternatives included replacement of pumps and motors with wet well modifications and construction of a new pump station.

Senior Consultant; Moilili-Kapahulu Sewer Rehabilitation/Reconstruction; Honolulu, Hawaii. Evaluated methods to increase flow capacity in this critical segment of sewer in Honolulu. The design alternatives report recommendation is for open trench construction of the Date Street Relief Sewer, cured in place pipe lining for rehabilitation of the Moilili-Kapahulu sewer, and 100 percent solids epoxy coating system for manhole rehabilitation. Senior reviewer for the study.

Technology Lead; Regional Wastewater Facilities Master Plan, Phases 1 and 2; Metropolitan Wastewater Management Commission; Eugene and Springfield, Oregon. For Phase 1, evaluated short-term improvements to increase facility efficiency. Identified several projects to improve process performance and reliability and to reduce operations and maintenance costs. Phase 2 required evaluation of growth and facility siting requirements, long-term water quality regulatory compliance, infiltration and inflow program assessment, determination of treatment plant cost-effective peak capacity expansion, alternative disinfection methods, air quality assessment, risk management, and expansion and diversification of the biosolids management program.

Senior Reviewer; Pearl City Wastewater Pump Station Capacity Study; Pearl City, Hawaii. Reviewed design alternatives and evaluated upgrades. Project needed to add flow for the Waiawa Ridge Development. The recommended alternative of a new 48-inch force main 12,500 feet long with an underwater crossing of West Loch of Pearl Harbor could cost $38 million. A 24-inch relief sewer between the discharge manhole of the new force main and Fort Weaver Road is recommended. This 7,000-foot-long 24-inch relief pipeline could cost $10 million and is needed in 2030. The Pearl City pump station upgrade was estimated to cost $34.5 million and is needed in 2019.

Senior Reviewer; Beachwalk Wastewater Pump Station to Ala Moana Park Sewer Phase 1 Force Main System; Honolulu, Hawaii. Reviewed contract documents for bidding construction to ensure consideration of existing facilities in sensitive soil conditions. The proposed 72-inch-diameter tunnel crosses under the existing 42-inch-diameter force main three times with less than 30 feet of separation. The Beachwalk force main is constructed within a formation that is identified to be liquefiable by strong ground shaking. Liquefaction can occur because of vibratory construction equipment in surrounding soils. Special monitoring and construction procedures will be used to protect existing facilities.

Senior Reviewer; Central Oahu Wastewater Facilities and Effluent Reuse Project, Wahiawa Wastewater Treatment Plant Improvements Plan; Hawaii. An objective of building the membrane bioreactor (MBR) plant is to produce reuse water and stop continuous discharge to Wahiawa Lake. The current capacity of the plant is 2.5 mgd (average daily flow). Initially the Central Oahu Park, along with golf courses and other points of application, will use up to 2 million gallons per day of Type R-1 effluent from the Wahiawa Wastewater Treatment Plant.

Project Manager; Large Sewer Structural Condition Assessment Program; City and County of Honolulu, Hawaii. The program identified critical sewers 15 inches to 84 inches in diameter to inspect with manned entry, closed circuit television, pole camera, sonar, and laser profiling to determine condition and need for repair or replacement. Some of the identified sewer segments will be inspected under the assessment contract and others will be inspected under a separate City contract for indefinite deliverables and indefinite quantities for inspection and repairs.

Senior Reviewer; Indefinite Delivery/Indefinite Quantity (IDIQ3) Contracts. Assisted in preparing and reviewing bid documents for IDIQ3 to hire two contractors for sewer inspections including about 10 miles of large-diameter sewer and about 100 miles of pipe in total in the first 18 months with three one-year extensions possible. The inspections will include closed circuit television, sonar, and laser profiling. Met regularly with the currently ongoing IDIQ2 contractors who are inspecting and lining pipe up to 24 inches in diameter and performing spot repairs. Inspected the contractors operations yards and project sites to understand construction processes and limitations that should be considered in future contracts.

Senior Reviewer; Waimalu WWPS Force Main Condition Assessment Report and Rehabilitation Plan. The 44-year-old force main was found to be in good condition and only minor rehabilitation work on the air bleeder manhole and the flow meter vault was recommended.

Senior Reviewer; Sewer Infiltration/Inflow Assessment and Rehabilitation Program Update; City of Honolulu; Honolulu, Hawaii. Initial work is to develop a work plan, perform flow monitoring, and analyze flow data. Subsequent work will be to update (recalibrate) the City's hydraulic model where appropriate, develop flows from population estimated to 2030 and beyond, determine hydraulic capacity limitations, and evaluate the existing hydraulic and structural condition assessments. The plan will determine changes needed in the Capital Improvements Program (CIP) resulting from the hydraulic limitations or the combination of hydraulic and structural condition limitations, including use of deep tunnels leading to the treatment plants.

Technology Leader; Influent Pump Station Assessment; Honouliuli Wastewater Treatment Facility (WWTF); Honouliuli, Hawaii. Performed a study to determine if adequate standby diesel engine power currently exists at the pump station to meet the required pumping demand to prevent spills at the current peak hour flow. It was determined that no new standby power is required at the IPS. However, automatic switch gear should be added to both standby generators. Automatic switch gear should also be added to the clarifier under drain pumps that should also be connected to the IPS standby generator switch gear. A cogeneration system was considered for standby power that would cost about $7 million with design-build procurement. At a power purchase cost of $0.14 per kWh, a one megawatt cogeneration unit could produce power worth about $1 million per year. The cogeneration system should have two engines with generators to be considered as a standby power supply for the IPS. In 2007, the Honouliuli WWTP consumed a total of about 12,500,000 Kwh and the power cost was about $1.8 million. The annual power cost could be reduced by about half with a cogeneration system.

Senior Reviewer; Aliamanu No. 1 and No. 2 Wastewater Pump Stations Upgrade and Sewer Relief Design Alternatives; Hawaii. The report evaluates alternatives of flood control around existing pump stations to reduce inflow and installation of a relief sewer to convey addition flow from inflow. Flood control requires cooperation of the Navy for work on adjacent property and extensive regrading but is the low cost alternative.

Senior Reviewer; Waikiki Sewer Rehabilitation/Reconstruction Design Alternatives; Honolulu, Hawaii. The report evaluated old sewers in the Waikiki section of Honolulu that are 10 feet deep to 15 feet deep in sandy soils in a densely developed area. Some segments require replacing with larger-diameter pipe to accommodate planned flows. Some pipe with adequate hydraulic capacity can be rehabilitated with cured in place pipe lining to minimize disruption. Identified and planned spot repairs.

Senior Review; Aiea Kai Place Sewer Rehabilitation Design Alternatives; Hawaii. The sewer lines in this area are in relatively good condition but will not attain self cleaning because of insufficient slope and flows and the lines have heavy deposits of grease and debris accumulation. The cost of replacing these lines will be very high since they need pile support and the new lines will have similar problems. These lines will need regular cleaning maintenance. The alternative evaluated was a pumped low pressure sewer system.

Senior Reviewer; The Kauhale Street Sewer Rehabilitation Design Alternatives; Hawaii. The system is vitrified clay pipe 50 to 75 years old and was mostly rated as excellent to fair condition by the consultant with the PACP process. Recommended spot repairs and rehabilitation by cured in place pipe lining of one segment.

Senior Reviewer; Waiawa Offsite Sewer Trunk Line; Hawaii. This difficult sewer construction project has 22 of 32 manholes greater than 15 feet deep and six are more than 40 feet deep. The 48-inch-diameter microtunnel project includes an inverted siphon and a connection to an existing pump station. The tunnel in steep terrain has segments with high velocity requiring special drop manholes for energy dissipation.

Senior Reviewer; The Foster Village Sewer Rehabilitation/Reconstruction Draft Design Alternatives; Hawaii. Determined which alternative to recommend in the final report. The evaluation of the 8-inch-diameter sewer considered open cut replacement and rehabilitation with cured in place pipe lining with spot repairs in isolated areas with structural damage.

Senior Reviewer; Kaneohe/Kailua Force Main No. 2 Design Alternatives; Hawaii. The study was for installing new 36-inch-diameter sewer force main by Horizontal Directional Drilling or Microtunneling methods. Installation of 10,000 feet of 42-inch-diameter steel casing or HDPE pipeline by HDD under the bay is unprecedented and is considered highly risky. Further study of modifications to the installation methods was recommended to reduce risk. Construction cost is estimated at about $50 million.

Senior Reviewer; Draft Design Alternatives; Makaha Interceptor Sewer Rehabilitation / Replacement; Hawaii. The sewer needing repair was evaluated for structural integrity and hydraulic capacity to determine which segments could be rehabilitated with lining and which segments require replacement with a larger size pipe.

Senior Reviewer; Wastewater Final Facilities Plan; City of McMinnville; McMinnville, Oregon. Made recommendations for wastewater treatment and reuse alternatives. The wastewater facilities plan was the final step in a planning process that ensured the city's wastewater discharges met the new Yamhill River water quality standards established by DEQ. Studied wastewater management options and recommended a cost-effective and environmentally sound plan to satisfy the planning criteria. Also recommended application rates for effluent irrigation and developed a plan for biosolids handling and reuse. Possible land application sites were reviewed for suitability. Production and application programs were estimated to the year 2015.

Honors and Awards

Academy of Distinguished Engineers; College of Engineering, Oregon Stater Award for distinguished contributions to the profession, OSU, and society at large; Oregon State University, 2009.

Engineering Excellence Award, Water Resources Category, in 1998 from Consulting Engineers of Idaho for Boise City's Twenty Mile South Farm biosolids application program

Honor Award for Engineering Excellence in 1995 from Consulting Engineers Council of Oregon for Potlatch Corporation's Poplar Tree Water Reuse System in Boardman, Oregon

Honor Award for Engineering Excellence in 1994 from American Consulting Engineers Council for City of Woodburn's Poplar Tree Reuse Demonstration System

National Engineering Excellence Award in 1993 from Consulting Engineers Council of Oregon and the American Consulting Engineers Council for Waste Management's Poplar Tree Irrigation System at Riverbend Landfill in McMinnville, Oregon

The Irrigation Association's National Award for Water and Energy Conservation in 1984, jointly awarded to CH2M HILL and the Eastern Oregon Farming Company

Professional Organizations / Affiliations

United States Committee for Irrigation and Drainage; Urban Uses Committee member
American Society of Agricultural Engineers
Water Environment Federation
The Irrigation Association
Oregon Water Resources Congress
Oregon Association of Clean Water Agencies; Reuse Committee member

Publications and Presentations

Contributing Author, "Design and Operation of Farm Irrigation Systems, 2nd Edition" (863 pages). ASABE Publication. 2007. ISBN: 1-892769-64-6

Contributing Author, "Phytoremdiation – Transformation and Control of Contaminants," (987 pages). Wiely Inter-Science. 2003. ISBN: 0-471-39435-1

Contributing Author, "Water Use and Reuse in Industries of the Future." Chapter for Industrial Water Management: A Systems Approach, 2nd Edition. Prepared under contract to Center for Waste Reduction Technologies for U.S. Department of Energy, American Institute of Chemical Engineers, 3 Park Avenue, New York, NY 10016. July 2003.

With Derrel L. Martin and Dale F. Heermann, USDA; 2007. Hydraulics of Sprinkler and Microirrigation Systems. Published by the American Society of Agricultural and Biological Engineers. Vol. 4: 620-645. August 2007. www.asabe.org.

ASABE Proceedings Contributing Author with J. K. Smesrud, J. L. Jordahl, R. Jackson. Proceedings of the Eighth International Drainage Symposium, Drainage VIII. March 21-24, 2004. Sacramento, California.

With Chung-Shih, Wenhao H. Sun, Marisa Toma, Francoise M. Robert, and Ryan K. Jones. 2004. Evaluation of Agriculture-Based Phytoremediation in Pacific Island Ecosystems Using Trisector Planters. International Journal of Phytoremediation, 6(1):77-33

With J.L. Jordahl, J.K. Smesrud, H.M. Emond, and M.Q. Cotten. Waste Management Using Trees: Wastewater, Leachate, and Groundwater Irrigation. Presented at the AEES 45th Conference on Phytoremediation. June 11, 2004.

With Henriette Emond and J. Jordahl. Reuse System Utilizing Saline, Sodic Wastewater: Pueblo of Acoma, New Mexico. Presented at the Water Environment Federation's 76th Annual Technical Exhibition and Conference. Los Angeles, California. October 10–15, 2003.

With Henriette Emond, J. Smesrud, M.Q. Motte, and F. Sinclair. City of Woodburn Land Applies Liquid and Dewatered Biosolids, Facultative Sludge Lagoon Supernatant, and Effluent on Hybrid Poplar Trees. Presented at the Water Environment Federation's 76th Annual Technical Exhibition and Conference. Los Angeles, California. October 10–15, 2003.

With Henriette Emond. Natural Treatment Systems TMDLs, Temperature Management Plans, and Reuse. Presented at the Pacific Northwest Clean Water Association: Water Environment School. Oregon City, Oregon. March 25–27, 2003.

With Henriette Emond. Biosolids Effects on Poplars. Presented at the Pacific Northwest Clean Water Association: Water Environment School. Oregon City, Oregon. March 25–27, 2003.

With Jim Jordahl, J.K. Smesrud, H.O. Emond, and M.Q. Motte. "Waste Management Using Trees: Wastewater, Leachate, and Groundwater Irrigation." Phytoremediation: Transformation and Control of Contaminants. To be published by John Wiley and Sons, Inc., 2003.

With Jason Smesrud, J. Jordahl, and G. Duvendack. Drip Irrigation of Landfill Leachate to Hybrid Poplars. Presented at the 2002 Pacific Northwest Clean Water Association Annual Meeting, Yakima, Washington. October 21, 2002.

With Henriette Emond and D. Whitaker of CH2M HILL and J. Russell and F. Kessler of City of Salem, Oregon. A Multifaceted Natural Reclamation System for Wastewater Treatment and Reuse—An Update. Presented at the Water Environment Federation WEFTEC Conference. September 28–October 2, 2002.

With Henriette Emond and D. Whitaker of CH2M HILL and J. Russell and F. Kessler of City of Salem, Oregon. A Multifaceted Natural Reclamation System for Wastewater Treatment and Reuse. Presented at Wetlands and Remediation, Batelle Second International Conference. Burlington, Vermont. September 5–6, 2001.

With Rich Coles, R. Harasick, T. Schade, J. Nelson, and G. Hille. Partnering Makes the Owens Lake Project Feasible. Presented at Water Environment Federation WEFTEC Conference. September 2002.

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With Quitterie Motte, J.K. Smesrud, J.L. Jordahl, R. Coles, and R. Harasick. Subsurface Drip Irrigation System for Dust Control with Irrigated Saltgrass at Owens Lake. Presented at 2001 Annual Agronomy Society of America Conference, Charlotte, North Carolina. October 2001.

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With Jason Smesrud, J.H. Dickey, S. Asare, A.L. Lanier, and J.L. Jordahl. Beneficial Reuse of Landfill Leachate by Hybrid Poplar. Presented at Food and Agriculture Organization of the United Nations International Poplar Conference, Portland, Oregon. September 2000.

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Exhibit B

Review Comments – July 23, 2014, Version of Waste Management Plan for Hawai'i Dairy Farms, Maha'ulepu

PREPARED FOR: Lisa Bail and Lisa Munger/Goodsill Anderson Quinn & Stifel
COPY TO: Jim Jordahl/CH2M HILL
PREPARED BY: Mark Madison/CH2M HILL
DATE: August 21, 2014

Overview: This document reflects my preliminary comments on Hawai'i Dairy Farms' Waste Management Plan dated July 23, 2014. Please be advised that additional comments are forthcoming, as due to the shortness of time, I was unable to complete my review of the Plan in its entirety. My comments below are organized by sections of the Waste Management Plan (referenced by section number).

- 1.0 Zero point source discharge only means that the waste does not discharge from a pipe into the environment. Non-point source discharge will distribute the waste over a large area and discharge to the environment may be equal in mass as a point source discharge. The impact to the environment from non-point source discharges should be evaluated by the Wastewater Branch in its review of the Management Plan ("Plan").
- 1.0 "1.3 animals per acre or 699 milking cows (grazing on ,...,517 acres)". This is only 0.77 acres per cow per year with 20 tons/acre is about 15 tons of pasture grass per cow per year, which is not consistent with feed needed for milk yield estimates. Of course, upon full build-out of the dairy's operation with 2,000 cows, the number of acres per cow and the corresponding amount of pasture grass per cow will be even less.
- 1.0 "Effluent Pond....will contain roughly 100 days of storage capacity." This storage capacity is only available when the pond is empty, which only occurs until the first milking. The Plan does not address how many days of capacity to hold additional manure is available on a normal operating scenario and how many days during wet weather when the effluent can't be land applied.
- 1.0 "The cows spend 22 hours in the paddock and only 2 hours in the milking area each day." The nutrient management calculations are for the manure from the cows for only 2 hours per day. The majority of the manure and nitrogen is directly discharged by the cattle onto the pasture. The plan underestimates the amount of manure and nitrogen on the pasture which can be moved by irrigation water and storm water to surface streams or groundwater aquifers.
- 1.0 "A small plot of land in the lower center of the valley is currently used for taro lo' i and will continue to be leased and farmed after the dairy and related pastures are in full operation." The center of the valley will have manure runoff during storm events. The Plan does not address this run-off or the impact of manure on the food value of Taro.
- 1.0 The cow cemetery is very near a stream in an area likely to have high seasonal perched groundwater. The Plan does not address the impact to groundwater of

decomposing animals being leached by storm water infiltration percolating to groundwater. The Plan should provide the total number of animals that will be buried on site in a typical year and in total over 20 years of operations.

- 2.2.1 Figure 5 indicates that many natural water courses are canals or ditches. Although the streams may have been straightened or cleaned in segments that cross the farm, they are still natural water courses and contain Waters of the State protected with water quality standards. The Plan does not address how non-point source discharges to these waters will affect aquatic habitat on the farm and downstream.
- 2.2.2 The Palustrine and Riverine wetlands within the site receive water from runoff and groundwater originating in the pastures. The Plan should address how the manure on the pastures that dissolves and moves with the water or is carried in storm water from large events like the 25 yr 24 hr storm will affect the wetlands flora and fauna and ecosystem functions.
- 2.2.3 The site makes up a significant portion of the watershed that feeds the groundwater aquifer under the site. The site has always had infiltration that enters the aquifer and will continue to be part of the aquifer recharge zone regardless of site management. All wells within the aquifer recharged by the farm must be shown on the map and well logs must be attached to the plan to allow risk assessment for every water user. Additional community drinking water wells exist within the aquifer recharged by the Dairy that are not discussed or shown of the map. The aquifer flow direction and recharge rate need to be calculated to define the amount of water from the site that contributes to flow from each well. In addition, the impact of nitrate, bacteria, and manure constituents that leach through the pastures on the public drinking water well Koloa F, which is less than ½ mile away from manure application fields, should be addressed. An appropriate discussion would include the travel time of nitrate in the aquifer, the cone of depression and zone of immediate recharge for the public water supply wells, and where the groundwater recharged by the Dairy discharges to wetlands, stream, and coastal shorelines. This Plan can't be properly reviewed without a detailed groundwater study.
- 2.3.1 "The average monthly precipitation depths will be used for sizing of the waste management systems and irrigation scheduling as required by the standards." Best management practices would consider daily precipitation for irrigation scheduling and waste management. Peak rainfall events and extended storms are the primary risk for waste management and they will be much greater than monthly average precipitation. The irrigation schedule should be adjusted for greater than average rainfall.
- 2.3.1 "The 25-year 24-hour precipitation data will be used for sizing of waste management systems as required by the standards." The Plan needs to identify which specific components of the waste management system are sized for the 25 yr. 24-hour storm as opposed to the statement in 2.3.1 that the waste management system is sized for the average monthly precipitation. The peak storm discharges over twice the monthly average of most months in only one day which will overwhelm a system designed for average monthly precipitation.
- 2.3.3 In September of 1996 there were 6 days of continuous rainfall followed by one week of non-continuous rainfall then immediately followed by 7 days of continuous rainfall. The

available storage in the manure and effluent storage basins during normal operations does not appear to be adequate to store during a prolonged period of rain followed by a short duration for saturated soils to dry enough for land application immediately followed by another extended period of continuous rainfall. This situation will force operators to apply during rainfall or before adequate drying which will result in runoff to surface water and deep percolation to the aquifer.

- 2.5 The soils data presented in the Plan appears to be a selected set of general conditions that does not inform the reader of the limitations of the site soils. I have attached both the entire site soils report as an exhibit (Exhibit E) and extracted pertinent sections (Exhibit D) that must be included as part of the Dairy's Plan to identify limitations so discussion of management within these limitations can be presented.
- The custom soil resources report (Exhibit E) was created for the specific area of Kauai that includes the proposed Dairy Operation and is much more detailed than the general information presented in the Plan. Yellow highlight was added to emphasize data that are in direct conflict with the Plan's claims that soils are suitable for an intensive confined animal feeding operation and animal waste disposal with land application and irrigation of effluent. The proposed Dairy Operation is situated on soils that are very limiting for land application of animal waste. An intensive animal waste management program for 699 cows on this site should not be allowed. A waste management program on this site will likely result in contamination of groundwater that is extracted by community wells within the aquifer recharged by the farm. Surface runoff from this site will contain manure contaminants that will be conveyed to streams, wetlands, and coastal waters.
- 4.1 The manure and urine that is deposited on the walkways and races is not accounted for in the nutrient balance. The Plan should state the amount of manure and urine that is deposited in these intensive use areas and describe its fate.
- 4.2.1 The Plan should state how many calves are on site at all times and describe the fate of their contaminated bedding and manure that is not presently defined or accounted for in the Plan.
- 4.2.4 The Plan should provide information concerning the nutrient content of feed that is wasted, how much waste feed is disposed of on the farm, the hormones, pharmaceuticals, and pesticides that are used on the Dairy and the ultimate annual usage at the Dairy of each. The ultimate fate of waste, and urine pass-through of pharmaceuticals, should be included.
- 5.0 The Plan should provide information concerning how much waste milk is produced annually and how is it disposed.
- 6.1 It is my professional opinion that a center pivot irrigation machine spraying effluent should never be permitted to cross a stream even with variable rate precision technology. I am very familiar with this technology and the frequency of failures of the wireless communication links, PC control, GPS control, very small valves at each nozzle that stick and fail open, and other normal mechanical failures that make it certain that at some times the pivot will discharge manure directly into the stream. No center pivot machines are 100% reliable and the complexity of the variable rate technology increases the failure rate of these special machines to several times that of standard pivots. If this equipment is used

nonetheless, the Plan should detail how the manure content of the stream will be measured and what operational shut downs will be triggered by manure in the stream.

- 6.2 It is my professional opinion that drip tape cannot be used in a cattle pasture. Drip tape is a one-use thin wall tape intended for crops such as vegetables with 6 month growing seasons and then tape disposal and replacement. Drip tape buried in pasture will fail with extensive leaks after cattle walk over it during the first large rain event. Heavy wall drip tube buried 12 inches deep will also have extensive cattle hoof damage and drip tube 12 inches deep is too deep to start new plants on the soil types on the site. Drip irrigation is not a feasible technology for cattle pastures that have cattle on them during heavy rainfall with the soils on this site. If drip tape is used nonetheless, the Plan should detail how the leaks will be detected at depth and how the aquifer will be monitored to know when the effluent has entered it.
- 6.2 Subsurface drip irrigation tubes under pastures with cattle grazing are often damaged by hooves sinking into saturated soils during extreme rainfall events. Cattle hooves will easily crush and cut any type of drip tubing. If such tubes are used nonetheless, the Plan should detail how drip tube leaks will be located and repaired, how long it will be before a cut drip tube can be located and repaired, how wastewater in groundwater will be monitored, and how much wastewater in groundwater will trigger a corrective action.
- 6.4 Irrigation setbacks must be defined as zones that no irrigation equipment can enter or cross. It is not acceptable to have a setback that an irrigation machine crosses while spraying effluent on part of the machine and if all systems are not perfect on the setback area. Perfect operation continuously over the life of the project will not occur with variable rate technology pivots. Partial circle pivots with physical stop barriers should be used on each side of the buffered streams so it is not physically possible for the irrigation equipment to enter the stream and fail. If equipment will enter the irrigation setbacks, the Plan must disclose how often the buffer and the streams will be penetrated by the variable rate pivot machine on an annual basis, the amount of manure that will drip off the machine even after the nozzles are turned off and the modifications to be made to the stream bed and riparian buffer wetlands to allow the wheels of the pivot machine to cross during all flow conditions without getting stuck.
- 6.4 Irrigation setbacks are intended to eliminate the potential for surface water runoff or wind drift spray to enter protected areas. The regional wind data and wind rose indicates that with center pivot irrigation and low pressure spray sprinklers significant water will blow much further than 50 feet into streams and 20 feet into the Taro field. Winds with velocity sufficient to blow sprinkler mist into and across the buffers occur on a regular basis for multiple months. Surface runoff will also exceed these flow distances during unexpected thunderstorms when the irrigation system is on or has recently irrigated near the buffers. The Plan should identify the wind speed beyond which irrigation will be terminated such that mist will not blow across buffers, and how wind speed will be monitored.
- 6.5 Irrigation demand is not calculated correctly in the Plan, and no supporting information or data is provided to allow review. This section is critical and can't be approved or even reviewed without much more data. Irrigation demand is never a constant, yet the Plan states: "**Irrigation water demand is based on a rate of 6 mm/0.24**

inches per day over the irrigated area." Irrigation demand is different on every soil type every day of the year based upon complex climatological data even for the same monoculture. Irrigation demand can be calculated for the 30 years of weather data to determine the statistically probable demand per day, week, and month. The irrigation demand from month to month likely changes by over 100%, and a "one number fits every day" design will fail. As but one example, the Plan fails to consider how much runoff will occur when the site is irrigated at an average annual demand when the actual demand is half that amount.

- 6.1 [sic] The section titled "Irrigation Schedule" is misleading since only general statements about irrigation are made and no schedule of irrigations is presented. A proper irrigation schedule for a wastewater management plan will include daily operations of each irrigation machine, soil moisture budget, monitoring targets, and rainfall contingencies. A wastewater management irrigation schedule is not based upon monthly average data. The plan defines a mostly dry day as less than 0.125" of rainfall but a full irrigation day is only 0.25 inches of effluent. Counting days with 50% of full irrigation as the definition of dry periods requires the duration of a dry period before irrigation is allowed to be double the amount presented. The rainfall data presented shows that there is more water applied by rain than used by the crop in December. The soil will be saturated with rainfall, in addition to the irrigation in November, and will not have capacity to hold additional water except during periods between rainstorms when it will dry only enough to hold the next rain storm. Soil water depletion to a level that requires irrigation for maximum crop yields will not occur in December. Excess water will runoff to surface water or percolate to groundwater. The soil moisture storage capacity will not be depleted to a level that allows any irrigation in December. The site will have surface water runoff and groundwater recharge in December without any irrigation and any amount of irrigation will add directly to the total amount of surface water runoff and groundwater recharge. A root zone soil moisture storage, depletion, and replenishment water balance is a critical part of a wastewater irrigation schedule and must be presented to allow evaluation of an irrigation plan. Data presented shows that January only requires 0.07" of irrigation properly timed with rainfall to meet crop demand without runoff or groundwater recharge. This is only about 1 hour of irrigation per month required. All additional water applied will directly result in additional surface water runoff to streams and groundwater recharge. The Plan must disclose how much runoff and recharge will be allowed per month, how much nitrate and bacteria will be allowed in the runoff and aquifer recharge before corrective action is triggered, what corrective action will be implemented when the off-site contamination exceeds the target level and how will steam water quality and groundwater aquifer quality impacts will be monitored.
- 6.1 "In the case of a continuously wet period that keeps soil at capacity, (the longest on 30-year record is 17 days) the irrigators can be programmed to drop effluent water only and at a rate as low as 0.04 inches, and the placement of the effluent water can be targeted to the freest draining soils on the farm. A target zone for an exceptionally wet season application is paddocks 111 - 115, where the Lualualei Clay soil is classified as "well drained" and a raceway (acting as a berm) separates the paddocks from any water ways." This statement is a direct admission of intentional groundwater recharge with effluent through saturated well drained soils when the site does not have irrigation needs in December and

January. It appears that the amount of groundwater recharge is equal to the amount of effluent that can't be held in the full storage lagoons over the two months that do not require irrigation when the soil water storage of rainfall is properly considered. Groundwater recharge with effluent is not acceptable in an aquifer with community drinking water wells.

- 7.1 This section accounts for manure for the two hours per day that the cows are in milking. The non-milking waking hours of 14 hours per day will also produce 87,654 pounds of manure that is directly deposited on the pasture. A 3 acre paddock with 115 cows on it will receive 4,807 pounds per acre per day of fresh manure application. The immediate concentration of manure nitrogen and other nutrients will greatly exceed the daily nutrient needs of the grass. The fresh manure will be applied every 18 days, and even though it may not exceed annual nutrient needs for the crop, it will greatly exceed nutrient needs the week that it is applied. The excess manure and nutrients will be readily available to runoff with irrigation and rainfall and percolate into groundwater. The excess irrigation planned for December and January when rainfall is enough to provide full crop water needs will certainly create discharge of manure at least one day per 18 day rotation when the cows apply 4,807 pounds/day/acre of fresh manure plus irrigation plus rainfall.
- 7.2 "Ponds will have minimal potential impacts from breach of embankment, accidental release, and liner failure." Any breach of embankment, accidental release, or liner failure will have a catastrophic impact on surface water streams, the aquifer, and coastal waters. The amount of storage in the settling pond and storage pond is not identified as minimum available storage which is the critical criteria. The size of the pond is less important than the amount of empty space that is available for buffer when the pond is full and ready to be emptied but unexpected rainfall requires additional storage. The pond suitability can't be evaluated with the information presented. At a minimum, the Plan needs to describe how much empty storage volume is available in each pond when the pond is full and ready to be cleaned out, whether the storage pond is emptied completely every 30 days regardless of weather, how much effluent must be discharged in December when there is no need for irrigation all month, and whether the settling pond performance changes when the "spare volume" in the storage pond is used during wet periods and the stored effluent backs up into the settling pond through the overflow pipes.
- 7.3 The Plan should state whether the emergency overflow containment area will have a liner.
- 7.4 "The best time to apply the effluent water is just after the cows have finished grazing, allowing 17days for the grass to utilize the nutrients before the cows next enter the paddock" This is actually the worst time to irrigate from an environmental protection perspective. The fresh manure will be most easily dissolved and mobilized with irrigation water that will runoff and create high nutrient percolation into the soil which is available for plant uptake but also deep percolation below the root zone. The Plan must disclose how the pivots that cover multiple soil types will be managed to not exceed the water holding capacity of every soil which is different and varies with plant uptake, rainfall, and soil depth and properties and the trigger point to stop irrigation if the soil moisture monitors indicate high moisture.

- 7.4 "Nonetheless, if a cataclysmic storm was forecast, the time to completely empty the storage pond, if it were full, is around 96 hours. If warranted due to potential impact from the approaching storm event, the settling pond could also be pumped empty within an additional 40 hours. If the forecasted storm is forecast six days prior, then virtually no effluent would remain in storage when the storm arrives." This statement is from a similar philosophy of management as the statement that, in December when irrigation needs are not enough, the excess effluent can be discharged to paddocks 111 to 115 because they are on well drained soils. Well drained soils with excess irrigation will recharge groundwater with effluent. Emptying the storage pond and settling pond because an extreme rain event is approaching will cause nearly all of the manure applied to soils (that are already wet) to be conveyed to streams and aquifers when the storm saturates the site and creates extreme runoff. If the ponds are emptied onto the fields before a major storm event, a point source discharge may be avoided but a major non-point source discharge will occur and in fact it appears that the site manager plans to create this worst case scenario as a standard procedure. This Plan can't be approved with intentional transfer of waste to the environment when extreme weather is approaching.
- 7.4 The gun application of manure is the single worst technology choice from the perspective of odor control. High pressure guns with high trajectory and a 65 feet spray radius spraying manure and dispensing a mist in the atmosphere that can drift for miles on a windy day are the poster child of neighbor odor complaints worldwide. If this method is used nonetheless, the Plan should identify the odor threshold at which operation of the big gun will be shut down when wind blows toward neighbors. An application rate of 9mm/hr exceeds the infiltration rate of some soils and will create runoff into streams. If this method is used nonetheless, the Plan should also describe how runoff will be monitored and controlled on low infiltration rate soils.
- 8.0 "Planned nutrient application rates were also compared to the Hawai'i NRCS 590 Nutrient Management Standard. This standard insures that the total amount of nutrients applied is not at a risk for nitrogen leaching or phosphorus indexing." The total annual nutrient loading rates are explained but the author appears to not understand that the primary risk is the immediate risk of high rate applications plus rainfall and irrigation even if the applications are infrequent. Application rates exceed soil infiltration rates. Applications are planned during December when the site soils are nearly always at field capacity and loadings proposed will generate deep percolation and runoff. A detailed soil water balance is required to prepare a waste management plan with any authority. A site soil investigation with test pits and samples to compare detailed soil survey data with actual field conditions is required to produce a plan that represents the actual site conditions and fully utilized the capacity of the specific soils while accommodating the limitations. This Plan cannot be approved because is too general in the most critical areas of data acquisition and utilization to support loading and management calculations.
- 8.2 "The effluent is highly diluted, to the extent that it will have next to no odor in the storage pond and certainly no odor at the farm boundary. The settling pond will also be aerated to help mitigate odor. To help further mitigate any odors arising from the facility a Windbreak / Shelterbelt (i.e. a multiple row planting of trees) will be established along the prevailing wind pattern of the pond." All dairies have odor at the farm boundary. Windbreaks can have a visual benefit and an immediate downwind benefit that exists

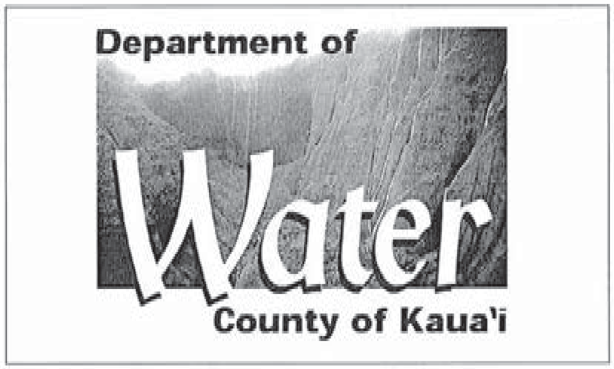
within the wind shadow that is usually only a few hundred feet. The odor further downwind is not improved by a windbreak. The Plan should explain how odor from pivots and big guns will be mitigated and monitored, and what odor threshold will create management change.

- 8.2 "Due to the high moisture and moderate temperatures, the microbial activity in the thatch is very high and the effluent will be largely broken down by microbial activity within 24 hours." This is not a true statement. Effluent nutrients are applied infrequently in large doses that will exceed microbial capacity to degrade nutrients. The effluent will flow through the microbial mat rapidly and infiltrate the soil or runoff. The breakdown of nutrients will occur over months and organic nitrogen will mineralize with some carry over occurring up to a year after application.
- 8.4.1 The nitrogen leaching potential must include rainfall plus irrigation which will totally change the results. Using only rainfall data is not correct for a fully irrigated site.
- 8.4.3 "However, less than two days after heavy rain, with rapid removal of the surface water during and after a significant rain event, they are observed as being dry enough to graze, even without a Kikuyu thatch." Rapid removal of water from the clay soil is equal to saying that there will be high rates of runoff. Such runoff should not be allowed.

Exhibit C

Water Quality Report

Covering the period of January 1, 2013 to December 31, 2013



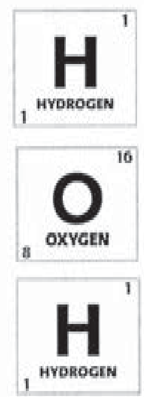
Kaua'i Department of Water
Kalaheo-Koloa Water System
2014

This report by the Kaua'i Department of Water describes the quality and source of your drinking water. The Safe Drinking Water Act, a federal law, requires water utilities to provide water quality information to its customers every year.

Providing safe drinking water is a complex business, but you and your neighbors have a right to know the results of our water quality monitoring. Safe drinking water is essential to our community. Your water is tested regularly through our certified laboratories and the State Department of Health.

In summary, our drinking water meets, or is better than, state and federal standards. We spend in excess of $400,000 in chemical and microbial testing each year to assure the safety of your water.

A Source Water Assessment, intended to enable "well-founded, fair and reasonable decisions for the protection and preservation of Hawai'i's drinking water" has been completed by the State Department of Health and the University of Hawai'i. For Further information on this assessment, please contact the Department of Water at (808) 245-5455



We welcome your interest in the Department of Water's water system. Please refer to the directory in this publication for the Department's phone numbers. Also, the Water Board normally meets on the fourthThursday of each month, and their meetings are open to the public. Please call (808) 245-5408 for the time, date and location.

Clyde Nakaya
Chairperson, Board of Water Supply

Kirk Saiki, P.E.
Acting Manager and Chief Engineer

Why am I getting this brochure?
The Safe Drinking Water Act has been amended to require water systems to provide its customers with an annual report of the quality of their drinking water. This brochure is a snapshot of the quality of the water we provided last year. Included are details about where your water comes from, what it contains and how it compares to Environmental Protection Agency (EPA) and state standards.

We are committed to providing you with information because informed customers are our best allies.

Is my drinking water safe?
Yes. The Department of Water regularly conducts microbiological analysis and has contracted for extensive chemical testing in order to comply with Environmental Protection Agency (EPA) and Hawai'i State standards. The standards are very strict in order to ensure safe drinking water.

Where does my water come from?
Your water comes from ground water ***(underground)*** sources. Rain that falls in the mountain filters through the ground into formations called aquifers. Wells are drilled into these formations and the water is pumped out. These formations can also be found in the mountains ***(still considered ground water)***. Tunnels are constructed to tap these sources. The quality of groundwater is very good and requires no treatment except for disinfection ***(as opposed to surface water sources that require filtration and stronger disinfection).***

The water supply for the Kalaheo-Koloa Water System water system comes from the following sources:

Kalaheo Area
Kalaheo Deepwell A — ***Kalaheo Deepwell B***

Lawa'i-Oma'o Area
Lawa'i Well No. 1 — ***Lawa'i Well No. 2***
Piwai Wells No. 2 & 3

Koloa-Po'ipu Area
Kolao Wells 16-A & 16-B — ***Koloa Wells C, D, E & F***

All of the water is chlorinated and pumped into the distribution system or stored in the following tanks:

Kalaheo Area

Kalaheo Nursery
100,000 gallon tank

Kalaheo Clear Well Storage Tank
300,000 gallon tank

Kuku'iolono #1
250,000 gallon tank

Kuku'iolono #2
200,000 gallon tank

Kakela Makai
200,000 gallon tank

Kalaheo 908 Tank
500,000 gallon tank

Lawa'i-Oma'o Area

Andrade Tank
30,000 gallon tank

Lawa'i
250,000 gallon tank

Piwai
100,000 gallon tank

Koloa-Po'ipu Area

Koloa
1,000,000 gallon tank

Koloa (Pa'anao)
250,000 gallon tank

Po'ipu
1,500,000 gallon tanks @ 2 each

Paanau No. 2
500,000 gallon tank

Oma'o Tank
500,000 gallon tank

How do contaminants get into our drinking water?

The sources of drinking water ***(both tap water and bottled water)*** include rivers, lakes, streams, ponds, reservoirs, springs and wells.

As water travels over the surface of the land or through the ground, it dissolves naturally occurring minerals and, in some cases, radioactive material, and can pick up substances resulting from the presence of animals or from human activity.

Therefore, drinking water, including bottled water may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that the water poses a health risk.

Contaminants that may be present in source water before we treat it include:

Microbial contaminants: Viruses and bacteria from sewage treatment plants, septic systems, agricultural livestock operations and wildlife.

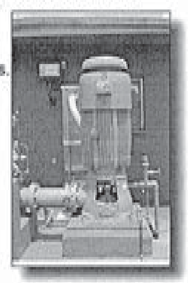
Inorganic contaminants: Salts and metals which can be naturally occurring or from other sources, such as urban storm water runoff, industrial or domestic wastewater discharges, oil and gas production, mining or farming.

Pesticides and herbicides: Variety of sources such as agriculture, urban storm water runoff and residential uses.

Radioactive contaminants: Naturally occurring.

Organic chemical contaminants: Synthetic and volatile organic chemicals, by-products of industrial processes and petroleum production, also from gas stations, urban storm water runoff, and septic systems.

To ensure safe tap water, EPA sets limits on these substances in water provided by public water systems.

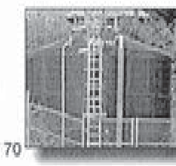


Should I take special precautions?

Some people may be more vulnerable to contaminants in drinking water than the general population. Immuno-compromised persons such as persons with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune system disorders,some elderly and infants can be particularly at risk from infections. These people should seek advice about drinking water from their healthcare providers.

EPA/CDC (Centers for Disease Control) guidelines on appropriate means to lessen the risk of infection by ***Cryptosporidium*** and other microbial contaminants are available from EPA's Safe Drinking Water Hotline (1-800-426-4791).

More information about contaminants can also be obtained by calling the EPA's Hotline.



Other Frequently Asked Questions:

What is the pH of my water?
The pH of your water in the Kalaheo-Koloa area can range from 7.3 to 7.8.

What is the hardness of my water?
The hardness of your water can range from 60 to 70 ppm.

Why do I notice off-odors or taste in my water?
Sometimes if water in your house is not used, the microbes in the pipes can grow and cause odors and funny taste. Flushing the water can resolve this problem. Water should be flushed in the morning or when not used for an extended period of time.

What causes my water to look milky when it comes out of the faucet?
Air trapped in the water lines causes this problem. Let the water sit in a glass. The water becomes clear from the bottom up if air is the cause. The water is safe to drink.

Why is chlorine added to my water?
Chlorine is added to control microbe levels in the water distribution system to keep the water safe. The chlorine level ranges between 0.1 to 0.5 ppm. The small amounts of chlorine in the water do not pose a health hazard. If you want to remove chlorine, either let it sit for a while or filter it through an activated carbon filter.

Water Quality Data

We are required to test your tap water for:

- Different types of chemical contaminants: Regulated contaminants, each with a maximum contaminant level (MCL) and a maximum contaminant level goal (MCLG); and unregulated contaminants, which don't have maximum contaminant levels.

- Coliform bacteria.

- Heavy metals (lead and copper).

Remember that just because these contaminants may be present in your water, it doesn't mean your water has a health risk.

This past year, we tested your water for a wide array of contaminants. Most of them were not found in your water, and only those that we found are reported in the test results section that follows.

Regulated Contaminants

Microbiological Contaminants
Total Coliform Bacteria
Fecal Coliform Bacteria

Radioactive Contaminants
Alpha emitters
Beta/photon emitters
Radium

Inorganic Contaminants
Antimony
Arsenic
Asbestos
Barium
Beryllium
Cadmium
Chromium
Copper
Cyanide
Fluoride
Lead
Mercury
Nitrate
Nitrite
Selenium
Thallium

Organic Contaminants
2,4-D
2,4,5-TP [Silvex]
Acrylamide
Alachlor
Atrazine
Benzo(a)pyrene
Carbofuran
Chlordane
Dalapon
Di(2-ethylhexyl) adipate
Di(2-ethylhexyl) phthalate
Dibromochloropropane
Dinoseb
Diquat
Dioxin
Endothall
Endrin
Epichlorohydrin
Ethylene dibromide
Glyphosate
Heptachlor
Heptachlor epoxide
Hexachlorobenzene
Hexachlorocyclopentadiene
Lindane
Methoxychlor
Oxamyl [Vydate]
PCBs [Polychlorinated biphenyls]
Pentachlorophenol
Picloram
Simazine
Toxaphene

Volatile Organic Contaminants
Benzene
Carbon tetrachloride
Chlorobenzene
o-Dichlorobenzene
p-Dichlorobenzene
1,2-Dichloroethane
1,1-Dichloroethylene
cis-1,2-Dichloroethylene
trans-1,2-Dichloroethylene
Dichloromethane
1,2-Dichloropropane
Ethylbenzene
HAA (Haloacetic Acid)
Styrene
Tetrachloroethylene
1,2,4-Trichlorobenzene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Trichloroethylene
1,2,3-Trichloropropane
TTHMs [Total trihalomethanes]
Toluene
Vinyl Chloride
Xylenes

Unregulated Contaminants

2,4,5-T
2,4-DB
Aldicarb
Aldicarb sulfone
Aldicarb sulfoxide
Aldrin
Butachlor
Carbaryl
Dicamba
Dieldrin
3-Hydroxycarbofurom
Methiocarb
Methomyl
Metolachlor
Metribuzin
Molinate
Nickel
Paraquat
Propachlor
Propoxur
Thiobencarb

Unregulated Contaminant Monitoring Rule 3

(CCCMR3)

1,3 - Butadiene
Chloromethane
1,1 - Dichloroethane
Bromomethane
Chlorodifluoromethane
Bromochloromethane
1,4 - Dioxane
Vanadium
Molybdenum
Cobalt
Strontium
Chromium - 6
Chlorate
Perfluorooctanesulfonic Acid
Perfluorononanoic Acid
Perfluorooctanoic Acid
Perfluorohexanesulfonic Acid
Perfluoroheptanoic Acid
Perfluorobutanesulfonic Acid

Results:

The following tables list all the drinking water contaminants that were found in 2013. Unless otherwise noted, the data presented in the following tables are from testing done January 1 - December 31, 2013

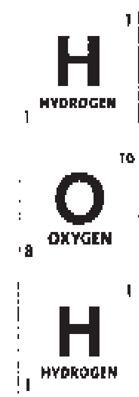
The State requires us to monitor for certain contaminants less than once per year because the concentrations of these contaminants are not expected to vary from year to year. Thus, some of the data, though representative of the water quality, is more than one year old

Terms and abbreviations used below:

Maximum Contaminant Level Goal (MCLG): is the level of contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety

Maximum Contaminant Level (MCL): the highest level of a contaminant that is allowed in drinking water. MCLs are set as close to the MCLGs as feasible using the best available treatment technology

Action Level (AL): the concentration of a contaminant which, when exceeded, triggers treatment or other requirements which a water system must follow



n/a not applicable

nd not detectable at testing limit

ppm parts per million or milligrams per liter (corresponds to one penny in $10,000)

ppb parts per billion or micrograms per liter (corresponds to one penny in $10 000 000).

pCi/L picocuries per liter (a measure of radiation)

mrem/year millirems per year (a measure of radiation exposure)

Microbiological Contaminants:

Substance	Highest Level Allowed (MCL)	EPA MCLG	Highest Monthly # of Positive Samples	Date	Violation	Source of Contaminant
Total Coliform Bacteria	No More than one sample per month is positive	0	1	2014	No	Naturally present in the environment

Inorganic Contaminants:

Substance	Highest Level Allowed (MCL)	EPA MCLG	Highest Level Detected	Detection Range	Date	Violation	Source of Contaminant
Chromium (ppb)	100	100	2.6	ND - 2.6	2011	No	Erosion of natural deposits
Nitrate (ppm)	10	10	0.7	0.3 - 0.9	2014	No	Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits

Organic Contaminants:

Substance	Highest Level Allowed (MCL)	EPA MCLG	Highest Level Detected	Detection Range	Date	Violation	Source of Contaminant
TTHMs (total trihalomethanes) (ppb)	80	NA	8	ND - 8	2014	No	By-product of drinking water chlorination
Trichloropropane (ppb)	0.6	NA	0.24	ND - 0.24	2014	No	Contaminant in pesticides used in soil fumigation

Lead and Copper Rule Compliance:

Substance	Action Level	MCLG	Highest Level Detected	# of Sites Sampled	# of Sites Found Above the AL	Date	Source of Contaminant
Lead (ppb)	15	0	ND	11	0	2012	Corrosion of household plumbing systems
Copper (ppm)	1.3	1.3	0.08	11	0	2012	Corrosion of household plumbing systems

[illegible]

Unregulated Contaminants:

Substance	Highest Level Allowed (MCL)	EPA MCLG	Highest Level Detected	Detection Range	Date	Violation	Source of Contaminant
Chlorate (ppb)	-	-	68	55-68	2014	No	Disinfection by-product
Chromium 6 (ppb)	-	-	2.8	1.9 - 2.8	2014	No	Erosion of natural deposits
Strontium (ppb)	-	-	56	56 - 56	2014	No	Erosion of natural deposits
Vanadium (ppb)	-	-	11	10 - 11	2014	No	Erosion of natural deposits

Radioactive Contaminants:

Substance	Highest Level Allowed (MCL)	EPA MCLG	Highest Level Detected	Detection Range	Date	Violation	Source of Contaminant
None Detected							

If present, elevated levels of lead can cause serious health problems, especially for pregnant women and young children. Lead in drinking water is primarily from materials and components associated with service lines and home plumbing. The Department of Water is responsible for providing high quality drinking water, but cannot control the variety of materials used in plumbing components. When your water has been sitting for several hours, you can minimize the potential for lead exposure by flushing your tap for 30 seconds to 2 minutes before using water for drinking or cooking. If you are concerned about lead in you water, you may wish to have your water tested. Information on lead in drinking water, testing methods, and steps you can take to minimize exposure is available from the Safe Drinking Water Hotline or at http://www.epa.gov/safewater/lead

Where to call

Who	About	Number
Kaua'i Dept. of Water	General inquiries Water Quality Report	245-5400
State Dept. of Health	Contaminants, health effects State toll-free access line	808-586-4258 274-3141, ext. 64250
EPA Safe Drinking Water Hotline	Contaminants, health effects	1-800-426-4791

Exhibit D

USDA United States Department of Agriculture

NRCS Natural Resources Conservation Service

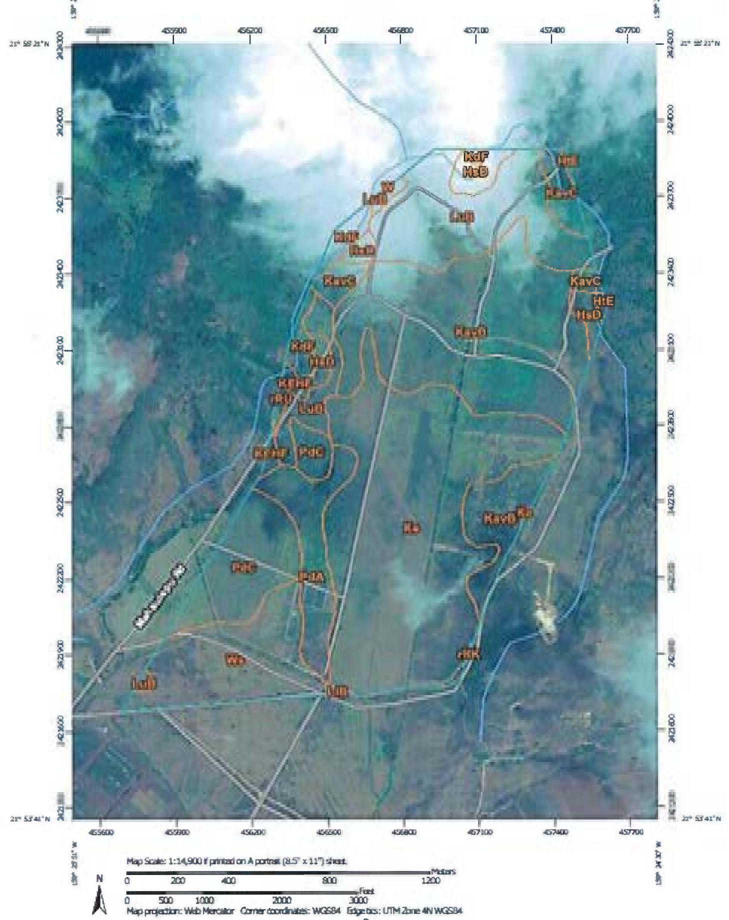
A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Island of Kauai, Hawaii

Contents

- Critical information in the site soils report includes the soil type location map and legend below and the following excerpts:

Custom Soil Resource Report
Soil Map



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Map Unit Legend

Island of Kauai, Hawaii (HI960)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
HsD	Hanamaulu silty clay, 15 to 25 percent slopes	17.3	2.9%
HtE	Hanamaulu stony silty clay, 10 to 35 percent slopes	1.1	0.2%
KavB	Kaena clay, brown variant, 1 to 6 percent slopes	152.0	25.4%
KavC	Kaena clay, brown variant, 6 to 12 percent slopes	17.0	2.8%
KdF	Kalapa silty clay, 40 to 70 percent slopes	12.5	2.1%
Ke	Kalihi clay	182.6	30.5%
KEHF	Kalapa very rocky silty clay, 40 to 70 percent slopes	4.0	0.7%
LIB	Lihue gravelly silty clay, 0 to 8 percent slopes	0.5	0.1%
LuB	Lualualei clay, 2 to 6 percent slopes	78.2	13.1%
PdA	Pakala clay loam, 0 to 2 percent slopes	31.1	5.2%
PdC	Pakala clay loam, 2 to 10 percent slopes	45.0	7.5%
rRK	Rock land	0.0	0.0%
rRU	Rubble land	1.7	0.3%
W	Water > 40 acres	1.9	0.3%
Ws	Waikomo stony silty clay	54.0	9.0%
Totals for Area of Interest		598.9	100.0%

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- The text below is pages 33 through 49 from:

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Island of Kauai, Hawaii

Waste Management

This folder contains a collection of tabular reports that present soil interpretations related to waste management. The reports (tables) include all selected map units and components for each map unit, limiting features and interpretive ratings. Waste management interpretations are tools designed to guide the user in evaluating soils for use of organic wastes and wastewater as productive resources. Example interpretations include land application of manure, food processing waste, and municipal sewage sludge, and disposal of wastewater by irrigation or overland flow process.

Agricultural Disposal of Wastewater by Irrigation and Overland Flow

Soil properties are important considerations in areas where soils are used as sites for the treatment and disposal of organic waste and wastewater. Selection of soils with properties that favor waste management can help to prevent environmental damage.

This table shows the degree and kind of soil limitations affecting the treatment of wastewater, including municipal and food-processing wastewater and effluent from lagoons or storage ponds. Municipal wastewater is the waste stream from a municipality. It contains domestic waste and may contain industrial waste. It may have received primary or secondary treatment. It is rarely untreated sewage. Food- processing wastewater results from the preparation of fruits, vegetables, milk, cheese, and meats for public consumption. In places it is high in content of sodium and chloride. In the context of this table, the effluent in lagoons and storage ponds is from facilities used to treat or store food-processing wastewater or domestic or animal waste.

Domestic and food-processing wastewater is very dilute, and the effluent from the facilities that treat or store it commonly is very low in content of carbonaceous and nitrogenous material; the content of nitrogen commonly ranges from 10 to 30 milligrams per liter. The wastewater from animal waste treatment lagoons or storage ponds, however, has much higher concentrations of these materials, mainly because the manure has not been diluted as much as the domestic waste. The content of nitrogen in this wastewater generally ranges from 50 to 2,000 milligrams per liter.

When wastewater is applied, checks should be made to ensure that nitrogen, heavy metals, and salts are not added in excessive amounts.

The ratings in the table are for waste management systems that not only dispose of and treat wastewater but also are beneficial to crops. The ratings are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect agricultural waste management. *Not limited* indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. *Somewhat limited* indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. *Very limited* indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings in the tables indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

Disposal of wastewater by irrigation not only disposes of municipal wastewater and wastewater from food-processing plants, lagoons, and storage ponds but also can improve crop production by increasing the amount of water available to crops. The ratings in the table are based on the soil properties that affect the design, construction, management, and performance of the irrigation system. The properties that affect design and management include the sodium adsorption ratio, depth to a water table, ponding, available water capacity, Ksat, slope, and flooding. The properties that affect construction include stones, cobbles, depth to bedrock or a cemented pan, depth to a water table, and ponding. The properties that affect performance include depth to bedrock or a cemented pan, bulk density, the sodium adsorption ratio, salinity, reaction, and the cation-exchange capacity, which is used to estimate the capacity of a soil to adsorb heavy metals. Permanently frozen soils are not suitable for disposal of wastewater by irrigation.

Overland flow of wastewater is a process in which wastewater is applied to the upper reaches of sloped land and allowed to flow across vegetated surfaces, sometimes called terraces, to runoff-collection ditches. The length of the run generally is 150 to 300 feet. The application rate ranges from 2.5 to 16.0 inches per week. It commonly exceeds the rate needed for irrigation of cropland. The wastewater leaves solids and nutrients on the vegetated surfaces as it flows downslope in a thin film. Most of the water reaches the collection ditch, some is lost through evapotranspiration, and a small amount may percolate to the ground water.

The ratings in the table are based on the soil properties that affect absorption, plant growth, microbial activity, and the design and construction of the system. Reaction and the cation-exchange capacity affect absorption. Reaction, salinity, and the sodium adsorption ratio affect plant growth and microbial activity. Slope, saturated hydraulic conductivity (Ksat), depth to a water table, ponding, flooding, depth to bedrock or a cemented pan, stones, and cobbles affect design and construction. Permanently frozen soils are unsuitable for waste treatment.

Report—Agricultural Disposal of Wastewater by Irrigation and Overland Flow

[Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the potential limitation. The table shows only the top five limitations for any given soil. The soil may have additional limitations]

Agricultural Disposal of Wastewater by Irrigation and Overland Flow–Island of Kauai, Hawaii

Map symbol and soil name	Pct. of map unit	Disposal of wastewater by irrigation		Overland flow of wastewater	
		Rating class and limiting features	Value	Rating class and limiting features	Value
HsD—Hanamaulu silty clay, 15 to 25 percent slopes					
Hanamaulu	100	Very limited		Very limited	
		Too acid	1.00	Seepage	1.00
		Too steep for surface application	1.00	Too acid	1.00
		Too steep for sprinkler application	1.00	Too steep for surface application	1.00
		Low adsorption	0.78	Low adsorption	0.78
HtE—Hanamaulu stony silty clay, 10 to 35 percent slopes					
Hanamaulu, stony	100	Very limited		Very limited	
		Too acid	1.00	Seepage	1.00
		Too steep for surface application	1.00	Too acid	1.00
		Too steep for sprinkler application	1.00	Too steep for surface application	1.00
		Low adsorption	0.78	Low adsorption	0.78
		Large stones on the surface	0.37		
KavB—Kaena clay, brown variant, 1 to 6 percent slopes					
Kaena variant	100	Very limited		Somewhat limited	
		Slow water movement	1.00	Stone content	0.99
		Depth to saturated zone	0.09	Seepage	0.37
		Too steep for surface application	0.08	Depth to saturated zone	0.09
		Large stones on the surface	0.01		
KavC—Kaena clay, brown variant, 6 to 12 percent slopes					
Kaena variant	100	Very limited		Somewhat limited	
		Slow water movement	1.00	Stone content	0.99
		Too steep for surface application	1.00	Too steep for surface application	0.50
		Too steep for sprinkler application	0.22	Seepage	0.37
		Depth to saturated zone	0.09	Depth to saturated zone	0.09
		Large stones on the surface	0.01		

Agricultural Disposal of Wastewater by Irrigation and Overland Flow–Island of Kauai, Hawaii					
Map symbol and soil name	Pct. of map unit	Disposal of wastewater by irrigation		Overland flow of wastewater	
		Rating class and limiting features	Value	Rating class and limiting features	Value
KdF—Kalapa silty clay, 40 to 70 percent slopes					
Kalapa	100	Very limited		Very limited	
		Too acid	1.00	Too acid	1.00
		Too steep for surface application	1.00	Too steep for surface application	1.00
		Too steep for sprinkler application	1.00	Seepage	0.49
		Slow water movement	1.00		
Ke—Kalihi clay					
Kalihi	100	Very limited		Very limited	
		Ponding	1.00	Ponding	1.00
		Slow water movement	0.62	Flooding	1.00
		Flooding	0.60	Seepage	1.00
		Depth to saturated zone	0.09	Depth to saturated zone	0.09
KEHF—Kalapa very rocky silty clay, 40 to 70 percent slopes					
Kalapa, very rocky	75	Very limited		Very limited	
		Too acid	1.00	Too acid	1.00
		Too steep for surface application	1.00	Too steep for surface application	1.00
		Too steep for sprinkler application	1.00	Seepage	0.49
		Slow water movement	1.00		
Rock outcrop	25	Not rated		Not rated	
LIB—Lihue gravelly silty clay, 0 to 8 percent slopes					
Lihue, gravelly	100	Somewhat limited		Very limited	
		Slow water movement	0.50	Seepage	1.00
		Too steep for surface application	0.08		
LuB—Lualualei clay, 2 to 6 percent slopes					
Lualualei	100	Very limited		Very limited	
		Ponding	1.00	Ponding	1.00
		Slow water movement	1.00	Flooding	0.40
		Too steep for surface application	0.08	Seepage	0.37

Agricultural Disposal of Wastewater by Irrigation and Overland Flow–Island of Kauai, Hawaii					
Map symbol and soil name	Pct. of map unit	Disposal of wastewater by irrigation		Overland flow of wastewater	
		Rating class and limiting features	Value	Rating class and limiting features	Value
PdA—Pakala clay loam, 0 to 2 percent slopes					
Pakala	100	Very limited		Very limited	
		Ponding	1.00	Seepage	1.00
		Too acid	1.00	Ponding	1.00
		Flooding	0.60	Too acid	1.00
				Flooding	1.00
PdC—Pakala clay loam, 2 to 10 percent slopes					
Pakala	100	Very limited		Very limited	
		Too acid	1.00	Seepage	1.00
		Too steep for surface application	0.68	Too acid	1.00
		Flooding	0.60	Flooding	1.00
rRK—Rock land					
Rock land	55	Very limited		Very limited	
		Slow water movement	1.00	Seepage	1.00
		Depth to bedrock	1.00	Depth to bedrock	1.00
		Droughty	1.00	Too steep for surface application	1.00
		Too steep for surface application	1.00		
		Too steep for sprinkler application	1.00		
Rock outcrop	45	Not rated		Not rated	
rRU—Rubble land					
Rubble land	100	Not rated		Not rated	
W—Water > 40 acres					
Water > 40 acres	100	Not rated		Not rated	
Ws—Waikomo stony silty clay					
Waikomo	100	Very limited		Very limited	
		Large stones on the surface	1.00	Depth to bedrock	1.00
		Droughty	1.00	Stone content	1.00
		Depth to bedrock	0.99	Seepage	1.00
		Slow water movement	0.50		
		Too steep for surface application	0.08		

Water Features

This folder contains tabular reports that present soil hydrology information. The reports (tables) include all selected map units and components for each map unit. Water Features include ponding frequency, flooding frequency, and depth to water table.

Water Features

This table gives estimates of various soil water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long- duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas.

Surface runoff refers to the loss of water from an area by flow over the land surface. Surface runoff classes are based on slope, climate, and vegetative cover. The concept indicates relative runoff for very specific conditions. It is assumed that the surface of the soil is bare and that the retention of surface water resulting from irregularities in the ground surface is minimal. The classes are negligible, very low, low, medium, high, and very high.

The *months* in the table indicate the portion of the year in which a water table, ponding, and/or flooding is most likely to be a concern.

Water table refers to a saturated zone in the soil. The water features table indicates, by month, depth to the top (*upper limit*) and base (*lower limit*) of the saturated zone in most years. Estimates of the upper and lower limits are based mainly on observations of the water table at selected sites and on evidence of a saturated zone, namely grayish colors or mottles (redoximorphic features) in the soil. A saturated zone that lasts for less than a month is not considered a water table.

Ponding is standing water in a closed depression. Unless a drainage system is installed, the water is removed only by percolation, transpiration, or evaporation. The table indicates *surface water depth* and the *duration* and *frequency* of ponding.

Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, *long* if 7 to 30 days, and *very long* if more than 30 days. Frequency is expressed as none, rare, occasional, and frequent. *None* means that ponding is not probable; *rare* that it is unlikely but possible under unusual weather conditions (the chance of ponding is nearly 0 percent to 5 percent in any year); *occasional* that it occurs, on the average, once or less in 2 years (the chance of ponding is 5 to 50 percent in any year); and *frequent* that it occurs, on the average, more than once in 2 years (the chance of ponding is more than 50 percent in any year).

Flooding is the temporary inundation of an area caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, and water standing in swamps and marshes is considered ponding rather than flooding.

Duration and *frequency* are estimated. Duration is expressed as *extremely brief* if 0.1 hour to 4 hours, *very brief* if 4 hours to 2 days, *brief* if 2 to 7 days, *long* if 7 to 30 days, and *very long* if more than 30 days. Frequency is expressed as none, very rare, rare, occasional, frequent, and very frequent. *None* means that flooding is not probable; *very rare* that it is very unlikely but possible under extremely unusual weather conditions (the chance of flooding is less than 1 percent in any year); *rare* that it is unlikely but possible under unusual weather conditions (the chance of flooding is 1 to 5 percent in any year); *occasional* that it occurs infrequently under normal weather conditions (the chance of flooding is 5 to 50 percent in any year); *frequent* that it is likely to occur often under normal weather conditions (the chance of flooding is more than 50 percent in any year but is less than 50 percent in all months in any year); and *very frequent* that it is likely to occur very often under normal weather conditions (the chance of flooding is more than 50 percent in all months of any year).

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and little or no horizon development.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

Absence of an entry indicates that the data were not estimated. The dash indicates no documented presence.

Water Features–Island of Kauai, Hawaii

Map unit symbol and soil name	Hydrologic group	Surface runoff	Month	Water table		Ponding			Flooding	
				Upper limit	Lower limit	Surface depth	Duration	Frequency	Duration	Frequency
				Ft	*Ft*	*Ft*				
HsD—Hanamaulu silty clay, 15 to 25 percent slopes										
Hanamaulu	B	High	Jan-Dec	—	—	—	—	None	—	None
HtE—Hanamaulu stony silty clay, 10 to 35 percent slopes										
Hanamaulu, stony	B	Medium	Jan-Dec	—	—	—	—	None	—	None
KavB—Kaena clay, brown variant, 1 to 6 percent slopes										
Kaena variant	D	Medium	January	2.0-5.0	>6.0	—	—	None	—	None
			February	2.0-5.0	>6.0	—	—	None	—	None
			March	2.0-5.0	>6.0	—	—	None	—	None
			April	2.0-5.0	>6.0	—	—	None	—	None
			November	2.0-5.0	>6.0	—	—	None	—	None
			December	2.0-5.0	>6.0	—	—	None	—	None
KavC—Kaena clay, brown variant, 6 to 12 percent slopes										
Kaena variant	D	High	January	2.0-5.0	>6.0	—	—	None	—	None
			February	2.0-5.0	>6.0	—	—	None	—	None
			March	2.0-5.0	>6.0	—	—	None	—	None
			April	2.0-5.0	>6.0	—	—	None	—	None
			November	2.0-5.0	>6.0	—	—	None	—	None
			December	2.0-5.0	>6.0	—	—	None	—	None

Water Features–Island of Kauai, Hawaii

Map unit symbol and soil name	Hydrologic group	Surface runoff	Month	Water table		Ponding			Flooding	
				Upper limit	Lower limit	Surface depth	Duration	Frequency	Duration	Frequency
				Ft	Ft	Ft				
KdF—Kalapa silty clay, 40 to 70 percent slopes										
Kalapa	B	Very high	Jan-Dec	—	—	—	—	None	—	None
Ke—Kalihi clay										
Kalihi	D	Negligible	January	2.0-5.0	>6.0	0.1-0.8	Very brief	Frequent	Very brief	Occasional
			February	2.0-5.0	>6.0	0.1-0.8	Very brief	Frequent	Very brief	Occasional
			March	2.0-5.0	>6.0	0.1-0.8	Very brief	Frequent	Very brief	Occasional
			April	—	—	0.1-0.8	Very brief	Frequent	Very brief	Rare
			May	—	—	0.1-0.8	Very brief	Frequent	Very brief	Rare
			June	—	—	0.1-0.8	Very brief	Frequent	Very brief	Rare
			July	—	—	0.1-0.8	Very brief	Frequent	Very brief	Rare
			August	—	—	0.1-0.8	Very brief	Frequent	Very brief	Rare
			September	—	—	0.1-0.8	Very brief	Frequent	Very brief	Rare
			October	—	—	0.1-0.8	Very brief	Frequent	Very brief	Rare
			November	2.0-5.0	>6.0	0.1-0.8	Very brief	Frequent	Very brief	Occasional
			December	2.0-5.0	>6.0	0.1-0.8	Very brief	Frequent	Very brief	Occasional
KEHF—Kalapa very rocky silty clay, 40 to 70 percent slopes										
Kalapa, very rocky	B	Very high	Jan-Dec	—	—	—	—	None	—	None
Rock outcrop	D	—	Jan-Dec	—	—	—	—	None	—	None
LlB—Lihue gravelly silty clay, 0 to 8 percent slopes										
Lihue, gravelly	B	Low	Jan-Dec	—	—	—	—	None	—	None

Water Features–Island of Kauai, Hawaii

Map unit symbol and soil name	Hydrologic group	Surface runoff	Month	Water table		Ponding			Flooding	
				Upper limit	Lower limit	Surface depth	Duration	Frequency	Duration	Frequency
				Ft	Ft	Ft				
LuB—Lualualei clay, 2 to 6 percent slopes										
Lualualei	D	Very low	January	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			February	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			March	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			April	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			May	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			June	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			July	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			August	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			September	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			October	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			November	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			December	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare

Water Features–Island of Kauai, Hawaii										
Map unit symbol and soil name	Hydrologic group	Surface runoff	Month	Water table		Ponding			Flooding	
				Upper limit	Lower limit	Surface depth	Duration	Frequency	Duration	Frequency
				Ft	Ft	Ft				
PdA—Pakala clay loam, 0 to 2 percent slopes										
Pakala	B	Very low	January	—	—	0.1-0.8	Very brief	Occasional	Very brief	Occasional
			February	—	—	0.1-0.8	Very brief	Occasional	Very brief	Occasional
			March	—	—	0.1-0.8	Very brief	Occasional	Very brief	Occasional
			April	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			May	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			June	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			July	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			August	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			September	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			October	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			November	—	—	0.1-0.8	Very brief	Occasional	Very brief	Occasional
			December	—	—	0.1-0.8	Very brief	Occasional	Very brief	Occasional

Water Features–Island of Kauai, Hawaii										
Map unit symbol and soil name	Hydrologic group	Surface runoff	Month	Water table		Ponding			Flooding	
				Upper limit	Lower limit	Surface depth	Duration	Frequency	Duration	Frequency
				Ft	Ft	Ft				
PdC—Pakala clay loam, 2 to 10 percent slopes										
Pakala	B	Medium	January	—	—	—	—	None	Very brief	Occasional
			February	—	—	—	—	None	Very brief	Occasional
			March	—	—	—	—	None	Very brief	Occasional
			April	—	—	—	—	None	Very brief	None
			May	—	—	—	—	None	Very brief	Rare
			June	—	—	—	—	None	Very brief	Rare
			July	—	—	—	—	None	Very brief	Rare
			August	—	—	—	—	None	Very brief	Rare
			September	—	—	—	—	None	Very brief	Rare
			October	—	—	—	—	None	Very brief	Rare
			November	—	—	—	—	None	Very brief	Occasional
			December	—	—	—	—	None	Very brief	Occasional
rRK—Rock land										
Rock land	D	Very high	Jan-Dec	—	—	—	—	None	—	None
Rock outcrop	D	—	Jan-Dec	—	—	—	—	None	—	None
rRU—Rubble land										
Rubble land	A	Low	Jan-Dec	—	—	—	—	None	—	None
W—Water > 40 acres										
Water > 40 acres	—	—	Jan-Dec	—	—	—	—	None	—	None
Ws—Waikomo stony silty clay										
Waikomo	D	Low	Jan-Dec	—	—	—	—	None	—	None

Water Management

This folder contains a collection of tabular reports that present soil interpretations related to water management. The reports (tables) include all selected map units and components for each map unit, limiting features and interpretive ratings. Water management interpretations are tools for evaluating the potential of the soil in the application of various water management practices. Example interpretations include pond reservoir area, embankments, dikes, levees, and excavated ponds.

Irrigation - General and Sprinkler

This table shows the degree and kind of soil limitations that affect irrigation systems on mineral soils. The ratings are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect these uses. *Not limited* indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected.

Somewhat limited indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. *Very limited* indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings in the table indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

Irrigation systems are used to provide supplemental water to crops, orchards, vineyards, and vegetables in area where natural precipitation will not support desired production of crops being grown.

Irrigation – general evaluates a soil's limitation(s) for installation and use of non- specific irrigation methods and is intended to provide initial planning information. Additional interpretations provide more specific information. This interpretation does not apply if the crop planned for irrigation is rice or other crops with unique plant physiological characteristics (such as cranberries). The ratings are for soils in their natural condition and do not consider present land use.

The soil properties and qualities important in design and management of irrigation systems are sodium adsorption ratio, depth to high water table, available water holding capacity, permeability, slope, calcium carbonate content, ponding, and flooding. Soil properties and qualities that influence installation are stones, depth to bedrock or cemented pan, and depth to a high water table. The properties and qualities that affect performance of the irrigation system are depth to bedrock or to a cemented pan, the sodium adsorption ratio, salinity, and soil reaction.

Irrigation, sprinkler (close spaced outlets drops) evaluates a soil for installation and use of sprinkler irrigation systems equipped with close spaced outlets on drops. The ratings are for soils in their natural condition and do not consider present land use.

Sprinkler irrigation systems equipped with low pressure spray nozzles mounted on close spaced drops apply water close to the ground surface. These systems are generally found on linear move or center pivot systems and they have separate slope criteria from other sprinkler systems due to their higher application rate which increase risk of runoff and irrigation-induced erosion on steeper slopes. Examples of these types of systems include Low Pressure in Canopy (LPIC), Low Energy Precision Application (LEPA), Low Elevation Spray Application (LESA), and Mid-Elevation Spray Application (MESA) systems. These types of irrigation systems are generally suitable for small grains, row crops, and vegetables.

The soil properties and qualities important in the design and management of sprinkler irrigation systems utilizing close spaced spray nozzles on drops are depth, available water holding capacity, sodium adsorption ratio, surface coarse fragments, permeability, salinity, slope, wetness, and flooding. The features that affect performance of the system and plant growth are surface texture, surface rocks, salinity, sodium adsorption ratio, wetness, erosion potential, and available water holding capacity.

Irrigation, sprinkler (general) evaluates a soil for installation and use of sprinkler irrigation systems excluding those equipped with close spaced outlets on drops. The ratings are for soils in their natural condition and do not consider present land use.

Sprinkler irrigation systems apply irrigation water to a field through a series of pipes and nozzles and can be either solid set or mobile. Generally, this type of irrigation system is suitable for small grains, row crops, vegetables, and orchards.

The soil properties and qualities important in the design and management of sprinkler irrigation systems are depth, available water holding capacity, sodium adsorption ratio, surface coarse fragments, permeability, salinity, slope, wetness, and flooding. The features that affect performance of the system and plant growth are surface rocks, salinity, sodium adsorption ratio, wetness, and available water holding capacity.

Information in this table is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil between the surface and a depth of 5 to 7 feet.

Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this table. Local ordinances and regulations should be considered in planning, in site selection, and in design. The irrigation interpretations are not designed or intended to be used in a regulatory manner.

Report—Irrigation - General and Sprinkler

[The information in this table provides irrigation interpretations for mineral soils. Onsite investigation may be needed to validate the interpretations and to confirm the identity of

the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the potential limitation. The table shows only the top five limitations for any given soil. The soil may have additional limitations]

Irrigation - General and Sprinkler–Island of Kauai, Hawaii

Map symbol and soil name	Pct. of map unit	Irrigation (general)		Irrigation, Sprinkler (close spaced outlet drops)		Irrigation, Sprinkler (general)	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
HsD—Hanamaulu silty clay, 15 to 25 percent slopes							
Hanamaulu	100	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope, sprinkler irrigation	1.00
		Too acid	0.44	Surface clay	0.88	Surface clay	0.88
		Rapid water movement	0.40	Water Erosion	0.50	Too acid	0.44
		Seepage	0.18	Too acid	0.44		
HtE—Hanamaulu stony silty clay, 10 to 35 percent slopes							
Hanamaulu, stony	100	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope, sprinkler irrigation	1.00
		Too acid	0.44	Surface clay	0.88	Surface clay	0.88
		Rapid water movement	0.40	Too acid	0.44	Too acid	0.44
		Seepage	0.18	Water Erosion	0.32		
KavB—Kaena clay, brown variant, 1 to 6 percent slopes							
Kaena variant	100	Not rated		Not Rated		Not Rated	
KavC—Kaena clay, brown variant, 6 to 12 percent slopes							
Kaena variant	100	Not rated		Not Rated		Not Rated	
KdF—Kalapa silty clay, 40 to 70 percent slopes							
Kalapa	100	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope, sprinkler irrigation	1.00
		Too acid	0.04	Water Erosion	1.00	Surface clay	0.98
				Surface clay	0.98	Slow water movement	0.61
				Slow water movement	0.61	Too acid	0.04
				Too acid	0.04		
Ke—Kalihi clay							
Kalihi	100	Not rated		Not Rated		Not Rated	

Irrigation - General and Sprinkler–Island of Kauai, Hawaii

Map symbol and soil name	Pct. of map unit	Irrigation (general)		Irrigation, Sprinkler (close spaced outlet drops)		Irrigation, Sprinkler (general)	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
KEHF—Kalapa very rocky silty clay, 40 to 70 percent slopes							
Kalapa, very rocky	75	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope, sprinkler irrigation	1.00
		Too acid	0.04	Water Erosion	1.00	Surface clay	0.98
				Surface clay	0.98	Slow water movement	0.90
				Slow water movement	0.90	Too acid	0.04
				Too acid	0.04		
Rock outcrop	25	Not rated		Not Rated		Not Rated	
LIB—Lihue gravelly silty clay, 0 to 8 percent slopes							
Lihue, gravelly	100	Somewhat limited		Somewhat limited		Somewhat limited	
		Seepage	0.18	Surface clay	0.98	Surface clay	0.98
		Slope	0.09	Slope	0.86		
		Rapid water movement	0.02				
LuB—Lualualei clay, 2 to 6 percent slopes							
Lualualei	100	Very limited		Very limited		Very limited	
		Ponding	1.00	Ponding	1.00	Ponding	1.00
		Slope	0.09	Surface clay	1.00	Surface clay	1.00
		Low water holding capacity	0.01	Slope	0.86	Slow water movement	0.61
				Slow water movement	0.61	Low water holding capacity	0.01
				Water Erosion	0.01		
PdA—Pakala clay loam, 0 to 2 percent slopes							
Pakala	100	Not rated		Not Rated		Not Rated	
PdC—Pakala clay loam, 2 to 10 percent slopes							
Pakala	100	Not rated		Not Rated		Not Rated	
rRK—Rock land							
Rock land	55	Not rated		Not Rated		Not Rated	
Rock outcrop	45	Not rated		Not Rated		Not Rated	
rRU—Rubble land							
Rubble land	100	Not rated		Not Rated		Not Rated	

Irrigation - General and Sprinkler–Island of Kauai, Hawaii							
Map symbol and soil name	Pct. of map unit	Irrigation (general)		Irrigation, Sprinkler (close spaced outlet drops)		Irrigation, Sprinkler (general)	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
W—Water > 40 acres							
Water > 40 acres	100	Not rated		Not Rated		Not Rated	
Ws—Waikomo stony silty clay							
Waikomo	100	Very limited		Very limited		Very limited	
		Low water holding capacity	1.00	Low water holding capacity	1.00	Low water holding capacity	1.00
		Depth to hard bedrock	1.00	Content of large stones	1.00	Content of large stones	1.00
		Content of large stones	1.00	Depth to hard bedrock	0.99	Depth to hard bedrock	0.99
		Slope	0.09	Slope	0.86	Surface clay	0.50
		Rapid water movement	0.02	Surface clay	0.50		

Exhibit E

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for
Island of Kauai, Hawaii

June 5, 2014

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (http://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means

Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the

individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

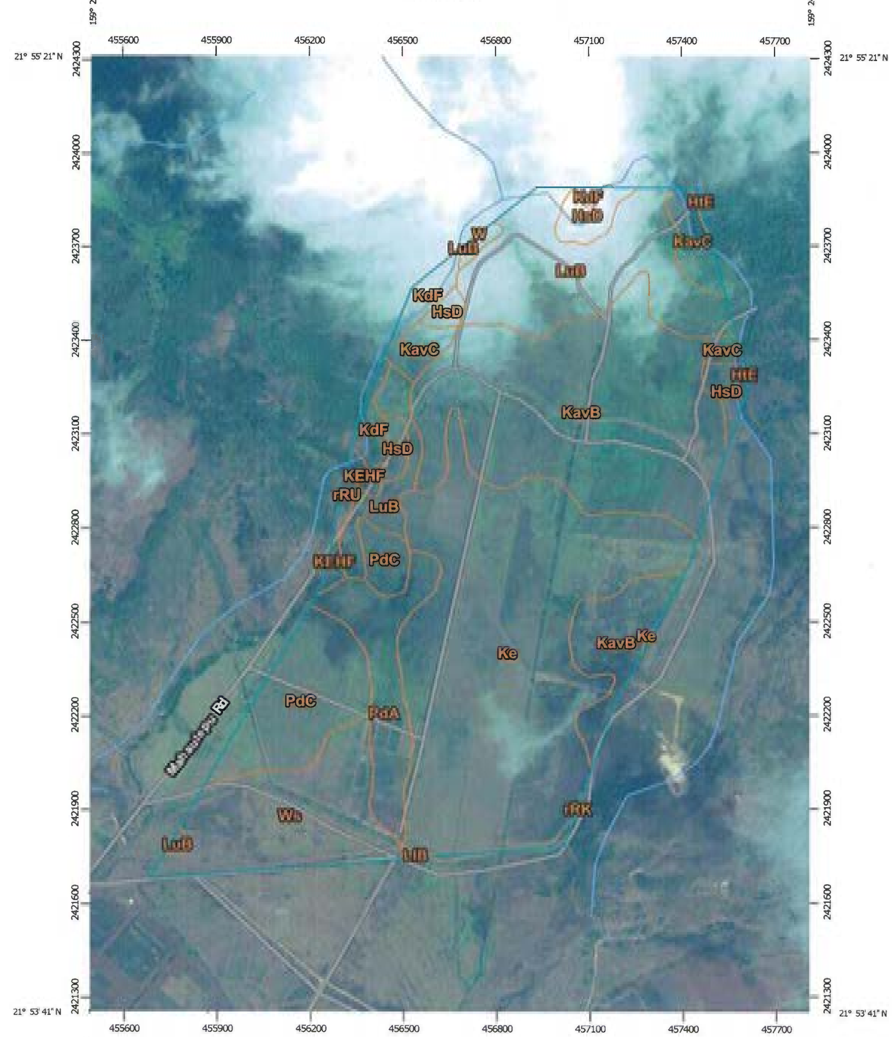
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map



Map Scale: 1:14,900 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 200, 400, 800, 1200

Feet: 0, 500, 1000, 2000, 3000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 4N WGS84

MAP LEGEND		MAP INFORMATION
Area of Interest (AOI) Area of Interest (AOI) **Soils** Soil Map Unit Polygons Soil Map Unit Lines Soil Map Unit Points **Special Point Features** Blowout Borrow Pit Clay Spot Closed Depression Gravel Pit Gravelly Spot Landfill Lava Flow Marsh or swamp Mine or Quarry Miscellaneous Water Perennial Water Rock Outcrop Saline Spot Sandy Spot Severely Eroded Spot Sinkhole Slide or Slip Sodic Spot	Spoil Area Stony Spot Very Stony Spot Wet Spot Other Special Line Features **Water Features** Streams and Canals **Transportation** Rails Interstate Highways US Routes Major Roads Local Roads **Background** Aerial Photography	The soil surveys that comprise your AOI were mapped at 1:24,000. Warning: Soil Map may not be valid at this scale. Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale. Please rely on the bar scale on each map sheet for map measurements. Source of Map: Natural Resources Conservation Service Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov Coordinate System: Web Mercator (EPSG:3857) Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required. This product is generated from the USDA-NRCS certified data as of the version date(s) listed below. Soil Survey Area: Island of Kauai, Hawaii Survey Area Data: Version 8, Dec 7, 2013 Soil map units are labeled (as space allows) for map scales 1:50,000 or larger. Date(s) aerial images were photographed: Aug 26, 2011—Oct 3, 2011 The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Island of Kauai, Hawaii (HI960)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
HaD	Hanamaulu silty clay, 15 to 25 percent slopes	17.3	2.9%
HtE	Hanamaulu stony silty clay, 10 to 35 percent slopes	1.1	0.2%
KavB	Kaena clay, brown variant, 1 to 6 percent slopes	152.0	25.4%
KavC	Kaena clay, brown variant, 6 to 12 percent slopes	17.0	2.8%
KdF	Kalapa silty clay, 40 to 70 percent slopes	12.5	2.1%
Ke	Kaihi clay	182.6	30.5%
KEHF	Kalapa very rocky silty clay, 40 to 70 percent slopes	4.0	0.7%
LIB	Lihue gravelly silty clay, 0 to 8 percent slopes	0.5	0.1%
LuB	Lualualei clay, 2 to 6 percent slopes	78.2	13.1%
PdA	Pakala clay loam, 0 to 2 percent slopes	31.1	5.2%
PdC	Pakala clay loam, 2 to 10 percent slopes	45.0	7.5%
rRK	Rock land	0.0	0.0%
rRU	Rubble land	1.7	0.3%
W	Water > 40 acres	1.9	0.3%
Wa	Waikomo stony silty clay	54.0	9.0%
Totals for Area of Interest		598.9	100.0%

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of

the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Island of Kauai, Hawaii

HsD—Hanamaulu silty clay, 15 to 25 percent slopes

Map Unit Setting
- *Elevation:* 200 to 700 feet
- *Mean annual precipitation:* 60 to 100 inches
- *Mean annual air temperature:* 72 to 73 degrees F
- *Frost-free period:* 365 days

Map Unit Composition
- *Hanamaulu and similar soils:* 100 percent

Description of Hanamaulu

Setting
- *Landform:* Terraces
- *Landform position (two-dimensional):* Toeslope
- *Landform position (three-dimensional):* Riser
- *Down-slope shape:* Linear
- *Across-slope shape:* Linear
- *Parent material:* Basic igneous rocks

Typical profile
- *H1 - 0 to 11 inches:* extremely acid, silty clay
- *H2 - 11 to 36 inches:* very strongly acid, silty clay
- *H3 - 36 to 72 inches:* very strongly acid, silty clay loam

Properties and qualities
- *Slope:* 15 to 25 percent
- *Depth to restrictive feature:* More than 80 inches
- *Natural drainage class:* Well drained
- *Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.20 to 2.00 in/hr)
- *Depth to water table:* More than 80 inches
- *Frequency of flooding:* None
- *Frequency of ponding:* None
- *Available water storage in profile:* Moderate (about 8.4 inches)

Interpretive groups
- *Farmland classification:* All areas are prime farmland
- *Land capability classification (irrigated):* 4e
- *Land capability classification (nonirrigated):* 4e
- *Hydrologic Soil Group:* B

HtE—Hanamaulu stony silty clay, 10 to 35 percent slopes

Map Unit Setting
- *Elevation:* 200 to 700 feet
- *Mean annual precipitation:* 60 to 100 inches
- *Mean annual air temperature:* 72 to 73 degrees F

- *Frost-free period:* 365 days

Map Unit Composition
- *Hanamaulu, stony, and similar soils:* 100 percent

Description of Hanamaulu, Stony

Setting
- *Landform:* Terraces
- *Landform position (two-dimensional):* Toeslope
- *Landform position (three-dimensional):* Riser
- *Down-slope shape:* Linear
- *Across-slope shape:* Linear
- *Parent material:* Basic igneous rocks

Typical profile
- *H1 - 0 to 11 inches:* extremely acid, stony silty clay
- *H2 - 11 to 36 inches:* very strongly acid, silty clay
- *H3 - 36 to 72 inches:* very strongly acid, silty clay loam

Properties and qualities
- *Slope:* 10 to 25 percent
- *Depth to restrictive feature:* More than 80 inches
- *Natural drainage class:* Well drained
- *Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.20 to 2.00 in/hr)
- *Depth to water table:* More than 80 inches
- *Frequency of flooding:* None
- *Frequency of ponding:* None
- *Available water storage in profile:* Moderate (about 8.4 inches)

Interpretive groups
- *Farmland classification:* Not prime farmland
- *Land capability classification (irrigated):* 4e
- *Land capability classification (nonirrigated):* 4e
- *Hydrologic Soil Group:* B

KavB—Kaena clay, brown variant, 1 to 6 percent slopes

Map Unit Setting
- *Elevation:* 50 to 150 feet
- *Mean annual precipitation:* 30 to 45 inches
- *Mean annual air temperature:* 73 to 75 degrees F
- *Frost-free period:* 365 days

Map Unit Composition
- *Kaena variant and similar soils:* 100 percent

Description of Kaena Variant

Setting
- *Landform:* Fans
- *Landform position (two-dimensional):* Toeslope

Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Formed in alluvium and colluvium

Typical profile
H1 - 0 to 10 inches: neutral, clay
H2 - 10 to 37 inches: neutral, stony clay
H3 - 37 to 54 inches: neutral, stony clay

Properties and qualities
Slope: 1 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: About 24 to 60 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 6.6 inches)

Interpretive groups
Farmland classification: All areas are prime farmland
Land capability classification (irrigated): 3w
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: D

KavC—Kaena clay, brown variant, 6 to 12 percent slopes

Map Unit Setting
Elevation: 50 to 150 feet
Mean annual precipitation: 30 to 45 inches
Mean annual air temperature: 73 to 75 degrees F
Frost-free period: 365 days

Map Unit Composition
Kaena variant and similar soils: 100 percent

Description of Kaena Variant

Setting
Landform: Fans
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Formed in alluvium and colluvium

Typical profile
H1 - 0 to 10 inches: neutral, clay
H2 - 10 to 37 inches: neutral, stony clay
H3 - 37 to 54 inches: neutral, stony clay

Properties and qualities
Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: About 24 to 60 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 6.6 inches)

Interpretive groups
Farmland classification: Not prime farmland
Land capability classification (irrigated): 3w
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: D

KdF—Kalapa silty clay, 40 to 70 percent slopes

Map Unit Setting
Elevation: 200 to 1,200 feet
Mean annual precipitation: 60 to 100 inches
Mean annual air temperature: 68 to 73 degrees F
Frost-free period: 365 days

Map Unit Composition
Kalapa and similar soils: 100 percent

Description of Kalapa

Setting
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope, rise
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Basic igneous rock

Typical profile
H1 - 0 to 10 inches: very strongly acid, silty clay
H2 - 10 to 60 inches: very strongly acid, clay

Properties and qualities
Slope: 40 to 70 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.8 inches)

Interpretive groups

Farmland classification: Not prime farmland
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B

Ke—Kalihi clay

Map Unit Setting

Elevation: 50 to 100 feet
Mean annual precipitation: 40 to 60 inches
Mean annual air temperature: 73 to 75 degrees F
Frost-free period: 365 days

Map Unit Composition

Kalihi and similar soils: 100 percent

Description of Kalihi

Setting

Landform: Alluvial fans
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Basic igneous rock

Typical profile

H1 - 0 to 16 inches: neutral, clay
H2 - 16 to 70 inches: neutral, clay

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.60 in/hr)
Depth to water table: About 24 to 60 inches
Frequency of flooding: Occasional
Frequency of ponding: Frequent
Available water storage in profile: Moderate (about 7.8 inches)

Interpretive groups

Farmland classification: Prime farmland if protected from flooding or not frequently flooded during the growing season
Land capability classification (irrigated): 3w
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: D

KEHF—Kalapa very rocky silty clay, 40 to 70 percent slopes

Map Unit Setting

Elevation: 0 to 10,000 feet
Mean annual precipitation: 10 to 175 inches
Mean annual air temperature: 45 to 75 degrees F
Frost-free period: 365 days

Map Unit Composition

Kalapa, very rocky, and similar soils: 75 percent
Rock outcrop: 25 percent

Description of Kalapa, Very Rocky

Setting

Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope, rise
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Basic igneous rock

Typical profile

H1 - 0 to 10 inches: very strongly acid, silty clay
H2 - 10 to 60 inches: very strongly acid, clay

Properties and qualities

Slope: 40 to 70 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.8 inches)

Interpretive groups

Farmland classification: Not prime farmland
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B

Description of Rock Outcrop

Setting

Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Mountainflank, side slope, tread, rise
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Basalt

Typical profile
H1 - 0 to 60 inches: , bedrock

Properties and qualities
Slope: 40 to 70 percent
Depth to restrictive feature: 0 inches to lithic bedrock
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately low (0.00 to 0.06 in/hr)
Available water storage in profile: Very low (about 0.0 inches)

Interpretive groups
Farmland classification: Not prime farmland
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8s
Hydrologic Soil Group: D

LIB—Lihue gravelly silty clay, 0 to 8 percent slopes

Map Unit Setting
Elevation: 0 to 800 feet
Mean annual precipitation: 40 to 60 inches
Mean annual air temperature: 72 to 75 degrees F
Frost-free period: 365 days

Map Unit Composition
Lihue, gravelly, and similar soils: 100 percent

Description of Lihue, Gravelly

Setting
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Basic igneous dust

Typical profile
H1 - 0 to 12 inches: slightly acid, gravelly silty clay
H2 - 12 to 60 inches: slightly acid, silty clay

Properties and qualities
Slope: 0 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Sodium adsorption ratio, maximum in profile: 5.0
Available water storage in profile: Moderate (about 8.4 inches)

Interpretive groups
Farmland classification: Prime farmland if irrigated
Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B

LuB—Lualualei clay, 2 to 6 percent slopes

Map Unit Setting
Elevation: 10 to 120 feet
Mean annual precipitation: 18 to 30 inches
Mean annual air temperature: 73 to 75 degrees F
Frost-free period: 365 days

Map Unit Composition
Lualualei and similar soils: 100 percent

Description of Lualualei

Setting
Landform: Alluvial fans
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Alluvium

Typical profile
H1 - 0 to 10 inches: neutral, clay
H2 - 10 to 60 inches: neutral, clay

Properties and qualities
Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Rare
Frequency of ponding: Rare
Available water storage in profile: Moderate (about 7.1 inches)

Interpretive groups
Farmland classification: Prime farmland if irrigated
Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: D

PdA—Pakala clay loam, 0 to 2 percent slopes

Map Unit Setting
Elevation: 0 to 400 feet
Mean annual precipitation: 25 to 40 inches
Mean annual air temperature: 73 to 75 degrees F
Frost-free period: 365 days

Map Unit Composition
Pakala and similar soils: 100 percent

Description of Pakala

Setting
Landform: Alluvial fans
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve, rise
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Alluvium

Typical profile
H1 - 0 to 16 inches: very strongly acid, clay loam
H2 - 16 to 60 inches: moderately acid, silty clay loam

Properties and qualities
Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Occasional
Frequency of ponding: Occasional
Available water storage in profile: Moderate (about 7.0 inches)

Interpretive groups
Farmland classification: Prime farmland if irrigated
Land capability classification (irrigated): 1
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: B

PdC—Pakala clay loam, 2 to 10 percent slopes

Map Unit Setting
Elevation: 0 to 400 feet
Mean annual precipitation: 25 to 40 inches

Mean annual air temperature: 73 to 75 degrees F
Frost-free period: 365 days

Map Unit Composition
Pakala and similar soils: 100 percent

Description of Pakala

Setting
Landform: Alluvial fans
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve, rise
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Alluvium

Typical profile
H1 - 0 to 16 inches: very strongly acid, clay loam
H2 - 16 to 60 inches: moderately acid, silty clay loam

Properties and qualities
Slope: 2 to 10 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.0 inches)

Interpretive groups
Farmland classification: Prime farmland if irrigated
Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B

rRK—Rock land

Map Unit Setting
Elevation: 0 to 6,000 feet
Mean annual precipitation: 15 to 60 inches
Mean annual air temperature: 57 to 75 degrees F
Frost-free period: 365 days

Map Unit Composition
Rock land and similar soils: 55 percent
Rock outcrop: 45 percent

Description of Rock Land

Setting
Landform: Pahoehoe lava flows

Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Mountainflank, side slope, riser, rise
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Basalt

Typical profile
H1 - 0 to 4 inches: neutral, silty clay
H2 - 4 to 8 inches: neutral, silty clay
H3 - 8 to 20 inches: , bedrock

Properties and qualities
Slope: 10 to 70 percent
Depth to restrictive feature: 4 to 10 inches to lithic bedrock
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 1.1 inches)

Interpretive groups
Farmland classification: Not prime farmland
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D

Description of Rock Outcrop

Setting
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Mountainflank, side slope, tread, rise
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Basalt

Typical profile
H1 - 0 to 60 inches: , bedrock

Properties and qualities
Slope: 10 to 70 percent
Depth to restrictive feature: 0 to 60 inches to lithic bedrock
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately low (0.00 to 0.06 in/hr)
Available water storage in profile: Very low (about 0.0 inches)

Interpretive groups
Farmland classification: Not prime farmland
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8s
Hydrologic Soil Group: D

rRU—Rubble land

Map Unit Setting
Elevation: 0 to 500 feet
Mean annual precipitation: 22 to 50 inches
Mean annual air temperature: 73 to 75 degrees F
Frost-free period: 365 days

Map Unit Composition
Rubble land: 100 percent

Description of Rubble Land

Setting
Landform: Mountain slopes
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Mountainbase
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Alluvium and colluvium

Typical profile
H1 - 0 to 60 inches: , extremely stony material

Interpretive groups
Farmland classification: Not prime farmland
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8s
Hydrologic Soil Group: A

W—Water > 40 acres

Map Unit Setting
Frost-free period: 365 days

Map Unit Composition
Water > 40 acres: 100 percent

Description of Water > 40 Acres

Properties and qualities
Depth to restrictive feature: More than 80 inches
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Ws—Waikomo stony silty clay

Map Unit Setting

Elevation: 0 to 360 feet
Mean annual precipitation: 35 to 60 inches
Mean annual air temperature: 73 to 75 degrees F
Frost-free period: 365 days

Map Unit Composition

Waikomo and similar soils: 100 percent

Description of Waikomo

Setting

Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve, rise
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Basalt

Typical profile

H1 - 0 to 14 inches: neutral, stony silty clay
H2 - 14 to 20 inches: slightly alkaline, stony silty clay loam
H3 - 20 to 30 inches: , bedrock

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: 10 to 20 inches to lithic bedrock
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 2.0 inches)

Interpretive groups

Farmland classification: Not prime farmland
Land capability classification (irrigated): 4s
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: D

Soil Information for All Uses

Soil Reports

The Soil Reports section includes various formatted tabular and narrative reports (tables) containing data for each selected soil map unit and each component of each unit. No aggregation of data has occurred as is done in reports in the Soil Properties and Qualities and Suitabilities and Limitations sections.

The reports contain soil interpretive information as well as basic soil properties and qualities. A description of each report (table) is included.

Soil Qualities and Features

This folder contains tabular reports that present various soil qualities and features. The reports (tables) include all selected map units and components for each map unit. Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Soil Features

This table gives estimates of various soil features. The estimates are used in land use planning that involves engineering considerations.

A *restrictive layer* is a nearly continuous layer that has one or more physical, chemical, or thermal properties that significantly impede the movement of water and air through the soil or that restrict roots or otherwise provide an unfavorable root environment. Examples are bedrock, cemented layers, dense layers, and frozen layers. The table indicates the hardness and thickness of the restrictive layer, both of which significantly affect the ease of excavation. *Depth to top* is the vertical distance from the soil surface to the upper boundary of the restrictive layer.

Subsidence is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence generally results from either desiccation and shrinkage, or oxidation of organic material, or both, following drainage. Subsidence takes place gradually, usually over a period of several years. The table shows the expected initial subsidence, which usually is a result of drainage, and total subsidence, which results from a combination of factors.

Potential for frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, saturated hydraulic conductivity (Ksat), content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured, clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that corrodes or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The steel or concrete in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than the steel or concrete in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low, moderate,* or *high,* is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion also is expressed as *low, moderate,* or *high.* It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Soil Features–Island of Kauai, Hawaii

Map symbol and soil name	Restrictive Layer				Subsidence		Potential for frost action	Risk of corrosion	
	Kind	Depth to top	Thickness	Hardness	Initial	Total		Uncoated steel	Concrete
		In	In		In	In			
HcD—Hanamaulu silty clay, 15 to 25 percent slopes									
Hanamaulu		—	—		0	—	None	High	High
HE—Hanamaulu stony silty clay, 10 to 35 percent slopes									
Hanamaulu, stony		—	—		0	—	None	High	High
KavB—Kaena clay, brown variant, 1 to 6 percent slopes									
Kaena variant		—	—		0	—	None	Moderate	Low
KavC—Kaena clay, brown variant, 6 to 12 percent slopes									
Kaena variant		—	—		0	—	None	Moderate	Low
KdF—Kalapa silty clay, 40 to 70 percent slopes									
Kalapa		—	—		0	—	None	High	High
Ke—Kaihi clay									
Kaihi		—	—		0	—	None	High	Low
KEHF—Kalapa very rocky silty clay, 40 to 70 percent slopes									
Kalapa, very rocky		—	—		0	—	None	High	High
Rock outcrop	Lithic bedrock	0	—	Indurated	0	—	None		

Soil Features–Island of Kauai, Hawaii

Map symbol and soil name	Restrictive Layer				Subsidence		Potential for frost action	Risk of corrosion	
	Kind	Depth to top	Thickness	Hardness	Initial	Total		Uncoated steel	Concrete
		In	In		In	In			
LtB—Lihue gravelly silty clay, 0 to 8 percent slopes									
Lihue, gravelly		—	—		0	—	None	Moderate	Moderate
LuB—Lualualei clay, 2 to 6 percent slopes									
Lualualei		—	—		0	—	None	Moderate	Moderate
PdA—Pakala clay loam, 0 to 2 percent slopes									
Pakala		—	—		0	—	None	Moderate	Moderate
PdC—Pakala clay loam, 2 to 10 percent slopes									
Pakala		—	—		0	—	None	Moderate	Moderate
rRK—Rock land									
Rock land	Lithic bedrock	4-10	—	Indurated	0	—	None	Moderate	Low
Rock outcrop	Lithic bedrock	0-60	—	Indurated	0	—	None	Moderate	Low
rRU—Rubble land									
Rubble land		—	—		0	—	None		
W—Water > 40 acres									
Water > 40 acres		—	—		0	—	None		
Ws—Waikomo stony silty clay									
Waikomo	Lithic bedrock	10-20	—	Indurated	0	—	None	Moderate	Low

Soil Features

This table gives estimates of various soil features. The estimates are used in land use planning that involves engineering considerations.

A *restrictive layer* is a nearly continuous layer that has one or more physical, chemical, or thermal properties that significantly impede the movement of water and air through the soil or that restrict roots or otherwise provide an unfavorable root environment. Examples are bedrock, cemented layers, dense layers, and frozen layers. The table indicates the hardness and thickness of the restrictive layer, both of which significantly affect the ease of excavation. *Depth to top* is the vertical distance from the soil surface to the upper boundary of the restrictive layer.

Subsidence is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence generally results from either desiccation and shrinkage, or oxidation of organic material, or both, following drainage. Subsidence takes place gradually, usually over a period of several years. The table shows the expected initial subsidence, which usually is a result of drainage, and total subsidence, which results from a combination of factors.

Potential for frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, saturated hydraulic conductivity (Ksat), content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured, clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that corrodes or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The steel or concrete in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than the steel or concrete in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion also is expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Soil Features–Island of Kauai, Hawaii									
Map symbol and soil name	Restrictive Layer				Subsidence		Potential for frost action	Risk of corrosion	
	Kind	Depth to top	Thickness	Hardness	Initial	Total		Uncoated steel	Concrete
		In	In		In	In			
HsD—Hanamaulu silty clay, 15 to 25 percent slopes									
Hanamaulu		—	—		0	—	None	High	High
HtE—Hanamaulu stony silty clay, 10 to 35 percent slopes									
Hanamaulu, stony		—	—		0	—	None	High	High
KavB—Kaena clay, brown variant, 1 to 6 percent slopes									
Kaena variant		—	—		0	—	None	Moderate	Low
KavC—Kaena clay, brown variant, 6 to 12 percent slopes									
Kaena variant		—	—		0	—	None	Moderate	Low
KdF—Kalapa silty clay, 40 to 70 percent slopes									
Kalapa		—	—		0	—	None	High	High
Ke—Kalihi clay									
Kalihi		—	—		0	—	None	High	Low
KEHF—Kalapa very rocky silty clay, 40 to 70 percent slopes									
Kalapa, very rocky		—	—		0	—	None	High	High
Rock outcrop	Lithic bedrock	0	—	Indurated	0	—	None		

Soil Features–Island of Kauai, Hawaii									
Map symbol and soil name	Restrictive Layer				Subsidence		Potential for frost action	Risk of corrosion	
	Kind	Depth to top	Thickness	Hardness	Initial	Total		Uncoated steel	Concrete
		In	In		In	In			
LIB—Lihue gravelly silty clay, 0 to 8 percent slopes									
Lihue, gravelly		—	—		0	—	None	Moderate	Moderate
LuB—Lualualei clay, 2 to 6 percent slopes									
Lualualei		—	—		0	—	None	Moderate	Moderate
PdA—Pakala clay loam, 0 to 2 percent slopes									
Pakala		—	—		0	—	None	Moderate	Moderate
PdC—Pakala clay loam, 2 to 10 percent slopes									
Pakala		—	—		0	—	None	Moderate	Moderate
rRK—Rock land									
Rock land	Lithic bedrock	4-10	—	Indurated	0	—	None	Moderate	Low
Rock outcrop	Lithic bedrock	0-60	—	Indurated	0	—	None	Moderate	Low
rRU—Rubble land									
Rubble land		—	—		0	—	None		
W—Water > 40 acres									
Water > 40 acres		—	—		0	—	None		
Ws—Waikomo stony silty clay									
Waikomo	Lithic bedrock	10-20	—	Indurated	0	—	None	Moderate	Low

Waste Management

This folder contains a collection of tabular reports that present soil interpretations related to waste management. The reports (tables) include all selected map units and components for each map unit, limiting features and interpretive ratings. Waste management interpretations are tools designed to guide the user in evaluating soils for use of organic wastes and wastewater as productive resources. Example interpretations include land application of manure, food processing waste, and municipal sewage sludge, and disposal of wastewater by irrigation or overland flow process.

Agricultural Disposal of Wastewater by Irrigation and Overland Flow

Soil properties are important considerations in areas where soils are used as sites for the treatment and disposal of organic waste and wastewater. Selection of soils with properties that favor waste management can help to prevent environmental damage.

This table shows the degree and kind of soil limitations affecting the treatment of wastewater, including municipal and food-processing wastewater and effluent from lagoons or storage ponds. Municipal wastewater is the waste stream from a municipality. It contains domestic waste and may contain industrial waste. It may have received primary or secondary treatment. It is rarely untreated sewage. Food-processing wastewater results from the preparation of fruits, vegetables, milk, cheese, and meats for public consumption. In places it is high in content of sodium and chloride. In the context of this table, the effluent in lagoons and storage ponds is from facilities used to treat or store food-processing wastewater or domestic or animal waste. Domestic and food-processing wastewater is very dilute, and the effluent from the facilities that treat or store it commonly is very low in content of carbonaceous and nitrogenous material; the content of nitrogen commonly ranges from 10 to 30 milligrams per liter. The wastewater from animal waste treatment lagoons or storage ponds, however, has much higher concentrations of these materials, mainly because the manure has not been diluted as much as the domestic waste. The content of nitrogen in this wastewater generally ranges from 50 to 2,000 milligrams per liter. When wastewater is applied, checks should be made to ensure that nitrogen, heavy metals, and salts are not added in excessive amounts.

The ratings in the table are for waste management systems that not only dispose of and treat wastewater but also are beneficial to crops. The ratings are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect agricultural waste management. *Not limited* indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. *Somewhat limited* indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. *Very limited* indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings in the tables indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

Disposal of wastewater by irrigation not only disposes of municipal wastewater and wastewater from food-processing plants, lagoons, and storage ponds but also can improve crop production by increasing the amount of water available to crops. The ratings in the table are based on the soil properties that affect the design, construction, management, and performance of the irrigation system. The properties that affect design and management include the sodium adsorption ratio, depth to a water table, ponding, available water capacity, Ksat, slope, and flooding. The properties that affect construction include stones, cobbles, depth to bedrock or a cemented pan, depth to a water table, and ponding. The properties that affect performance include depth to bedrock or a cemented pan, bulk density, the sodium adsorption ratio, salinity, reaction, and the cation-exchange capacity, which is used to estimate the capacity of a soil to adsorb heavy metals. Permanently frozen soils are not suitable for disposal of wastewater by irrigation.

Overland flow of wastewater is a process in which wastewater is applied to the upper reaches of sloped land and allowed to flow across vegetated surfaces, sometimes called terraces, to runoff-collection ditches. The length of the run generally is 150 to 300 feet. The application rate ranges from 2.5 to 16.0 inches per week. It commonly exceeds the rate needed for irrigation of cropland. The wastewater leaves solids and nutrients on the vegetated surfaces as it flows downslope in a thin film. Most of the water reaches the collection ditch, some is lost through evapotranspiration, and a small amount may percolate to the ground water.

The ratings in the table are based on the soil properties that affect absorption, plant growth, microbial activity, and the design and construction of the system. Reaction and the cation-exchange capacity affect absorption. Reaction, salinity, and the sodium adsorption ratio affect plant growth and microbial activity. Slope, saturated hydraulic conductivity (Ksat), depth to a water table, ponding, flooding, depth to bedrock or a cemented pan, stones, and cobbles affect design and construction. Permanently frozen soils are unsuitable for waste treatment.

Report—Agricultural Disposal of Wastewater by Irrigation and Overland Flow

[Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the potential limitation. The table shows only the top five limitations for any given soil. The soil may have additional limitations]

Agricultural Disposal of Wastewater by Irrigation and Overland Flow–Island of Kauai, Hawaii					
Map symbol and soil name	Pct. of map unit	Disposal of wastewater by irrigation		Overland flow of wastewater	
		Rating class and limiting features	Value	Rating class and limiting features	Value
HsD—Hanamaulu silty clay, 15 to 25 percent slopes					
Hanamaulu	100	Very limited		Very limited	
		Too acid	1.00	Seepage	1.00
		Too steep for surface application	1.00	Too acid	1.00
		Too steep for sprinkler application	1.00	Too steep for surface application	1.00
		Low adsorption	0.78	Low adsorption	0.78
HtE—Hanamaulu stony silty clay, 10 to 35 percent slopes					
Hanamaulu, stony	100	Very limited		Very limited	
		Too acid	1.00	Seepage	1.00
		Too steep for surface application	1.00	Too acid	1.00
		Too steep for sprinkler application	1.00	Too steep for surface application	1.00
		Low adsorption	0.78	Low adsorption	0.78
		Large stones on the surface	0.37		
KavB—Kaena clay, brown variant, 1 to 6 percent slopes					
Kaena variant	100	Very limited		Somewhat limited	
		Slow water movement	1.00	Stone content	0.99
		Depth to saturated zone	0.09	Seepage	0.37
		Too steep for surface application	0.08	Depth to saturated zone	0.09
		Large stones on the surface	0.01		
KavC—Kaena clay, brown variant, 6 to 12 percent slopes					
Kaena variant	100	Very limited		Somewhat limited	
		Slow water movement	1.00	Stone content	0.99
		Too steep for surface application	1.00	Too steep for surface application	0.50
		Too steep for sprinkler application	0.22	Seepage	0.37
		Depth to saturated zone	0.09	Depth to saturated zone	0.09
		Large stones on the surface	0.01		

Agricultural Disposal of Wastewater by Irrigation and Overland Flow–Island of Kauai, Hawaii					
Map symbol and soil name	Pct. of map unit	Disposal of wastewater by irrigation		Overland flow of wastewater	
		Rating class and limiting features	Value	Rating class and limiting features	Value
KdF—Kalapa silty clay, 40 to 70 percent slopes					
Kalapa	100	Very limited		Very limited	
		Too acid	1.00	Too acid	1.00
		Too steep for surface application	1.00	Too steep for surface application	1.00
		Too steep for sprinkler application	1.00	Seepage	0.49
		Slow water movement	1.00		
Ke—Kalihi clay					
Kalihi	100	Very limited		Very limited	
		Ponding	1.00	Ponding	1.00
		Slow water movement	0.62	Flooding	1.00
		Flooding	0.60	Seepage	1.00
		Depth to saturated zone	0.09	Depth to saturated zone	0.09
KEHF—Kalapa very rocky silty clay, 40 to 70 percent slopes					
Kalapa, very rocky	75	Very limited		Very limited	
		Too acid	1.00	Too acid	1.00
		Too steep for surface application	1.00	Too steep for surface application	1.00
		Too steep for sprinkler application	1.00	Seepage	0.49
		Slow water movement	1.00		
Rock outcrop	25	Not rated		Not rated	
LIB—Lihue gravelly silty clay, 0 to 8 percent slopes					
Lihue, gravelly	100	Somewhat limited		Very limited	
		Slow water movement	0.50	Seepage	1.00
		Too steep for surface application	0.08		
LuB—Lualualei clay, 2 to 6 percent slopes					
Lualualei	100	Very limited		Very limited	
		Ponding	1.00	Ponding	1.00
		Slow water movement	1.00	Flooding	0.40
		Too steep for surface application	0.08	Seepage	0.37

Agricultural Disposal of Wastewater by Irrigation and Overland Flow–Island of Kauai, Hawaii					
Map symbol and soil name	Pct. of map unit	Disposal of wastewater by irrigation		Overland flow of wastewater	
		Rating class and limiting features	Value	Rating class and limiting features	Value
PdA—Pakala clay loam, 0 to 2 percent slopes					
Pakala	100	Very limited		Very limited	
		Ponding	1.00	Seepage	1.00
		Too acid	1.00	Ponding	1.00
		Flooding	0.60	Too acid	1.00
				Flooding	1.00
PdC—Pakala clay loam, 2 to 10 percent slopes					
Pakala	100	Very limited		Very limited	
		Too acid	1.00	Seepage	1.00
		Too steep for surface application	0.68	Too acid	1.00
		Flooding	0.60	Flooding	1.00
rRK—Rock land					
Rock land	55	Very limited		Very limited	
		Slow water movement	1.00	Seepage	1.00
		Depth to bedrock	1.00	Depth to bedrock	1.00
		Droughty	1.00	Too steep for surface application	1.00
		Too steep for surface application	1.00		
		Too steep for sprinkler application	1.00		
Rock outcrop	45	Not rated		Not rated	
rRU—Rubble land					
Rubble land	100	Not rated		Not rated	
W—Water > 40 acres					
Water > 40 acres	100	Not rated		Not rated	
Ws—Waikomo stony silty clay					
Waikomo	100	Very limited		Very limited	
		Large stones on the surface	1.00	Depth to bedrock	1.00
		Droughty	1.00	Stone content	1.00
		Depth to bedrock	0.99	Seepage	1.00
		Slow water movement	0.50		
		Too steep for surface application	0.08		

Water Features

This folder contains tabular reports that present soil hydrology information. The reports (tables) include all selected map units and components for each map unit. Water Features include ponding frequency, flooding frequency, and depth to water table.

Water Features

This table gives estimates of various soil water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas.

Surface runoff refers to the loss of water from an area by flow over the land surface. Surface runoff classes are based on slope, climate, and vegetative cover. The concept indicates relative runoff for very specific conditions. It is assumed that the surface of the soil is bare and that the retention of surface water resulting from irregularities in the ground surface is minimal. The classes are negligible, very low, low, medium, high, and very high.

The *months* in the table indicate the portion of the year in which a water table, ponding, and/or flooding is most likely to be a concern.

Water table refers to a saturated zone in the soil. The water features table indicates, by month, depth to the top (*upper limit*) and base (*lower limit*) of the saturated zone in most years. Estimates of the upper and lower limits are based mainly on observations of the water table at selected sites and on evidence of a saturated zone, namely grayish colors or mottles (redoximorphic features) in the soil. A saturated zone that lasts for less than a month is not considered a water table.

Ponding is standing water in a closed depression. Unless a drainage system is installed, the water is removed only by percolation, transpiration, or evaporation. The table indicates *surface water depth* and the *duration* and *frequency* of ponding. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, *long* if 7 to 30 days, and *very long* if more than 30 days. Frequency is expressed as none, rare, occasional, and frequent. *None* means that ponding is not probable; *rare* that it is unlikely but possible under unusual weather conditions (the chance of ponding is nearly 0 percent to 5 percent in any year); *occasional* that it occurs, on the average, once or less in 2 years (the chance of ponding is 5 to 50 percent in any year); and *frequent* that it occurs, on the average, more than once in 2 years (the chance of ponding is more than 50 percent in any year).

Flooding is the temporary inundation of an area caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, and water standing in swamps and marshes is considered ponding rather than flooding.

Duration and *frequency* are estimated. Duration is expressed as *extremely brief* if 0.1 hour to 4 hours, *very brief* if 4 hours to 2 days, *brief* if 2 to 7 days, *long* if 7 to 30 days, and *very long* if more than 30 days. Frequency is expressed as none, very rare, rare, occasional, frequent, and very frequent. *None* means that flooding is not probable; *very rare* that it is very unlikely but possible under extremely unusual weather conditions (the chance of flooding is less than 1 percent in any year); *rare* that it is unlikely but possible under unusual weather conditions (the chance of flooding is 1 to 5 percent in any year); *occasional* that it occurs infrequently under normal weather conditions (the chance of flooding is 5 to 50 percent in any year); *frequent* that it is likely to occur often under normal weather conditions (the chance of flooding is more than 50 percent in any year but is less than 50 percent in all months in any year); and *very frequent* that it is likely to occur very often under normal weather conditions (the chance of flooding is more than 50 percent in all months of any year).

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and little or no horizon development.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

Absence of an entry indicates that the data were not estimated. The dash indicates no documented presence.

Water Features–Island of Kauai, Hawaii										
Map unit symbol and soil name	Hydrologic group	Surface runoff	Month	Water table		Ponding			Flooding	
				Upper limit	Lower limit	Surface depth	Duration	Frequency	Duration	Frequency
				Ft	*Ft*	*Ft*				
HsD—Hanamaulu silty clay, 15 to 25 percent slopes										
Hanamaulu	B	High	Jan-Dec	—	—	—	—	None	—	None
HtE—Hanamaulu stony silty clay, 10 to 35 percent slopes										
Hanamaulu, stony	B	Medium	Jan-Dec	—	—	—	—	None	—	None
KavB—Kaena clay, brown variant, 1 to 6 percent slopes										
Kaena variant	D	Medium	January	2.0-5.0	>6.0	—	—	None	—	None
			February	2.0-5.0	>6.0	—	—	None	—	None
			March	2.0-5.0	>6.0	—	—	None	—	None
			April	2.0-5.0	>6.0	—	—	None	—	None
			November	2.0-5.0	>6.0	—	—	None	—	None
			December	2.0-5.0	>6.0	—	—	None	—	None
KavC—Kaena clay, brown variant, 6 to 12 percent slopes										
Kaena variant	D	High	January	2.0-5.0	>6.0	—	—	None	—	None
			February	2.0-5.0	>6.0	—	—	None	—	None
			March	2.0-5.0	>6.0	—	—	None	—	None
			April	2.0-5.0	>6.0	—	—	None	—	None
			November	2.0-5.0	>6.0	—	—	None	—	None
			December	2.0-5.0	>6.0	—	—	None	—	None

Water Features–Island of Kauai, Hawaii										
Map unit symbol and soil name	Hydrologic group	Surface runoff	Month	Water table		Ponding			Flooding	
				Upper limit	Lower limit	Surface depth	Duration	Frequency	Duration	Frequency
				Ft	Ft	Ft				
KdF—Kalapa silty clay, 40 to 70 percent slopes										
Kalapa	B	Very high	Jan-Dec	—	—	—	—	None	—	None
Ke—Kalihi clay										
Kalihi	D	Negligible	January	2.0-5.0	>6.0	0.1-0.8	Very brief	Frequent	Very brief	Occasional
			February	2.0-5.0	>6.0	0.1-0.8	Very brief	Frequent	Very brief	Occasional
			March	2.0-5.0	>6.0	0.1-0.8	Very brief	Frequent	Very brief	Occasional
			April	—	—	0.1-0.8	Very brief	Frequent	Very brief	Rare
			May	—	—	0.1-0.8	Very brief	Frequent	Very brief	Rare
			June	—	—	0.1-0.8	Very brief	Frequent	Very brief	Rare
			July	—	—	0.1-0.8	Very brief	Frequent	Very brief	Rare
			August	—	—	0.1-0.8	Very brief	Frequent	Very brief	Rare
			September	—	—	0.1-0.8	Very brief	Frequent	Very brief	Rare
			October	—	—	0.1-0.8	Very brief	Frequent	Very brief	Rare
			November	2.0-5.0	>6.0	0.1-0.8	Very brief	Frequent	Very brief	Occasional
			December	2.0-5.0	>6.0	0.1-0.8	Very brief	Frequent	Very brief	Occasional
KEHF—Kalapa very rocky silty clay, 40 to 70 percent slopes										
Kalapa, very rocky	B	Very high	Jan-Dec	—	—	—	—	None	—	None
Rock outcrop	D	—	Jan-Dec	—	—	—	—	None	—	None
LIB—Lihue gravelly silty clay, 0 to 8 percent slopes										
Lihue, gravelly	B	Low	Jan-Dec	—	—	—	—	None	—	None

Water Features–Island of Kauai, Hawaii										
Map unit symbol and soil name	Hydrologic group	Surface runoff	Month	Water table		Ponding			Flooding	
				Upper limit	Lower limit	Surface depth	Duration	Frequency	Duration	Frequency
				Ft	Ft	Ft				
LuB—Lualualei clay, 2 to 6 percent slopes										
Lualualei	D	Very low	January	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			February	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			March	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			April	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			May	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			June	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			July	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			August	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			September	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			October	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			November	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			December	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare

Water Features–Island of Kauai, Hawaii

Map unit symbol and soil name	Hydrologic group	Surface runoff	Month	Water table		Ponding			Flooding	
				Upper limit	Lower limit	Surface depth	Duration	Frequency	Duration	Frequency
				Ft	Ft	Ft				
PdA—Pakala clay loam, 0 to 2 percent slopes										
Pakala	B	Very low	January	—	—	0.1-0.8	Very brief	Occasional	Very brief	Occasional
			February	—	—	0.1-0.8	Very brief	Occasional	Very brief	Occasional
			March	—	—	0.1-0.8	Very brief	Occasional	Very brief	Occasional
			April	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			May	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			June	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			July	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			August	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			September	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			October	—	—	0.1-0.8	Very brief	Rare	Very brief	Rare
			November	—	—	0.1-0.8	Very brief	Occasional	Very brief	Occasional
			December	—	—	0.1-0.8	Very brief	Occasional	Very brief	Occasional

Water Features–Island of Kauai, Hawaii

Map unit symbol and soil name	Hydrologic group	Surface runoff	Month	Water table		Ponding			Flooding	
				Upper limit	Lower limit	Surface depth	Duration	Frequency	Duration	Frequency
				Ft	Ft	Ft				
PdC—Pakala clay loam, 2 to 10 percent slopes										
Pakala	B	Medium	January	—	—	—	—	None	Very brief	Occasional
			February	—	—	—	—	None	Very brief	Occasional
			March	—	—	—	—	None	Very brief	Occasional
			April	—	—	—	—	None	Very brief	None
			May	—	—	—	—	None	Very brief	Rare
			June	—	—	—	—	None	Very brief	Rare
			July	—	—	—	—	None	Very brief	Rare
			August	—	—	—	—	None	Very brief	Rare
			September	—	—	—	—	None	Very brief	Rare
			October	—	—	—	—	None	Very brief	Rare
			November	—	—	—	—	None	Very brief	Occasional
			December	—	—	—	—	None	Very brief	Occasional
rRK—Rock land										
Rock land	D	Very high	Jan-Dec	—	—	—	—	None	—	None
Rock outcrop	D	—	Jan-Dec	—	—	—	—	None	—	None
rRU—Rubble land										
Rubble land	A	Low	Jan-Dec	—	—	—	—	None	—	None
W—Water > 40 acres										
Water > 40 acres	—	—	Jan-Dec	—	—	—	—	None	—	None
Ws—Waikomo stony silty clay										
Waikomo	D	Low	Jan-Dec	—	—	—	—	None	—	None

Water Management

This folder contains a collection of tabular reports that present soil interpretations related to water management. The reports (tables) include all selected map units and components for each map unit, limiting features and interpretive ratings. Water management interpretations are tools for evaluating the potential of the soil in the application of various water management practices. Example interpretations include pond reservoir area, embankments, dikes, levees, and excavated ponds.

Irrigation - General and Sprinkler

This table shows the degree and kind of soil limitations that affect irrigation systems on mineral soils. The ratings are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect these uses. *Not limited* indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. *Somewhat limited* indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. *Very limited* indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings in the table indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

Irrigation systems are used to provide supplemental water to crops, orchards, vineyards, and vegetables in area where natural precipitation will not support desired production of crops being grown.

Irrigation – general evaluates a soil's limitation(s) for installation and use of non-specific irrigation methods and is intended to provide initial planning information. Additional interpretations provide more specific information. This interpretation does not apply if the crop planned for irrigation is rice or other crops with unique plant physiological characteristics (such as cranberries). The ratings are for soils in their natural condition and do not consider present land use.

The soil properties and qualities important in design and management of irrigation systems are sodium adsorption ratio, depth to high water table, available water holding capacity, permeability, slope, calcium carbonate content, ponding, and flooding. Soil properties and qualities that influence installation are stones, depth to bedrock or cemented pan, and depth to a high water table. The properties and qualities that affect performance of the irrigation system are depth to bedrock or to a cemented pan, the sodium adsorption ratio, salinity, and soil reaction.

Irrigation, sprinkler (close spaced outlets drops) evaluates a soil for installation and use of sprinkler irrigation systems equipped with close spaced outlets on drops. The ratings are for soils in their natural condition and do not consider present land use.

Sprinkler irrigation systems equipped with low pressure spray nozzles mounted on close spaced drops apply water close to the ground surface. These systems are generally found on linear move or center pivot systems and they have separate slope criteria from other sprinkler systems due to their higher application rate which increase risk of runoff and irrigation-induced erosion on steeper slopes. Examples of these types of systems include Low Pressure in Canopy (LPIC), Low Energy Precision Application (LEPA), Low Elevation Spray Application (LESA), and Mid-Elevation Spray Application (MESA) systems. These types of irrigation systems are generally suitable for small grains, row crops, and vegetables.

The soil properties and qualities important in the design and management of sprinkler irrigation systems utilizing close spaced spray nozzles on drops are depth, available water holding capacity, sodium adsorption ratio, surface coarse fragments, permeability, salinity, slope, wetness, and flooding. The features that affect performance of the system and plant growth are surface texture, surface rocks, salinity, sodium adsorption ratio, wetness, erosion potential, and available water holding capacity.

Irrigation, sprinkler (general) evaluates a soil for installation and use of sprinkler irrigation systems excluding those equipped with close spaced outlets on drops. The ratings are for soils in their natural condition and do not consider present land use.

Sprinkler irrigation systems apply irrigation water to a field through a series of pipes and nozzles and can be either solid set or mobile. Generally, this type of irrigation system is suitable for small grains, row crops, vegetables, and orchards.

The soil properties and qualities important in the design and management of sprinkler irrigation systems are depth, available water holding capacity, sodium adsorption ratio, surface coarse fragments, permeability, salinity, slope, wetness, and flooding. The features that affect performance of the system and plant growth are surface rocks, salinity, sodium adsorption ratio, wetness, and available water holding capacity.

Information in this table is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil between the surface and a depth of 5 to 7 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this table. Local ordinances and regulations should be considered in planning, in site selection, and in design. The irrigation interpretations are not designed or intended to be used in a regulatory manner.

Report—Irrigation - General and Sprinkler

[The information in this table provides irrigation interpretations for mineral soils. Onsite investigation may be needed to validate the interpretations and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the potential limitation. The table shows only the top five limitations for any given soil. The soil may have additional limitations]

Irrigation - General and Sprinkler–Island of Kauai, Hawaii

Map symbol and soil name	Pct. of map unit	Irrigation (general)		Irrigation, Sprinkler (close spaced outlet drops)		Irrigation, Sprinkler (general)	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
HsD—Hanamaulu silty clay, 15 to 25 percent slopes							
Hanamaulu	100	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope, sprinkler irrigation	1.00
		Too acid	0.44	Surface clay	0.88	Surface clay	0.88
		Rapid water movement	0.40	Water Erosion	0.50	Too acid	0.44
		Seepage	0.18	Too acid	0.44		
HtE—Hanamaulu stony silty clay, 10 to 35 percent slopes							
Hanamaulu, stony	100	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope, sprinkler irrigation	1.00
		Too acid	0.44	Surface clay	0.88	Surface clay	0.88
		Rapid water movement	0.40	Too acid	0.44	Too acid	0.44
		Seepage	0.18	Water Erosion	0.32		
KavB—Kaena clay, brown variant, 1 to 6 percent slopes							
Kaena variant	100	Not rated		Not Rated		Not Rated	
KavC—Kaena clay, brown variant, 6 to 12 percent slopes							
Kaena variant	100	Not rated		Not Rated		Not Rated	
KdF—Kalapa silty clay, 40 to 70 percent slopes							
Kalapa	100	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope, sprinkler irrigation	1.00
		Too acid	0.04	Water Erosion	1.00	Surface clay	0.98
				Surface clay	0.98	Slow water movement	0.61
				Slow water movement	0.61	Too acid	0.04
				Too acid	0.04		
Ke—Kalihi clay							
Kalihi	100	Not rated		Not Rated		Not Rated	

Irrigation - General and Sprinkler–Island of Kauai, Hawaii

Map symbol and soil name	Pct. of map unit	Irrigation (general)		Irrigation, Sprinkler (close spaced outlet drops)		Irrigation, Sprinkler (general)	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
KEHF—Kalapa very rocky silty clay, 40 to 70 percent slopes							
Kalapa, very rocky	75	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope, sprinkler irrigation	1.00
		Too acid	0.04	Water Erosion	1.00	Surface clay	0.98
				Surface clay	0.98	Slow water movement	0.90
				Slow water movement	0.90	Too acid	0.04
				Too acid	0.04		
Rock outcrop	25	Not rated		Not Rated		Not Rated	
LIB—Lihue gravelly silty clay, 0 to 8 percent slopes							
Lihue, gravelly	100	Somewhat limited		Somewhat limited		Somewhat limited	
		Seepage	0.18	Surface clay	0.98	Surface clay	0.98
		Slope	0.09	Slope	0.86		
		Rapid water movement	0.02				
LuB—Lualualei clay, 2 to 6 percent slopes							
Lualualei	100	Very limited		Very limited		Very limited	
		Ponding	1.00	Ponding	1.00	Ponding	1.00
		Slope	0.09	Surface clay	1.00	Surface clay	1.00
		Low water holding capacity	0.01	Slope	0.86	Slow water movement	0.61
				Slow water movement	0.61	Low water holding capacity	0.01
				Water Erosion	0.01		
PdA—Pakala clay loam, 0 to 2 percent slopes							
Pakala	100	Not rated		Not Rated		Not Rated	
PdC—Pakala clay loam, 2 to 10 percent slopes							
Pakala	100	Not rated		Not Rated		Not Rated	
rRK—Rock land							
Rock land	55	Not rated		Not Rated		Not Rated	
Rock outcrop	45	Not rated		Not Rated		Not Rated	
rRU—Rubble land							
Rubble land	100	Not rated		Not Rated		Not Rated	

Irrigation - General and Sprinkler–Island of Kauai, Hawaii								
Map symbol and soil name	Pct. of map unit	Irrigation (general)		Irrigation, Sprinkler (close spaced outlet drops)		Irrigation, Sprinkler (general)		
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
W—Water > 40 acres							
Water > 40 acres	100	Not rated		Not Rated		Not Rated	
Ws—Waikomo stony silty clay							
Waikomo	100	Very limited		Very limited		Very limited	
		Low water holding capacity	1.00	Low water holding capacity	1.00	Low water holding capacity	1.00
		Depth to hard bedrock	1.00	Content of large stones	1.00	Content of large stones	1.00
		Content of large stones	1.00	Depth to hard bedrock	0.99	Depth to hard bedrock	0.99
		Slope	0.09	Slope	0.86	Surface clay	0.50
		Rapid water movement	0.02	Surface clay	0.50		

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Exhibit 10

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August 25, 2014

VIA EMAIL

Sina Pruder, P.E.
Chief
Wastewater Branch
Environmental Management Division
Department of Health
919 Ala Moana Blvd., Room 309
Honolulu, HI 96814

Re: Additional Comments re Hawai'i Dairy Farms' Waste Management Plan, dated July 23, 2014

Dear Ms. Pruder:

This letter supplements our letters of August 11 and 22, 2014. In our prior letters, we presented preliminary comments on behalf of Kawailoa Development LLP ("Kawailoa") regarding Hawai'i Dairy Farms' Waste Management Plan ("Plan"), dated July 23, 2014, for its proposed dairy farm ("Dairy") in Māhā'ulepū, Kaua'i.

This letter contains additional comments from Mark Madison of CH2MHill, attached as Exhibit F. Comments are provided concerning Section 8.5 to the end of the Plan.

Introduction.

The comments submitted by Kawailoa, through Dr. Meyer and Mr. Madison, demonstrate that the Plan is not satisfactory. The Plan contains erroneous, speculative, incomplete, inconsistent and contradictory information, is not supported by scientific data, does not follow generally accepted practices and does not comport with law. It fails to address significant issues that have a direct impact on the environment of the Māhā'ulepū area, including surface water, ground water and nearby Class 1 waters. Simply put, the Plan does not protect the public health of the State.

Ultimately, the burden should be on the Dairy to demonstrate to the Department that its Plan will not jeopardize the interests of all members of the community. It should be the

Dairy's burden to show that its application will not risk pollution to the waters of the State and will instead preserve the environment.

This is a very serious matter to all those who visit, live or work in the Poipu and Koloa area. It is a serious matter because of the irreparable harm to the environment that will follow from the Plan. And while the Dairy should have the burden, this matter is serious enough that Kawailoa feels obliged to step forward to offer its comments. However, it is not Kawailoa's obligation to correct any deficiencies in the Plan. Likewise, the Department should not approve a plan that compromises the environmental interests of the State.

Kawailoa appreciates that the Department will consider all comments and all information submitted. All are important. For convenience and by way of a summary, however, the points to keep in mind and to highlight are as follows:

Summary of Dr. Meyer's Comments.

As can be seen in the comments of Deanne Meyer and Mark Madison, the Plan is seriously deficient and should not be approved by the Department of Health. Simply put, there are too many unanswered questions and data gaps for the Department to conduct the review contemplated by its rules. To recap briefly:

Dr. Meyer summarized her concerns as follows:

- "Hawai'i Dairy Farms' Waste Management Plan ("Plan"), dated July 23, 2014, contains incomplete and/or contradictory information. Significantly, the Plan fails to address herd size and composition, average expected milk production, potential nutrients available for land application, reasonable expectation for crop yields in the early years, stocking rate, confirmation that the settling pond will or won't be aerated, reasonable recovery of estimated nitrogen excretion, reasonable initial frequency and protocols for manure sampling, the need to import more than 80% of nitrogen applied to pasture, the high fertilization rates compared to sugar cane production, the minimum feedback analysis to determine if nutrient applications met or exceeded crop needs and how to modify accordingly to be protective of water resources."

- "The Plan also contains numerous inconsistencies and contradictory information, such as herd size (both number of animals and weight of cows), use of terminology (effluent, solids, manure), and that storage ponds will have next to no odor then describe odor mitigations for the storage pond."

- "The Plan, as it currently stands, is highly problematic because insufficient information is provided to determine if nutrient management of effluent, solids and manure will be consistent with pasture needs and production and protective of water resources and how long term importation of nutrients to the facility (fertilizer and feed) will impact existing natural resources and surrounding landscape."

- "The Plan identifies that all facilities and infrastructure presented in the application are for 2000 cows. Yet, it is unclear when the base number of 699 or 2000 cows is used. The Hawai'i Department of Health ("Department") should reject the Plan because it cannot properly form a decision on the Plan's sufficiency until all of these issues are resolved." As a corollary, the Plan must properly count the number of animals. The Plan for example, does not identify dry cows, lactating cows, bulls, calves and replacement heifers. Each has different feed requirements and different manure estimates.

- The assumptions relating to the feed for the herd are highly suspect (pasture requirements, walking distances, diet formulation etc.). If the feed and nutrient assumptions are misstated, the manure that is estimated to be excreted will also be misstated.

Twelve pages of comments support her conclusions.

Summary of Mr. Madison's Comments.

Next, Mr. Madison provided two sets of comments noting the deficiencies and the questions that need to be answered before any Plan can be approved. For example:

- The Plan does not address the significant non-point source discharges from dairy operations, including run-off and groundwater recharge. For example: "Non-point source discharge will distribute the waste over a large area and discharge to the environment may be equal in mass as a point source discharge." "The plan underestimates the amount of manure and nitrogen on the pasture which can be moved by irrigation water and storm water to surface streams or groundwater aquifers." In addition, background water quality sampling must take place with respect to all streams, wetlands and coastal areas.

- The Plan does not adequately address storage capacity during wet weather conditions. "The Plan does not address how many days of capacity to hold additional manure is available on a normal operating scenario and how many days during wet weather when the effluent can't be land applied." "The available storage in the manure and effluent storage basins during normal operations does not appear to be adequate to store during a prolonged period of rain followed by a short duration for saturated soils to

dry enough for land application immediately followed by another extended period of continuous rainfall."

- The Plan does not consider the limitations of the site soils. Mr. Madison provided a custom soil resources report for the site that is far more detailed than the information in the Plan. The actual data "are in direct conflict with the Plan's claims that soils are suitable for an intensive confined animal feeding operation and animal waste disposal with land application and irrigation of effluent. The proposed Dairy Operation is situated on soils that are very limiting for land application of animal waste. An intensive animal waste management program for 699 cows on this site should not be allowed. A waste management program on this site will likely result in contamination of groundwater that is extracted by community wells within the aquifer recharged by the farm. Surface runoff from this site will contain manure contaminants that will be conveyed to streams, wetlands, and coastal waters." Moreover, the Plan must include a soil study that will provide baseline information on the water holding capacity of the various soils. The study must be more detailed than the information presented by the Plan. The study should be conducted by a hydrologist, soils engineer or expert of equivalent training and experience.

- The Plan does not use appropriate technology, let alone the best available technology. "It is my professional opinion that a center pivot irrigation machine spraying effluent should never be permitted to cross a stream even with variable rate precision technology." "It is my professional opinion that drip tape cannot be used in a cattle pasture." "The gun application of manure is the single worst technology choice from the perspective of odor control. High pressure guns with high trajectory and a 65 feet spray radius spraying manure and dispensing a mist in the atmosphere that can drift for miles on a windy day are the poster child of neighbor odor complaints worldwide."

- "Irrigation demand is not calculated correctly in the Plan, and no supporting information or data is provided to allow review. This section is critical and can't be approved or even reviewed without much more data." The Plan contains "a direct admission of intentional groundwater recharge with effluent through saturated well drained soils when the site does not have irrigation needs in December and January. It appears that the amount of groundwater recharge is equal to the amount of effluent that can't be held in the full storage lagoons over the two months that do not require irrigation when the soil water storage of rainfall is properly considered. Groundwater recharge with effluent is not acceptable in an aquifer with community drinking water wells."

- The current Plan does not address the effect of the Dairy's operations on Kaua'i County water wells, shown on page 9 of the Plan. "The site has always had infiltration that enters the aquifer and will continue to be part of the aquifer recharge zone regardless of site management. All wells within the aquifer recharged by the farm must be shown on the map and well logs must be attached to the plan to allow risk assessment for every water user. Additional community drinking water wells exist within the aquifer recharged by the Dairy that are not discussed or shown of the map. The aquifer flow direction and recharge rate need to be calculated to define the amount of water from the site that contributes to flow from each well."

- The Plan does not comport with the applicable Natural Resources Conservation Service, Pacific Islands Area, Conservation Practice Standard Nutrient Management Code. "The addition of one more day's Nitrogen requirement to the site on the day that the cattle have just deposited fresh manure is significant and should not be allowed. Irrigation when cattle are on the pasture depositing fresh manure and for several days after fresh manure is deposited also should not be allowed. The fresh manure risk of runoff and deep percolation is greatest on the day that it is applied and still has a high moisture content, which allows it to quickly saturate and mobilize with irrigation or storm water runoff. The Plan should prohibit adding additional moisture to wet manure."

- The Plan fails to protect water quality. "Background water quality in all streams, wetlands, aquifers, and coastal areas nearby and downstream of the Dairy must be understood to establish the impact of future dairy operations." "The Plan as presented represents a significant risk to groundwater and surface waters including sensitive coastal waters and wetlands and should not be approved." "Future testing of the soil and the ground water is minimal and too infrequent to be meaningful. Moreover, no remedial or mitigation plan is provided in the event that sampling reveals water contamination."

Twelve pages of comments support Mr. Madison's conclusions.

Conclusion.

As previously discussed, the planned size of the Dairy is 2,000 cows. While the Plan purports to be for the first phase, it actually seeks approval of the same facilities that will be used in Phase 2. In other words, all of the buildings, ponds, wastewater systems, pastures, irrigation system, graves, etc. are exactly the same. As approval is sought for full build-out, the impacts of the dairy at full build-out must be studied now.

The Plan should be rejected by the Department because Hawai'i Dairy Farms does not come close to meeting its burden of demonstrating that no pollution or harmful environment degradation will occur. The HRS Chapter 343 process would allow the public to have an opportunity to identify the critical issues that are missing in the Plan, would allow Hawai'i Dairy Farms to respond to them and would inform the Department's decision-making process.

Thank you for your attention to this matter. Please do not hesitate to contact me with any questions regarding these comments.

Sincerely,

Lisa Woods Munger

cc: Edward Bohlen, Esq.
Becky Mitschele, EPA Region 9, NPDES Permits Office
Jun Fukada, Kawailoa Development LLP

Enclosure:
Exhibit F, Mark Madison's Second Set of Comments on Hawai'i Dairy Farms' Waste Management Plan

Review Comments – July 23, 2014, Version of Waste Management Plan for Hawai'i Dairy Farms, Maha'ulepu

PREPARED FOR:	Lisa Bail and Lisa Munger/Goodsill Anderson Quinn & Stifel
COPY TO:	Jim Jordahl/CH2M HILL
PREPARED BY:	Mark Madison/CH2M HILL
DATE:	August 25, 2014

Overview: This document supplements my preliminary comments dated August 21, 2014 relating to the Hawai'i Dairy Farms' Waste Management Plan ("Plan") dated July 23, 2014. The comments below address the remaining sections of the Plan not previously addressed in my prior comments. They are organized by sections of the Plan (referenced by section number).

- 8.5 "The impact of the irrigated solids effluent is negligible and can be done at any stage in the rotation without materially affecting the nutrient loading as it is a little more than a day's [Nitrogen] requirement of the grass." The addition of one more day's Nitrogen requirement to the site on the day that the cattle have just deposited fresh manure is significant and should not be allowed. Irrigation when cattle are on the pasture depositing fresh manure and for several days after fresh manure is deposited also should not be allowed. The fresh manure risk of runoff and deep percolation is greatest on the day that it is applied and still has a high moisture content, which allows it to quickly saturate and mobilize with irrigation or storm water runoff. The Plan should prohibit adding additional moisture to wet manure.
- 8.5 The nitrogen application tables all show that the pasture will require over 700 pounds per acre which does not account for nitrogen already in the soil. The Spectrum Analytic soil fertility analysis data sheets and tables presented show all essential plant nutrients except for nitrogen, so the author of the Plan assumes that the soil contains zero nitrogen and shows that all plant needs can be applied with manure and fertilizer. All agricultural soil contains nitrogen, and land that was previously farmed in sugar cane may contain a significant amount of nitrogen. It is likely that the entire nutrient mass balance presented in sections 8.3, 8.4, and 8.5 will change when existing nitrogen on site is considered. The soil sample data presented appears to be for composite grab samples of surface soil. Soil sampling procedures to determine residual soil nitrogen for best management practices on a waste management site will use collected samples from throughout the plant root zone, which will be several feet thick. Every depth of the soil in the previous crop root zone has residual nitrogen and it is likely that the mass of residual nitrogen will reduce the amount of manure that can be applied. *Natural Resources Conservation Service Pacific Islands Area Conservation Practice Standard Nutrient Management (Ac.) Code 590* states: "The soil and tissue tests must include analyses pertinent to monitoring or amending the annual nutrient budget, e.g., pH, electrical conductivity(EC) and sodicity where salts are a concern, soil organic matter, phosphorus, potassium, or other nutrients and test for nitrogen where applicable." There should be no question that an understanding of nitrogen is central to this Plan and that the foregoing

code section is applicable and required. Code 590 also states:

- "Nutrients must not be surface-applied if nutrient losses offsite are likely. This precludes spreading on:
  - fields when the top 2 inches of soil are saturated from rainfall."
- "The total single application of liquid manure:
  - must not exceed the soil's infiltration or water holding capacity
  - be based on crop rooting depth
  - must be adjusted to *avoid* runoff or loss to subsurface tile drains."

The Plan should not be approved without full accounting of existing site conditions especially existing soil nitrogen.

- 8.6.2 "If it is raining on the scheduled application day, then the volume from that day will be carried over until the next scheduled day. If there are 17 contiguous rain days (longest on record), the worst case is the A, B, C and D are all delivered on E. The critical issue is not the lump of nutrients, but the day's effluent that can be stored in the pond." The critical issue is the lump of nutrients. Applying nutrients on field E that are intended to be applied on fields A, B, C, D, and E will result in 5 times the application rate that is recommended throughout the Plan (which already has one of the highest rates of nitrogen application per acre in Hawaii). This Plan should not be approved to allow applying 5 times an already high rate especially if it is raining.
- 8.7 The plan to apply effluent in equal amounts every month disregards the large variable of available soil moisture holding capacity that exists month to month and from soil type to soil type and is not a good management practice, nor a generally accepted agricultural and management practice. Code 590 precludes spreading of effluent when the top 2 inches of soil are saturated from rainfall. The rate of saturation and draining of the top 2 inches of soil will be different for every soil type and is not presented or accounted for in this Plan. A plan to apply effluent in December when most of the soil types on site are consistently wet from rainfall should not be approved.
- 8.8 "Soils samples and testing will be performed at least every three years." The background soils analysis by Spectrum Analytic does not include any data for nitrogen. If the next soil test is in 3 years it is possible that the site is operating with excess nitrogen in the soil and polluting the groundwater with deep percolation for 3 years before it is detected. The Plan should not be approved without background soil nitrogen data and a minimum of annual soil testing through the full depth of the crop root zone and 1 ft below the crop rooting depth to account for nitrogen that could still be utilized by the crop and nitrogen that can only end up in groundwater.
- 9.1 Background water quality in all streams, wetlands, aquifers, and coastal areas nearby and downstream of the Dairy must be understood to establish the impact of future dairy operations. Background water quality sampling must collect samples for 12 months prior to Dairy operations to capture the large differences that occur naturally with runoff and recharge from month to month based upon rainfall, flora and fauna growth and

decomposition, natural turbidity, and other background influences. Startup dairy operations should not be approved until all background data is collected, reported, and approved by regulatory agencies.

- 9.1.2 "A variety of actions could be taken to mitigate water quality issues that arise at the site. It is likely that one or more of the following actions would be considered and taken to address typical water quality concerns for this type of agricultural operation[.]" Response planning should include the target amount of water quality degradation that will trigger each response. The Plan does not state targets of water contamination in surface waters or aquifers that will trigger a change in operations nor does it document that the change in operations will mitigate the contamination and return the operation to a non-polluting performance. The Plan can't be approved with a statement that: "it is likely that one or more of the following actions would be considered." This language in a plan makes it most likely that no action will occur.

The soil testing protocol is a minimal amount for crop management and is not adequate for a waste management plan for a high density pasture system. Soil samples should extend throughout the root zone and below the root zone to account for all nitrogen in the system. Additional nutrient applications must be adjusted annually to account for residual nutrients in the entire root zone not just the upper 8" and the adjustment should be approved by regulatory agencies. The paddock samples should not be composited by groups of adjacent paddocks but should represent specific soil types. There must be an O&M plan in place for effluent application irrigation systems especially the high maintenance variable rate sprinkler machines that will cross multiple water courses during operations.

The Plan as presented represents a significant risk to groundwater and surface waters including sensitive coastal waters and wetlands and should not be approved.

Exhibit 11

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September 12, 2014

VIA EMAIL

Sina Pruder, P.E.
Chief
Wastewater Branch
Environmental Management Division
Department of Health
919 Ala Moana Blvd., Room 309
Honolulu, HI 96814

Re: Status of Kawailoa's Requests Submitted in the Letter Dated August 11, 2014

Dear Ms. Pruder:

I am writing to follow up on the requests that were submitted to the Hawai'i Department of Health (the "Department") on behalf of Kawailoa Development LLC ("Kawailoa") in the letter dated August 11, 2014. We have not received a response since our requests were made over a month ago. Please advise us of a date at which a decision from DOH will be made with respect to our requests.

Our requests in subsection "C" of the August 11, 2014 letter are summarized as follows:

- Since Hawai'i Dairy Farms ("HDF") has not prepared an environmental assessment for its proposed wastewater treatment unit and its dairy farm, the Department cannot proceed with decision-making on HDF's waste management plan until the project has complied with Chapter 343.

- Construction of the Dairy has already commenced without a storm water permit in violation of Hawai'i Administrative Rules ("HAR") § 11-55-04. Since HDF's construction activities have involved far in excess of one acre of property and since a storm water permit has not been obtained, all construction activities must cease immediately.

- The entire island of Kaua'i is a critical wastewater disposal area, HAR § 11-62 Appendix E, and the dairy farm is proposing a unique, highly intensive agricultural use. Therefore, it is appropriate that the Department exercise its discretion to require that the Dairy's wastewater system be approved in writing by the Kaua'i Board of Water Supply, pursuant to HAR § 11-62-6(k).

- Under a number of existing administrative rules of the Department, permits are necessary and should be required for the Dairy's wastewater treatment works. *See*, HAR § 11-62-50(a)(5), HAR § 11-62-50(b)(5), HAR § 11-62-50(d)(6) and/or HAR § 11-62-50(e).

- The Department has the authority to hold a public meeting prior to its decision regarding the Plan, pursuant to HAR § 11-62-10. We requested a public meeting because the proposed Dairy is in a location of great public importance and the Dairy's operations pose serious risks to the entire watershed.

Finally, we request a status update on the Department's review of HDF's Waste Management Plan ("Plan") dated July 23, 2014. In this respect, we want to emphasize that Hawai'i Revised Statutes ("HRS") § 343-5(e) states:

> Whenever an applicant proposes an action specified by subsection (a) that requires approval of an agency and that is not a specific type of action declared exempt under section 343-6, the agency initially receiving and agreeing to process the request for approval shall require the applicant to prepare an environmental assessment of the proposed action at the earliest practicable time to determine whether an environmental impact statement shall be required.
> (Emphases added).

Since HDF's Plan proposes a wastewater treatment unit that requires the Department's approval, the Department has an affirmative duty to require HDF to prepare an environmental assessment "at the earliest practicable time." Therefore, the Department cannot proceed with decision-making on HDF's Plan until the project has complied with Chapter 343.

Because we raised these issues over a month ago, we request that the Department provide us with a timeline for its response. Thank you for your attention to this matter.

Sincerely,

Lisa Woods Munger

LWM

cc: Edward Bohlen, Esq.
Becky Mitschele, EPA Region 9, NPDES Permits Office
Jun Fukada, Kawailoa Development LLP

Exhibit 12

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF HEALTH
P. O. BOX 3378
HONOLULU, HI 96801-3378

LINDA ROSEN, M.D., M.P.H.
DIRECTOR OF HEALTH

In reply, please refer to:
File:

Dairy munger 9-19-14

September 23, 2014

Ms. Lisa Woods Munger
Goodsill Anderson Quinn & Stifel
999 Bishop Street
First Hawaiian Center, Suite 1600
Honolulu, Hawaii 96813

Dear Ms. Munger:

Subject: Status of Kawailoa's Requests Submitted in the Letter Dated August 11, 2014

The Department of Health (DOH) received your letter dated September 12, 2014 regarding the subject matter. Thank you for your interest. As requested, provided below are our responses to your inquiries.

1. Since Hawaii Dairy Farms ("HDF") has not prepared an environmental assessment for its proposed wastewater treatment unit and its dairy farm, the Department cannot proceed with decision-making on HDF's waste management plan until the project has complied with Chapter 343.

   DOH's response: Attached is a letter DOH sent to HDF, dated September 15, 2014, indicating that DOH was not proceeding with decision-making on their WMP.

2. Construction of the Dairy has already commenced without a storm water permit in violation of Hawaii Administrative Rules ("HAR") § 11-55-04. Since HDF's construction activities have involved far in excess of one acre of property and since a storm water permit has not been obtained, all construction activities must cease immediately.

   DOH's response: Thank you for bringing this allegation to our attention. As you are aware, commencement of land disturbance activities of one (1) acre or more without a National Pollutant Discharge Elimination System (NPDES) permit is a violation of Hawaii Revised Statutes, Chapter 342D-50.

3. The entire island of Kauai is a critical wastewater disposal area, HAR §11-62 Appendix E, and the dairy farm is proposing a unique, highly intensive agricultural use. Therefore, it is appropriate that the Department exercise its discretion to require that the Dairy's wastewater system be approved in writing by the Kauai Board of Water Supply, pursuant to HAR §11-62-6(k).

   DOH's response: To date, DOH has not received any comments from the Kauai Board of Water Supply regarding concerns they may have in regards to the dairy. Therefore, the DOH does not believe that it is necessary to require the Dairy's wastewater system to be approved in writing by the Kauai Board of Water Supply if concerns have not been raised.

4. Under a number of existing administrative rules of the Department, permits are necessary and should be required for the Dairy's wastewater treatment works. See, HAR § 11-62-50(a)(5), HAR § 11-62-50(b)(5), HAR § 11-62-50(d)(6) and/or HAR § 11-62-50(c).

   DOH response: The DOH does not issue permits for livestock wastewater treatment systems. All General Permits for domestic wastewater treatment works expired on December 9, 2009. Individual Permits are only issued for wastewater treatment works and facilities that treat domestic wastewater sludge for land application purposes.

5. The Department has the authority to hold a public meeting prior to its decision regarding the Plan, pursuant to HAR § 11-62-10. We requested a public meeting because the proposed Dairy is in a location of great public importance and the Dairy's operations pose serious risks to the entire watershed.

   DOH response: DOH reviewed and provided comments on HDF's WMP, but indicated in the letter to HDF dated September 15, 2014, that DOH was not approving or taking any other action on their WMP. Since DOH is not making a decision on the WMP, DOH does not see need for it to hold a public hearing.

Should you have any questions, please contact me at telephone no. 586-4294.

Sincerely,

SINA PRUDER, P.E., CHIEF
Wastewater Branch

SP:lmj

STATE OF HAWAII
DEPARTMENT OF HEALTH
P. O. BOX 3378
HONOLULU, HI 96801-3378

Hawaii Dairy Mgmt Unit

September 15, 2014

Mr. Paul T. Matsuda, P.E.
Group 70 International
925 Bethel Street, 5th Floor
Honolulu, Hawaii 96813-4307

Dear Mr. Matsuda:

Subject: **Hawaii Dairy Farm (HDF)**
Waste Management Plan (WMP)
Mahaulepu, Kauai, Hawaii
TMK: (4) 2-9-003:001 por and 006 por & (4) 2-9-001:001 por

Thank you for your responses to the Department of Health, Wastewater Branch's (DOH-WWB) questions dated June 3, 2014 for the subject WMP. DOH-WWB has reviewed HDF's building facilities plan for Phase One only. Based on that review, the DOH-WWB does not object to the issuance of a building permit. DOH-WWB is not approving or taking any other action at this time on HDF's overall WMP.

Please be informed that DOH's sign-off on the building permit is also contingent on the DOH Sanitation Branch's review of the HDF's plans. As of today, the DOH Sanitation Branch is still reviewing the plans for HDF and has not given their approval to sign-off on the building permit. Should you have any questions about the status of this review process, please contact the Sanitation Branch at 586-8000.

In prior meetings, HDF agreed to take baseline water quality data of the Waiopili Stream. DOH-WWB requests that HDF provides the following data:

Establish baseline water quality data for the Waiopili Stream. The water should be tested for nutrients (nitrate, nitrite, ammonia, total phosphate and total nitrogen), e.coli, enterococci and clostridium. A minimum of one sample should be taken 50 feet upstream of the dairy, adjacent to the dairy at mid-point of the dairy property and 50 feet downstream of the dairy property. The sampling results should be submitted to DOH-WWB by November 30, 2014.

Should you have any questions or concerns, please feel free to contact me at (808) 586-4294.

Sincerely,

SINA PRUDER, P.E., CHIEF
Wastewater Branch

SP:mj

Exhibit 13

GOODSILL ANDERSON QUINN & STIFEL
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September 30, 2014

Gary Gill (gary.gill@doh.hawaii.gov)
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Sina Pruder, P.E. (sina.pruder@doh.hawaii.gov)
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Jessica Wooley (jessica.wooley@doh.hawaii.gov)
Director
Office of Environmental Quality Control
Hawai'i State Department of Health
235 South Beretania Street
Suite 702
Honolulu, Hawai'i 96813

Re: Chapter 343 Environmental Review as a Condition Precedent to the Approval of Hawaii Dairy Farms' Waste Management Plan, dated July 24, 2014

Dear Ladies and Gentlemen:

On behalf of Kawailoa Development LLP, we have written to the Wastewater Branch on four prior occasions with comments and concerns relating to the Hawai'i Dairy Farms' Waste Management Plan ("Waste Mgmt. Plan"), dated July 23, 2014, for its proposed dairy farm ("Dairy") in Māhā'ulepū, Kaua'i. Our letters are dated August 11, 2014, August 21, 2014, August 25, 2014 and September 12, 2014, and copies are available upon request.

In the first of our letters, we conveyed that the Waste Mgmt. Plan proposes a "wastewater treatment unit" as that term is defined in Hawai'i Administrative Rules ("HAR")

Chapter 11-62 and that the Dairy project is therefore subject to Hawai'i Revised Statutes ("HRS") Chapter 343.

Hawai'i Dairy Farms ("HDF") has not prepared an environmental assessment and therefore may not proceed with its project until it does so. The Department and any of its branches likewise are not allowed to proceed with decision-making on a project that has not complied with Chapter 343.

We recently received a copy of a letter from Sina Pruder of the Wastewater Branch dated September 15, 2014 to Mr. Paul T. Matsuda of Group 70 International informing Mr. Matsuda of "DOH's sign-off on the building permit." The letter also states that the DOH's sign-off "is 'contingent' on the DOH Sanitation Branch's review of the HDF's plans ..." and that the DOH Sanitation Branch must give "their approval to sign-off on the building permit."

We also recently received a copy of an application by the Dairy to the Clean Water Branch dated September 9, 2014 for an NPDES General Permit Authorizing Discharges of Storm Water Associated with Construction Activities in connection with the Dairy project.

We ask that no action be taken on the Waste Mgmt. Plan or any other application in connection with the Dairy project by the Department of Health or any of its branches until an environmental assessment of the proposed action is prepared and a determination is made whether an environmental impact statement shall be required. Chapter 343 mandates that an environmental assessment be prepared "at the earliest practicable time to determine whether an environmental impact statement shall be required." HRS § 343-5(a)-(b).

Thank you for your attention to this matter.

Very truly yours,

Lisa Woods Munger

LWM

cc: Edward Bohlen, Esq., Office of the Attorney General
Becky Mitschele, EPA Region 9, NPDES Permits Office
Jun Fukada, Kawailoa Development, LLP

Exhibit 14

GOODSILL ANDERSON QUINN & STIFEL
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October 15, 2014

Gary Gill (gary.gill@doh.hawaii.gov)
Deputy Director
Office of the Director of Health
Hawai'i State Department of Health
1250 Punchbowl Street
Honolulu, Hawai'i 96813

Peter Oshiro (peter.oshiro@doh.hawaii.gov)
Sanitation Branch
Hawai'i State Department of Health
591 Ala Moana Boulevard
Honolulu, Hawai'i 96813

Re: Chapter 343 Environmental Review as a Condition Precedent to the Approval of Hawaii Dairy Farms' Proposed Dairy Farm Plans

Dear Gentlemen:

On behalf of Kawailoa Development LLP, we previously wrote to the Department of Health ("DOH") and three of its agencies on September 30, 2014 relating to Hawai'i Dairy Farms' proposed dairy farm ("Dairy") in Māhā'ulepū, Kaua'i.

In our letter, we conveyed that the Hawai'i Dairy Farms ("HDF") proposes a "wastewater treatment unit" as that term is defined in Hawai'i Administrative Rules ("HAR") Chapter 11-62 and that the Dairy project is therefore subject to Hawai'i Revised Statutes ("HRS") Chapter 343.

HDF has not prepared an environmental assessment and therefore may not proceed with its project until it does so. The Department and any of its branches, including the Sanitation Branch, likewise are not allowed to proceed with decision-making on a project that has not complied with Chapter 343.

As discussed in our prior letter, we recently received a copy of a letter from Sina Pruder of the Wastewater Branch dated September 15, 2014 to Mr. Paul T. Matsuda of Group 70 International informing Mr. Matsuda of "DOH's sign-off on the building permit." The letter also states that the DOH's sign-off is "contingent on the DOH Sanitation Branch's review of the HDF's plans ..." and that the DOH Sanitation Branch must give "their approval to sign-off on the building permit."

In response to our government records request dated October 2, 2014, we received copies of emails referring to a "construction plans review" being conducted by the Sanitation Branch. We understand that in addition to the building permit approval, HDF requires the Sanitation Branch's approval for its future dairy farm. HAR § 11-15-49 states that "[p]roperly

prepared plans for all milkhouses, milking barns, stables, parlors, transfer stations, receiving stations, and milk plants regulated under this chapter which are hereafter constructed, reconstructed, or extensively altered, shall be submitted to the director for written approval before work is begun. A copy of the approved plans shall be retained by the permittee for inspection by the director."

We ask that no action be taken on the building permit, future dairy plans, or any other application in connection with the Dairy project by the Sanitation Branch until an environmental assessment of the proposed action is prepared and a determination is made whether an environmental impact statement shall be required. Chapter 343 mandates that an environmental assessment be prepared "at the earliest practicable time to determine whether an environmental impact statement shall be required." HRS § 343-5(a)-(b).

Thank you for your attention to this matter.

Very truly yours,

Lisa Woods Munger

LWM

cc: Edward Bohlen, Esq., Office of the Attorney General

Jun Fukada, Kawailoa Development, LLP

Exhibit 15

GOODSILL ANDERSON QUINN & STIFEL
A LIMITED LIABILITY LAW PARTNERSHIP LLP

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November 3, 2014

VIA EMAIL

Emilee Stevens
Regulatory Biologist
US Army Corps of Engineers
Honolulu District
Building 230, CEPOH-RO
Fort Shafter, Hawai'i 96858-5440
Email: emilee.r.stevens2@usace.army.mil

Re: <u>Review of Hawai'i Dairy Farms' Proposed Dairy Farm Plans</u>

Dear Ms. Stevens:

I am writing on behalf of Kawailoa Development LLP ("Kawailoa") regarding Hawai'i Dairy Farms' proposed dairy farm ("Dairy") in Māhā'lepū, Kaua'i.

Kawailoa is the owner of the Grand Hyatt Kaua'i and the Poipu Bay Golf Course. Kawailoa has a substantial interest in the Dairy's plans as both the Grand Hyatt Kaua'i and the Poipu Bay Golf Course will be directly affected by the Dairy's operations. The project boundary of the Dairy will be less than one mile from the boundary of the Poipu Bay Golf Course and a mile and a half from the boundary of the Grand Hyatt Kaua'i.

On October 17, 2014, we received an interim response to our FOIA request to the U.S. Army Corps of Engineers ("ACOE"), which asked for copies of documents pertaining to the Dairy. Included in the response was an email sent to Wendy Wiltse of EPA on September 24, 2014. In that email, you noted that under 33 CFR § 323.4(a)(3), the discharge of dredged or fill material associated with the construction or maintenance of irrigation ditches, or the maintenance (not construction) of drainage ditches is exempt from requiring a Section 404 permit. You further wrote that "[e]ven if the dairy farm conducted maintenance activities already, so long as they are solely maintenance activities in drainage ditches, the activity would be exempt with or without a verification letter[.]"

Although Hawai'i Dairy Farms' work in the drainage ditches is being characterized as "maintenance," and thus falling under the permitting exemption, the construction activities for the Dairy cannot be correctly characterized as such. According to the U.S. Army Corps of Engineers' Regulatory Guidance Letter dated July 4, 2007, "maintenance"

includes a repair to an existing structure or features to keep the ditch in its existing state or proper condition, or to preserve it from failure or decline, whereas "construction" includes new work or work that results in an extension or expansion of an existing structure.

First, Hawai'i Dairy Farms has already constructed bridges spanning the ditches for the center pivot irrigation machine. A picture of the bridges is attached as Exhibit A. Second, berms will be constructed along the ditches, which act as new control structures. Third, a roadside ditch will be constructed to provide adequate surface drainage. According to Hawai'i Dairy Farms, the roadside ditch will be designed on stable grades and at a minimum one foot below the top of the road surface to provide internal drainage. ACOE should assure itself of the exact location of the ditch, as it is possible that the new roadside ditch will extend to an existing ditch. Finally, an extensive system of pipelines will be constructed, and although the exact locations of the pipes remain unclear, it is possible that at least one of them will be placed in a drainage ditch. Therefore, this exemption cannot apply to the Dairy since new construction work, and not maintenance work, is being done on the drainage ditches.

Additionally, in Hawai'i Dairy Farms' Notice of Intent for a National Pollutant Discharge Elimination System ("NPDES") permit, it wrote that a Section 404 permit is inapplicable "for normal ongoing farming activities" per conversation with you on July 25, 2014 and September 4, 2014. However, "normal farming" practices are only exempt from permitting under Section 404 when conducted as part of an <u>ongoing operation</u>. 33 CFR § 323.4(a)(1). The Dairy's operations cannot be characterized as "ongoing" since the Dairy and its activities are far from being an established operation. Therefore, this exemption also does not apply to the Dairy.

In an email dated September 5, 2014 from Ryan Char, he wrote that the wetland at the southernmost tip of the project is not within the project boundary and will not be impacted. However, the U.S. Fish and Wildlife Service's National Wetlands Inventory map, attached as Exhibit B, shows four additional bodies of water within the upper half of the Dairy's property boundaries. Hawai'i Dairy Farms only discussed the wetland south of the property, but did not address the waterbodies in the upper half of its property. We therefore request that the ACOE look into these waterbodies that are not addressed by Hawai'i Dairy Farms.

There are many concerns with the Dairy's intensive use of the land, and a lot of the issues center around the Dairy's direct impacts on ground water, surface water and nearby Class 1 ocean waters. We therefore request your careful consideration of the issues raised in this letter while you review the Dairy's plans.

Thank you for your attention to this matter. Please do not hesitate to contact me if you have any questions.

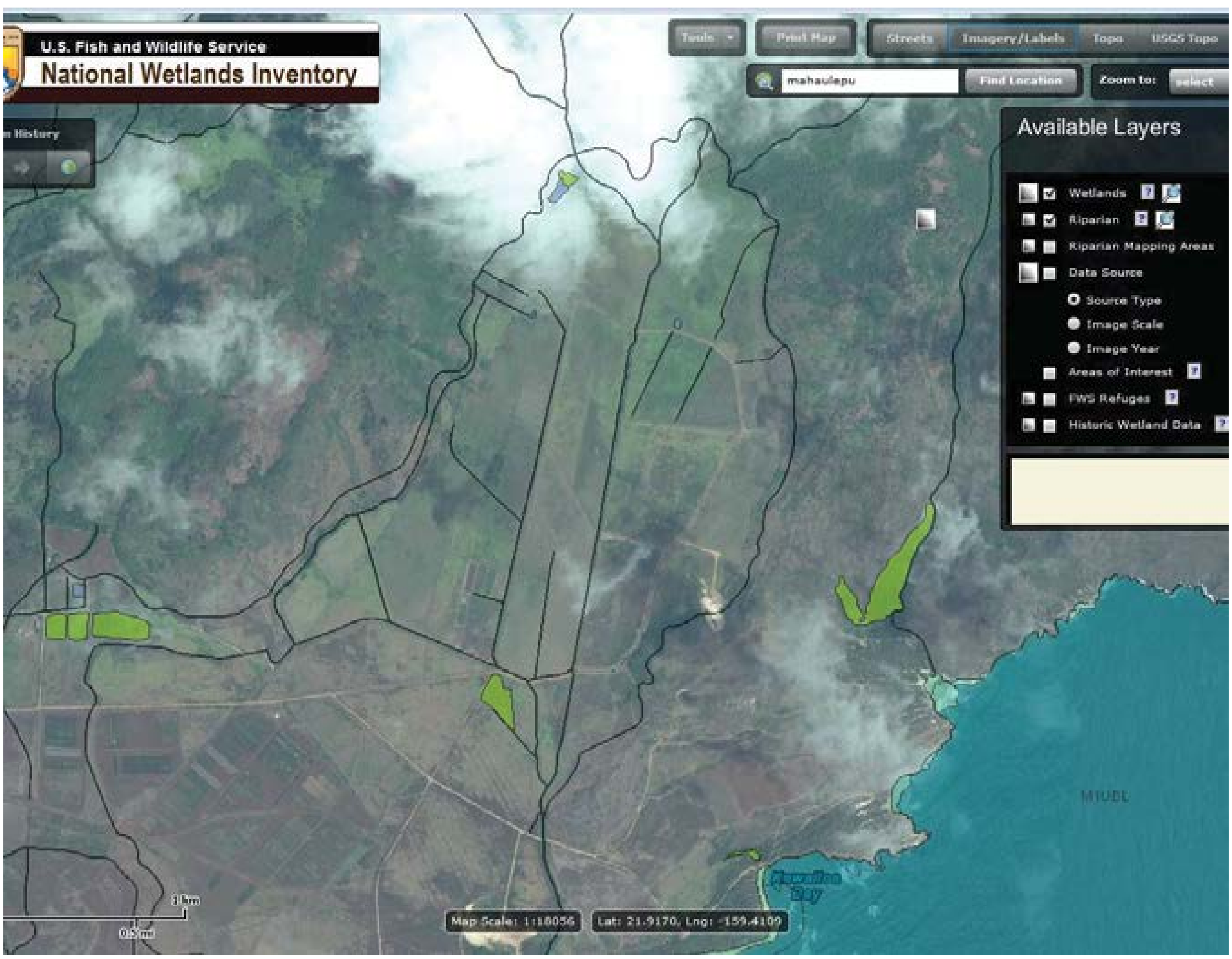
Very truly yours,

Lisa A. Bail

LAB

cc: Wendy Wiltse, Environmental Protection Agency Region 9
Jun Fukada, Kawailoa Development LLP

Enclosures:
Exhibit A, Aerial photograph of bridges for the center pivot irrigation machine taken in the summer of 2014
Exhibit B, U.S. Fish and Wildlife Service's National Wetlands Inventory Map


U.S. Fish and Wildlife Service
National Wetlands Inventory
Tools
Print Map
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Find Location
Zoom to:
select
Available Layers
Wetlands
Riparian
Riparian Mapping Areas
Data Source
Source Type
Image Scale
Image Year
Areas of Interest
FWS Refuges
Historic Wetland Data
M1UBL
Map Scale: 1:18056
Lat: 21.9170, Lng: -159.4109
1 km
0.5 mi

Exhibit 16

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February 23, 2015

HAND DELIVERY AND U.S. MAIL

Laura McIntyre Environmental Planning Office Hawai'i State Department of Health 1250 Punchbowl Street Honolulu, Hawai'i 96813	Jeff Overton Principal Planner Group 70 International, Inc. 925 Bethel Street, 5th Floor Honolulu, Hawai'i 96813

U.S. MAIL AND EMAIL

Hawai'i Dairy Farms, LLC
P.O. Box 1690
Koloa, Hawai'i 96756-1690
HDF@Group70int.com

Re: Comments on Hawai'i Dairy Farms'
Environmental Impact Statement Preparation Notice

To Whom It May Concern:

This letter is sent on behalf of Kawailoa Development LLP ("Kawailoa Development") to provide comments on the Environmental Impact Statement Preparation Notice ("EISPN"), published in the Environmental Notice on January 23, 2015, for the dairy farm ("Dairy") proposed by Hawai'i Dairy Farms ("HDF") in Māhā'ulepū, Kaua'i.

Kawailoa Development is the owner of the Grand Hyatt Kaua'i and the Poipu Bay Golf Course. Kawailoa Development has a substantial interest in the Environmental Impact Statement ("EIS") process, pursuant to Hawai'i Revised Statutes ("HRS") chapter 343, as both the Grand Hyatt Kaua'i and the Poipu Bay Golf Course will be directly affected by the operations of the Dairy. The project boundary of the Dairy will be less than a mile from the boundary of the Poipu Bay Golf Course and a mere mile and a half from the boundary of the Grand Hyatt Kaua'i. Kawailoa Development therefore requests that it be a consulted party pursuant to Hawai'i Administrative Rules ("HAR") § 11-200-15.

I. OVERVIEW

This project is of significant public interest. Not only will the project affect the over 1,000 employees at the Grand Hyatt Kaua'i and Poipu Bay Golf Course, but adverse consequences resulting from the Dairy's operations will be a concern for all who visit, live or work in the Po'ipū and Koloa area. The full-scale operations of the Dairy have already been acknowledged by Hawai'i Dairy Farms to be a Concentrated Animal Feeding Operation ("CAFO"), and at 2,000 cows, or even 699 cows (HDF's purported first phase), the Dairy will be one of the largest and most concentrated in the State. As the U.S. Environmental Protection Agency ("EPA") has stated, "The concentrations of waste from these animals increase the potential to impact air, water, and land quality." Given such potential impacts, a careful and deliberate review of the environmental impacts is imperative before permits are granted.

Kawailoa Development offers its comments in two categories: comments on the EIS process and comments on the scope of impact evaluation.

II. COMMENTS ON THE EIS PROCESS

A. An After-The-Fact EIS Violates Chapter 343

For the reasons set forth in its Second Amended Complaint, filed *ex officio* on December 9, 2014 in Civil No. 14-1-0141 JRV, pending before the Circuit Court of the Fifth Circuit, Kawailoa Development disagrees with HDF's statement that "[n]one of the agricultural operations associated with the [Dairy] constitute a 'trigger' under HRS Chapter 343 requirements." EISPN at 4-2. In brief, HDF has proposed to construct and operate a wastewater treatment unit and is therefore required to study the impacts of its wastewater treatment unit and its Dairy as required by HRS Chapter 343. HDF's statement that the EIS is "being prepared voluntarily," EISPN at 1-1, is flatly incorrect. HDF's failure to disclose in the EISPN that the Dairy will have a wastewater treatment unit constitutes a withholding of vital information.

On the cover page of the EISPN, HDF states that the document was "prepared pursuant to Hawai'i Revised Statutes, Chapter 343, Environmental Impact Statement Law and Chapter 200 of Title 11, Administrative Rules, Department of Health, Environmental Impact Statement Rules." *See also* EISPN at 4-2 (the EISPN was prepared "pursuant to HRS Chapter 343 and HAR Chapter 200."). According to the EISPN, however, HDF purports to have already received the following permits and approvals:

- County of Kaua'i - Building Permit (November 2014)
- County of Kaua'i - Grading and Grubbing Agricultural Exemption (March 2014)
- State of Hawai'i Department of Health Wastewater Branch - Animal Feeding Operation/Waste Management Plan (October 2014)

- U.S. Department of Agriculture Natural Resources Conservation Service – Agricultural Conservation Plan (no date provided)

EISPN at 2-4. The EISPN fails to disclose that HDF also received approval from the Department Wastewater Branch for its Individual Wastewater System on April 23, 2014. *See* Exhibit A. Additionally, there are applications for permits and approvals currently pending before the Department and other State agencies, including the National Pollutant Discharge Elimination System ("NPDES") Construction Stormwater General Permit and Historic Preservation Review.

It is well-settled that the purpose of Chapter 343 is informed decision making. HRS § 343-1 ("It is the purpose of this chapter to establish a system of environmental review which will ensure that environmental concerns are given appropriate consideration in decision making along with economic and technical considerations."). Hence, the Hawai'i EIS Law requires that, "the agency initially receiving and agreeing to process the request for approval shall require the applicant to prepare an environmental assessment of the proposed action at the earliest practicable time." The EIS rules mandate that,

> An EIS is meaningless without the conscientious application of the EIS process as a whole, and shall not be merely a self-serving recitation of benefits and a rationalization of the proposed action. Agencies shall ensure that statements are prepared <u>at the earliest opportunity in the planning and decision-making process</u>. This shall assure an early open forum for discussion of adverse effects and available alternatives, and that the decision-makers will be enlightened to any environmental consequences of the proposed action.

HAR § 11-200-14 (emphasis added). HDF's EIS process will result in the very "meaningless" EIS contemplated by the rules. Where permits have already been issued, the EIS will be the contemplated "self-serving recitation of benefits and a rationalization of the proposed action."

The Hawai'i Supreme Court has long held that an EIS must precede any state or county approvals. *See, e.g., Molokai Homesteaders Coop. Ass'n.*, 63 Haw. 453, 467-68, 629 P.2d 1134, 1144 (1981) (noting that an EIS is a "prerequisite" for Board approval of a request); *Sierra Club v. Office of Planning*, 109 Hawai'i 411, 416-17, 126 P.3d 1098, 1103-04 (2006) (holding a land reclassification petition as the earliest practicable time at which to prepare the environmental assessment). Further,

> <u>[D]ecisions reflecting environmental considerations can most easily be made when other basic decisions are also being made, that is, during the early stages of project conceptualization and planning</u>. . . . [E]arly environmental assessment comports with the purpose of HEPA to alert decision-makers early in the

> development process because, "after major investment of both time and money, it is likely that more environmental harm will be tolerated."

Sierra Club, 109 Hawai'i at 419, 126 P.3d at 1106 (citations omitted) (emphasis in original). Since the EIS informs the decision-making process, it is an abuse of the EIS process for HDF to propose an EIS that rationalizes approvals that have already been issued. Environmental review after decisions have already been made is "a *post hoc* rationalization to support action already taken." *Citizens for the Protection of the North Kohala Coastline v. County of Hawai'i*, 91 Hawai'i 94, 105, 979 P.2d 1120, 1131 (1999).

Here, HDF proposes an after-the-fact EIS that violates Chapter 343. Although HDF has stated that it prepared the EISPN and will prepare the appropriate environmental documents in accordance with HRS chapter 343, it already sought and received apparent approvals for portions of its proposed action without first satisfying the mandates of Chapter 343. Moreover, based on such approvals, HDF has already conducted site work that is part of and necessary to the construction of its Dairy. By placing the cart before the horse, the EIS process is turned on its head. Environmental assessments and environmental impact statements are the bases for future decisions, permits and approvals. The EIS does not presume such decisions, permits and approvals. If conducted only after the decisions have been predetermined, however, a mockery will have been made of the EIS process.

In sum, this EISPN and any EIS prepared in accordance with it do not comply with the procedures mandated by Chapter 343 and its implementing rules. Without waiving its right to challenge the process proposed by HDF which violates Chapter 343, Kawailoa Development provides further comments below.

B. Alternatives Must Be Considered

Hawai'i Administrative Rules ("HAR") § 11-200-17(f) sets forth a list of categories of alternatives to be considered and directs that "[p]articular attention shall be given to alternatives that might enhance environmental quality or avoid, reduce, or minimize some or all of the adverse environmental effects, costs, and risks." HDF must carefully consider at least two additional alternatives in its Draft EIS.

First, the alternative locations that the EISPN proposes to consider as required by HAR § 11-200-17(f)(5) are arbitrarily limited to the island of Kaua'i. EISPN at 2-3. There is nothing in HAR § 11-200-17(f)(5) that limits "alternative locations" to those on the same island as the proposed project. It is appropriate and important that the EIS consider alternative locations on all islands. Given the size of the Dairy either at initial or at full-scale operations, milk production and distribution will not be limited only to Kaua'i. Kaua'i has no milk processing facilities. Among other things, HDF must consider the environmental impacts incident to transportation of its milk products in its EIS and compare those to statewide locations that are larger and/or better suited than Māhā'ulepū valley and where inter-island transportation for milk processing may not be required.

Second, the Draft EIS must consider "[t]he alternative of postponing action pending further study[.]" HAR § 11-200-17(f)(4). In-depth studies of environmental and cultural issues, and particularly impacts to groundwater and surface water, must be undertaken before the dairy can be constructed. As will be discussed below, the Dairy at full-scale operation poses serious, irreversible risks to Māhā'ulepū and it is crucial that in-depth research is conducted prior to the Dairy's operations.

C. Discharges from the Dairy Must be Identified and Evaluated

HDF's EISPN makes the cavalier and conclusory statement that its Dairy will be "zero-discharge." EISPN at 1-2, 2-2, 3-4. While this might be a marketing slogan or a hoped-for result, the extent and nature of the discharges to be generated by the Dairy should be the result of careful and scientific study conducted via the EIS process. Whether there might not be any point-source discharge is subject to serious debate, but the fact of the matter is that there will be discharge. As indicated by the Dairy's own statement in Section 4.0, "Potential for increased air and water emissions will be evaluated in the Draft EIS." HDF's assumption that its Dairy is zero-discharge misleads the public and foretells a dangerously breezy Draft EIS. If HDF assumes no discharges (presumably because it says so), then there will be no impacts to evaluate in a Draft EIS. Such an assumption relating to the nature and extent of discharges (whether nutrients, organic matter and/or bacteria) is at the heart of this matter. An in-depth consideration of the environmental ramifications of Dairy operations, and their related discharges is required.

HDF's claim of zero-discharge, whether defined as in the EISPN as zero discharge with respect to nutrients in the manure, or by any other means, EISPN at 2-2, is contradicted in the EISPN itself. A detailed root zone soil water balance, for example, would not have been required to show available water holding capacity throughout the year with the proposed rainfall, irrigation, manure loading, wastewater loading, and off-site storm water that will overflow onto the fields.

Moreover, the Draft EIS should describe how many of the 2,000 cows are milking and dry, or just milking. The description of the associated ancillary stock should also include how many cows are dry, replacement heifers, bulls, or pre-weaned calves. The location of each cow should be described, as well as the plans for their shelter during inclement weather. The location also affects the amount of nutrients in the pasture. The Draft EIS should describe the paddock rotation schedule. The long transit times may translate to more manure deposited on cow runs, where no plants are growing, as opposed to the pasture.

Even assuming there is no point source discharge from this facility, there will be obvious storm water discharge. Grazing cattle will deposit feces and urine as they graze, and these fecal parts are prone to intense rainfall events. Nutrients, organic matter, and bacteria will be discharged through storm water from the paddocks to waterbodies. The potential for storm water to carry nutrients and manure from the feedlot areas and pastures to the ditches draining the property and ultimately to the coast must be carefully and thoroughly evaluated. The Draft EIS should also discuss its drainage plans and whether depressions in the field will be drained with buried perforated pipe or surface drains to reduce ponding and vector breeding.

III. TECHNICAL SCOPING COMMENTS

Technical, scientific comments are provided by Kawailoa Development with the assistance of two experts: Dr. Deanne Meyer and Mr. Mark Madison in sections III.A., B. and C., below. Dr. Meyer is a Research Scientist and Cooperative Extension Specialist in the Department of Animal Science at the University of California, Davis (UC Davis). Mr. Madison is an agricultural, environmental and civil engineer, and senior project manager with CH2M HILL, a global engineering and consulting firm.

A. Groundwater

Section 3.1.3 of the EISPN provides that the Māhā'ulepū well site contains up to 14 irrigation wells drilled by former sugar plantations and "[d]rinking water and irrigation water supply for HDF, and ground water quality will be addressed in the Draft EIS." The EISPN fails to acknowledge that the Dairy will impact groundwater. The environmental impacts on groundwater cannot be ignored in the Draft EIS.

The environmental impact of potential wellhead inundation with wastewater must be quantified. Wellhead analysis is crucial to prevent pollution migration to groundwater. Therefore, existing wellhead installation reports need to be analyzed to ensure no environmental impacts will occur from manure storage or application events. The analysis should include the potential lateral movement of manure or feed nutrients through soil to wellheads.

In addition, the non-uniform application of urine and feces by grazing dairy cattle can lead to groundwater contamination. The environmental impact of the cattle mob's grazing activities on groundwater, surface water and air emissions must therefore be quantified. Furthermore, proper wellhead installation practices for new wells must be identified and followed to protect the wells from inundation of manure effluent.

The environmental impact of the over-application of liquids from the storage pond at times when storage capacity is insufficient—such as in times of rain—must be quantified. This is especially critical during wet periods; the Draft EIS must address the increased groundwater contamination potential from irrigating well-drained soils during wet periods.

The animal cemetery also needs to be analyzed, particularly because the cemetery appears to be located in soil with a 6-12% slope. Digging the defined trenches for mortality may be challenging in sloping soils and erosion control will be essential. Runoff will need to be diverted so that the cemetery will not be inundated and the decomposing animals will not leach into the groundwater. Animal disposal issues in a catastrophic event may exceed the assimilative capacity of the soil at the animal cemetery to treat and remove nutrients and fluids of decomposing cattle. Additionally, it is apparent that a riverine is located next to the paddock with the cemetery. Management of the riverine is important to ensure that it does not flow onto the cemetery. The Draft EIS should assess if positive drainage will exist to minimize the ponding of rain water and to prevent deep percolation near feed or waste storage locations and the animal cemetery.

Because the nitrogen cycle is inefficient, with losses occurring from application to plant uptake, it is critical that the Draft EIS examine the nutrient balance in the watershed. Because the desired rates of growth for the kikuyu grass will require importing high quantities of fertilizer, the environmental impact for this must be quantified. Nutrient application rates should be compared to site specific conditions that may differ from values in the NRCS 590 Nutrient Management standard. Environmental monitoring of the groundwater wells is critical to ensure safety of the groundwater supply. Moreover, monitoring is important to ensure that volatilized ammonia will not damage surface water or plant productivity once deposited back to the water or ground. Examination of the nutrient balance should consider: (1) nutrient loads from milking cows, dry cows, and calves; (2) actual net removal of nutrients in a grazing system, as net removal is generally very low in grazed systems (cattle are voiding wastes as they are eating); (3) ammonia volatilization and denitrification; (4) total waste production (urine and manure); and (5) nitrogen carryover from one year to the next from incomplete mineralization of organic nitrogen. The impact on groundwater will accumulate over time and should be presented in a long term nutrient plan accounting for all forms of nitrogen.

The phosphorus index is an index value that identifies if there are sufficient or insufficient amounts of phosphorus in the soil. It is important to have a feedback mechanism to evaluate if the targets of the Dairy are achieved and if they are not, what modifications need to occur and what potential environmental ramifications may occur as a result. The phosphorus index value calculations should therefore be reviewed to determine when soil storage capacity for phosphorus will be exceeded. The impact of elevated phosphorus in groundwater and coastal freshwater should be presented and a timeline for phosphorus breakthrough should be projected.

B. Surface Water

Section 3.1.3 of the EISPN fails to disclose that two defined and regulated State Waters traverse the Dairy property, improperly characterizing them as "ditches." According to the Hawai'i Clean Water Branch Water Quality Map, two streams run through the middle of Māhā'ulepū valley and discharge into the ocean. State water quality data designates the two streams in Māhā'ulepū valley as Class 2.

> The objective of class 2 waters is to protect their use for recreational purposes, the support and propagation of aquatic life, agricultural and industrial water supplies, shipping, and navigation. The uses to be protected in this class of waters are all uses compatible with the protection and propagation of fish, shellfish,

> and wildlife, and with recreation in and on these waters. These waters shall not act as receiving waters for any discharge which has not received the best degree of treatment or control compatible with the criteria established for this class. No new treated sewage discharges shall be permitted within estuaries.

HAR § 11-54-3(b)(2) (emphasis added). The two streams in Māhā'ulepū valley converge and are classified as Class 1 as the waterbody approaches the Māhā'ulepū coast and discharges into the ocean.

> It is the objective of class 1 waters that these waters remain in their natural state as nearly as possible with an absolute minimum of pollution from any human-caused source. To the extent possible, the wilderness character of these areas shall be protected. Waste discharge into these waters is prohibited, except as provided in section 11-54-4(e). Any conduct which results in a demonstrable increase in levels of point or nonpoint source contamination in class 1 waters is prohibited.

HAR § 11-54-3(b)(1) (emphasis added). The waterbody discharges into the ocean, which is classified as Class A.

> It is the objective of class A waters that their use for recreational purposes and aesthetic enjoyment be protected. Any other use shall be permitted as long as it is compatible with the protection and propagation of fish, shellfish, and wildlife, and with recreation in and on these waters. These waters shall not act as receiving waters for any discharge which has not received the best degree of treatment or control compatible with the criteria established for this class.

HAR § 11-54-3(c)(2) (emphasis added).

The Draft EIS must properly characterize the two state waters flowing through the middle of the Dairy and evaluate impacts to the stated goals for these waters and the adjacent marine waters

In addition, HDF fails to identify wetlands in and adjacent to the dairy property. According to the U.S. Fish and Wildlife Service's National Wetlands Inventory map, there are four bodies of water within the upper half of the Dairy's property boundary. Additionally, there is a wetland just south of the Dairy's property boundary. The identification of wetlands is important as they feed downstream waters, trap floodwaters, recharge groundwater supplies and provide fish and wildlife habitat. In the Draft EIS, HDF must, with input and approval from the U.S. Army Corps of Engineers, delineate the boundary of wetlands within its property. The

Draft EIS must evaluate Dairy impacts on these regulated wetlands. The Draft EIS must also evaluate whether activities impacting wetlands are subject to regulation under Swampbuster provisions of the Food Security Act of 1985 that discourages the conversion of wetlands to cropland use.

Given the presence of surface waters throughout the Dairy, it is important to protect riparian areas during construction as well as operation. The Draft EIS should address whether cattle will be fenced out of the riparian areas or whether water flow will be altered to avoid the areas with cattle. Depending on the type of fencing used, construction could generate erosion resulting in sedimentation in riparian areas and surface waters.

The Dairy is located at the bottom of a steep watershed with a creek flowing through the center of the manure application fields. Additionally, the perimeter of the property has greater slopes, which is problematic because runoff will likely be greater from these areas and will be directed through the paddocks. Therefore, the potential for flash floods to flow over the farm may be high. A detailed hydrologic analysis and storm water flow projection should be conducted and compared to the capacity of the stream channel to project field flooding and flushing. The Draft EIS should determine whether concrete or roofed surfaces increase runoff to surface waters during severe storm events, and whether intense rainfall events will result in pond inundation or runoff of manure from pastures.

Surface water exiting the property should be monitored during storm events before land is disturbed, during construction, and after the Dairy is operational. Monitoring activities should include an analysis of pH, temperature, turbidity, fecal coliform, and BOD5. Analysis of downstream sedimentation will be important, particularly because subsequent runoff from roads and manure may impact sedimentation. That is, the Draft EIS should analyze the amount of sediment (depth), the dimension of the active water paths (streams, creeks), and whether there are flora or fauna in downstream surface waters that may be harmed by sedimentation and runoff.

The impact of storm water runoff on surface water during construction must be analyzed. Construction activities could result in the degradation of receiving water, especially during storm events. The construction of buildings, fences and roads, and the installation of irrigation systems must be evaluated with respect to soil conservation and prevention of erosion. Storm water discharge should be sampled to ensure that environmental impact is not occurring; this would include the first water running off during a storm event as well as sampling during large rainfall events (1" or more in 24 hours).

The Draft EIS should also study how the Dairy's operational activities will affect surface water. The environmental impact of runoff from areas of intensive use (including the area where cows enter the milking parlor, gate openings, cattle water troughs, cow walkways, and roads) must be identified. The Draft EIS should assess if mud will accumulate (and potentially be carried in storm water runoff) in these intensively used areas.

Any potential failure of the retention pond storage structure and its environmental impact must be identified. If pond failure results in over-application of effluent to fields, impacts to groundwater must be identified and analyzed.

The water balance and irrigation schedule must be examined in detail, including soil water holding capacity by soil type, hydraulic loading from irrigation, precipitation, and evapotranspiration (ET). Evapotranspiration estimates should be based on Penman-Monteith calculations of crop ET from reference crop ET. The southwest corner of the farm contains shallow soils over bedrock that will need to be managed. This area will be drip irrigated with fresh water, but nutrient loading will come from periodic application of settling pond solids.

Finally, irrigation system failure or wind drift of irrigation with effluent must be accounted for, and the potential impact on surface water must be determined so that appropriate setback distances may be identified. The Draft EIS must examine the potential for malfunction of the GPS system and for unintended, accidental irrigation of effluent directly on the creek, drainage ditches and raceways. The Draft EIS must also describe and evaluate whether the irrigation system will adequately correct for wind speeds and directions during irrigation.

C. Air Quality

The EISPN broadly states that air quality conditions and agricultural odor conditions will be evaluated in the Draft EIS. EISPN at 3-3. However, the discussion of air quality in the EISPN is oversimplified. First, construction related activities may generate dust emissions, including PM10 and PM2.5, as well as exhaust emissions. Second, the Dairy's operations may generate exhaust emissions from daily operational activities. PM emissions may be generated from project operational activities, including vehicular traffic on unpaved roads and access roads, animal movement on unpaved surfaces, and equipment operation. Third, project operations may also generate ammonia and hydrogen sulfide emissions. Ammonia deposition in surface waters or plants should be evaluated.

Additionally, the Draft EIS should analyze the animal facilities as a source of flies, mosquitoes and odor. The following odor and gas emission sources should be considered: milking parlor, effluent lagoons, manure directly deposited on pasture by cows, effluent irrigation, and periodic solids application from the lagoons. The Draft EIS should analyze the potential for periodic sludge applications from the settling pond via "gun" application to produce odors, and identify options for reducing the odor potential. The Draft EIS should also address the need for monitoring and for adaptive management to control odor issues (such as sludge application methods and adequate aeration of the effluent pond to control odors). Drag sock (LEPA) technology on the center pivots should be included in the evaluation as a potential means of providing both efficient irrigation (uniform application) while at the same time greatly reducing the potential for odors.

Greenhouse gas emissions from the cows, decomposing manure, decomposing buried dead animals and Dairy operations should be quantified.

The Draft EIS must also assess air impacts from transportation of the Dairy's unprocessed milk to a neighbor island for processing. It is unclear whether the Dairy has committed to returning all processed milk to Kaua'i for sale. If the intent is to return processed milk to Kaua'i for sale, then air quality impacts from this additional transportation must also be included in the analysis of air quality impacts in the Draft EIS.

D. Socio-Economic Conditions

The EISPN states that "a projection of the HDF's anticipated economic impact will be included in the Draft EIS," in the context of a paragraph regarding the amount of milk needed to sustain 70,000 people on the island of Kaua'i. EISPN at 3-3. This paragraph insinuates that the economic impact that will be studied involves the economics of providing locally-produced milk, processed on Oahu, to a Kaua'i population. An economic impact analysis should not be so limited. In particular, the EISPN must evaluate the negative economic impact on businesses and property owners in the Po'ipū area caused by odor, vectors, air impacts and water impacts from the Dairy.

The businesses in the surrounding area, including the Grand Hyatt Kaua'i and the Poipu Bay Golf Course, will be directly affected by odor and flies from Dairy operations. The Grand Hyatt Kaua'i employs more than 1,000 residents of Kaua'i, and hosted many guests, conventions and functions in 2014. The economic impacts of odors and flies, which will not be welcomed by surrounding businesses and their guests and customers must be studied in detail in the Draft EIS so that decisionmakers issuing approvals can evaluate the economic impact of the Dairy on the Kaua'i community.

Finally, "HDF will grow Kikuyu and Kikuyu-Guinea grass throughout the pastures." EISPN at 2-2. These grasses have been considered to be invasive. The economic impact of these invasive grasses on surrounding land areas must be identified and evaluated.

E. Soils and Topography

Although Section 3.1.3 states that no changes in topography will occur, HDF's Waste Management Plan ("Waste Mgt. Plan") states otherwise. According to the Waste Mgt. Plan dated July 23, 2014, "[a] secondary berm will be constructed downhill of the effluent ponds at the edge of the paddock before the existing drainageway and farm road." Waste Mgt. Plan at 49. Additionally, the Waste Mgt. Plan describes a raceway which will act as a berm to separate the paddocks from any water ways. *Id.* at 40. Further, HDF's plans to install a drip irrigation line, *id.* at 30, are also an indication that soil will be disturbed if the line will be underground.

The extensive poorly drained, clay soils at the site may be subject to compaction with cattle grazing when soil conditions are wet, reducing grass nutrient utilization and increasing runoff. The claim that the combination of management of soil moisture with robust kikuyu thatch will prevent soil damage is improbable and should be further evaluated. The Draft EIS should also evaluate how manure will be kept on the pasture as fertilizer given the greater amount of runoff.

The Draft EIS should examine possible differences in grass growth and yield between research test plots without cattle and plots with rotational grazing. If the soils are currently depleted of the essential nutrients required for crop growth, reasonable estimates of yield must be used. When nitrogen is applied to meet higher yield expectations and the yields are not achieved, the excess nitrogen is likely discharged into the environment. This increases the amount of nitrogen quantity in the landscape and results in the release of greenhouse gases. Moreover, biological process involved in the nitrogen cycle make it unlikely that recovery of 100 percent of excreted nitrogen occur in an animal operation. Therefore, the Draft EIS must consider impacts associated with the "learning curve" of bringing the land from being marginal in production to being high-producing forage land. It must also define the cumulative impact of importing the nitrogen into the watershed on a recurring basis. Finally, the Draft EIS should study the impact of continuous kikuyu growth at high rates on the quality of the topsoil.

F. Botanical and Faunal Resources

In 2008, the National Park Service ("NPS") published a reconnaissance survey of Māhā'ulepū in order to provide a preliminary evaluation of the resources of Māhā'ulepū for potential inclusion in the national park system. According to NPS, habitats for five endemic endangered birds are scattered throughout Māhā'ulepū. *Id.* at 19. The endemic endangered birds known in the area are the Hawaiian coot (*'alae ke'oke'o*), common moorhen (*'alae 'ula*), Hawaiian duck (*koloa maoli*), Hawaiian stilt (*ae'o*), and the Hawaiian goose (*nēnē*). *Id.* Intermittent streams and wetlands at Māhā'ulepū provide habitats for these birds, and nēnē and koloa are known to frequent the taro lease land in Māhā'ulepū valley. *Id.* The broad natural depression in this valley fills with water after heavy rain and draws many water birds, including sixty koloa during one such event. *Id.* The wetlands in Māhā'ulepū valley are also hydrologically linked to the Makauwahi Cave complex, a critical habitat for endangered arthropods that rely on seepage of nutrient-rich water. *Id.* at 29.

According to NPS, "[b]ecause sensitive conservation areas are mingled with active agricultural land throughout the study area, future activities on agricultural land could cause major impacts on significant sources." *Id.* at 52. NPS concluded that the natural and cultural resources of Māhā'ulepū "are deemed nationally significant. These areas encompass unique geologic landforms and fossils, rare species and habitats, and storied sites important to native Hawaiian and United States history." *Id.* at 49.

The Dairy's impacts on the species in the immediate area must be studied in the Draft EIS. In particular, the Draft EIS should:

- Evaluate the impact of increased nutrients in wetlands and groundwater to impact the endangered arthropods that live in the Makauwahi Cave complex.
- Evaluate the impact of construction on botanical and faunal resources.
- Evaluate the impact of Dairy-related transportation on botanical and faunal resources.
- Evaluate the likelihood that standing water, including the Dairy's treatment ponds will attract additional water birds, and the impacts on water birds from the Dairy's operations. Water birds are attracted to areas with sufficient water levels and vegetation to promote breeding and foraging. Even intermittent streams may attract Hawaiian water birds to the site.
- Evaluate the likelihood that open pasture and wetlands will attract nēnē, ae'o, the Hawaiian duck or other species, and the impacts on those species from the Dairy's operations.
- Evaluate the likelihood that wetlands, water and the Dairy's wastewater treatment ponds will attract feral mallards (*Anas platyrhynchos*), which post the most important threat to the Hawaiian duck by hybridization.
- Describe any nighttime lighting for the Dairy's operations and evaluate the impacts of nighttime lighting on endangered seabirds (including the threatened Newell's shearwater (*Puffinus aricularis newelli*) and endangered Hawaiian petrel (*Pterodroma sandwichensis*) and the endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*).
- Describe the Dairy's use of electric fencing and barbed wire, and evaluate the impacts of electric fencing on avian species and the hoary bat.
- Use presence/absence heterodyne bat detector and visual surveys to quantify the number of Hawaiian hoary bats in the Dairy area.
- Evaluate the impacts of vegetation foraging or removal or other potentially disruptive activities on the wetlands and state waters in the Dairy area.

- Evaluate restoration of Dairy land at the end of the Dairy lease period to prevent typical reversion to domination by the large African grass known as Guinea grass (*Panicum maximum*; Carpenter, 2008), which are then invaded by the fast-growing tree known as albizia (*Falcateria molucana*).
- Consult with the USFWS to determine whether USFWS intends to designate the Dairy area as critical habitat for any floral, faunal or insect species in its intended upcoming designation of critical habitat on Kaua'i.
- In addition, the intended "assessment of arthropods/vector insects (e.g., flies" in the Draft EIS should include and assessment of the likelihood of wind patterns transporting these insects to the Poipu Bay Golf Course, the Grand Hyatt Hotel and other properties in the Po'ipū area.

In addition, the Dairy should evaluate its inability to mitigate impacts on avian species. For other Kaua'i projects, the USFWS has required that, "If a Hawaiian waterbird or Hawaiian goose is observed in the vicinity of project operations, all harvesting and other activities that may be disruptive will cease until the bird(s) disperse from the area through their own volition." *See* Letter from USFWS to Green Energy Hawaii, LLC dated October 3, 2011. Unlike the harvesting operations contemplated by Green Energy Hawaii, which could cease, Dairy operations cannot. In other words, without an alternate location on Kaua'i to which the cows can be moved, the Dairy will not be able to remove all cows from the facility until birds disperse of their own volition, and the birds will continue to be impacted by Dairy operations. The Draft EIS must evaluate the Dairy's inability to implement mitigation measures required by USFWS of other Kaua'i projects.

Since Dairy construction has already begun, and test fields are already in operation (EISPN at 2-2), it is too late for the Dairy to evaluate the impacts of these activities on flora and fauna. This evaluation, however, should have preceded agency decisionmaking regarding these activities, as required by Chapter 343. The Draft EIS must evaluate this failure.

G. Comprehensive Nutrient Management Plan

The Comprehensive Nutrient Management Plan (or Conservation Plan), which was apparently approved by the U.S. Department of Agriculture's Natural Resources Conservation Service, contains information essential to the EIS. The information contained in the Plan may be important to the extent it relates to the Dairy's impacts on the environment. It should be referenced in and attached to the Draft EIS so that its content is available to the public for review and comment as part of the EIS process.

IV. CONCLUSION

The approvals and permits purportedly already received by HDF for its Dairy are invalid. Such approvals and permits, if any, should have been preceded by the EIS and should be the result of the EIS process. To attempt the reverse, would turn the EIS process on its head. An after-the-fact EIS undermines the very purpose of the EIS process. HDF cannot be allowed to circumvent Hawaii's environmental laws.

Moreover, it is not enough for HDF to repeatedly assert there will be no discharge. Just because HDF says so isn't sufficient for the EIS process. The Māhā'ulepū area, including the ground water and nearby Class 1 waters, are pristine and irreplaceable, and any discharge will cause irreparable damage. Once the harm has been done, any remedies will be wholly lacking and unsatisfactory. HDF proposes a highly intensive use of the land, and the Dairy will directly affect both the quality and quantity of runoff water that inevitably will find its way into the streams, wetlands and ocean or seep into the groundwater table. Because the Dairy will have such widespread effects, Kawailoa Development requests that it become a consulted party.

Very truly yours,

Lisa Bail

LAB

cc: Jun Fukada, Kawailoa Development LLP
Virginia Pressler, Director, Hawai'i State Department of Health

Encl.: Hawai'i Dairy Farms' Individual Wastewater System permit

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

DIRECTOR OF HEALTH

STATE OF HAWAII
DEPARTMENT OF HEALTH
P.O. Box 3378
Honolulu, Hawaii 96801-3378

COPY

4/23/2014

James Turturici
Kodani & Associates
3126 Akahi St.
Lihue, HI 96766

Dear Sir/Madam:

Subject: Individual Wastewater System (IWS) for
Owner/Lessee: Hawaii Dairy Farms LLC
Project Site: Hawaii Dairy Farms, Koloa, HI
TMK: 429003001
IWS File No.: 51486 (Septic Tank)
Old File No.: N/A

The subject wastewater plans have been reviewed by the Wastewater Branch for conformance to applicable provisions of Hawaii Administrative Rules, Title 11, Chapter 62, entitled Wastewater Systems. The IWS plan conforms to applicable provisions of Chapter 11-62.

The Department of Health will sign an applicable county building permit application provided that all information submitted as part of the IWS plan and county building permit application are consistent with each other and meet applicable provisions of Chapter 11-62 at the time of permit signature.

As the professional engineer responsible for the design of the above wastewater plan, it is your responsibility to inform the owner/lessee of the property that:

A) The IWS plans must be attached to each set of permit construction plans, or provided to the contractors.
B) The IWS must be installed by a licensed contractor holding an A, C9, C-37, C-37a or C43 license, and
C) The IWS must be inspected by the engineer, and authorized in writing by the Department before use.

Should you have any questions, please feel free to contact Lori Vetter at 241-3323

Sincerely,

Sina Pruder

SINA PRUDER, P.E.
Chief, Wastewater Branch

Exhibit 17

GOODSILL ANDERSON QUINN & STIFEL
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May 8, 2015

VIA EMAIL (Alan.S.Downer@hawaii.gov)
and U.S. MAIL

Mr. Alan Downer
Administrator
Hawai'i State Historic Preservation Division
Kakuhihewa Building
601 Kamokila Blvd., Suite 555
Kapolei, Hawai'i 96707

Re: Hawai'i Dairy Farms' AIS Dated February 2015

Dear Mr. Downer:

We are writing on behalf of Kawailoa Development LLP ("Kawailoa") regarding Hawai'i Dairy Farms' Archaeological Inventory Survey ("AIS") dated February 2015 for the proposed dairy ("Dairy") in Māhā'ulepū, Kaua'i. We had previously written to you on April 10, 2015, immediately after the AIS was made available for comment.

In response to our letter of April 10, 2015, we received a copy of the AIS, as well as a review letter dated April 13, 2015 by Susan Lebo of the Hawai'i State Historic Preservation Division ("SHPD"). We understand that Scientific Consultant Services, Inc., the preparer of the AIS, is currently revising the AIS based on Ms. Lebo's review letter, and that the revised AIS will be available on the SHPD website for public review and comment once it is submitted.

We appreciate the thoroughness and thoughtfulness with which your office conducted its review, and concur with the revisions described in SHPD's April 13, 2015 letter.

We have been in contact with the Kaua'i Lead Archaeologist, Mary Jane Naone, who has confirmed that while we may submit comments on the draft AIS dated February 2015, we will also be able to submit comments on the revised AIS once it has been completed. Pursuant to our understanding, we therefore take and appreciate the opportunity to provide initial comments below. Our comments are further to the points made in SHPD's review letter and our prior letter of April 10, 2015. Additionally, we appreciate the chance to provide comments on the revised AIS in the future when such revisions are available.

* * *

1. Scope of the Project. The review letter dated April 13, 2015 by Ms. Lebo documents the scope of the project as follows: "According to conversations with SCS staff, we understand about 499 head of cattle will be retained in the project area."

The size of the herd planned for the Dairy site in fact is much larger than 499. According to public documents filed by Hawai'i Dairy Farms ("HDF"), the site is "projected to be capable of supporting up to 2,000 productive dairy cows at full-scale operations." *See*, Section 2.3 re "Proposed Action" of the Environmental Impact Statement Preparation Notice (January 2015) submitted by HDF. Recognizing that dairy operations with more than 700 cows will require additional regulatory review as a Concentrated Animal Feeding Operation, the initial phase proposed by the Dairy contemplates 699 cows. *Id.*

Whether 499, 699 or 2,000 cows, the consequences arising from the crowded and confined nature of the Dairy operations will be significant. The manure volume from the herd and the concentration of herd numbers resulting from the pasture rotation is described by the Dairy in Section 7.1 re "Effluent/Manure Volume" of its Waste Management Plan for the Department of Health (July 23, 2014), also a public document, as follows:

> … A mature kiwi-cross cow's weight is about 1,210 lbs. and it produces an average of 143 lbs. of manure per day or 8.8 (1.05 gallons) average per waking hour. The 699 cows in Phase 1 will be maintained in mobs of 105-115 animals on a 54-acre block that is subdivided into 18 paddocks. The cows graze for one day per paddock, so once every 18 days the entire mob (all 105-115 animals) will produce the majority of its effluent on that one paddock as it grazes….

A simple calculation will show that the 2,000 head of cattle (among other things, not counting calves), each with 143 pounds of manure, will collectively produce 286,000 pounds of manure per day. The manure will be left untreated on the fields or, if produced in the milking areas, will be removed from the milking barns into waste treatment ponds and sprayed onto the fields by mechanized liquid spray guns.

Moreover, the 2,000 head of cattle will not have the entire area to graze, but will be confined to 1/18 of the pasture lands, the other 17/18 of the fields being required to lay fallow while the grass is allowed to regrow after grazing. (The amount of grazing area will be the total project area less the milking barns, holding pens, calving sheds, effluent ponds and other infrastructure).

Putting aside the environmental impacts from the production of manure and the concentration of animals as large as the dairy cows, the risk of destruction that the Dairy operations will have on archaeological, historic and cultural resources is substantial. Any such resources that are not identified and protected will probably be lost or impacted. After-the-fact identification and/or mitigation will be meaningless. Sugar cane cultivation has already caused the loss of some amount of archaeological, historic and cultural resources. Dairy operations will be even more destructive and complete than sugar operations.

The scope of the project is therefore important. Large numbers of large animals in a small space require that the scope of the project be understood before any action is taken. To be clear, a general description of the scope of the project is not sufficient. The AIS must describe the proposed project activities in detail to determine what impact, if any, the project may have on the historic properties. The revised AIS should therefore include a discussion of (1) the work that has been already been done and the work is planned for the Dairy's construction, and (2) how the identified historic sites have been and will be impacted.

The scope of the project should also clearly be shown on figures showing project components in relation to identified archaeological and historic features.

2. Valley Trails. The AIS is internally contradictory regarding valley trails. On the same page (page 135 of the AIS) that it asserts that "there was no evidence on the ground for any trails," the AIS also acknowledges that present-day animal and hunting trails could be the current usage of traditional paths and that pre-Contact/Historic era trails may have connected the project area to the upper ridgeline as evidenced by the presence of the Keolewa Heiau on Hā'upu Ridge and a former heiau, Hanakalauea Heiau, within the valley. In addition, the Topographic Map of Māhā'ulapū Valley appearing in Figure 7 of the AIS contains a reference to a path.[1]

That historic trails existed is also reflected in testimonies in support of Land Commission Awards ("LCAs"), as well as modern day consultation. It would be entirely consistent with the once sizable native Hawaiian population in Māhā'ulapū Valley that trails and other resources from mauka to makai were used by those who lived in the valley. Trails would have been part and parcel of the village in the valley. A trail system from mauka to makai would have been necessary to provide access to and from the salt ponds and cultural resources.

The AIS cannot simply conclude that trails do not exist. Such a conclusion is contrary to the available evidence and to the AIS itself.

3. LCAs and Historic Sites. The AIS identifies 16 significant historic properties, including several that are pre-Contact. The AIS also notes at least six LCAs. The existence of LCAs is extremely significant as LCAs are known indicators of habitation and in turn, subsurface iwi kupuna. As the AIS itself provides on page 25, "Many of the LCAs for Māhā'ulapū are tightly clustered within the 'Ili of Kawailoa which is within the current project

[1] The map depicted in Figure 7 is incorrectly identified as an "1854 Topographic Map." The map instead is dated 1896.

area. . . There is a cluster east of Māhā'ulapū Ditch near the center of the valley. The remainder of the valley was deemed crown land." Indeed, Princess Victoria Kamāmalu, a granddaughter of Kamehameha I, was awarded much of the ahupua'a of Māhā'ulapū. Exhibit A at B-8.[2]

The AIS continues on page 25 that "the total would have been 108 persons." Notwithstanding such express declaration that a sizable population for the upper valley existed (all likely associated with the LCAs), there is no record in the AIS of efforts made or methods used to identify individuals who may have a connection to these LCAs or have any information about known iwi kupuna on the project site. This is especially and additionally important given the fact that petroglyphs and other known significant historic properties have been found on or near the site. Understanding all of the historic creations in the valley in relation with each other should be a priority of the AIS.

The AIS moreover is incomplete in stating without more (on page 35) that prior field work and archaeological investigations have uncovered "some confusion over site designations," but in not resolving the "confusion." That there may be "some confusion" is not questioned. As an example, prior reports on other project in the area reflect that the LCA land parcel numbers may have been improperly recorded on maps and do not appear to match the given site descriptions as documented in the Māhele testimonies. *See* Exhibit A at B-9. Further, the AIS includes summaries of testimonies for LCAs "within the project area" that reference salt ponds. *See* AIS at p. 27. It is questionable whether salt ponds would have been located so far inland, which should beget the question of whether LCA testimonies summarized in the AIS for "LCAs within the project area" have been correctly identified.

The AIS must identify the correct LCA testimony for the LCAs within and near the project area to ensure that cultural consultation with potential lineal and cultural descendants (especially the cultural descendants with knowledge of subsurface iwi kupuna), will be conducted.

4. Public Interest in the Cultural Significance of Māhā'ulepū. The AIS does not reflect the already heightened public interest in the cultural significance and preservation of the project site.

In 2001, the Kaua'i County Council adopted Resolution No. 2001-25, which acknowledges that "Māhā'ulepū is a living cultural landscape and a place sacred to many Native Hawaiians, particular those of the Kōloa area whose ancestral remains are buried at Māhā'ulepū." Exhibit B. Additionally, the Resolution provides that "the unique opportunity to

[2] Because of her high status, Kamāmalu was not required to provide documentation of dwelling upon, or cultivating the land as was required of native tenants or commoners. *Id.*

apply the ahupua'a framework of care-taking and management of watersheds from mountain peak to the ocean exists at both Kīpū Kai and Māhā'ulepū."

Māhā'ulepū's cultural significance is also recognized by the State. During the same year that the Kaua'i County Council passed its resolution, the House and Senate passed similar resolutions supporting the future preservation of Māhā'ulepū. Exhibits C-E. The resolutions declare, "Maha'ulepu is a heritage landscape where it is possible to preserve and restore diverse and significant natural, scenic, cultural, archaeological, historic, scientific, and recreational resources." *Id.*

Lastly, the National Park Service in February 2008, published a Reconnaissance Survey of Māhā'ulepū. The Survey was a first step for evaluation of Māhā'ulepū and surrounding properties for inclusion into the national park system.

5. Cultural Consultation and Outreach. Adequate cultural consultation and identification of historic and cultural resources were not conducted. If any consultation in fact was conducted, no documentation exists of such consultation. The Hawai'i Administrative Rules ("HAR") § 13-276-5(g) require that the AIS include information on the consultation process with individuals knowledgeable about the project area's history or public input. The AIS is also required to set forth information on the personnel conducting the consultation process, as well as the methods of identifying and contacting knowledgeable persons. In and of itself, but especially given the numerous LCAs, the lack of information on the consultation process is especially problematic.

By themselves, the sixteen already-identified historic properties, including significant petroglyphs and known heiau in the area, should have triggered consultation with native Hawaiian organizations, including the Office of Hawaiian Affairs, Kaua'i/Lāna'i Island Burial Council, Aha Moku Council, and other known organizations. Pursuant to HAR § 13-284-6, the Office of Hawaiian Affairs must be consulted for native Hawaiian properties which may have significance. No such consultation is apparent in the AIS, and if any consultations did occur, no documentation exists of the outcome.

6. Ground-Disturbing Activities and Effect Determination. Significant ground-disturbing activities have already taken place on the property prior to even the initial AIS pursuant to the County's apparent approval of the agricultural exemption and building permits. That said, as shown in the photos taken by Department of Health and attached as Exhibit F, the Dairy has already installed extensive subsurface irrigation systems and bridges on the property for its operations. Attached as Exhibit G is a map of the Dairy's extensive irrigation system, already installed. In addition, the Dairy has been actively cultivating a portion of the property in connection with field trials since last year. Upon information and belief, the field trials have

included the planting, cultivating and mowing of pasture grass. None of such past work is described or addressed in the AIS.

In addition, the AIS does not describe the activities that are proposed or the impact that such activities may have on the historic properties. The work (both past and present) related to the project must not only be described in the AIS, but also HAR § 13-284-7(e) requires that an effect determination shall be submitted with the report. While it should go without saying, the rules make clear that a sufficient description of the project activities is necessary so that the nature of possible effects can be understood. The AIS lacks detail describing the scope of the project and is silent on specific effect determinations. By way of example only, protection of the petroglyphs identified and other historic properties from trampling by cattle must be part of the AIS.[3]

7. Architectural Inventory Survey. Pursuant to HAR § 13-284-5, an architectural survey may be relevant for the historic properties related to the former sugarcane use, including the ditch systems, culverts, reservoir, bridges, flumes and retaining walls. Such a survey should be considered.

8. Mitigation. Pursuant to HAR § 13-276-8, the AIS should include a mitigation commitment. Simply stating that the AIS consultants will undertake "no further work," (see for example, page ii of the AIS) is not a mitigation commitment.

HAR § 13-284-8(a) requires that the proposed mitigation commitment be submitted concurrently with the survey report, including the effects determinations if significant historic properties are present in the project area and will be affected. HAR § 13-284-8(a) further requires that the proposed mitigation commitment must include a table of significant historic properties, indicating the form or forms of mitigation proposed for each property (preservation, archaeological data recovery, architectural documentation, historical documentation, ethnographic documentation). The purpose of these requirements is to provide SHPD, Native Hawaiian organizations, and the public with sufficient information to determine whether the report is adequate. The AIS is lacking in these important requirements.

9. Procedural Errors. Although the AIS itself declares that it was prepared pursuant to HAR Chapters 13-284 and 13-276, there no indication that the processes established in such rules in fact were followed. *Kaleikini v. Yoshioka*, 128 Hawai'i 53, 283 P.3d 60 (2012) and *Hall v. DLNR*, 128 Hawai'i 455, 458-59, 290 P.3d 525, 528-29 (App. 2012), Hawai'i

[3] Additionally, it is unclear whether separate and apart from grazing, the movement and rotation of cattle will adversely impact the identified historic properties. Of particular concern are those historic properties that could be subject to destruction if the cattle are permitted to trample over the retaining walls, ditch system, bridges, etc., whether unintentionally or otherwise.

Revised Statutes ("HRS") § 6E-42 and HAR Chapter 13-284 mandate a sequential process through which SHPD reviews and comments on the effects of a proposed project on historic properties. Had this process been followed, the AIS should have been conducted when Hawai'i Dairy Farms first sought agency approval for its proposed Dairy.

The plain language of the statute and rules require that the approving agencies have advised SHPD on the effect of the proposed project on historic properties or burial sites *prior* to any approval. HRS § 6E-42 ("Before any agency or officer of the State or its political subdivisions approves any project involving a permit . . . or other entitlement for use, which may affect historic property, aviation artifacts, or a burial site, the agency or office shall advise the department and prior to any approval allow the department an opportunity for review and comment on the effect of the proposed project on historic properties . . . .). Moreover, under *Hall*, where a project has the potential to disturb historic burials, the AIS shall be conducted prior to any ground disturbance. *Hall*, 128 Hawai'i at 468, 290 P.3d at 538.

Hawai'i Dairy Farms has asserted that it has received approvals for the following from the State of Hawai'I or County of Kaua'i: (1) agricultural exemption; (2) approval for its Individual Wastewater System; (3) building permits; and (4) Waste Management Plan. As shown in Exhibit F, ground-disturbing activities have already been conducted on the property pursuant to one or more of these approvals. Additionally, an approval was granted by the federal Natural Resources Conservation Service and West Kaua'i Soil and Water Conservation District for the Dairy's conservation plan.

There is no indication in the AIS whether SHPD was advised of the project and whether it granted a concurrence prior to any of the agency approvals. A completed AIS must come first. There is nothing showing that the Dairy has respected that process.

10. Conclusion. We again appreciate the chance to provide input on the AIS. We hope that our comments are helpful, and we very much remain an interested party in this matter. We agree with SHPD that the AIS is not adequate and must be revised. Please notify us when the revised AIS is submitted and available for public download.

* * *

Thank you for your work in connection with the AIS and revised AIS and for your attention to this matter. Please do not hesitate to contact me with any questions regarding these comments.

Very truly yours,

Lisa A. Bail

LAB

cc: Mary Jane Naone, Kaua'i Lead Archaeologist
Susan A. Lebo, Ph.D., Oahu Lead Archaeologist
Jun Fukada, Kawailoa Development LLP

Enclosures:

Exhibit A, "Appendix B: Historical Documentary Research" by Helen Wong Smith, B.A. and Kepa Maly, excerpted from *Archaeological Inventory Survey, Grove Farm Kawailoa Property, Lands of Paa and Mahaulepu, Koloa District, Island of Kauai*, by Paul H. Rosendahl, Ph.D., Inc. (Feb. 1994).

Exhibit B, Kaua'i County Council Resolution No. 2001-25 (2001)

Exhibit C, Senate Resolution No. 97, S.D. 1 (2001)

Exhibit D, House Resolution No. 91, H.D. 1 (2001)

Exhibit E, House Concurrent Resolution No. 95, H.D. 1 (2001)

Exhibit F, Four photos of the Dairy site taken by the Hawai'i Department of Health, dated November 2014

Exhibit G, HDF Irrigation Map, taken from the Waste Management Plan dated July 23, 2014

APPENDIX B: HISTORICAL DOCUMENTARY RESEARCH

by Helen Wong Smith, B.A. and Kepa Maly

This report includes information not only on the *ahupua'a* of Paa and Mahaulepu, in which the project area is located, but also on the nearby *ahupua'a* of Weliweli, whose history is interwoven with that of the project area. While there is relatively little legendary and early historical information about these three *ahupua'a*, the historian fares better with the relatively recent history of Koloa District, of which these *ahupua'a* are part. With the arrival of the missionaries, Chinese settlement, and the development of the plantation, historical data becomes more plentiful. Information from archaeological surveys (including oral history not found elsewhere), from Bennett (1931) to Rosendahl (1988), brings the picture into sharper focus. A section on Land Commission Awards documents the extent of diversified agriculture and industry in the Koloa area during the 1840s, including what became the biggest industry of all, sugar. The final section of this report describes the rise of the sugar plantation and the town that grew up with it.

BACKGROUND

The landscape of the Koloa area was largely shaped by the Koloa Volcanic Series. This sequence of eruptions left 40 volcanic cones, or *pu'u*, scattered over the eastern two-thirds of the island (Macdonald et al. 1983). The estimated age of this volcanic series, the last on Kauai, is 1.5 million years, and its legacy of volcanic cones is characteristic of late-stage, or post-erosional, volcanic activity in Hawaii (Friends 1985).

In pre-contact times, Kauai's relative geographic isolation meant the relative isolation of its people, as well. They had relatively little contact with inhabitants of the other major Hawaiian Islands. In a paper read before the Hawaiian Historical Society, Wendell Bennett told the group, "...there was much more communication between all parts of Kauai, than between Kauai and the other islands. In other words Kauai may be considered as a cultural unity" (1930 p.54).

Fornander's translations of Hawaiian words (1969) may provide some insight into the meaning of the names given to two of the *ahupua'a* in or near the project area:

> Pa'a, v. to burn, scorch, consume, by fire; adj. scorched, burnt; s. dryness, thirst (III:252).
>
> Weli, v. to branch out, as roots of a tree, to take root; s. a shoot, a scion, a sucker, the phosphorescent light in the sea, the light from sparks of fire; weli or welina and walina, a form of salutation = Health to you, May you prosper" (III:286).

More recently, Pukui, Elbert, and Mookini have assigned the following literal meanings: Pa'a: "dry, rocky"; Maha'ulepu: "and falling together"; Weli: "fear" (1974).

Exhibit A

The Koloa area was frequently the site of abortive invasions from the other islands. The following legend tells of one such attempt. It is the story of Kalaunuiohua (The leaf of the fruitful coconut), ruler of Hawaii Island, who is said to have lived during the latter half of the 13th century or early 14th (Fornander 1969, Kamakau 1961). His goal was to conquer all the islands; his nemesis was the prophetess, Waahia. Kalaunuiohua had repeatedly failed in attempts to destroy Waahia. Finally, she went to him and commanded that he burn the temple at Keeku, and told him that if he wished to rule all the islands he must refrain from watching the spectacle during the day of destruction. He did as ordered, and refrained from looking until shortly before nightfall, when he could no longer contain his curiosity. When he peeked through a hole in his hut, an unseen voice spoke: "You have kept [the command] from sunrise to near sundown. Then you lost the time until night. You shall win for a time and then lose."

Kalaunuiohua went on to conquer the eastern islands, but when he prepared to attack Kauai, the "island of the sunset," his warriors reminded him of the prophecy. Disregarding their warning, he proceeded to Koloa, and there he lost the power of Waahia to the chief of Kauai, Kukona. Kukona defeated Kalaunuiohua and kept him prisoner for many years. The name of the battle was Ka-wele-wele, or, "the battle after refusing to fulfill the command of the gods" (Westervelt 1917).

C.A. Snyder and S. Young (1973) recount a more recent legend, although they specify no date. According to Hawaiian beliefs, relatives of the royal family sometimes possessed magical powers. This was apparently so in the case of Joseph, son of John Kumukamalii Palama. Joseph had the ability to speak to schools of fish in Hawaiian, sending them toward Lawai-kai, a valley situated in the *ahupua'a* of Lawai, Koloa District, where fishermen were waiting with nets.

PRE-CONTACT HISTORY AND ARCHAEOLOGICAL SITES

The *ahupua'a* of Paa and Mahaulepu extend in a southwesterly direction from the Haupu Range. The remains of ancient species of flightless birds have been found near the coast of Mahaulepu (Friends 1985).

Keoneloa (the long sand) is a half-mile long beach between the cliffs of Makawehi on the east and Makahuena on the west. The small boat landing of Kaneaukai was once located at the western end of the beach. Although the beach lies mostly in the *ahupua'a* of Paa, it is often considered part of the Mahaulepu coast. Keoneloa, which is part of the project area, is well-known for its petroglyph ledge, which is usually obscured by sand. Burials have been documented in the dunes at Keoneloa for many years.

For ten days during in June 1897 the ledge was clear of its usual sand covering, and sixty-seven pictures and markings were exposed. Koloa resident J.K. Farley visited the petroglyphs that month, and the following year he provided the first written account of them. The smallest carvings were one foot long, and the largest were over six feet. Some of them were deeply carved into the ledge. Though he tried, Farley was unable to learn the origin of the carvings, or their age.

He interviewed a resident of the area, a woman by the name of Kauila, who recalled first seeing the petroglyphs in 1848, while on a class excursion. She told Farley that even more carvings had been exposed then than in 1897, and that there was another ledge fifty to one hundred feet farther inland. This second ledge, she claimed, displayed carvings of fish, birds, a canoe, and figures combining the bodies of cattle with the heads and ears of pigs. Her teacher, a Catholic priest named Alexandro, had asked her father and grandfather about the origin of the petroglyphs, but the natives of the area, who all knew of them, did not know who made them. They could only say that the figures had always been there.

Farley took special note of two carvings, one resembling a cross, and one a flag. Since neither symbol was familiar to Hawaiians before Western contact, he dated some of the petroglyphs to historic times. He also experimented by cutting a four-foot figure with a hatchet, a task which occupied him for two hours (Farley 1898:119-125). One can imagine the difficult labor of the Hawaiians working with stone implements. Stokes (1946) reasoned that such figures could be made by pecking out the design with the aid of a pebble.

In 1916, when storms swept the beach clear, exposing the ledge again, J.M. Lydgate, a Kauai resident, was there when representatives of the Bishop Museum photographed the pretroglyphs and removed a slab for their collection. Lydgate concurred with Farley's hypothesis of foreign influence in some of the petroglyphs, and he included this observation:

> A slab 3' square or so and 8 or 10 inches thick was drilled out and split off of the solid ledge and transported mostly on the shoulders of men over the rough trail to the Koloa landing. What mostly impressed these men was not the wonder of the inscription but the weight of it. (Lydgate 1916:5).

It is reported that during World War II military exercises, heavy vehicle tracks cut up portions of the ledge, and an invasion of sea urchins and *limu* obscured the view.

Human skeletal remains have been found in the sand dunes that front the *ahupua'a* of Weliweli, Paa and Mahaulepu. Whether or not this was a battle site has been a controversy for many years. Authorities on Hawaiian history argue convincingly on both sides.

In 1826, Rev. Samuel Whitney toured Kauai with the governor and a retinue of over a hundred Hawaiians. At Mahaulepu, Whitney wrote:

> We passed over a mound of sand, white with human bones. I asked whether they were slain in battle; and was informed that this was the place for burying the dead, and that the wind had blown the sand away from the bones. "But why," said I, "is this ground chosen?" "Because it is soft and the people are lazy," was the reply.

Referring to this story, Stokes observes that the governor of Kauai was a chief from Hawaii Island, and that Kauaians often claimed that such persons were frequently less than honest or forthcoming. But Stokes also notes that the *kama'aina* of the area considered the site a cemetery, not a battleground (1946:32).

In 1867 Sanford B. Dole, who lived near the site, wrote to a Professor Wyman with a possible explanation of the remains:

> Over this whole extent of sand beaches and hills, human bones are thickly scattered, and here it was that I collected the skulls. Ten years ago they were much more numberous (sic) than now. The wind is constantly uncovering the skeletons, and when exposed, they are quickly destroyed by the weather and the feet of cattle. At the time I speak of, it was easy to find perfect skeletons in the exact position in which they were buried. This is now impossible and even perfect crania are becoming more scarce with every year. In olden times the natives often made use of the soft sand beaches for sepulture (sic), but the immense number that is buried here forbids the idea that it was a common burying place. The present generation of natives know nothing definite on the subject. One of their traditions, as near as I remember is that a fight between two large fleets of canoes took place off the coast, and that the defeated party was driven ashore at this place, and many of them killed.
>
> A second tradition is this: a tribe passing along the coast in canoes, and having landed in a secluded little cove which is now pointed out, to bathe and refresh themselves, a rival tribe charged down from the hills around and cut off almost the whole party.
>
> Those who have studied the subject, I think, give to the great pestilence *Mai Ahulau*, which raged through the islands soon after their discovery, the credit of peopling this and other similar graveyards. Infant skulls are sometimes found, and also skulls that appear as if they had been pierced by spears, or fractured with clubs. The skulls which I collected for you were some of them above, and some below the surface of the land (Neller 1981:3-4).

Neller records the professor's response: "Wyman commented that the collection was nearly all adult, with only one belonging to a child, and that as far as he was concerned they did not offer evidence of having been killed in battle, as there were no marks of injuries by weapons. A few showed signs of bone disease" (ibid:4).

W.D. Alexander felt that the area may have been the scene of the defeat of the 13th century would-be conqueror of the major islands, the ill-fated Kalaunuiohua (see above). He wrote:

> About the end of the 13th Century, Kalaunuiohua, a warlike and ambitious *Moi* (king) of Hawaii undertook to subdue the whole group."

Farley also mentions that "...the sand hills to the west of Keoniloa (sic) are said to have been old battle fields; they were certainly used as burial grounds" (1898:121).

A story recorded by Augustus Knudsen, "The Defeat of Kamehameha's Army" (1914), lends considerable support to the battlefield thesis. The source of the story was an overseer named Puako, employed by Knudsen. According to the historical record, in April of 1796 Kamehameha's attacking Pelekunu fleet was stopped midway on its journey to Kauai from Oahu by a severe storm, forcing its return. The local Kauai version is that a few canoes made it through, and the surviving warriors were slaughtered at Mahaulepu.

The remarkable detail in Puako's story makes the tale more credible. Because Kamehameha's attack was expected, Puako said, lookouts were posted on headlands to watch for the invasion. The first sighting of the invading fleet was from the headland of Kipu, overlooking Mahaulepu, and the warning spread quickly throughout the island. In Knudsen's words, "When the morning star arose the alarm had reached forty miles to Mana...around the populous valley of Hanapepe, Makaweli and Waimea."

Warriors from these districts gathered to await the arrival of Kamehameha's fleet at Mahaulepu. "In the gloom of darkness before dawn," the chiefs at Koloa decided they had a sufficient force, "for the warriors of Weliweli had reconnoitered and again reported that there were probably not more than six thousand warriors on the beach." The combined Kauai forces, led by Kaumualii, attacked Kamehameha's surviving men as they were resting on the beach. Spearmen made up the first line, followed by men bearing heavy stones to sink the enemy canoes.

Kamehameha's forces put up a strong resistance, but soon were outflanked. When they tried to launch their canoes, the Kauai forces rushed forward to drop the weights. Once a double-hulled canoe is in the surf and enough rocks are piled into one side of it, it will capsize. As the capsized canoes were driven up to shore by the breaking waves, they wrought further havoc among Kamehameha's men (Knudsen 1914:138-9).

According to Puako's story, it was essential that Kamehameha's men save the war god, Kalaipahoa, the feather image that had carried Kamehameha to triumph through the island chain. Surrounded by a wall of frantic warriors, three canoes got away safely bearing the high priest, the commanding officer, and the image of Kalaipahoa. Half of the canoes escaped, but one-quarter of the fleet was captured by Kaumualii. According to Puako, the beach was strewn with dead and 543 prisoners were taken. Some of these were of chiefly rank and were sacrificed at Polihale *heiau*. Although Puako did not participate in the battle, he claims to have guarded the royal captives and witnessed their sacrifice (ibid.).

There are differing estimates of the number of men who fought that day. Knudsen reports that Kauaians set the total number of dead at four thousand, but others say that this number represents Hawaii Island warrior casualties alone. Another version claims that only half of Kamehameha's army landed, putting the invading force at ten thousand men (ibid:140-1).

In an analysis of Puako's story, Stokes points out several inaccuracies. First, Stokes says, Puako placed the wrong chief at the head of the army that defeated Kamehameha. In 1796 Kauai was involved in an internal war, as Keawe fought against his elder half-brother, Kaumualii. Keawe had the support of the large Waimea district, while Kaumualii's loyalists held the east side of the island (Broughton [6] p.44 and Bishop [4]). According to Broughton, Keawe defeated Kaumaulii in July of that year, and had taken him prisoner ([6] p.73). Thus Keawe's forces would have been in power at the time Puako claims Kamehameha's men were defeated by the forces of Kaumaulii.

Secondly, according to Stokes, Puako mistakes the name of Kamehameha's war god, referring to it as Kalaipahoa in his "first hand account." As Stokes points out, it is well known that Kamhameha's war god was not Kalaipahoa, but Kukailimoku, inherited from his uncle and foster-father, Kalaniopuu, and thirty generations of royal ancestors. Kalaipahoa was a different god entirely, the poison god from Molokai, used by sorcerers. It would have been out of place on the battle field (1946:42).

Thirdly, Stokes argues that is is more likely that Puako's story is linked to Kalaunuiohua's unsuccessful 13th century invasion of Kauai (Fornander [11 p.68], Stokes 1946:43). He adds, "Nevertheless the improbability or impossibility of the affair are clearly shown by the journal

entries of foreigners recorded at Kauai immediately before and after the time of the alleged event [Kamehameha's 1796 invasion]. Information gathered by reliable authorities more than a century ago proves that the raconteur was ignorant of the name of the chief, and of the current history and native customs of the time in which he claimed to have lived, and implies that then he was not even born" (Stokes 1946:45).

Stokes questions the large number supposedly slain in 1796 at Koloa. He cites instances when, through the passage of time, casualty counts in war and disaster have been exaggerated (1946:38). He cites Bingham's observation concerning casualties resulting from the wars of Kamehameha: "It is supposed that some six thousand of the followers of this chieftain, and twice that number of his opposers, fell in battle during his career, and by famine and distress occasioned by his wars and devastations, from 1780 to 1796" [3 p. 49]. Kamehameha conducted eleven campaigns during these years. The greatest loss of life, according to many early writers, occurred not on the battlefield, but from the side effects of warfare, starvation and sickness following the destruction of food sources. Of course, these consequences struck hardest at the families of the vanquished.

A reference by Stokes to Ellis further substantiates this point: "In Hawaiian warfare, massed conflicts were rare" [10 p. 144]. Ellis adds, "...the bodies of the slain...were thus scattered in many directions. They lay where they fell...those killed in flight remained unburied" [10 p.144; 9 p.173; 10 p. 146]. Thus it appears that buried skeletons, like those in Koloa sand dunes, are probably not the remains of those killed in war, for those killed in war usually remained unburied. According to Stokes, then, those buried at Koloa probably died naturally ibid:36).

Other Archaeological Sites

Other important sites within or near the project area are described below. The citations are drawn primarily from the work of archaeologists who surveyed the area, from Bennett (1931) to Rosendahl (1988).

Weliweli Heiau: Kikuchi places this heiau "Along the shore between the dune burials and the sand-petroglyph beach..." (1963:73). Thrum describes it as "A paved heiau of large size, po'okanaka class; walls 4 feet high; portions of same said to be still standing" (1907). When Bennett surveyed it in 1930, he noted that "The cane field has been cleared and the stones piled over this heiau" (1931:120). There seems to be some confusion regarding name of this *heiau* and location. Kikuchi writes, "...the temple would now be in the confines of Pa'a *ahupua'a* rather than in the Weliweli boundaries" (1963:73). Rosendahl notes that its original name was different and that the *heiau* probably owes its current name to its location. "The large mass of stones on the shore abutting Keoneloa Beach may be the remnants of Kane'aukai heiau...and was misnamed Weliweli after its *ahupua'a* location" (1988). A Lahainaluna manuscript (1885) described Kaneaukai: "It was located directly above Makaihuene. Pa'a was the name of the *ahupua'a* on which it stood. It belonged to Kahai a crab (god) who sometimes turned into a fish and swam into the sea." The owner of the land, Mr. Antone Vindinha, reported that vandals had taken rocks from the structure for walls and fireplaces, because of the attractive growth of lichen on them (Kikuchi 1963:72).

Waiopili Heiau: Bennett reports "...a rectangular, walled enclosure, is built on an old lava flow and made of lava blocks...There is a semblance of paving, but most of the floor is the fairly smooth lava in natural position. The function, and the age of the pile of stones forming the tower in the southwest corner of the structure are questionable. It is a unique feature for Kauai heaius. The walls are made of great slabs of lava 3 to 4 feet wide on edge in double row and filled in between with smaller stone. The blocks of lava are chinked together. Coral is found" (1931:120). Kikuchi reports that, "portions of the back wall complex were rebuilt. The entire structure was cleared of the shrubs and bushes...[and] to our surprise was in very good condition" (1963:77). Ching et al. suggest a possible explanation for this preservation: "Temples such as Waiopili did not exist in isolation, but were rather one of the focal points in the Hawaiian community" (1974). A Lahainaluna manuscript cited by Kikuchi says that the function of the *heiau* was "...for the purpose of multiplying food plants. This heiau was dedicated to Kane-pua'a" (1963:77). The pond which abuts the heiau is called Kapunakea. Ching et al. claim that the pond was originally called Waiopili, but that the name was later transferred to the *heiau*. Kapunakea means "the white spring," and probably refers to the appearance of the clear water of the spring against the white limestone background. Both the *heiau* and pond are directly inland of a large limestone quarry (1974).

Kaneiolouma Heiau: Bennett gives a detailed physical description of the *heiau* but offers no information on its purpose (1931:119). Thrum admits that no information or explanation could be obtained, though he observes that a walled section toward the northwest corner was built for more modern purposes (1907). Kaneiolouma Heiau (Site 119) is located near Poipu Beach Park.

Hanakalauae Heiau: The only mention of this heiau in Mahaulepu is by Thrum, who claims that it was destroyed by a man named Fredenberg, who used its stones for cattle pens (1907).

Additional sites within the project area are noted in Rosendahl's Archaeological Mitigation Report of November 1988. They are a railroad bed, walls, and two fishing altars:

> **Site 3090 - Railroad bed**: This is a long wall, 4 meters wide by 2.5 meters high, constructed of stacked pahoehoe. It is located just inland of Keoneloa Beach. The wall is believed to be part of an old railroad berm which has since been destroyed in places, and generally stripped of its stones. Local informants claim that the plantation used the railroad here, and the width and height of the structure would attest to the fact that it was, indeed, used to support a railroad track. No iron spikes, rails, or other railroad paraphernalia were found, however. On a 1918 Koloa Sugar Co. map, no rail construction is evident in the area; if a railroad berm did exist, either it was built after 1918, or the map is not complete.
>
> The Keoneloa berm ended approximately at the border of Weliweli and Paa, and may have been built up by dumping field stones along the beach area. The temple and fishing altars, to some observers, resemble field stone dumps more closely than they do religious structures. Perhaps field stones were dumped on the existing structures, covering and building up the area to its present state (Kikuchi 1984b:5).

Site 3202 - Walls: Ching et al. (1974) describe this wall as a cattle fence located inland from and paralleling Keoneloa Beach; the wall measures 0.7 m wide by 1.3 m high.

Site 3199 - Wall: This wall is oriented north-south, and defines a portion of the boundary between Weliweli and Paa. It is core-filled and measures 1.8 m high and 22.9 m long (Kikuchi 1984b:6). According to Kikuchi, only a few meters of the wall remain.

Site 83A - Kaauaakahaia Fishing Altar: According to the Lahainaluna Ms. (1885), this "...was a place to lay the first catch as well as to make the fish multiply so that the land will not be in need of fish."

Site 83B - Hali'i Fishing Altar: "It was an altar for the purposes of multiplying fish to supply the need of those on land" (Lahainaluna Ms. 1885). The manuscript also states that two additional fishing shrines were located on the boundary of Weliweli and Paa. The location suggests that the ruins now strung along the shore may be those of these three religious structures. If this is the case, it would account for the width of this massive shoreline rock "wall."

The early Hawaiians probably raised crops in the project area and vicinity. Handy writes, "...the people of Paa district subsisted almost entirely on sweet potatoes. One informant who spent her childhood in this district remembers the potato patches enclosed in stone walls. Kōloa had many taro plantations but sweet potatoes must have had a large place in the subsistence economy of the people" (1940:153). Handy and Handy also refer to Paa: "Pa'a is very dry. Breadfruit, yams and bananas were planted in gulches. Weliweli is about like Pa'a. Both of these narrow land sections lie on a slight seaward promontory, Makahuena Point. Bennett [1931:118] found an irrigation ditch and terraces, indicating that there used to be some wet taro grown in the area which is now dry. Desiccation may have been partly caused by clearing the woodland when the first sugar plantation on Kauai was established there" (Handy & Handy 1972:427).

POST-CONTACT HISTORY

Settlement and Land Use as Documented in Awards of the Māhele

In 1848, under the ever growing influence of Western business interests, Kamehameha III formalized the Māhele; a division of land between the crown, government, lesser chief's [*konohiki*], and native tenants of the land. The Māhele allowed native Hawaiians who lived upon and worked the land the right to make claims for their land. The *Kuleana* Act of 1850 formalized the recording of those claims, giving, in fee simple appropriate (i.e. land parcels upon which native tenants worked or lived) "*Kuleana*" lands to the native tenants. Preceding the Māhele, all land and natural resources were held in trust by the high chiefs, and their use was given at the prerogative of the high chiefs (*ali'i 'ai ahupua'a* or *ali'i 'ai moku*) and their representatives or land agents (*konohiki*), who were generally lesser chiefs as well. A review of the *Buke Māhele* (Land Division Books) and historic maps (*Figures B-1 and B-2, at end*), provides readers with a rich documentation of the community of Mahā'ulepū in the mid-1800s. It appears that approximately 28 native Hawaiians applied for and received lands in Mahā'ulepū. One of the awardees was Princess Victoria Kamāmalu, a granddaughter of Kamehameha I, and Kamāmalu's award included most of the *ahupua'a* of Mahā'ulepū. Because of her high status, Kamāmalu was not required to provide documentation of dwelling upon, or cultivating the land as was required of native tenants, or commoners.

Testimonies document that many of the families had been upon the land at least since the time of Kaumuali'i (c. 1796-1824), the people cultivated both dry- and wet-land taro, *'auwai* (irrigation systems) were used to supply water to the *lo'i* (taro pond fields), sweet potatoes were cultivated on *kula* (dryland parcels), numerous families developed salt ponds and produced salt, and at least two fishponds, Kapunakea and Keahikia were maintained as well. The primary residences appear to have been situated in the coastal zone not far from the school. Claimants also maintained inland plots which were cultivated in wet land taro along Wailā'au and Wailua streams, while even further upland, some claimants maintained orange and banana trees. On the *kula* (flat dry lands) some claimants cultivated sweet potatoes as well. The house sites and garden plots were connected with trails, and many of the individual parcels were enclosed with rock walls. One additional point of interest associated with the Māhele testimonies is that nearly all of the *'ili* (small land parcels) claimed by the native tenants were identified by their individual land names, and not simply identified as Mahā'ulepū.

It should be noted here that one difficulty was encountered while doing this study, the LCA *'apana* (land parcel or portion) numbers identified in the Māhele records, and those numbers on both the historic maps (1897) and the more recent Real Property Tax Division TMK map *(Figure B-3, at end)*, do not appear to match the given site descriptions as documented in the Māhele testimonies. These discrepancies may been seen while reviewing the parcel descriptions and locations (Table B-1, below), and comparing those numbers with the numbers recorded on the maps. It simply appears that somehow parcel numbers were improperly recorded on the maps. By matching the LCA testimony descriptions with certain land and/or site features, one can generally locate each site described by the Hawaiian awardee.

Table B-1. Parcel Descriptions and Locations

Foreign Register Testimonies (Volume 13) for
Land Court Award (L.C.A) Claims at Mahā'ulepū, Kaua'i

LCA Number Vol. & Page	Awardee	Parcel No. & *'Ili* Name	Land use(s)
4537 13:52	'Ewaliko	1 - Kalaiki	Two *lo'i* (taro pond fields)
		2 - Wailā'au	A salt pond bounded by the *kula* (flat land)
		3 - Mahā'ulepū Village	A *pā hale* (house lot), fenced in
4543 13:55	'Aukai (Kamumu [w])	1 - Kalaiki	Three *lo'i*
4575 13:61	Iosepa (Josepha)	1- Wailua	Seven *lo'i*
		2 - Kawailoa	Two salt ponds
		3 - Kahunananiho	*Kula* land, bounded north by the hill of Keke
4577 13:53	Isaia	1 - Kauki'i	Six *lo'i*
		2 - Kauki'i	Three *lo'i*
		3 - Mahā'ulepū Village	A house lot

Table B-1. (cont.)

LCA Number Vol. & Page	Awardee	Parcel No. & *'Ili* Name	Land use(s)
4577 13:53(cont.)		4 - Kama'i	Potato field on the kula; surrounded on all sides by a stone wall
		5 - Kawailoa	Two salt ponds
		6 - Kawailoa	Two salt ponds
4630 13:60	Petero	1 - Kaualehu	Two *lo'i* and a *kula* parcel
		2 - Haula	Three fishponds
4631 13:60	Pā - Pāhinakua	1 - Waipao	One *lo'i* and the *'auwai* (irrigation ditch)
4634 13:64	Poka'akua	1 - Kekaualehu	Five *lo'i*
		2 - Kawailoa	A salt pond
4635 13:52	Pu'ukahea	1 - Wailua	Two *lo'i* and an *'auwai*
		2 - Kawailoa	A salt pond
		3 - Halulu	A sweet potato lot enclosed by a stone wall
4638 13:50	Pā'ao'ao	1 - Halulu	Eight *lo'i*
		2 - Halulu	Mountain side area planted in orange trees
		3 -	Two salt ponds
		4 -	A house lot, bounded on the north by a stone wall which separates it from the *muliwai* (an estuary - dune banked shore line pond)
4691 13:63	Li'i	1- Kalanui	Two *lo'i*
		2 - Kawailoa	A salt pond
		3 - Mahā'ulepū Village	A house lot, fenced in
4767 13:51	Nāpali'ala (Nāhoa'ōlelo [w])	1 - Kauki'i	A *lo'i*
		2 - Kawailoa	A salt pond
4768 13:12	Nāhinu	1 - Kapalou hikina (Kōloa)	A house lot and ten *lo'i*
		2 - Kioea	Four *lo'i* and a *kula* parcel
		3 - [Ka]Wailoa	A salt pond
		4 - [Ka]Punakea	A house lot - bounded by the: hog pen (mauka); hog pen and kula (Puna); pool of Wailā'au (makai); and school house yard (Hanapēpē)
4769 13:26	Nahuma	1- Waipao	Five *lo'i* and two dry *kalo* (taro) patches
		2 - Kauki'i	Two *lo'i*
		3 - Kioea	Seven dry *kalo* patches
		4 - Kauki'i (Kapunakea)	The fishpond called Keahikia
		5 - Mahā'ulepū Village	House lot
		6 - Waipā	A *kula* parcel with five orange trees
		7 - Kaisea (at Kawailoa)	Two salt ponds
4770 13:56	Na'ahuao	1 - [Ka]Lanui	Two *lo'i*
		2 - Kauki'i	Several dry *lo'i* and a *kula* parcel
		3 - Kawailoa	A salt pond
		4 - Halulu	A potato field

Table B-1. (cont.)

LCA Number Vol. & Page	Awardee	Parcel No. & *'Ili* Name	Land use(s)
4771 13:52	Nanini	1 - Kapakalehu	Three lo'i
		2 - Kawailoa	One *kuakua pa'akai* (a rock and/or dirtlined salt pond)
		3 - Mahā'ulepū Village	A house lot
		4 - Kaeaea	Parcel planted with banana and orange trees; bounded north by the cliff of Hā'upu, and east by the ridge of Kaeaea
4906 13:28	Kealahili	1 - Kaualehu	Two *lo'i* and a *kula* parcel
		2 -	A house lot, house fenced in with a stone wall
4910 13:58	Kahe'e	1 - Kauki'i	One *lo'i* and a *kula* parcel
		2 - Mahā'ulepū Village	A house lot, fenced in
		3 - Kawailoa	Five small ponds
		4 - Halulu	A potato field
		5 - Kapakalehu	An orange tree
4996 13:55	Kamalule	1 - Papakea	Five *lo'i* and a *kula* parcel
		2 - Kawailoa	One salt pond (*kuakua pa'akai* - a rock and/or dirt lined salt pond
		3 - Halulu	A potato field; bounded on the south by the pig pen of Mika, and on the west by a foot path
4997 & 6667 13:4	Mika	1-Papakea	One *lo'i*
		2-Waiolua (Wailua)	Three *lo'i*
		3 - Kauki'i	One *lo'i*
		4 - Koholāiki	One salt pond
4998 13:56	Kauluamano	1 - Waipao	Two *lo'i*
		2 - Kawailoa	Six salt ponds
		3 - Mahā'ulepū Village	A house lot, fenced in
4999 13:57	Keahi	1 - [Ka]Lanui	One *lo'i*
		2 & 3 - Kawailoa	Two salt ponds
5077 13:62	Kao and Kaehu	1 - Kapakalehu	Three *lo'i* (taro pond fields) on the plain
		2 - Mahā'ulepū Village	House lot
		3 - Kawailoa	Two small salt ponds
		4 - Kawailoa	One small salt pond
5079 13:30	Kuheke	1 - Kalanui	Five *lo'i*
		2 - Kauki'i	Three *lo'i*
		3 - Kawailoa	A salt pond
5080 13:29	Kiko	1 - Kalaiki	Five *lo'i*
		2 - Mahā'ulepū Village	A house lot enclosed with a stone wall
		3 - Kawailoa	A salt pond
		4 - Kahoukahe	A sweet potato field enclosed with a stone wall

Table B-1. (cont.)

LCA Number Vol. & Page	Awardee	Parcel No. & *'Ili* Name	Land use(s)
5082 13:60	Kaikamahine	1 - Waipao (marsh)	One *lo'i*
		2 - Pae'ole	One *lo'i*
		3 - Mahā'ulepū Village	A *kula* parcel and house lot
		4 - Kawailoa	A salt pond
5093 13:54	Keahikuni	1 - Kalua	Two *lo'i*
		2 - Mahā'ulepū Village	A house lot
		3 - Halulu	A potato field, fenced in; bounded east by the foot path leading to the village
		4 - Kawailoa	Two salt ponds
5289 13:59	Ka'ilikea	1 - Kauki'i	Three *lo'i* and a *kula* parcel
		2 - Mahā'ulepū Village	A house lot; bounded on the north by a stone wall
		3 & 4 Kawailoa	Two salt ponds

Use of the Land for Plantation

After Western contact, agriculturalists in the area experimented with mulberry for silkworms, coffee, and tapioca. In 1836 Charles Titcomb and Sherman Peck planted two hills in Kōloa, known as Mauna Kilika (Silk Mountain), to nurture silkworms. After problems hatching the cocoons, a drought in 1840, and aphid infestation, they abandoned the project in 1842 (Friends 1985). According to A. Alexander, cane was grown in the Koloa district prior to the plantation, and a Chinese-operated mill produced sugar and molasses (1985). W.O. Smith cites a sugar mill, possibly the same one, at Mahaulepu in his paper of 1915 (IN Alexander 1985).

Although most historic accounts cite Ladd & Co. as the first successful sugar plantation in Hawaii, some accounts contend that the sugar industry was pioneered, developed, and placed on a working and profitable basis by Chinese, who dominated the industry until the mid-1800s. "Although eventually taken over entirely by American and European companies and management, commercial sugar production in Hawaii was first undertaken by Chinese entrepreneurs" (Dr. C.E. Glick, *Sojourners & Settlers* IN Ching 1985). "About that time they lost control due largely to the great amount of capital that the plantations required" (Matsuoka, 1961). Kuykendall credits John Wilkinson, an English agriculturalist, with starting the first sugar plantation in Manoa valley in 1825, ten years before Ladd & Co. began operations on Kauai. The harvest from his seven acres of cane supplied a rum distillery at the time of his death in 1826.

Ladd & Co., with the aid of William Hooper, started their plantation on twelve acres at Koloa in 1835 (Friends 1985, Star Bulletin 1935). They negotiated a lease, signed on July 29, 1835, with Kamehameha III and the Governor Kaikioewa, for a tract of almost 1,000 acres at Koloa. The terms were for 50 years at an annual rate of $300 (Ching 1985).

The agreement allowed them to "hire native laborers...provided they pay to Kamehameha III and Kaikioewa one-fourth of a dollar a month each man...and, to each native so employed they shall pay satisfactory wages...they (laborers) received housing and food (fish and poi) which cost the company about $00.01 per man per day. The old accounts...say Hooper agreed with the chiefs to pay each man $2.00 a month, but soon found he also had to pay each man 12 and 1/2 cents a day (hapawalu = 1/2 a quarter) to get them to report to work" (ibid.).

After a hard first decade, Dr. Wood, the major creditor, became the sole owner of the company, and he renamed it Koloa Plantation. In 1848, he renegotiated the lease with the government, gaining new terms of 2,200 acres for 50 years, at $650 a year (ibid.).

In 1935, one hundred years after the founding of the plantation, the Honolulu Star Bulletin published an article containing the following account:

> By 1850 Koloa Plantation had 450 acres in cultivation... yielding a crop of slightly over two tons. A great swamp, first drained for use as caneland, when found to consist of peat bog formed of prehistoric forests, was later converted into a huge reservoir that today is one of the important units in the plantation's irrigation system. Efforts at draining the 400 acre swamp continued for about 20 years, much of it under the direction of George Dole, elder brother of Sanford Dole, manager for several years. An outlet was blasted through pahoehoe lava and the whole plain cut into sections with miles of ditches. Then the buried forest came to light, "huge trees of ohiahua, lehua and loulu palms," estimated at 1,000 years old. The prehistoric forest was used as a wood supply for the plantation furnishing 200-300 cords annually...Planted in cane, the reclaimed area was found infertile...Ultimate use of the swamp was not as caneland but as a reservoir...covering an area of 425 acres and [with] a capacity of 2,300,000,000 gallons of water. From 1851 to 1857 Judge Samuel Burbank, brother-in-law of Dr. Wood, was manager and part owner of Koloa plantation. In 1854 a new mill was erected...Dr. Wood after 27 years as owner of the plantation sold out in 1872 and left the islands. Paul Isenberg took a half interest, J.N. Wright and Adolf Haneberg each a fourth. Today, the company owns in fee simple 2,776.67 acres of cane land, the bulk of which is irrigated. It leases 1,180 acres. The mill is an example of modern engineering efficiency. [It was] Completely rebuilt in 1913 on a new site at a cost of $375,000 Star Bulletin 3/2/35 p.7).

Although Chinese no longer ran their own mill in the Koloa district, many were employed by Koloa Plantation. Manager Hooper had written to his partners that "the Chinese fixed up their quarters as if they intended to stay forever" (Char 1974:14). Hooper wisely capitalized on Chinese expertise in sugar production, importing workers from China and employing many of them as sugar boilers. In another letter to his partners, Hooper mentioned the need to import pans and earthenware pots from China for crystallizing and draining the sugar (Ching 1985). This knowledge was jealously guarded by the Chinese, for whom it represented economic leverage. This created problems for Hooper, who wrote in 1839, "...the little Chinaman (working at Koloa Plantation) is bent on going to Oahu for some cause...if not allowed he says it would be the same as hemo ka poo (cut off his head). Chinamen on Oahu have written letters that for showing someone at Hanalei how to make sugar the Chinese in Honolulu tell him to pay $500" (Kai 1974:42).

Under the management of John Wright (1871-1882), the workers at Koloa Plantation were mostly unskilled Chinese, under contract for 46 cents a day, working from 6 a.m. to 3 p.m. (Ching 1985). Koloa Plantation was sold to Grove Farm Co. in 1948.

Koloa town was a natural outgrowth of the plantation. Hooper's basement doubled as the local jail; the post office was part of the plantation store; and the plantation supplied the town with water and electricity. Bob Krauss (1978) reports that "At Koloa, a Prussian named W.E. Anton Cropp kept a small dungeon where he imprisoned balky workers." Krauss does not mention the year or whether Cropp was employed by Koloa Plantation. Throughout the 1800s, Koloa Landing was a busy port, and Koloa was one of the main commercial centers on Kauai (Historic Koloa 1985).

Isabella Bird traveled the Hawaiian Islands between January and August of 1873, and penned the following remarks on the Koloa area:

> ...we anchored at Koloa Roads. The view is a pleasant one. The rains have been abundant, and the land, which here rises rather gradually from the sea, is dotted with houses, abounds in signs of cultivation, and then spreads up into a rolling country between precipitous ranges of mountains. The hills look something like those of Oahu, but their wonderful greenness denotes a cooler climate and more copious rains, also their slopes and valleys are densely wooded, and Kauai obviously has its characteristic features, one of which must certainly be a superabundance of that most unsightly cactus, the prickly pear, to which the motto nemo me impune lacessit most literally applies" (Bird 1964:190).

Wherever people settle, churches soon follow, and Koloa was no exception. A Congregational Mission was established at Koloa in 1835, and in 1843 Kamehameha III gave the Catholic church 17 acres there. St. Raphael was established on the land 1856 (Friends 1985).

Missionaries were responsible for the first public school on Kauai. In 1841, Rev. Gulick built a permanent school house for Hawaiian children (Koloa School 1977). In 1855, Rev. Daniel Dole (who founded Punahou School) started a school for the children of Protestant missionaries and plantation supervisors. It was located near the present Kauai Mortuary (Friends 1985). A boarding school for girls was established by Dr. Smith in 1862 (ibid.), and in 1877, prominent Kauai citizens formally petitioned the Board of Education to establish a free school in Koloa. They requested that the Board provide J.K. Burkett, the future principal, with $1200 a year salary, a pay equal to the amount he was making at Lahainaluna (Koloa School 1977).

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COUNTY COUNCIL
COUNTY OF KAUAI

Resolution

No. 2001-25,
Draft 1

RESOLUTION SUPPORTING THE FUTURE PRESERVATION OF MĀHĀ'ULEPŪ

WHEREAS, Māhā'ulepū is a heritage landscape where it is possible to preserve and restore diverse significant natural, scenic, cultural, archaeological, historic, scientific and recreational resources; and

WHEREAS, Māhā'ulepū is a living cultural landscape and a place sacred to many Native Hawaiians, particularly to those of the Kōloa area whose ancestral remains are buried at Māhā'ulepū; and

WHEREAS, it is in the economic and social interest of the County of Kaua'i to conserve its valuable natural and cultural resources and to create parks and preserves for the future; and

WHEREAS, the ahupua'a of Māhā'ulepū is also directly adjacent to Kīpū Kai, an entire ahupua'a which is a future State land preserve; and

WHEREAS, the unique opportunity to apply the ahupua'a framework of care-taking and management of watersheds from mountain peak to the ocean exists at both Kīpū Kai and Māhā'ulepū; and

WHEREAS, landowners should receive fair value for land dedicated or sold for public purposes; and

WHEREAS, the Kaua'i General Plan states that Māhā'ulepū needs a community-based planning effort that engages the landowner and local community interests, drawing upon the County government, the State Department of Land and Natural Resources (DLNR), and various professional experts, as needed; NOW, THEREFORE:

BE IT RESOLVED, that the Council of the County of Kaua'i supports and is willing to participate in collaborative planning efforts to explore options for the preservation of Māhā'ulepū that would make it possible to preserve the irreplaceable natural and cultural resources of Māhā'ulepū, and to sustain the experience of this place as an undeveloped area with compatible uses.

BE IT FURTHER RESOLVED, that the Council of the County of Kaua'i extends its mahalo to the Grove Farm Company, Inc., for continuing to keep Māhā'ulepū open to the public, both residents and visitors.

BE IT FURTHER RESOLVED, that the Council of the County of Kaua'i thanks Governor Benjamin J. Cayetano for his declaration of support for preservation of Māhā'ulepū and asks the Governor to continue his leadership towards preservation of Māhā'ulepū.

Exhibit B

BE IT FURTHER RESOLVED, that copies of this resolution be forwarded to the Honorable Benjamin J. Cayetano, Governor of the State of Hawai'i; the Honorable Mazie K. Hirono, Lieutenant Governor of the State of Hawai'i; the Honorable Maryanne W. Kusaka, Mayor of the County of Kaua'i; State Senator Jonathan Chun; State Senator Avery B. Chumbley; State Representative Ezra R. Kanoho; State Representative Bertha C. Kawakami; State Representative Hermina M. Morita; Ms. Lynn P. McCrory, State Board of Land and Natural Resources Kaua'i Member; and Mr. David W. Pratt, President and Chief Executive Officer, Grove Farm Company, Inc.

INTRODUCED BY:

/s/ RON KOUCHI
/s/ BILL "KAIPO" ASING
/s/ BRYAN BAPTISTE
/s/ GARY HOOSER
/s/ DARYL KANESHIRO
/s/ JAMES KUNANE TOKIOKA
/s/ RANDAL VALENCIANO

	Aye	Nay	Exc.
Asing	X		
Baptiste	X		
Hooser	X		
Kaneshiro	X		
Kouchi	X		
Tokioka	X		
Valenciano	X		
TOTAL	7	0	0

CERTIFICATE OF ADOPTION

We hereby certify that Resolution No 2001-25, Draft 1, was adopted by the Council of the County of Kauai, State of Hawaii, Lihue, Kauai, Hawaii, on April 11, 2001.

County Clerk

Chairman & Presiding Officer

Dated 4/11/2001

Report Title:

Maha`ulepu Park

THE SENATE
TWENTY-FIRST LEGISLATURE, 2001
STATE OF HAWAII

S.R. NO. 97 S.D. 1

SENATE RESOLUTION

SUPPORTING THE FUTURE PRESERVATION OF Maha`ulepu.

WHEREAS, Maha`ulepu is a heritage landscape where it is possible to preserve and restore diverse and significant natural, scenic, cultural, archaeological, historic, scientific, and recreational resources; and

WHEREAS, Maha`ulepu is a living cultural landscape and a place sacred to many Native Hawaiians, particularly to those of the Kaloa area whose ancestral remains are buried at Maha`ulepu; and

WHEREAS, it is in the economic and social interest of the State of Hawaii to conserve its valuable natural and cultural resources, and to create parks and preserves for the future; and

WHEREAS, the ahupua'a of Maha`ulepu is directly adjacent to Kipu Kai, an entire ahupua'a which is a future State land preserve; and

WHEREAS, the unique opportunity to apply the ahupua'a framework of care-taking and management of watersheds from mountain peak to the ocean exists at both Kipu Kai and Maha`ulepu; and

WHEREAS, the County of Kauai General Plan states that Maha`ulepu needs a community-based planning effort that engages the landowner and local community interests, drawing upon the County government, the Department of Land and Natural Resources, and various professional experts; and

Exhibit C

WHEREAS, the County of Kauai has expressed its gratitude to the Grove Farm Company, Inc. for keeping Maha`ulepu open to the public, both residents and visitors; and

WHEREAS, Governor Benjamin Cayetano has declared his support for the preservation of Maha`ulepu; now, therefore,

BE IT RESOLVED by the Senate of the Twenty-First Legislature of the State of Hawaii, Regular Session of 2001, that it supports a collaborative planning effort to explore options that would make it possible to preserve the irreplaceable natural and cultural resources of Maha`ulepu, and to sustain the special experience of this place; and

BE IT FURTHER RESOLVED that certified copies of this Resolution be transmitted to the members of Hawaii's Congressional Delegation, the Honorable Benjamin J. Cayetano, Governor of the State of Hawai’i, the Honorable Mazie K. Hirono, Lieutenant Governor of the State of Hawai’i, the Honorable Maryanne W. Kusaka, Mayor of the County of Kaua’i, Members of the State Board of Land and Natural Resources, Members of the Council of the County of Kaua’i, and the President and Chief Operating Officer of Grove Farm Company, Inc.

Report Title:

Preservation of Maha'ulepu

HOUSE OF REPRESENTATIVES

TWENTY-FIRST LEGISLATURE, 2001

STATE OF HAWAII

H.R. NO. 91 H.D. 1

HOUSE RESOLUTION

SUPPORTING THE FUTURE PRESERVATION OF Maha'ulepu.

WHEREAS, Maha'ulepu is a heritage landscape where it is possible to preserve and restore diverse and significant natural, scenic, cultural, archaeological, historic, scientific, and recreational resources; and

WHEREAS, Maha'ulepu is a living cultural landscape and a place sacred to many Native Hawaiians, particularly to those of the Koloa area whose ancestral remains are buried at Maha'ulepu; and

WHEREAS, it is in the economic and social interest of the State to conserve its valuable natural and cultural resources and to create parks and preserves for the future; and

WHEREAS, the ahupua'a of Maha'ulepu is directly adjacent to Kipu Kai, an entire ahupua'a which is a future State land preserve; and

WHEREAS, the unique opportunity to apply the ahupua'a framework of care-taking and management of watersheds from mountain peak to the ocean exists at both Kipu Kai and Maha'ulepu; and

WHEREAS, the County of Kaua'i General Plan states that Maha'ulepu needs a community-based planning effort that engages the landowner and local community interests, drawing upon the County, the Department of Land and Natural Resources, and various professional experts; and

Exhibit D

WHEREAS, many residents and visitors are grateful to the Grove Farm Company, Inc., for keeping Maha'ulepu open to the public; and

WHEREAS, Governor Benjamin Cayetano has declared his support for the preservation of Maha'ulepu; now, therefore,

BE IT RESOLVED by the House of Representatives of the Twenty-first Legislature of the State of Hawaii, Regular Session of 2001, that this body supports a collaborative planning effort to explore options that would make it possible to preserve the irreplaceable natural and cultural resources of Maha'ulepu, and to sustain the special experience of this place; and

BE IT FURTHER RESOLVED that certified copies of this Resolution be transmitted to the Honorable Benjamin J. Cayetano, Governor of the State of Hawai'i, the Honorable Mazie K. Hirono, Lieutenant Governor of the State of Hawai'i, the Honorable Maryanne W. Kusaka, Mayor of the County of Kaua'i, members of the Board of Land and Natural Resources, members of the Council of the County of Kaua'i, and the President and Chief Operating Officer of Grove Farm Company, Inc.

Report Title:

Preservation of Maha'ulepu

HOUSE OF REPRESENTATIVES

TWENTY-FIRST LEGISLATURE, 2001

STATE OF HAWAII

H.C.R. NO. 95 H.D. 1

HOUSE CONCURRENT RESOLUTION

SUPPORTING THE FUTURE PRESERVATION OF Maha'ulepu.

WHEREAS, Maha'ulepu is a heritage landscape where it is possible to preserve and restore diverse and significant natural, scenic, cultural, archaeological, historic, scientific, and recreational resources; and

WHEREAS, Maha'ulepu is a living cultural landscape and a place sacred to many Native Hawaiians, particularly to those of the Koloa area whose ancestral remains are buried at Maha'ulepu; and

WHEREAS, it is in the economic and social interest of the State to conserve its valuable natural and cultural resources and to create parks and preserves for the future; and

WHEREAS, the ahupua'a of Maha'ulepu is directly adjacent to Kipu Kai, an entire ahupua'a which is a future State land preserve; and

WHEREAS, the unique opportunity to apply the ahupua'a framework of care-taking and management of watersheds from mountain peak to the

Exhibit E

ocean exists at both Kipu Kai and Maha'ulepu; and

WHEREAS, the County of Kaua'i General Plan states that Maha'ulepu needs a community-based planning effort that engages the landowner and local community interests, drawing upon the County, the Department of Land and Natural Resources, and various professional experts; and

WHEREAS, many residents and visitors are grateful to the Grove Farm Company, Inc., for keeping Maha'ulepu open to the public; and

WHEREAS, Governor Benjamin Cayetano has declared his support for the preservation of Maha'ulepu; now, therefore,

BE IT RESOLVED by the House of Representatives of the Twenty-first Legislature of the State of Hawaii, Regular Session of 2001, the Senate concurring, that this body supports a collaborative planning effort to explore options that would make it possible to preserve the irreplaceable natural and cultural resources of Maha'ulepu, and to sustain the special experience of this place; and

BE IT FURTHER RESOLVED that certified copies of this Concurrent Resolution be transmitted to the Honorable Benjamin J. Cayetano, Governor of the State of Hawai'i, the Honorable Mazie K. Hirono, Lieutenant Governor of the State of Hawai'i, the Honorable Maryanne W. Kusaka, Mayor of the County of Kaua'i, members of the Board of Land and Natural Resources, members of the Council of the County of Kaua'i, and the President and Chief Operating Officer of Grove Farm Company, Inc.

Exhibit F


11/06/2014


11/06/2014

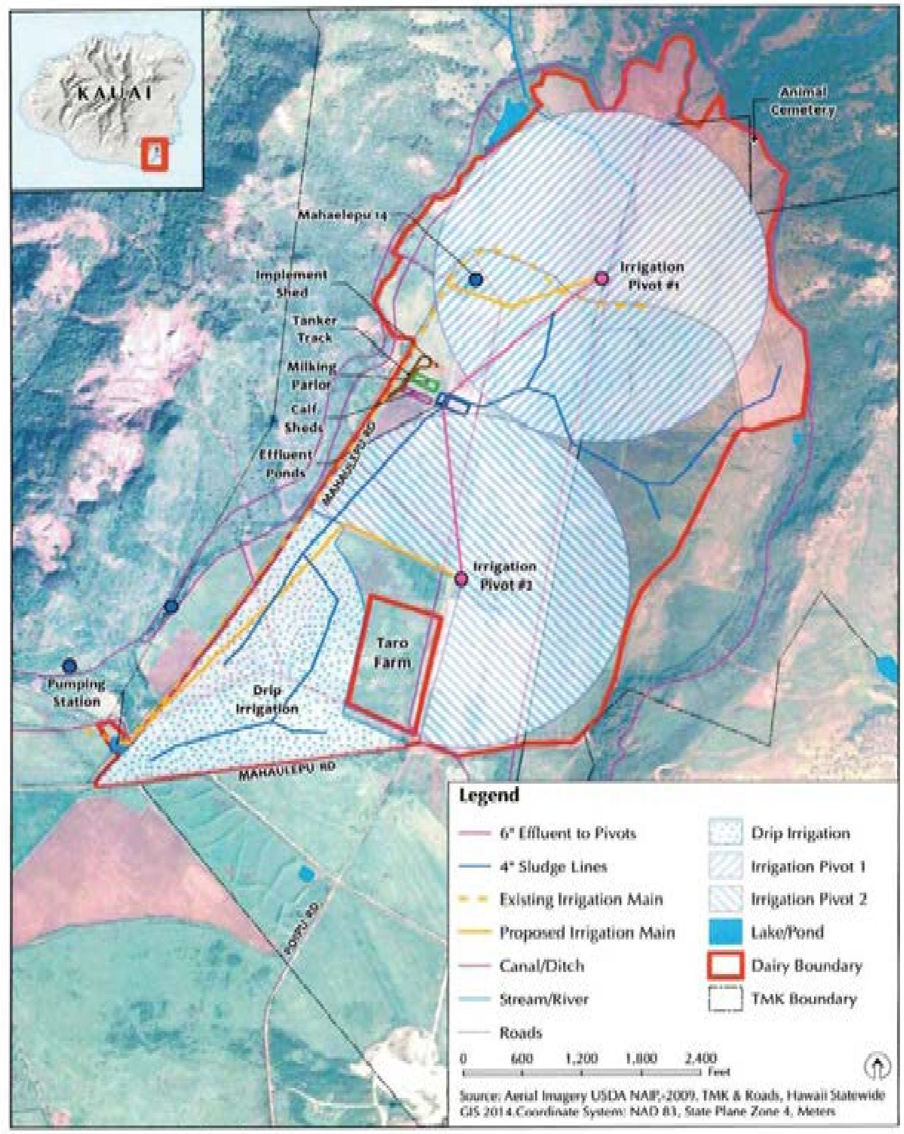

Figure 12 – Irrigation Map

Exhibit G

Exhibit 18

GOODSILL ANDERSON QUINN & STIFEL
A LIMITED LIABILITY LAW PARTNERSHIP LLP

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May 22, 2015

VIA CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Peter Tausend, Chairman
West Kaua'i Soil & Water Conservation District
4334 Rice Street, Room 104
Lihue, HI 96766-1801

Jenna Dunn
District Conservationist
NRCS Service Center
4334 Rice Street, Room 104
Lihue, HI 96766-1801

Re: Rescission of Approval of Hawai'i Dairy Farms' Soil Conservation Plan – Endangered Species

Dear Mr. Tausend and Ms. Dunn:

This office represents Kawailoa Development LLP ("Kawailoa Development"). Kawailoa Development is the owner of the Grand Hyatt Kaua'i and the Poipu Bay Golf Course, which are located close to Hawai'i Dairy Farms' proposed dairy. The purpose of this letter is to request that the West Kaua'i Soil & Water Conservation District ("West Kaua'i SWCD") and the U.S. Department of Agriculture Natural Resources Conservation Service ("NRCS") rescind their approval of the Dairy's soil conservation plan ("Plan") due to impacts identified by the U.S. Fish & Wildlife Service ("USFWS") to endangered species on the subject property.

Hawai'i Dairy Farms began its ground-disturbing activity last year, is conducting field trials (including mowing activities), and has already installed its irrigation systems. *See* photographs enclosed as Exhibit A. Hawai'i Dairy Farms' activities have endangered the following species identified by the USFWS: endangered Hawaiian black-necked stilt, endangered Hawaiian moorhen, endangered Hawaiian coot, endangered Hawaiian duck, endangered Hawaiian goose, endangered Hawaiian hoary bat, endangered Hawaiian petrel, threatened Newell's shearwater, and the band-rumped storm-petrel, which is a candidate for listing. Additionally, the proposed project area is in the vicinity of designated critical habitat for two endangered arthropods, the Kaua'i cave wolf spider and the Kaua'i cave amphipod, as well as the endangered plant, ohai.

Upon review of the Dairy's Environmental Impact Statement Preparation Notice ("EISPN"), U.S. FWS sent a comment letter to Hawai'i Dairy Farms on February 23, 2015, a copy of which is attached as Exhibit B. The comment letter requires the following actions to avoid and minimize project impacts to listed species, candidate species, and critical habitat:

- The effluent ponds should be covered or enclosed to minimize the attraction of waterbirds and geese.
- Electric fencing should not be used as part of the dairy.
- Clostridium botulinum, a bacteria commonly occurring in nutrient-rich substrate, may result in paralysis and most often in mortality when ingested by Hawaiian waterbirds or Hawaiian geese. The spraying of pastures with decaying animal materials will increase the risk for avian botulism.
- A biological monitor should conduct Hawaiian waterbird and Hawaiian goose nest surveys prior to project initiation, and a biological monitor should be present "during all construction activities, earth moving activities, land clearing/disking activities, and mowing of pastures to ensure that waterbirds or geese nests are not adversely impacted."
- Barbed wire should not be used for fencing because Hawaiian hoary bats can become entangled.

Based on the fact that the Dairy undertook its ground-disturbing activities prior to receipt of the USFWS letter, Kawailoa Development believes that the Dairy failed to have a biological monitor conduct nest surveys, and failed to have a biological monitor present "during all construction activities, earth moving activities, land clearing/disking activities, and mowing of pastures to ensure that waterbirds or geese nests are not adversely impacted."

It is therefore apparent that there are a multitude of issues related to endangered species that have yet to be resolved between Hawai'i Dairy Farms, U.S. FWS and the public. It is also clear that the Dairy failed to implement any of the measures required by USFWS before undertaking its onsite activities, including grading and grubbing work, subsurface construction of its irrigation system and implementation of its field trials. The issues related to endangered species constitute new information and resource concerns that merit the immediate halt of any and all construction activities.

Approval of the conservation plan by NRCS and West Kauai SWCD triggered consultation requirements under Section 7 of the Endangered Species Act ("ESA"). Pursuant to Section 7(a)(2) of the ESA, if the proposed project is funded, authorized, or permitted by a Federal agency, then that agency must consult with U.S. FWS. That is, each federal agency shall insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined to be critical. 16 USC § 1536(a)(2). The approval by NRCS and West Kauai SWCD of the Dairy's conservation plan authorized the action. "Action," pursuant to 50 CFR § 402.02, refers to all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies in the United States. Examples include, but are not limited to actions directly or indirectly causing modifications to the land, water, or air. 50 CFR § 402.02.

Additionally, according to the NRCS website, NRCS is an agency that provides technical and financial assistance to private land users on a voluntary basis and as such is considered an "action agency" with regard to compliance under ESA. NRCS is required by the ESA to protect and conserve federally listed species and species proposed for listing. This responsibility includes, but is not limited to research, protection, habitat acquisition, restoration, enhancement and maintenance.[1] NRCS and West Kaua'i SWCD failed to fulfill ESA requirements when they approved the Dairy's conservation plan.

The December 17, 2013 West Kauai SWCD soil conservation plan approval letter states,

> In issuing this conservation plan, the West Kauai Soil & Water Conservation District relies on the information and data which you provided to us. If, subsequent to the issuance of this approved conservation plan, such information and data prove to be false, incomplete or inaccurate, this approval may be modified, suspended or revoked.

The NRCS planning process also requires that the planner must "[r]evisit earlier steps if new objectives or resource concerns are identified." USDA, NRCS National Planning Procedures Handbook ("NPPH") at 600-C.16, 600-C.24 (Jan. 2013). We are copying Department of Land and Natural Resources Chair Suzanne Case on this letter because West Kaua'i SWCD is part of the Department of Land and Natural Resources, as constituted under Hawaii Revised Statues Chapter 180.

[1] http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/plantsanimals/fishwildlife/?cid=stelprdb1042231

The information related to endangered species constitutes new information and resource concerns that require rescission by NRCS and West Kaua'i SWCD of the December 2013 Plan approval.

Very truly yours,

Lisa A. Bail

LAB

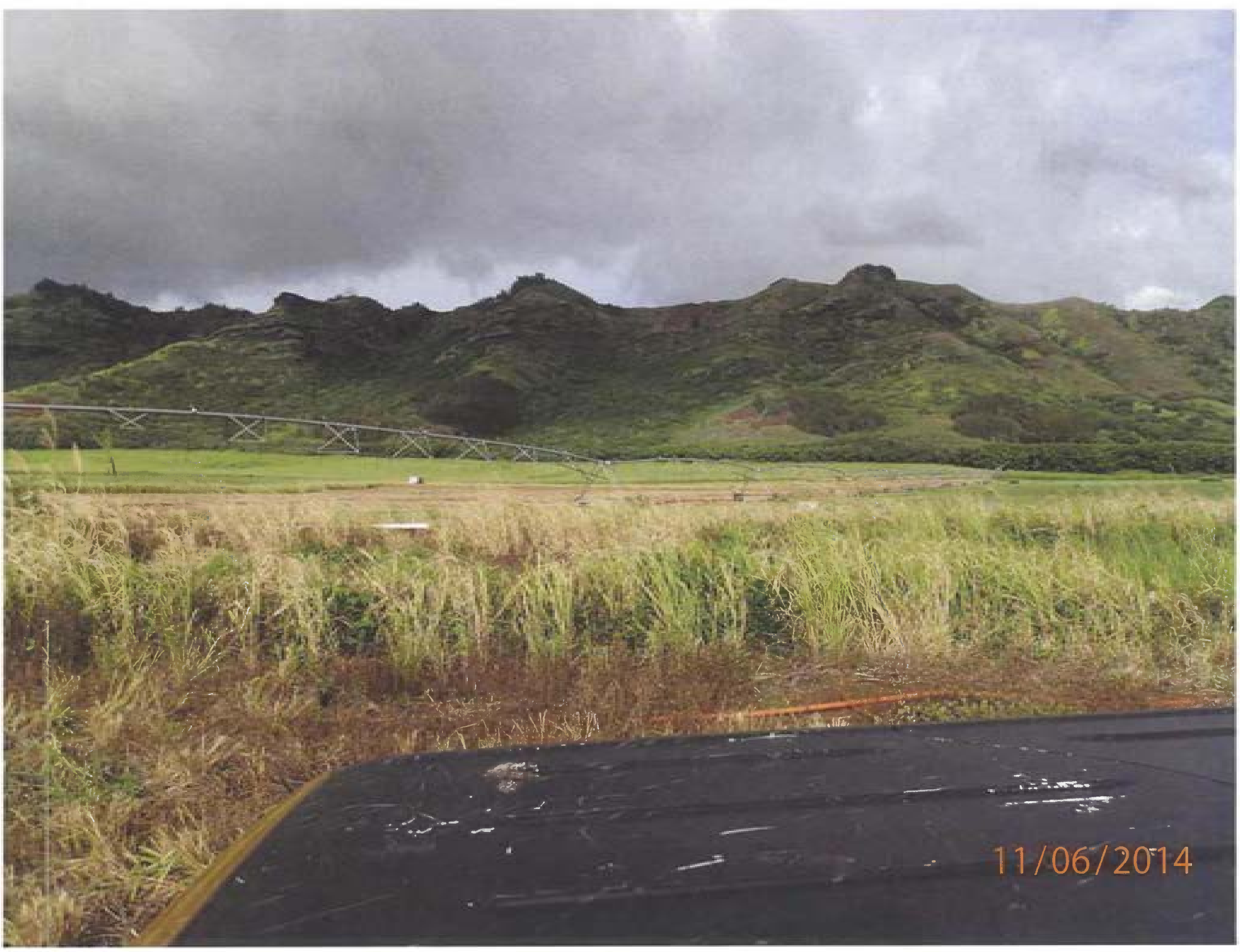
Enclosures: Exhibit A, Photographs of the Dairy site taken by the Hawai'i Department of Health, dated November 2014

Exhibit B, Comment letter from U.S. Fish and Wildlife Service dated February 23, 2015

cc (w/encls.): Aaron Nadig, Biologist, U.S. Fish & Wildlife Service
Michael Moule, P.E., Chief, Engineering Division, County of Kaua'i
Suzanne Case, Esq., Chairperson, Hawai'i Department of Land and Natural Resources
Patricia McHenry, Esq.
Kendall J. Moser, Esq.

Exhibit A


11/06/2014


11/06/2014

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122
Honolulu, Hawai'i 96850

In Reply Refer To:
2015-TA-0138

FEB 23 2015

Jeffrey H. Overton
Group 70 International, Inc.
925 Bethel Street, Fifth Floor
Honolulu, Hawaii 96813

Subject: Technical Assistance for the Proposed Hawaii Dairy Farms, Kauai

Dear Mr. Overton:

The U.S. Fish and Wildlife Service (Service) received your letter, dated January 26, 2015, requesting our comments on the Notice of Preparation of Environmental Impact Statement (EISPN) for the proposed Hawaii Dairy Farms (HDF) on the island of Kauai. Hawaii Dairy Farms, LLC proposes to establish and operate a grass-fed diary, capable of supporting 2,000 dairy cows, including commercial dairy facilities and pastures managed for Kikuyu and Kikuyu-Guinea grasses. The proposed dairy facilities consist of barn and milking parlor, cow walkways, farm roads, effluent settling and storage ponds, water distribution system and tanks, operations buildings, and associated infrastructure (electrical power, wastewater, and communications). The pasture design will include approximately 118 fenced paddocks (~4.5 to 5.0 acres each). The development will be located on approximately 578 acres consisting of portions of three larger parcels (TMK (4) 2-9-003:001 and 006 portion; TMK (4) 2-9-001:001) adjacent to Mahaulepu Road, east of Koloa town. We offer the following comments to assist you in the preparation of the draft Environmental Impact Statement (EIS). Our comments are provided under the authorities of the Endangered Species Act of 1973 (ESA), as amended (16 U.S.C 1531 *et seq.*), and the Fish and Wildlife Coordination Act of 1934 (FWCA), as amended (16 U.S.C. 661 *et seq.*; 48 Stat. 401).

We reviewed the information you provided and pertinent information in our files, including data compiled by the Hawaii Biodiversity and Mapping Program, as it pertains to federally listed species and designated critical habitat. The following species are known to occur or transit through the proposed project area: the endangered Hawaiian black-necked stilt (*Himantopus mexicanus knudseni*), Hawaiian moorhen (*Gallinula chloropus sandvicensis*), Hawaiian coot (*Fulica alai*), Hawaiian duck (*Anas wyvilliana*) (hereafter collectively referred to as Hawaiian waterbirds);the endangered Hawaiian goose (*Branta sandvicensis*); the endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*); and the endangered Hawaiian petrel (*Pterodroma sandwichensis*), the threatened Newell's shearwater (*Puffinus auricularis newelli*), and a candidate for listing the band-rumped storm-petrel (*Oceanodroma castro*) (hereafter collectively referred to as seabirds). The proposed project area is in the vicinity of designated critical habitat

Exhibit B

for the following species: two endangered arthropods, the Kauai cave wolf spider (*Adelocosa anops*) and the Kauai cave amphipod (*Spelaeorchestia koloana*) (hereafter collectively referred to as arthropods); and an endangered plant, ohai (*Sesbania tomentosa*). We provide the following comments which include recommendations to avoid and minimize project impacts to listed species, candidate species, and critical habitat.

Hawaiian Waterbirds and Hawaiian Goose
The EISPN states that Hawaiian waterbirds and Hawaiian geese are known to utilize water features around the HDF parcel. Our information suggests that considerable numbers of Hawaiian waterbirds frequent the project area. The Service recommends you incorporate the following measures into your project description to avoid and minimize impacts to Hawaiian waterbirds and Hawaiian geese.

Waterbirds and geese may be attracted to the effluent settling and storage ponds as well as managed pastures. Waterbirds and geese attracted to sub-optimal habitat may suffer adverse impacts, such as predation and/or reduced reproductive success, and thus the project may create an attractive nuisance. Measures to minimize their attraction to ponds, such as covering or enclosing the ponds, should be considered. To minimize predation and/or reduced breeding success of waterbirds and geese using pastures, a predator control program should be implemented to control non-native predators, such as feral cats and rats.

Injury or mortality of adults and juveniles may potentially occur due to entanglement or collision with fencing and/or collision with vehicles on farm roads. Additional details on fencing are necessary to assess potential impacts to Hawaiian waterbirds and Hawaiian geese. Electric fencing (commonly used to control movement of cows in pastures) should not be used for fencing as part of the proposed project. To minimize potential collision with vehicles, the Service recommends you install signage near roadways to warn drivers (e.g., farm workers and visitors) to be wary of birds in the areas.

Under certain environmental conditions, *Clostridium botulinum*, a bacteria commonly occurring in nutrient-rich substrate, may produce toxins that when ingested by Hawaiian waterbirds or Hawaiian geese results in paralysis and most often mortality (referred to as avian botulism). The EISPN states that 100% of manure from up to 2,000 dairy cows will be treated and applied to fertilize pasture grasses. The spraying of pastures with decaying animal materials will promote a nutrient-rich bacterial substrate. We recommend you work with our office so that we may assist you in developing measures to avoid fostering conditions that promote avian botulism and a monitoring plan for early detection and response.

Displacement and/or loss of nests may potentially occur during project construction and operation (e.g., clearing areas, disking, and/or mowing of pastures). To minimize and avoid impacts due to displacement and/or loss of nests, we recommend the following measures:

- A biological monitor should conduct Hawaiian waterbird and Hawaiian goose nest surveys at the proposed project site prior to project initiation.
- Any documented nests or broods within the project vicinity should be reported to the Service within 48 hours.

- A 100-foot buffer should be established and maintained around all active nests and/or broods until the chicks have fledged. No potentially disruptive activities or habitat alteration should occur within this buffer.
- The Service should be notified immediately prior to project initiation and provided with the results of pre-construction Hawaiian waterbird and Hawaiian goose surveys.
- A biological monitor(s) should be present on the project site during all construction activities, earth moving activities, land clearing/disking activities, and mowing of pastures to ensure that waterbirds or geese nests are not adversely impacted.
- If a Hawaiian waterbird or Hawaiian goose is observed within the project site, or flies into the site while activities are occurring, the biological monitor should halt all activities within 100 feet of the individual(s). Work should not resume until the Hawaiian waterbird(s) or goose leave the area on their own accord.
- A post-construction report should be submitted to the Service with 30 days of the completion of the project. The report should include the results of surveys, the location and outcome of documented nests, and any other relevant information.

We suggest the draft EIS provide additional information on effluent ponds (e.g., number, location, and sizes), fencing materials and site layout, fertilization practices (e.g., effluent treatment, application amounts, frequency), outline measures to avoid and minimize the various potential impacts described above, and examine potential impacts that may occur as a result of establishment and operation of the HDF project.

Hawaiian Hoary Bat
The Hawaiian hoary bat roosts in both exotic and native woody vegetation and, while foraging, will leave young unattended in "nursery" trees and shrubs when they forage. If trees or shrubs suitable for bat roosting are cleared during the breeding season, there is a risk that young bats could inadvertently be harmed or killed. To minimize impacts to the endangered Hawaiian hoary bat, woody plants greater than 15 feet (4.6 meters) tall should not be disturbed, removed, or trimmed during the bat birthing and pup rearing season (June 1 through September 15). Site clearing should be timed to avoid disturbance to Hawaiian hoary bats in the project area.

Additionally, Hawaiian Hoary bats forage for insects from as low as three feet to higher than 500 feet above the ground. When barbed wire is used for fencing, Hawaiian hoary bats can become entangled. Barbed wire should not be used for fencing as part of the proposed project.

Seabirds
Seabirds, including the Newell's shearwater, Hawaiian petrel, and band-rumped storm petrel fly at night and are attracted to artificially-lighted areas resulting in disorientation and subsequent fallout due to exhaustion. Seabirds are also susceptible to collision with objects that protrude above the vegetation layer, such as utility lines, guy-wires, and communication towers. Additionally, once grounded, they are vulnerable to predators and are often struck by vehicles along roadways. We recommend the following minimization measures be incorporated into your project description:

- Construction activities should only occur during daylight hours. Any increase in the use of nighttime lighting, particularly during peak fallout period (September 15 through December 15), could result in additional seabird injury or mortality.

- If exterior facility lights cannot be eliminated due to safety or security concerns, then they should be positioned low to the ground, be motion-triggered, and be shielded and/or full cut-off. Effective light shields should be completely opaque, sufficiently large, and positioned so that the bulb is only visible from below.

The draft EIS should examine potential impacts to the Newell's shearwater, Hawaiian petrel, and band-rumped storm petrel that may occur as a result of construction and the operational use exterior lights associated with the proposed project.

Utility poles and overhead lines may constitute a collision hazard for seabirds as they traverse between the ocean and their breeding colonies. Additional information on the design of the proposed utility system for the development, including the number of utility poles, length of powerline, configuration of powerlines, and height of utility poles and overhead powerlines, in the area is necessary to assess the potential impacts to seabirds. We suggest the draft EIS provide this additional informational as well as determine whether undergrounding power lines in the proposed development area is feasible to avoid impacts to seabirds. If it is not feasible to underground power lines or install power lines at or the below the vegetation layer, other measures to minimize the potential for seabird collision should be analyzed in the draft EIS (e.g., vertical versus horizontal arrays, etc.).

Arthropods
The Kauai cave wolf spider and the Kauai cave amphipod are found only on the island of Kauai in the Koloa area from four to six caves respectively. They occur in small, subterranean spaces, voids, and cracks, requiring a woody debris food source. Cave ecosystems are threatened by contamination from surface sources of toxic chemicals from spills, pesticides, and waste disposal which enter caves via streams and/or ground-water seepage. The proposed HDF site is hydrologically linked to the sensitive cave habitats. We recommend the draft EIS address any project components that have the potential to impact the critical habitat (e.g., wastewater and pasture fertilization practices) and minimize potential disturbance.

Sesbania tomentosa
Sesbania tomentosa occurs on the coast located southeast of the HDF site. The primary threat to the species on the island of Kauai is habitat degradation caused by competition with various introduced plant species, including but not limited to buffelgrass (*Cenchrus ciliaris*), swollen fingergrass (*Chloris barbarta*), sourgrass (*Digitaria insularis*), and haole koa (*Leucaena leucocephala*). Other threats include lack of adequate pollination, fire, destruction by off-road vehicles, other human disturbances, and storms. The Service recommends that your draft EIS address any project components that have the potential to impact the critical habitat and minimize potential disturbance.

Under the ESA, take is defined to mean "...to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in any such conduct." Harass is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. Harm is defined by the

Service to include significant habitat modification or degradation that results in death or injury to listed species by impairing behavioral patterns including breeding, feeding, or sheltering.

When additional information on the proposed project description becomes available, we recommend you contact our office early in the planning process so that we may further assist you with ESA compliance. If it is determined that the proposed project may affect federally listed species or critical habitat, the project proponent(s) should coordinate with us under section 10 of the ESA or consult with us pursuant to section 7 of the ESA as follows. If the proposed project is funded, authorized, or permitted by a Federal agency, then that agency should consult with us pursuant to section 7(a)(2) of the ESA. If no Federal agency is involved with the proposed project, the applicant should apply for an incidental take permit under section 10(a)(1)(B) of the ESA. A section 10 permit application must include a habitat conservation plan that identifies the effects of the action on listed species and their habitats, and defines measures to minimize and mitigate those adverse effects.

Additionally, we recommend you incorporate the attached best management practices into your project description to avoid and minimize impacts to water resources that have the potential to occur during establishment and construction of the proposed project.

We appreciate your efforts to conserve protected species. If you have questions regarding this letter, please contact Adam Griesemer, Endangered Species Biologist (phone: 808-285-8261).

Sincerely,

Aaron Nadig
Island Team Manager
Oahu, Kauai, North Western Hawaiian Islands, and American Samoa

cc: Laura McIntyre, HDOH

U.S. Fish and Wildlife Service
Recommended Standard Best Management Practices

The U.S. Fish and Wildlife Service (USFWS) recommends the following measures to be incorporated into project planning to avoid or minimize impacts to fish and wildlife resources. Best Management Practices (BMPs) include the incorporation of procedures or materials that may be used to reduce either direct or indirect negative impacts to aquatic habitats that result from project construction-related activities. These BMPs are recommended in addition to, and do not over-ride any terms, conditions, or other recommendations prepared by the USFWS, other federal, state or local agencies. If you have questions concerning these BMPs, please contact the USFWS Aquatic Ecosystems Conservation Program at 808-792-9400.

1. Authorized dredging and filling-related activities that may result in the temporary or permanent loss of aquatic habitats should be designed to avoid indirect, negative impacts to aquatic habitats beyond the planned project area.

2. Dredging/filling in the marine environment should be scheduled to avoid coral spawning and recruitment periods, and sea turtle nesting and hatching periods. Because these periods are variable throughout the Pacific islands, we recommend contacting the relevant local, state, or federal fish and wildlife resource agency for site specific guidance.

3. Turbidity and siltation from project-related work should be minimized and contained within the project area by silt containment devices and curtailing work during flooding or adverse tidal and weather conditions. BMPs should be maintained for the life of the construction period until turbidity and siltation within the project area is stabilized. All project construction-related debris and sediment containment devices should be removed and disposed of at an approved site.

4. All project construction-related materials and equipment (dredges, vessels, backhoes, silt curtains, etc.) to be placed in an aquatic environment should be inspected for pollutants including, but not limited to; marine fouling organisms, grease, oil, etc., and cleaned to remove pollutants prior to use. Project related activities should not result in any debris disposal, non-native species introductions, or attraction of non-native pests to the affected or adjacent aquatic or terrestrial habitats. Implementing both a litter-control plan and a Hazard Analysis and Critical Control Point plan (HACCP – see *http://www.haccp-nrm.org/Wizard/default.asp*) can help to prevent attraction and introduction of non-native species.

5. Project construction-related materials (fill, revetment rock, pipe, etc.) should not be stockpiled in, or in close proximity to aquatic habitats and should be protected from erosion (*e.g.*, with filter fabric, etc.), to prevent materials from being carried into waters by wind, rain, or high surf.

6. Fueling of project-related vehicles and equipment should take place away from the aquatic environment and a contingency plan to control petroleum products accidentally spilled during the project should be developed. The plan should be retained on site with the person responsible for compliance with the plan. Absorbent pads and containment booms should be stored on-site to facilitate the clean-up of accidental petroleum releases.

7. All deliberately exposed soil or under-layer materials used in the project near water should be protected from erosion and stabilized as soon as possible with geotextile, filter fabric or native or non-invasive vegetation matting, hydro-seeding, etc.

Exhibit 19

GOODSILL ANDERSON QUINN & STIFEL
A LIMITED LIABILITY LAW PARTNERSHIP LLP

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July 20, 2015

VIA E-MAIL

Peter Tausend, Chairman
West Kaua'i Soil & Water Conservation District
4334 Rice Street, Room 104
Lihue, HI 96766-1801
Peter.Tausend@pioneer.com

Bruce Petersen
Director for the Pacific Islands Area
Natural Resources Conservation Services
U.S. Department of Agriculture
300 Ala Moana Blvd., #4-118
Honolulu, HI 96850
Bruce.Petersen@hi.usda.gov

Re: Rescission of Approval of Hawai'i Dairy Farms' Soil Conservation Plan – Endangered Species

Dear Mr. Tausend and Mr. Petersen:

This letter responds to Patricia McHenry's letter dated June 26, 2015, relating to my May 22, 2015 request that the West Kaua'i Soil & Water Conservation District ("West Kaua'i SWCD") and the U.S. Department of Agriculture Natural Resources Conservation Service ("NRCS") rescind any approvals of the Hawai'i Dairy Farm's soil conservation plan ("Plan") due to impacts identified by the U.S. Fish & Wildlife Service ("USFWS") to endangered species on the subject property. As set forth below, we have two concerns.

First, and most importantly, Hawai'i Dairy Farms' response fails entirely to address the issue raised by the USFWS: impacts to threatened and endangered species. The need to address these impacts is urgent. The impacts are ongoing, particularly given that the grass mowing involved in the current field trials could have devastating impacts to nesting birds. Since new resources concerns have been raised by the USFWS, the approval must be revisited, as required by the NRCS Handbook cited in our first letter.

Second, Hawai'i Dairy Farms has not been forthright in the approval process for its Plan, as well as its nutrient management plan, and has misled the community about the approval it previously claimed to have obtained from the NRCS. Hawai'i Dairy Farms' new assertion that its plans were never approved by NRCS is contrary to its own representation to the public. As just one example, the enclosed fact sheet handed out by Hawai'i Dairy Farms stated that the "NRCS permit" was "completed." As a second example, Hawai'i Dairy Farms was able to obtain an agricultural exemption from the County of Kaua'i ("County") based on conservation plan approval by West Kaua'i SWCD, as evidence by the County's March 18, 2014 letter (copy enclosed) which states, "We are granting an agricultural exemption for the area and conservation practices specifically shown on your conservation plan <u>that was approved</u> by the West Kaua'i Soil and Water Conservation District on December 17, 2013." (Emphasis added.)

As set forth above, the public has been led to believe by Hawai'i Dairy Farms' own statements that an NRCS permit was obtained. Unlike the Hawai'i EIS Law process, where the goal is to provide informed decision-making on environmental issues, Hawai'i Dairy Farms' Plan and the conservation issues related to such Plan have been protected as confidential by NRCS and West Kaua'i SWCD.[1] If in fact, an approval was obtained or a permit issued by West Kaua'i Soil and Water Conservation District,[2] we request rescission of such approval or permit.

In conclusion, the information related to endangered species is significant and should not be ignored. The public and the federal government, through the USFWS, need assurances that threatened and endangered species are not impacted by the Dairy's plan. We therefore request rescission of any Plan approvals by the West Kaua'i SWCD.

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[1] In 2014, we issued a FOIA request to NRCS and a government records request to West Kaua'i SWCD. Our FOIA request was denied by NRCS and West Kaua'i SWCD's response to our records request was extremely limited based on provisions in the Food Conservation and Energy Act of 2008.

[2] By letter from Bruce Petersen of the Natural Resources Conservation Service on July 8, 2015, I am informed that Hawai'i Dairy Farms' conservation plan is not approved or permitted by NRCS as it "is not a funded, authorized or permitted project." Not having received similar information from West Kaua'i SWCD, the rescission request in this letter is therefore directed to West Kaua'i SWCD.

Very truly yours,

Lisa A. Bail

LAB

Enclosures: Exhibit A, Hawaii Dairy Farms' Fact Sheet Handout, dated February 26, 2014
Exhibit B, Letter from County of Kaua'i Department of Public Works to Hawai'i Dairy Farms dated March 18, 2014

cc: Aaron Nadig, Biologist, U.S. Fish & Wildlife Service
Michael Moule, P.E., Chief, Engineering Division, County of Kaua'i
Suzanne Case, Esq., Chairperson, Hawai'i Department of Land and Natural Resources
Patricia McHenry, Esq.
Kendall J. Moser, Esq.
Jenna Dunn, District Conservationist, NRCS Service Center

Hawai'i Dairy Farms
Fact Sheet

History

- Until 1984, Hawai'i produced 100% of its milk through local dairies
- By 2008, costs had skyrocketed for importing feed and other materials, causing nearly all local dairies to close
- The two remaining dairies on the Big Island only produce about 9 percent of the state's milk supply, leaving the rest to be imported
- More than 6 years ago, Grove Farm started working on how to restart Kaua'i's dairy industry
- New models were considered and it was determined that New Zealand's grass-fed model would be the cleanest, most cost-effective, sustainable method
- Ulupono Initiative was founded in 2009 to make investments toward Hawai'i's self-sufficiency through increasing local food production and renewable energy use, as well as reducing and reusing waste
- In 2012, Grove Farm, Finistere Ventures, Kamehameha Schools, Maui Land & Pineapple and Ulupono Initiative partnered to do grass trials statewide to find the best site for the state's first grass-fed dairy
- Kaua'i was found to be the optimal location
- Ulupono Initiative made the investment to begin work on the dairy site in Maha'ulepu, leasing the land from Grove Farm

Operations

- 582 acres of active pasture in Maha'ulepu, wrapping around the Haraguchi Taro Farm; located more than 2 miles from populated areas
- Pasture-based rotational grazing model focuses on farming the grass for the good of the cows and milk production
- 70% Kikuyu grass diet, supplemented with 30% feed
- Grass diet results in lower methane output from cattle, minimizing smell
- 2 irrigation pivots and gun/drip irrigation with water sourced from Waita Reservoir, existing well on site was previously used in pasture operations
- Zero discharge system utilizes 2 effluent ponds for wastewater to recycle as nutrient rich material for pasture management; cows rotate through pastures to evenly apply manure and urine as fertilizer
- Computerized monitoring tracks soil and effluent content to meet all regulatory requirements, while also optimizing both farm and environmental management
- Water system is being upgraded to improve overall water flow to the area
- Irrigation system controlled by GPS to best manage application of water and diluted effluent without contaminating ditches, water troughs or Haraguchi Taro Farm
- The farm is designed using setbacks, native plants and fencing to protect all drainage ditches and keep water clean
- Fencing will enhance safety around drainage ditches and the effluent ponds
- There will be virtually no smell from ponds, irrigation or pasture past 20-50 feet; but we are exploring additional mitigation efforts

As of 2/26/2014

Exhibit A

- The farm was designed using area historical rainfall data to accommodate extreme flooding/drought; cows will be rotated out of areas with standing water to allow for drainage and pasture rejuvenation
- At steady-state operations, there will be roughly 1,800 Kiwi Cross cows at the dairy farm; non-milking cows, calves and bulls will be managed in partnership with local ranchers offsite
- 152 paddocks allow for 6 groups of 300-330 cows to rotate through their own set of 18 pastures over 18 days, allowing even application of manure/urine for proper fertilization and wastewater management
- The milking parlor will house a 60-stall rotary milking platform
- Precision agricultural model uses technology to monitor the health of cows, milk quality and pasture productivity for maximum efficiency

Economics

- Local milk production will reach 20 percent, including Hawai'i Dairy Farms' roughly 3.7 million gallons per year at steady-state operations, reducing our dependence on imported milk
- Statewide distribution of more local milk at current market prices
- There will be 10-15 full time operational jobs at the farm
- Construction jobs, including capacity building for local suppliers
- $17.5+ million investment in local food production
- First commercial use of Important Agricultural Lands on Kaua'i

Development Timeline

- NRCS permit – *completed*
- Animal Feed Operation (AFO) permit – *in progress*
- Comprehensive Nutrient Management Plan (CNMP) – *in progress*
- Building permits – *in progress*
- Irrigation and pasture preparation – *in progress*
- Offtake contract for milk processing/distribution – *in negotiations*
- Timeline - *Pending Permit Approvals*:
  - Groundbreaking – Spring
  - Cow arrival – Late Summer/Early Fall
  - Milk production – Early 2015

Please visit our website at www.HawaiiDairyFarms.com to learn more.

Contact:

Amy Hennessey
Director of Communications
Hawai'i Dairy Farms and Ulupono Initiative
(808) 544-8973
amy@ulupono.com or info@hawaiidairyfarms.com

Bernard P. Carvalho, Jr.
Mayor

Nadine K. Nakamura
Managing Director

Larry Dill, P.E.
County Engineer

Lyle Tabata
Deputy County Engineer

DEPARTMENT OF PUBLIC WORKS
County of Kaua'i, State of Hawai'i
4444 Rice Street, Suite 275, Līhu'e, Hawai'i 96766
TEL (808) 241-4992 FAX (808) 241-6604

March 18, 2014

Hawai'i Dairy Farms, LLC.
3083 Akahi Street
Līhu'e, HI 96766
Attention: Mr. James Garmatz

SUBJECT: APPLICATION FOR AN AGRICULTURAL EXEMPTION FROM THE SEDIMENT AND EROSION CONTROL ORDINANCE NO. 808, KŌLOA DISTRICT, TMK: 2-9-003:001 POR

Dear Mr. Garmatz:

We are exempting the grading, grubbing and stockpiling operations for the captioned property under Section 22.7.6 of the County's Sediment and Erosion Control Ordinance No. 808, an Ordinance Regulation and Controlling Grading, Grubbing, Stockpiling and Soil Erosion and Sedimentation within the County of Kaua`i. We are granting an agricultural exemption for the area and conservation practices specifically shown on your conservation plan that was approved by the West Kaua`i Soil and Water Conservation District on December 17, 2013. Grading, grubbing and stockpiling permits are not required as long you are working with the West Kaua`i Soil & Water Conservation District and implementing the conservation practices in your plan to the standards and specifications set by the National Resources Conservation Service. Enclosed is our approval of the Agricultural exemption which is subject to the conditions as noted.

Should you have any questions, please contact Paul Togioka at (808) 241-4889.

Sincerely,

MICHAEL MOULE, P.E.
Chief, Engineering Division

SI

cc: Design & Permitting
Planning Department
Mr. Ben Vinhateiro, USDA/NRCS, 4334 Rice Street, Suite 104, Līhu'e, HI 96766
Mr. Peter Tausend, Chairman WK-SWCD, 4334 Rice Street, Suite 104, Lihu'e, HI 96766

An Equal Opportunity Employer

Exhibit B

APPLICATION NO. AE-2014-2

COUNTY OF KAUA`I
Department of Public Works
Engineering Division

APPROVAL OF AGRICULTURAL EXEMPTION FROM THE COUNTY OF KAUA'I'S SEDIMENT AND EROSION CONTROL ORDINANCE NO. 808, KŌLOA DISTRICT, TMK: 2-9-003:001 POR

TO: Hawai'i Dairy Farms, LLC.
3083 Akahi Street
Līhu'e, HI 96766
Attention: Mr. James Garmatz

This is to inform you that your Application No. AE-2014-2 for an Agricultural Exemption from the County of Kaua'i's Sediment and Erosion Control Ordinance No. 808 is approved subject to the following conditions:

1. The graded or grubbed area is to be used exclusively for agricultural production.
2. The applicant agrees to continue or establish the agricultural operations within one year and agrees further not to take actions to change from the specified agricultural operations to a different type of land use for the period of time stated.
3. This exemption shall be good for ten (10) years from the date of approval unless revoked sooner for non-compliance of conditional requirements or the conservation plan is terminated sooner by the appropriate Soil and Water Conservation District Board.
4. The applicant has authorized the County Engineer or his designee to inspect the applicant's files held by the East & West Kaua'i Soil and Water Conservation Districts.
5. This Agricultural Grading Exemption is specific to the applicant and TMK listed and is non-transferable.
6. Best Agricultural Management Practices BAMP's shall be implemented at all times to the maximum extent practicable to prevent damage by sedimentation, erosion or dust to streams, water courses, natural areas and the property of others. It shall be the permittee's and the property owner's responsibility to ensure that Best Management Practices (BMP'S) are satisfactorily implemented.

Date of Issue: 17 MARCH 2014

Issued By: [signature]
Design and Permitting Section

cc: Design & Permitting
Planning Department
Ben Vinhateiro, USDA/NRCS
Mr. Peter Tausend, Chairman West Kaua`i SWCD

Exhibit 20

GOODSILL ANDERSON QUINN & STIFEL
A LIMITED LIABILITY LAW PARTNERSHIP LLP

LISA A. BAIL

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DIRECT DIAL:
(808) 547-5787

INTERNET:
lbail@goodsill.com

June 4, 2015

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Bruce Petersen
Director for the Pacific Islands Area
Natural Resources Conservation Service
U.S. Department of Agriculture
300 Ala Moana Blvd., #4-118
Honolulu, HI 96850

Peter Tausend, Chairman
West Kaua'i Soil & Water Conservation District
4334 Rice Street, Room 104
Lihue, HI 96766-1801

Re: Rescission of Approval of Hawai'i Dairy Farms' Soil Conservation Plan – Historic Properties

Dear Mr. Petersen and Mr. Tausend:

This office represents Kawailoa Development LLP ("Kawailoa Development"). Kawailoa Development is the owner of the Grand Hyatt Kaua'i and the Poipu Bay Golf Course, which are located close to Hawai'i Dairy Farms' proposed dairy ("Dairy"). The purpose of this letter is to request that the West Kaua'i Soil & Water Conservation District ("West Kaua'i SWCD") and the U.S. Department of Agriculture Natural Resources Conservation Service ("NRCS") rescind their approval of the Dairy's Soil Conservation Plan ("Plan") due to at least fifteen newly identified and documented historic properties and cultural resources.

Hawai'i Dairy Farms began its ground-disturbing activity last year and has already installed its irrigation systems. Photographs taken by the Hawai'i Department of Health ("DOH") during its November 2014 site visit are attached as Exhibit A. It is evident that construction work began prior to any archaeological assessment.

Hawai'i Dairy Farms should not have started any construction activities prior to review by the Hawai'i State Historic Preservation Division ("SHPD"). However, only after it started its construction activities, Hawai'i Dairy Farms submitted its revised Archaeological Inventory Survey ("AIS") to the SHPD. The AIS is attached as Exhibit B. According to the

AIS, only one historic property, a carved petroglyph boulder, was previously identified. *See* AIS at p. ii. It was not until the revised AIS dated February 2015 that "a total of 15 historic properties were newly identified and documented." *Id.* Included in the historic properties are heiau, petroglyph rocks, and pre-Contact/Historic sites. Moreover, the revised AIS discloses multiple Land Commission Awards ("LCAs") within the project area. Such awards are evidence of a once sizable native Hawaiian resident population in Māhā'ulepū Valley, and as it was a common practice to bury family members close to one's home, burials are likely clustered around the LCAs.

SHPD sent a letter to Hawai'i Dairy Farms on April 13, 2015, attached as Exhibit C, describing twenty-three points of revision that must be made prior to its approval of the AIS. As such, there are a multitude of archaeological issues that have yet to be resolved between Hawai'i Dairy Farms, SHPD and the public. The fifteen newly identified historic properties constitute new information and resource concerns that merit the immediate halt of any and all construction activities until the review by SHPD is complete and proper studies and outreach to descendants and Native Hawaiian organizations have been conducted.

The State Level Agreement between NRCS and SHPD ("State Level Agreement") "provides for implementation of policies and procedures developed by NRCS to more effectively ensure that effects of conservation activities on historic properties are thoroughly considered in the earliest planning stages and that cultural resource protection is accomplished as efficiently as possible." The State Level Agreement provides that conservation practices that are considered "Undertakings" require cultural resource consideration and Section 106 compliance. Hawai'i Dairy Farms' proposed Dairy includes waste treatment lagoons, which fall within the definition of "Undertakings" in the State Level Agreement. The State Level Agreement also provides that all sites with planned structural activities will be field investigated by the NRCS Cultural Resource Specialist, who will determine the presence or absence of cultural resources and report the findings to SHPD. We have seen no record indicating that this field investigation occurred prior to the construction of irrigation structures or that the results of any investigation were reported to SHPD.

Hawai'i Dairy Farms has already conducted ground-disturbing activities. These activities include construction of the irrigation system structures and field trials (see DOH photos attached as Exhibit A), and also grading, grubbing and trenching. In addition, Hawai'i Dairy Farms has also obtained a building permit allowing for the construction of additional structures, such as the implement shed, milking shed, and two calving sheds.

Finally, the State Level Agreement provides that NRCS should consult on a case-by-case basis with SHPD and the Office of Hawaiian Affairs ("OHA") to identify specific groups for consultation. We are unaware of any information confirming that such consultation, in face, occurred. SHPD and OHA should not be denied the consultation provided in the State Level Agreement.

The December 17, 2013 West Kauai SWCD soil conservation plan approval letter states,

> In issuing this conservation plan, the West Kauai Soil & Water Conservation District relies on the information and data which you provided to us. If, subsequent to the issuance of this approved conservation plan, such information and data prove to be false, incomplete or inaccurate, this approval may be modified, suspended or revoked.

The NRCS planning process also requires that the planner must "[r]evisit earlier steps if new objectives or resource concerns are identified." USDA, NRCS National Planning Procedures Handbook ("NPPH") at 600-C.16, 600-C.24 (Jan. 2013). Obviously the information upon which West Kaua'i SWCD relied upon in approving the conservation plan was at a minimum incomplete. We are copying Department of Land and Natural Resources Chair Suzanne Case on this letter because West Kaua'i SWCD is part of the Department of Land and Natural Resources, as constituted under Hawaii Revised Statues Chapter 180. Continued development by Hawai'i Dairy Farms gravely jeopardizes these now known historic properties and cultural resources, as well as potentially unknown cultural significant resources, including human burial remains.

Compliance with the State Level Agreement is required, and the fifteen newly identified historic properties constitute new information and resource concerns that require rescission by NRCS and West Kaua'i SWCD of the December 2013 Plan approval.

Very truly yours,

Lisa A. Bail

LAB

Enclosures: Exhibit A, Photographs of the Dairy site taken by the Hawai'i Department of Health, dated November 2014

Exhibit B, *Archaeological Inventory Survey of 580-Acres in Māhā'lepū Ahupua'a, Koloa District, Kaua'i Island, Hawai'i*, prepared for Hawai'i Dairy Farms LLC, dated February 2015

Exhibit C, Hawai'i State Historic Preservation Division's review letter April 13, 2015

cc (w/encls.): Alan Downer, Administrator, Hawai'i State Historic Preservation Division
Suzanne Case, Esq., Chairperson, Hawai'i Department of Land and Natural Resources
Jenna Dunn, District Conservationist NRCS
Patricia McHenry, Esq.
Kendall Moser, Esq.
Jun Fukada, Kawailoa Development LLP

Exhibit A


11/06/2014


11/06/2014

SCS Project Number 1597-4 AIS

ARCHAEOLOGICAL INVENTORY SURVEY OF 580-ACRES IN MĀHĀʻULEPŪ AHUPUAʻA, KOLOA DISTRICT, KAUAʻI ISLAND, HAWAIʻI [TMK: (4) 2-9-003:001 POR. AND 006 POR.; 2-9-001:001 POR.]

Prepared by:
Jeff Putzi, B.A.,
James Powell, B.A.,
Milton Ching, A.A.,
and
Michael Dega, Ph.D.

Revised February 2015
DRAFT

Prepared for:
Hawaii Dairy Farms LLC.
737 Bishop Street, Suite 2360
Honolulu, Hawaiʻi 96813

SCIENTIFIC CONSULTANT SERVICES Inc.
1347 Kapiolani Blvd., Suite 408 Honolulu, Hawaiʻi 96814

Exhibit B

ABSTRACT

Scientific Consultant Services, Inc. (SCS), conducted Archaeological Inventory Survey (AIS) in advance of proposed improvements for a proposed dairy farm on a 580 acre property within Māhāʻulepū Valley, Māhāʻulepū Ahupuaʻa, Koloa District, Island of Kauaʻi. The property is owned by Maha`ulepu Farms, LLC. and comprised of TMK: (4) 2-9-003-001 por. & 006 por. and (4) 2-9-001:001 por. The entire valley floor had been previously utilized for intensive sugar cane cultivation, crop cultivation, and livestock pasturage since the 1830s. Prior to this time, the valley was utilized by Hawaiians for the cultivation of traditional food crops.

Full, 100% pedestrian survey was conducted over the entire 580-acre project area and beyond, within a 100 meter zone bordering the northern flanks of the project area. One previously identified historic property, a carved petroglyph boulder (State Site 50-30-10-3094), was re-identified during the current project. During the current AIS, a total of 15 historic properties were newly identified and documented. Three of these sites are believed to be associated with pre-Contact and/or early historic times, including an enclosure and two retaining wall remnants. The remaining sites consist of bridges, ditches, and culverts dating from the 20th century and affiliated with sugar cane cultivation. In addition to survey, a total of seventeen trenches were mechanically excavated in various portions of the project area, with no cultural findings. Test units were placed in the pre-Contact enclosure, which aided in refining functional interpretations.

Sites 50-30-10-2250 through -2264 have been assessed as significant under Criterion D (information important in prehistory or history). Sites -3094 and -2250, both occurring off site, have been assessed as significant under Criterion D and E. Of the total 16 sites in the project area, inclusive of Site -3094, no further work is recommended for twelve of the sites or the remainder of the project area. Preservation is recommended for Site 3094, the petroglyph boulders, and Site -2250, an enclosure interpreted as an agricultural *heiau*.

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INTRODUCTION

At the request of Hawaii Dairy Farms (HDF) Maha`ulepu Farms, LLC (landowner), Scientific Consultant Services, Inc. (SCS) conducted Archaeological Inventory Survey (AIS) in advance of proposed improvements on a 580-acre property in Māhā‘ulepū Valley, Māhā‘ulepū Ahupua‘a, Koloa District, Island of Kaua‘i (TMK: (4) 2-9-003:001 por. & 006 por.; 2-9-001:001 por.) (Figure 1 and Figure 2). The property is owned by Maha`ulepu Farms, LLC. Improvements are proposed by Hawaii Dairy Farms, LLC and are related to infrastructure of a commercial dairy. These include modifying existing dirt roads, grading ground surfaces for the construction of buildings, the excavation of effluent ponds, and the excavation of pipelines for the watering of cattle.

Field work was conducted between July 7, 2014 and July 25, 2014 and August 21, 2014 through August 26, 2014 by archaeologists Jeff Putzi, B.A., James Powell, B.A., Milton Ching, B.A., and Michael Dega, Ph.D. (Principal Investigator). Archaeological Inventory Survey was performed to identify all historic properties occurring in the project area and near environs, gather sufficient information to document these properties, to evaluate the significance of any newly identified historic properties, to determine the project effect on these properties, and to make mitigation recommendations to address possible adverse impacts to identified historic properties, pursuant to Hawaii Administrative Rules (HAR) 13-284 and 13-276.

During the current Archaeological Inventory Survey, one previously identified site, State Site 50-30-10-3094 was relocated. This site remains off-site, outside the proposed dairy area. In addition, a total of fifteen historic properties were newly identified and documented. Three of these sites are believed to be associated with pre-Contact and/or early historic times, including an enclosure of two retaining wall remnants. The remaining sites consist of bridges, ditches, culverts, and a flume system dating from the 20th century and are directly associated with sugar cane cultivation. In addition to survey, a total of seventeen trenches were mechanically excavated in various portions of the project area, with no cultural findings. Test units were placed in the pre-Contact enclosure, which aided in refining functional interpretations.

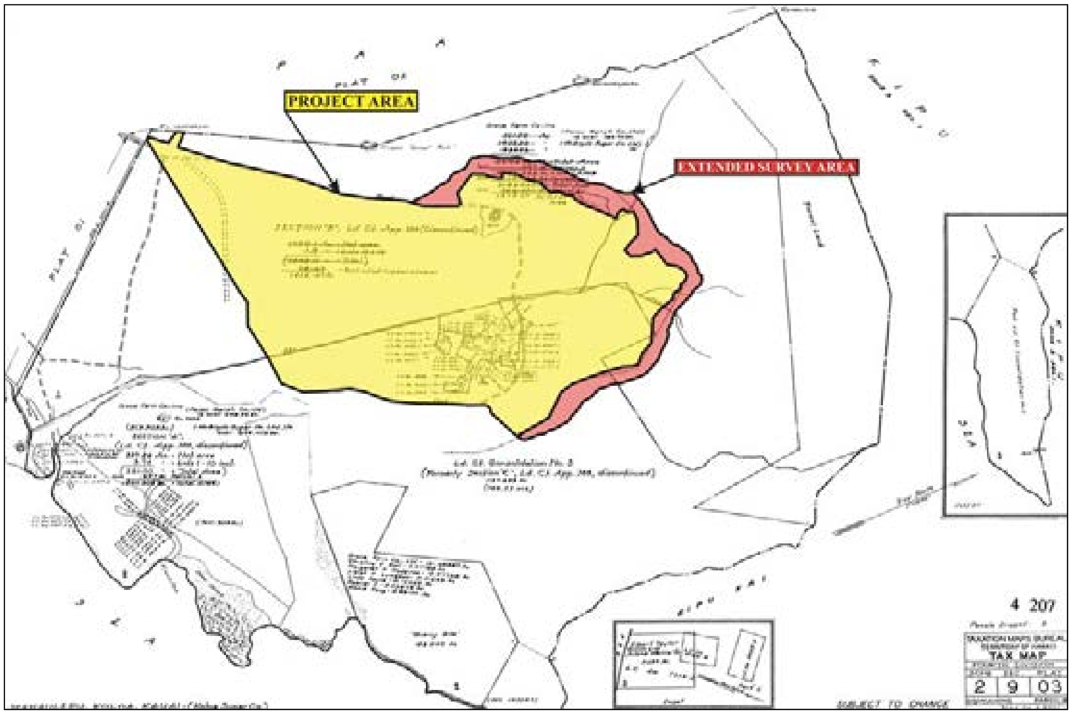

Figure 2. Tax Map Key Showing Project Area.

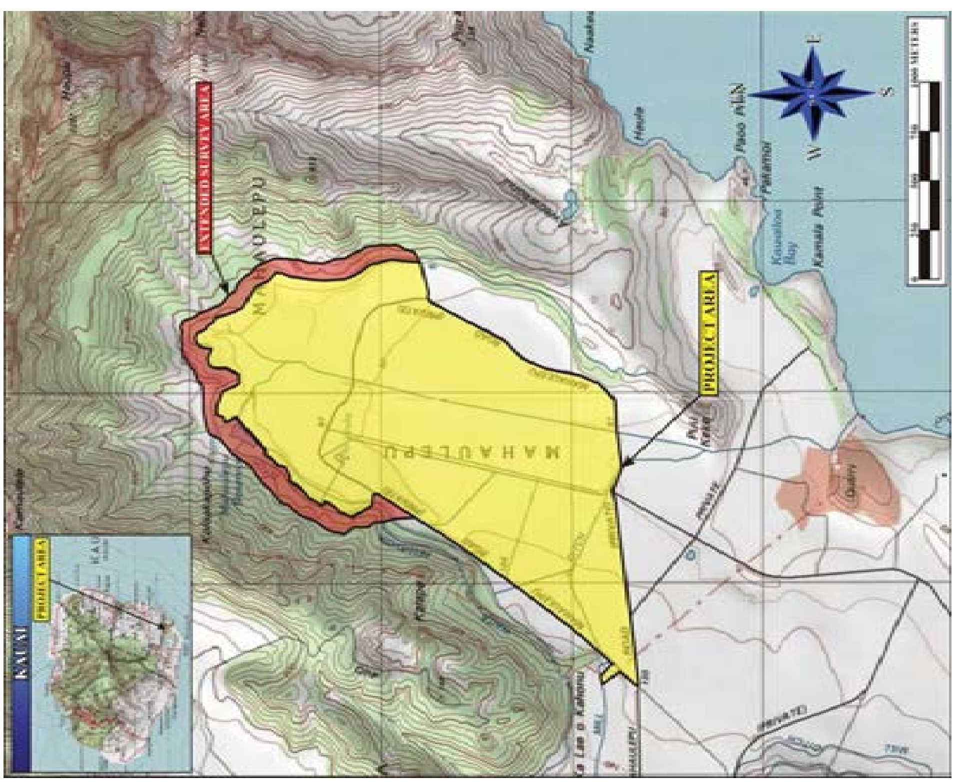

Figure 1. USGS Koloa Quadrangle Map Showing Project Area.

PROJECT AREA LOCATION AND ENVIRONMENT

The project area is situated entirely within Māhā‘ulepū Valley, on the southeastern side of the island of Kaua‘i (see Figures 1 and 2). The project area does not extend up any of the adjacent slopes or ridgelines on the east, north, or west, and does not extend south beyond Māhā‘ulepū Road. Māhā‘ulepū Valley is separated by a ridge from Aweoweonui Valley, within Kipu Kai Ahupua‘a, to the east. The ridge is of interest because the northern end is composed of basalt, the middle is limestone, and the southern end is composed of the Haula Sand Dunes. The *ahupua‘a* boundary with Kipu Kai crosses this ridge, and the beach front boundary of Māhā‘ulepū Ahupua‘a extends from Kawelikoa Point in the north to Makahuena Point in the south.

A second ridge separates Māhā‘ulepū Valley from Paa Valley, an *ahupua‘a* on the west (Figure 3). The north end of Māhā‘ulepū Valley is formed by Ha‘upu Ridge and dominated by Mount Ha‘upu (Figure 4 and Figure 5). There are named peaks on all three ridges. South of the project area lies Kapunakea Pond, a relictual water feature. Māhā‘ulepū is literally translated as “and falling together” (Pukui *et al.* 1974:138), a likely allusion to the ridges bordering the expansive valley.

The project area occurs at an elevation of c. 80 feet amsl to 200 feet amsl and is partially bounded by Māhā‘ulepū Road. The road enters the valley along the base of a slope on the western side, extends north, then runs to the east, several hundred meters from the north end of the valley. Traversing the valley, the road then turns south along the eastern ridge slope base, continues the length of the ridge, then turns west, eventually rejoining the entrance. The eastern and western sections of the road form part of the project area boundaries.

Two parallel dirt roads extend north to south along the center of the valley floor. Both roads have an irrigation ditch parallel to their lengths. Māhā‘ulepū Ditch is present on the eastern flank and consists of a modified stream course, the source of which are a series of braided streams at the north end of the valley. These streams enter the valley on the eastern and western sides of the ditch and are referred to as “east stream” and “west stream” in documentation and field notes. The western ditch was constructed in the 20th century and its origins are the Māhā‘ulepū Reservoir, at the northwest end of the valley. The reservoir is filled by a series of wells in the immediate vicinity. The ditch does not appear to have originally been a natural stream course that was modified during the Plantation era. This course is referred to here as the Main Ditch. The primary road up the valley is alongside the Main Ditch. This ditch feeds the active taro farm at the southern end of the valley. The taro farm borders, but is not within the

project area. Smaller ditches run both parallel and perpendicular to the two larger ditches. The Main Ditch and Māhā‘ulepū Ditch join south of the project area to form what is then referred to as Waiopili Stream. Waiopili Stream eventually joins a natural spring and the remnants of Kapunakea Pond, then runs by Waiopili Heiau, one of the most significant cultural sites on Kaua‘i, and on to the ocean. Land Commission Awards (LCA) along Māhā‘ulepū Ditch in the center of the valley are noted as being in Kawailoa Ili, but it is unclear if this stream also went by the same name (see below).

The climate of the project area is not extreme, with rainfall accumulating at an average rate of 53 inches *per annum*, with average temperatures ranging from 72-86 degrees in the Summer and 64-80 degrees in the winter (NPS 2008:7).

SOILS, LANDFORM, AND VEGETATION

The Ha‘upu Mountains that flank the project area are composed of the most ancient volcanic series in the high islands, the Waimea Canyon Basalts (NPS 2008:11). These formed during the shield-building stage of the Kaua‘i volcano, as eruptions gradually built up its sides and widened its base. Most of the Ha‘upu range is part of the ancient Napali member of the Waimea series, dating from 4.35 to 5.1 million years ago. The caldera of Mt. Ha‘upu is a separate Ha‘upu member and remains undated. (Blay and Siemens 2004).

Māhā‘ulepū lands below Ha‘upu ridge are part of the Koloa series that cloaks most of the eastern half of Kaua‘i. The series formed as the Kaua‘i volcano ceased major eruption and began to erode, with occasional small eruptions at lava domes, cinder cones, and spatter cones. These produced a layer of lava that, though not large in mass, nevertheless covered a large area. Koloa volcanics within the study area at Māhā‘ulepū include both underlying lava and visible vents, ranging from 0.5 to 2.0 million years in age (Blay and Siemens 2004).

Figure 4. Project Area Overview. View to Northwest.

Figure 3. Project Area Overview. View to Southwest.

Figure 5. Project Area Overview. View to North, Center of Māhāʻulepū Valley.

Portions of the valley's slopes have been identified as rRK, Rockland (Foote *et al*. 1972: Sheet 32). This is composed of areas where exposed rock covers 25 to 90 percent of the surface. Rock outcrops and very shallow soils are the main characteristics. The rock outcrops are mainly basalt and andesite. This land type topography is characterized as nearly level to very steep. Elevations range from near sea level to more than 6,000 feet, with annual rainfall amounts between 15 to 60 inches. The vegetation at lower elevations consists mainly of *kiawe*, *klu*, *piligrass*, Japanese tea *and koa haole*.

Soils on the slopes of the valley are also identified as associated with the KEHF series or Kalapa very rocky silty clay (Foote *et al*. 1972: Sheet 32). This is a well-drained soil that occurs at the base of slopes and is associated with moderately sloping to very steep topography. Elevations range from 200 to 1,200 feet above sea level, with annual rainfall amounts between 60 to 100 inches. Associated vegetation consists of guava, *lantana*, sensitive plant, *pilipiliula*, *ohia*, Japanese tea, and ferns.

Soils within the valley have been classified as LPE or Lualualei Series, composed of extremely stoney clay (Foote *et al*. 1972: Sheet 32). This series consists of well-drained soils on the coastal plains, alluvial fans, and on talus slopes. They are nearly level and gently sloping. Elevations range from 10 to 125 feet above sea level, with annual rainfall amounts to 50 inches per year. There is a prolonged dry spell during the summer. These soils are associated with sugarcane, truck crops, pasture, wildlife habitat, urban development, and military installations on Kauaʻi. Associated vegetation consists of *kiawe*, *koa haole*, bristly foxtail, *uhaloa*, and fingergrass. This soil type, extremely stony clay, was identified in several trenches during the current project, with most stratigraphic trenches excavated on the valley floor being composed of a shallow O-horizon overlaying brown/yellow clays (see below). In other words, there are exceptions to the general soil survey.

Soil Mapping

Twelve different soils within Māhāʻulepū Valley are identified on a USGS/USDA Soil Map kindly provided to the field crew (NRCS 2006, Hawaii Dairy Farms LLC; Figure 6). During pedestrian survey of areas with sparse or no ground vegetation, the transition of soils was visibly recognizable. The soils map has also been divided into Hawaii Dairy Farm interior designations (P=paddocks) and details the various soil regimes across the valley floor, these soil differences most likely a product of water, whether through transport, ground water, or run-off deposition.

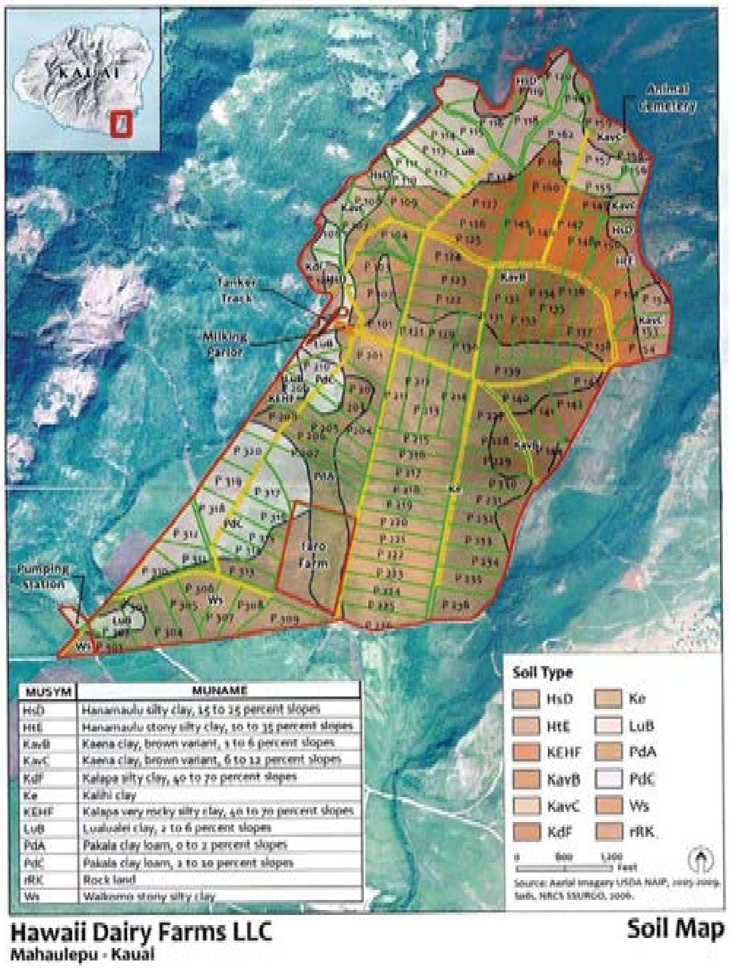

Figure 6. Soil and Paddock Map of Māhā‘ulepū Valley (USDA; Soils NRCS 2006).

The project area has been utilized for commercial sugar cane cultivation and/or livestock pasturage since the middle of the 19th century and thus, is fairly clear of any vegetation. Currently, most of the property lies fallow with the soils exposed. Some of the areas are covered with grasses up to 0.3 m tall, and smaller areas at the northeast and northwest ends of the valley are 100% covered by grasses up to 2.0 m tall. Within the project area are very few scattered *koa haole* and java plum trees, these occurring outside the main valley footprint which has been extensively cleared for well over a hundred years. The slopes of the valley outside the project area are forested.

TRADITIONAL AND HISTORIC SETTING

Early settlement and agricultural development is thought to have been first established on the windward sides of the Hawaiian Islands sometime in the A.D. 900-1000 range on Kaua‘i during what is known as the Colonization Period (Kirch 2011:22). Most likely arriving from east Polynesia, these early inhabitants brought with them a variety of tools, fishing gear, and household goods. Dogs, pigs and chickens were brought by these Polynesian voyagers for food. The Polynesian rat also arrived with the voyagers, but whether these were intentionally transported as a food source is under consideration. Considering that every food crop cultivated by the Hawaiians arrived with them shows a considerable knowledge not only of the planting and harvesting of these crops but the ability to transport their seeds, cuttings, and roots.

Prior to European Contact (1778), Hawaiians cultivated taro in both irrigated and dry fields. Other dryland agriculture crops included ‘*uala* (sweet potato), *uhi* (yams), *maia* (bananas), *ipu* (gourds), and *ko* (sugar cane). Grasses were utilized for thatching the roofs of structures and covering floors, which were then covered by *hala* mats. Important arboreal crops included *niu* (coconut) and *ulu* (breadfruit). Other trees were utilized for the construction of canoes, house frames, tools, and weapons, matting, and sails from *hala* (pandanus). K*apa* cloth from *wauke* (paper mulberry) was also tended. There were a variety of medicinal plants utilized and plants such as *olona*, grown to provide fibers for making cordage (Handy and Handy 1972).

Hawaiian aquaculture was extensive, with the construction and maintenance of coastal and riverine fish ponds. Their fishing ranged from shoreline to pelagic with different strategies for each. In order to maintain and benefit from all of these resource zones, Hawaiian polities were organized into *ahupua*‘*a* which gave residents access to a wide array of resources extending from mountain top forests to deep sea fishing zones. *Ahupua*‘*a* boundaries could expand, contract, appear, and disappear, as dependent upon political events. Given the size of Māhā‘ulepū Valley and environs, this *ahupua*‘*a* was highly valued.

PRE-CONTACT ERA

Initial Polynesian settlement of Kauaʻi occurred in the resource-rich regions surrounding Wailua River, on the east coast, the equally verdant Waimea River region on the southern coast, and the Hanalei region on the north coast (Joesting 1984). As with all the Hawaiian islands, each district and region was eventually settled. These settlements developed into polities which allied, warred, and co-existed with one another until Kauaʻi came under unified rule of a single king. This process occurred in different stages on different islands. Because of the relative distance of Kauaʻi from O‘ahu, Molokai, Maui, Lanaʻi, and Hawaiʻi Island, the politics of Kauaʻi and her neighbor Niʻihau became their own entity, while the other islands struggled first for internal control and later, for the conquest and rule of several, and ultimately all, the islands.

The primary residence of the high king was in the Wailua River region of Kauaʻi, with miles of cultivated lands, mountain resources, religious sites, and shoreline to pelagic fishing. Broad stretches of beach allowed for canoe landings but there was no deep water anchorage, despite the presence of the Wailua River.

As discussed more below, pre-Contact sites have been most commonly identified in coastal or near coastal areas, locations removed from intensive sugar cane production. Initial settlement is presumed near the coastline in the A.D. 1000-1200 range, with expansion inland during the A.D. 1400-1600s, as was typical across the islands (see Kirch 1985). Agricultural field systems were created at these inland areas, closer to fresh water resources and soil more amenable to *kalo* and sweet potato production. Permanent habitation locales were present from the coast to this more inland area, with ceremonial sites, walls, and other associated structures being built. Within the mountainous areas, such as at the back of Māhāʻulepū Valley, temporary habitation loci such as rockshelters/caves or small enclosures (C-shapes) would have been utilized by those gathering upland resources. The middle zone, such as Māhāʻulepū, was ideal for agriculture and homesteads, as witnessed by the numerous LCA's occurring in a small section of the valley later. However, historic land use obliterated much of the archaeological signatures for these settlements.

In early 1778 Captain James Cook and the two ships under his command, H.M.S. *Resolution* and H.M.S. *Discovery* arrived off of Kauaʻi. Finding that they could not make land fall at Wailua, Cook continued westward until reaching Waimea. This would be the beginning of contact between Europeans and Hawaiians (Salmon 2003).

EUROPEAN CONTACT AND THE KAMEHAMEHA DYNASTY

The third voyage commanded by Captain Cook was undertaken primarily to discover the fabled Northwest Passage, which supposedly linked the Pacific, Arctic, and Atlantic Oceans. As

he had during previous journeys, Cook visited Tahiti and it was from there that he set out for the northern Pacific coast of North America.

The voyage put him within sight of the island of O‘ahu, but adverse winds prevented his arrival. Continuing on to Kauaʻi, he sighted Wailua, but could not make landfall. The ships continued southwest and then westward, past Mt. Haʻupu and Māhāʻulepū Valley. Both were sketched and drawn by expedition artist John Webber, the first European artwork to depict a Hawaiian Island.

Cook found a manageable anchorage at the mouth of Waimea River. Several trips ashore by him and a select group of his officers, marines, and crew led to generally good relations with the Hawaiians. It is unclear what Cook and the others learned about the politics of Kauaʻi and her eastern neighbor. It is probable that at this time (1778) Kaeokulani was ruler of Kauaʻi. He was of high rank, a chief born on Maui, and the half-brother of the paramount king of Maui, Kahekilii.

After a short time on Kauaʻi in the early months of 1778, Cook departed to continue the search for the Northwest Passage. A year passed after which Cook returned to the Hawaiian Islands. This time, Maui was sited and briefly visited, but the island of Hawaiʻi became the focus of the remainder of the voyage of Cook and ultimately of his demise, at Kealakekua Bay (Salmond 2003).

After the death of Cook, the journey continued, now under the command of Captain Clerke. The ship passed O‘ahu, and returned to Waimea, Kauaʻi. After their departure a short time later, it would not be until 1786 that Europeans returned to the Hawaiian Islands, with Waimea (Kauaʻi) receiving her share of British and American vessels focusing on the lucrative fur trade in the Pacific Northwest. These visits coincided with, and perhaps accelerated, the growing conflict for control of the eastern islands. Beginning in approximately 1790, battles on and around Maui, Molokai, and Hawaiʻi Island between several rulers occurred with increasing ferocity. Safely in control of Kauaʻi, Kaeokulani became a participant, bringing fleets of warriors to assist his half-brother on Maui. Many European and American ship captains had contact with all the rivals, and a fairly coherent chronology of events is known. What certainly is known is that Kaeokulani was killed during a battle in Honolulu in 1794 while fighting his nephew Kalanikupule, who had taken rule of Maui and O‘ahu upon the death of his father Kahekili in Waikiki, several years earlier in 1791 (Ridley 2010).

The son of Kaeokulani was Kaumualiʻi. Born around 1780, the young king went through a period where a Regent (an older relative) made the decisions, but Kaumualiʻi eventually came to rule on his own. The remainder of his days was spent trying to keep Kamehameha, who had consolidated the rule of the other islands, from bringing Kauaʻi in as well.

Kamehameha had difficulty solidifying his rule. Rebellions, plague, and appeasing subordinates all kept him from mounting more than two serious efforts at physical conquest of Kauaʻi. The first effort to fail occurred in 1796 when Kamehameha sailed with an invasion fleet for Kauaʻi. Hit by a heavy storm, the fleet turned back to Oʻahu (Kamakau 1961). The second effort failed in 1804 when Kamehameha mustered his forces on Oʻahu. The army fell victim to *Okuʻu*, a smallpox epidemic. Kamehameha himself almost died, and far too many of his troops, counselors, and their families did succumb (Kamakau 1961). In 1810 Kamehameha used diplomacy, suggesting that he rule the eastern islands in name and deed, while Kaumualiʻi acknowledge his suzerainty but continue to rule Kauaʻi and Niʻihau. It was agreed that the arrangement would end with the death of Kaumualiʻi and that rule would then pass to the heirs of Kamehameha. It was an arrangement that Kamehameha and Kaumualiʻi would honor, but that the heirs of Kamehameha would not (Joesting 1984).

This arrangement lasted between 1810 and 1822. It endured the death of Kamehameha the Great in 1819. During these 12 years, Kaumualiʻi solidified rule of his kingdom and engaged in efforts to gain foreign weapons and support from the Russian Fur Company (Mills 2002). Also during this time, the trade in sandalwood flourished. Harvested in the Hawaiian Islands, traded for goods to European and American captains, and sold in the Chinese trade ports of Macao and Canton, sandalwood became the first Hawaiian cash crop (Ridley 2010). The Hawaiians called it *laau ala* (sweet wood) or *iliahi* (fiery surface) for its reddish blooms. They used this wood for scenting bark cloth, making dyes, and for medicinal purposes (Ridley 2010).

At first, the sandalwood revenue went solely to the paramount chiefs, Kamehameha and Kaumualiʻi. However, with the death of Kamehameha, nearly all of his chiefs called upon the young heir, Liholiho, and the Regents, among whom was Kaʻahumanu, the favorite wife of Kamehameha but not mother of his heirs, to allow the chiefs to harvest sandalwood for their own profit. This practice would affect and disrupt the rule of Hawaiʻi and the welfare of the common people for decades.

The upland forests were scoured, crops were neglected, commoners suffered malnutrition and disease, chiefs went into debt to foreigners, and Liholiho was hard pressed to find new resources for his chiefs to exploit. Kauaʻi appeared to be the answer. While continuing to honor the arrangement made by his father, Liholiho arrived on Kauaʻi in 1822, visited with Kaumualiʻi, and then kidnapped him, returning to Oʻahu with his captive. In order to secure the rule of Kauaʻi, Kaumualiʻi was forced to marry not an heir of Kamehameha, but his wife, Kaʻahumanu.

To ensure her hold, she also wed her new husband's son, Kealiʻiahonui. This second marriage was later dissolved. However, ties between dynasties stayed strong as Kealiihonui married a granddaughter of Kamehameha, named Kekauōnohi (Mills 2002).

Kaʻahumanu had been instrumental in the overthrow of the *kapu* system of Hawaiian governance and social behavior, as well as one of the earliest and most prominent proponents of conversion to Christianity. That she utilized polyandry to achieve control of Kauaʻi is just one example of her abilities to utilize both traditional and introduced ways of life to achieve her goals (Joesting 1984).

While still titular ruler, the king did not exercise any power. Governors were appointed by the Regents, the first of these being the brother of Kaʻahumanu, named Kahekili Keʻeaumoku. Beginning with this Governor, land acquisitions beneficial not just to the Kamehameha line but to their powerful subordinates started.

The practice of allowing individual chiefs to harvest sandalwood was carried over to Kauaʻi. How many Kauaʻi chiefs retained their lands is not certain. What was certain is that the mountains of Kauaʻi, including Haʻupu, yielded the valuable resource. And practically the only place that it could be shipped was from the only secure anchorage at Waimea River. Waimea also served as a provisioning port of call to the growing number of whaling ships that began to appear in the Pacific.

The independent rule of Kauaʻi came to an end in 1824 with the death of Kaumualiʻi. This same year, the heir of Kamehameha, Liholiho Kamehameha II also died. The kingdom of Hawaiʻi would now be ruled by a queen.

THE REGENCY OF KAʻAHUMANU

Kaʻahumanu was one of Kamehameha's primary wives, his favorite in fact, but not of sufficient rank to be mother of his heirs. It appears she never bore the king, or anyone else, any children. From her actions following his death in 1819, it is apparent that Kaʻahumanu considered herself Kamehemeha's heir. The mother of the heirs, Keopuolani, died in 1823. Her first son was Liholiho, born in 1796, made king in 1819, and died visiting London in 1824. Her second son was Kauikeaouli Kamehameha III, born in 1813. Her daughter, Nahienaena was born in 1815 (Day 1984). With the death of Liholiho and his mother, Kaʻahumanu became Regent of the kingdom until Kauikeaouli would come of age. Her rule of Hawaiʻi in general, and Kauaʻi specifically, was adroit, intelligent, and shrewd.

George Kaumualiʻi and a number of Kauaʻi chiefs forcefully resisted the rule of the Kamehameha line, and their revolt was crushed. As with many Byzantine events in Hawaiian history, some Kaua‘i chiefs stood with the old, while others stood with the new. In this case, as with any other, people chose what they thought would benefit them most. Those who rebelled had their lands and lives taken, while those who did not, benefitted.

The first long term governor during the regency was Kaikioewa, a high chief born at Waimea, Kaua‘i. He was a first cousin and brother in law of Kamehameha, a guardian of Kamehameha III, and a principal leader in crushing the 1824 rebellion (Mills 2002). He reigned as governor from 1825 until his death in 1839. During his tenure, we know of at least one *konohiki*, or land manager, for Māhā‘ulepū. Documents show that in 1826, Hukiku was *konohiki*. He was in attendance that year during a visit by the governor. Kaikioewa was accompanied by missionary Samuel Whitney of Waimea, who left an account of this event. It is unknown if Hukiku was Kaua‘i born, or one of the conquerors invested with this stewardship. He may be the chief Kukiku, who Kaikioewa named commander of Paulaula o Hipo, also known as "The Russian Fort" (Mills 2002).

During his term as governor, Kaikioewa claimed Ha‘upu Ridge, to the east/northeast of Māhā‘ulepū, as his personal sandalwood reserve. One of the duties Hukiko performed may have been overseeing the efforts to harvest sandalwood from the ridge and transport it to foreign ships at Waimea or Koloa. Eventually the governor would, as did so many other *ali‘i*, go into debt to foreign captains and merchants. When the sandalwood ran out, it is not clear how Kaikioewa paid his bills (Joesting 1984).

Ka‘ahumanu ruled as Regent until her death in 1831. A daughter of Kamehameha, Kīna‘u, took over as regent until 1834 at which time Kauikeaouli Kamehameha III took the throne. He had lived on Kaua‘i as a boy under the protection of Kaikioewa but had spent the majority of his youth on O‘ahu. Ruling until his own early death in 1854, his reign was admirable for its civil rights, efficiency, and the creation of the Great Mahele, by which land awards to commoners and granting ownership to the disenfranchised was achieved. In Māhā‘ulepū, there were many Land Commission Awards (LCA; see below), but the majority of the acreage was retained by the government and/or the crown. During his reign, there was an increase in the number of immigrants from Europe, the United States, and China. Missionaries, merchants, laborers, and farmers of multiple nationalities added to the diversity and complexity of the Kingdom.

LAND COMMISSION AWARDS

On Kaua‘i, and in Māhā‘ulepū Valley specifically, a number of land claims were made by residents who had been allowed use of the land during the reign of the previous king. In the valley, LCA 5080 to Kiko, LCA 4767 to Napaliala, and LCA 4769 to Nahuma, for example,

were all claimants who had tenure from Kaumuali‘i. It is presumed that their neighbors had similar histories (Ching 1974). That these residents all received their awards is notable because their claims were based on the right of use granted by the former ruler, and not by permission of the Kamehameha Dynasty. Figure 7, an 1854 map of the valley, depicts a "house" and "cattle pen" in the northern part of the valley and the LCA's just below, in what today is the mid-section of the valley cum project area. An 1897 survey map by Monsarrat (Figure 8) shows a close-up of the LCAs.

The Mahele was yet another drastic change in the lives of Hawaiians. Commoners, also known as *maka‘ainana*, had for centuries been allowed use, but denied ownership, of the lands they worked. This changed in the late 1840s when private ownership of lands was made into law. Certainly *ali‘i*, or nobles, had the better of the deal, but commoners were allowed to claim, through right of labor and longevity of occupancy, Land Commission Awards (LCA). King Kauikeaouli Kamehameha III was a sovereign brought up in the old ways who saw that some things must change, and orchestrated this new policy. A legal process was established, in which land claimants testified, and had others support their testimony, before a Commission appointed by the king. Traditional land use was communal and land use was often dendritic, following the course of streams and occupation zones from the coast to the mountains. Claimants were often related and the lands they claimed were as varied in their usage as there were in their location. For a traditional *ahupua‘a* to work, those *mauka* had to work with those *makai* and with the private ownership offered through the Mahele, the risks became greater. A commoner who did not own the land could not go into debt. One who did could achieve profit or debt.

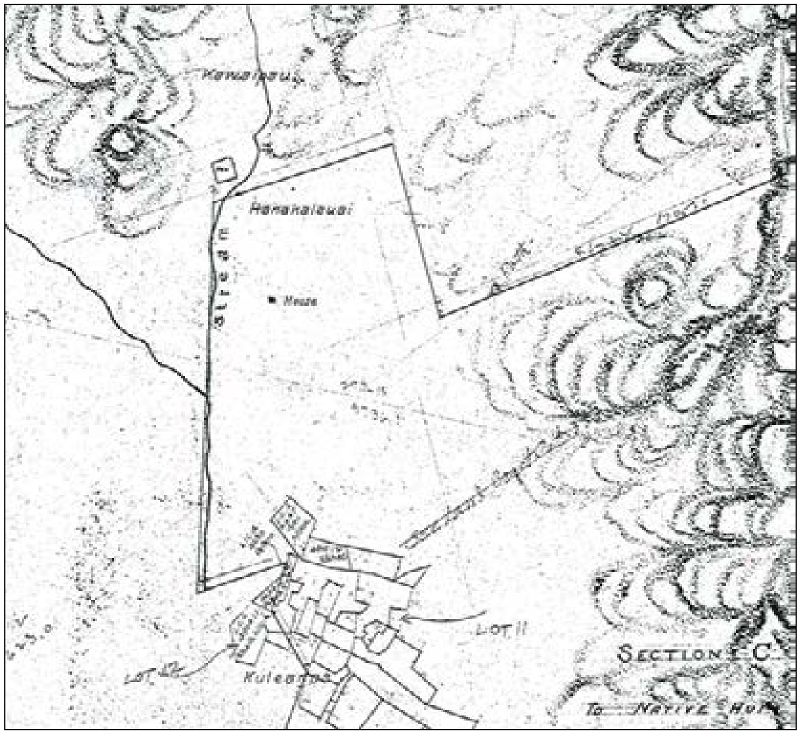

Figure 7. 1854 Topographic Map of Māhā‘ulepū Valley Showing Location of “House”, “Cattle Pen”, and LCAs in Mid-Valley.

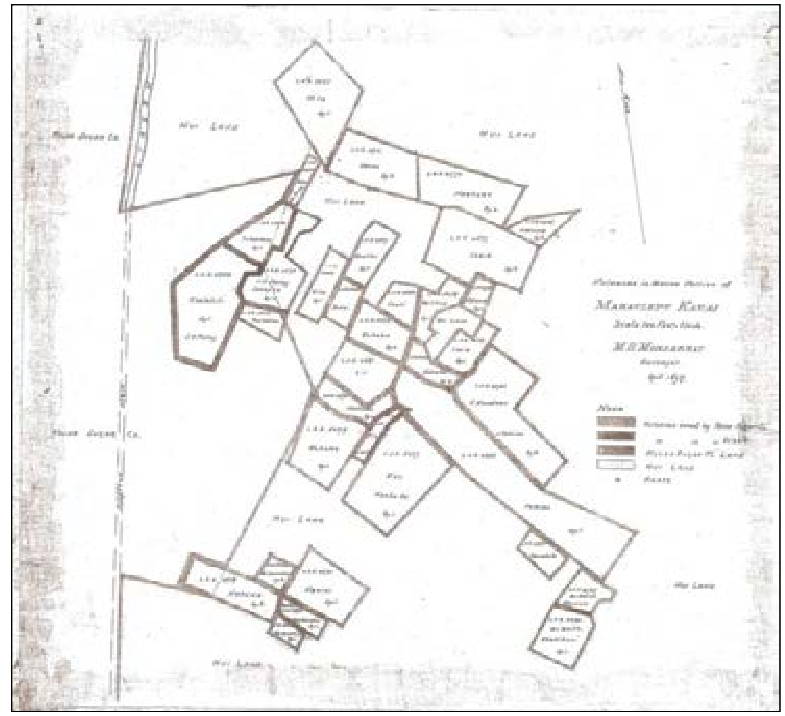

Figure 8. 1897 Monsarrat Map of LCAs in Māhā‘ulepū Valley.

Land claim testimonials are complex documents. Boundaries are defined in a variety of ways. Land divisions descend in size from *ahupua‘a* to *kuleana* to *‘ili*, thence *apana,* and finally *mala,* which are individual garden plots, fields and/or *lo‘ i* (Pukui 1957). Other boundaries are defined by names of neighboring occupants or by use of the land. Testimonies were given regarding which chief had granted the occupant use of the land. This is compelling, because occupants claimed title based on grants from Kaumuali‘i, last independent king of Kaua‘i, to Kaikioewa, governor from 1824 to 1839 for the Kamehameha Dynasty, to his *konohiki* for Māhā‘ulepū, Hukiki. They invoked the names of Ka‘ahumanu, the Regent for nearly a decade, to Kīna‘u, regent and half-sister to King Kauikeaouli Kamehameha III until he took the throne. Some claims were contested, others were not, and some were won on appeal. When one studies the LCAs of Māhā‘ulepū, it can be seen that claims of land, in a variety of places, for a variety of uses, were made by individuals throughout the *ahupua‘a*. With modern ownership, a traditional lifestyle could be maintained, but once individual plots began to be sold, and relationships were sundered, life for the commoners and nobles alike began to change drastically.

Many of LCAs for Māhā‘ulepū are tightly clustered within the ‘Ili of Kawailoa, which is within the current project area (Figure 9). There is a cluster east of Māhā‘ulepū Ditch near the center of the valley. The remainder of the valley was deemed crown land. Below are some of the claimants of these parcels. It is interesting to note the estimated population of this portion of Māhā‘ulepū Valley at this time. In 1848, 46 male names appear in genealogical records (M. Ching, LDS Records). If one were to reasonably add one wife and at least one child per household, the population would have been 138 persons. In 1855, a total of 36 male names occur in the Māhā‘ulepū records. Using the same figures, the total would have been 108 persons. This represents a fairly sizeable population for this upper valley at that time, all likely associated with the LCAs.

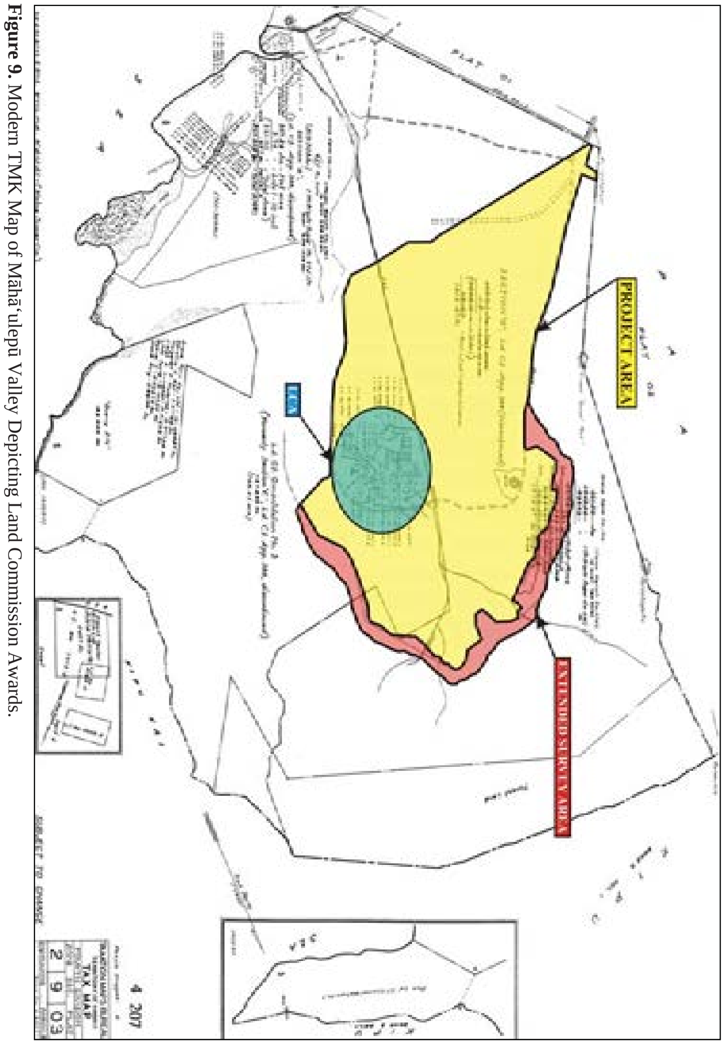

Figure 9. Modern TMK Map of Māhā‘ulepū Valley Depicting Land Commission Awards.

The following are names and LCAs that are on the LCA map within the project area and are mentioned in previous literature (Ching 1974). Claimants used owners of adjacent lands as boundary references and/or supporters of their claims. Many claimants were related in some way. The LCAs within the project area often had claims downstream of Māhā‘ulepū Ditch on the coast.

LCA 4767 Napaliala received his lands in the days of Kaumuali‘i who died in 1824. This was waste land when Napaliala took it over, occupied it, and developed it. He died in the late 1840s and his wife then possessed the land.

LCA 4769 was another native who occupied lands previous to 1824. One piece was wasteland when he took it over, built on it, and fenced it with stone. In addition he received on the death of relatives other lands occupied previous to 1824: 2 *lo‘i* in the ‘Ili of Kauki‘i, which had belonged to his wife through her parents; 7 dry taro patches in Kioea received through his father-in-law, *kula* land at Waipa which his brother had taken possession of, planted orange trees and cultivated; and two salt ponds. Nahuma appears to have been an affluent native.

LCA 4910 Kahee claimed property in the ‘ili of Kapakalehu; this property in the late 1840s had one orange tree. The *konohiki* contested the title of the claiming that Governess Kekaonohi had given it, and two more to him and that he had cared for them, harvesting the fruit. Kahee never collected the oranges but contended that the governess had no right to give the trees to the konohiki as they had belonged to Kahee's parents, who had planted them and he was the rightful heir. That was the foundation of his claim.

LCA 5080 Kiko took over waste land, built his own fences and dug his own salt pond in the ‘Ili of Kawailoa. The date of occupancy is not given but it probably was later than Kaumuali‘i, for Kiko's *lo‘i* came from Kīna‘u 's time. Kīna‘u was a daughter of Kamehameha, mother of the kings Kamehameha IV and V, and was regent between the death of Ka‘ahumanu and the ascendancy of Kamehameha III, her half-brother. The reference to waste lands is intriguing. Some (Ching 1974) have taken this to mean that a declining population is clearing previously untouched lands for cultivation. Others (Putzi 2014) feel that waste lands are areas that were previously cultivated but, left unattended because of declining population and hence overgrown, are being brought back into production because of the incentive of individual ownership. It may be that ownership, as well as the threat of feral cattle and pigs, led to the construction of fences, either stone or wooden posts, to delineate property boundaries.

Other claimants shown on the LCA map were identified in the Mahele Database, but not in Ching's (1974) report.

LCA 4770 Naahuao. The land came to Naahuao through his father, who was granted the land by Hukiku, the *konohiki* of Māhā‘ulepū during the reign of Governor Kaikioewa.

He gives his testimony as follows:

> Greetings to the Land Commissioners: Be it known to you, the ones who quiet land titles, that I, Naahuao, a man living at Mahaulepu, island of Kauai have a claim for land, and the kula. The genuine land is 56 fathoms long by 26 fathoms wide. The mala of noni is 26 fathoms long by 13 fathoms wide. The salt land is 6 fathoms long by 4 fathoms wide. Another salt land is 10 fathoms long by 7 fathoms wide. A house lot is 28 fathoms on the long sides and 25 fathoms on the wide side. My message is ended. A respectful farewell to you, Naahuao (Mahele Database).

LCA 6667 Mika received lands from Ahukai. LCA 4543: on the LCA map but no further information has been gained. Mika received lands from Kaikioewa in the days of Kinau. His testimony reads:

> The Land Commissioners, greetings: I, Mika, a Hawaiian subject living in Mahaulepu, hereby state my claim for 4 lo‘i, 5 sweet potato enclosures, 4 mala of noni, and 3 orange trees. However, these claims are not situated together, but are in various cultivated places of Mahaulepu, also 1 mala of uhi/yam/ a kula planting of wauke and one other lo‘i. 1 loko/ either fish pond or taro pond/ and 13 lo‘i are bounded 80 fathoms on the east, 80 fathoms on the south, 20 fathoms on the west and 10 fathoms on the north. That is my claim which was received from Ahukai. There is also a kula named Hoopouliloa. Respectfully, Mika

The testimony of Mika says much about how Hawaiians utilized the landscape. Parcels were utilized for the cultivation of several food crops, for raising fish, and the growth of *wauke* for the production of *kapa* cloth. Except for the orange trees, this is a classic example of Traditional Hawaiian life. The mention of sweet potato enclosures is interesting because *‘uala* were raised in long rows of intermittent mounds. It may be that these fields were fenced in to protect them from pigs or cattle, or that land ownership required definitive boundaries.

It is worthy to note that all the LCAs in the Māhā‘ulepū project area are confined to a central area, on the east side of Māhā‘ulepū Stream (see Figure 9), with the remainder of the valley claimed as Crown Lands. These LCAs, noted above, form a tight cluster. Of additional interest, during the height of the sandalwood trade the adjacent Ha‘upu Ridge was claimed by Kaikioewa. It would appear that after his death in 1839, these mountain claims would revert to government control.

The Governor of Kaua‘i in 1842 was Kekauonohi, the granddaughter of Kamehameha who had wed Keliiahonui after having been a wife to her uncle Liholiho Kamehameha II. During her governorship she partook in land exchanges, consolidating her grants in Māhā‘ulepū and Koloa. These consolidated lands would become the basis for the next cash crop, one that could be rejuvenated and continued, unlike sandalwood. From the 1830s until the 1980s, sugar would be the economic focus of Māhā‘ulepū. Remnants of industrial-level sugar cane cultivation in the area represent the greatest number of historic properties documented during the current AIS study.

SUGAR AND THE HISTORIC ERA OF MĀHĀ‘ULEPŪ

Sugar cane began to be grown and milled commercially in Māhā‘ulepū Valley and around Koloa in the 1820s, one of the first places in Hawai‘i where sugar was commercially grown (Donohugh 2001). The earliest efforts were undertaken by Chinese immigrants who had a small mill in Māhā‘ulepū, as well as in Koloa and other parts of the island. The mills were small, producing raw sugar and molasses for local consumption. By 1835, however, many of these farmers were out of business and were later employed by new plantation owners. In 1835 the Koloa Plantation, owned by Ladd and Company, was up and running, the first attempt at producing industrial-level sugar cane. The land was leased for a fifty year period from Kaua‘i Governor Kaikioewa and King Kamehameha III. Importantly, the lease was the first of its kind in Hawai‘i and represented the first formal recognition that someone other than a chief could control land use (PBR 2011). Koloa Plantation, established in 1841, is universally known to be the first formal sugar cane plantation in the islands. Ladd and Company was the first owner of the Plantation but financial difficulties caused them to sell in 1845. Robert Wood and his brother-in-law kept the plantation going however.

The sugar industry grew sporadically between 1845 and 1875. At this latter date, the Hawaiian Government scored a coup of its own when a reciprocity treaty with the United States was negotiated. This allowed all unrefined Hawaiian sugar to be admitted into the United States duty free. The cultivation of sugar was going to become profitable (Alexander 1985:74).

Koloa Plantation commenced growing sugar cane in Māhā‘ulepū Valley in 1878, a practice that continued for almost one hundred years. A total of 875 acres of the flat valley floor was made available. The land was level, sheltered, and with a good underground water supply. Work began on the infrastructure necessary. One initial problem was the ground water. Some of the valley was saturated and had to be drained off, the water diverted to irrigate drier fields (Alexander 1985). Sugar cane requires much water so in 1897, the Koloa Plantation excavated several wells to irrigate the cane in Māhā‘ulepū (see Donohugh 2001 and PBR 2011).

The various parcels around Koloa went through a succession of owners until 1864 when George N. Wilcox consolidated and purchased all of Māhā‘ulepū Valley and coastal lands, and founded Grove Farm Company. By 1897 the main source of irrigation water for the valley came from the ground water. At the northwest end of the valley six wells were drilled and the water was pumped approximately a quarter mile to the north into the recently constructed Māhā‘ulepū Reservoir (Figure 10). The area of the wells was known as “Maha‘ulepu 14”, probably because that was the number of wells eventually drilled and/or in service. The primary source of irrigation water for Māhā‘ulepū appears to have been six wells drilled in 1897. Four more were drilled later and all were located near the western side of the valley. These wells pumped water to Māhā‘ulepū Reservoir, where it was stored and released, when needed, to various parts of the valley via the irrigation ditch.

Irrigation ditches at both the north and south ends of the reservoir served to transport water to the crops and to receive water from existing streams descending from Ha‘upu Ridge (Alexander 1985:97-98). A pumping station and full-time resident staff with their families lived in a camp here. The larger north to south, excavated irrigation ditch that extends the length of the valley was excavated but does not appear on the 1935 Koloa Plantation map SEE MAP. Intensification of irrigation efforts which added to the waters provided by Maha‘ulepu Ditch began after this date.

The thick clay soils were difficult to till using plows pulled by teams of oxen. However, with the introduction of steam powered tractors, more land began to be put into production. Development began to escalate at the start of the 20th Century. The number of laborers increased from 430 in December, 1900 to 769 in July, 1901. In February, 1904 it was reported that 600 out of 730 men were “working on permanent improvements.” Infrastructure modifications in the valley intensified at the start of the 20th Century with the excavation of canals, reservoirs, and wells. A narrow gauge railway was also constructed in the valley. It extended from Koloa Mill to “Maha‘ulepu 14”, a series of wells on the valley floor at the northwestern end of the valley itself, within the project area. The railway tracks were movable but no evidence of them was found in the valley during the current AIS. Other portable narrow gauge rail systems were utilized to facilitate the harvest.

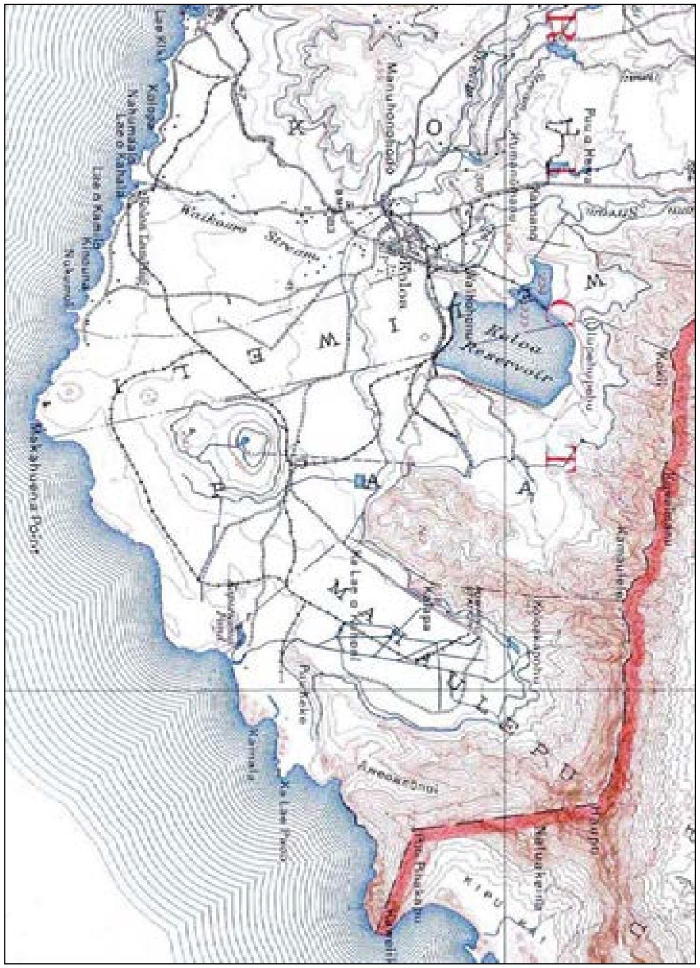

Figure 10. 1912 USGS Territory of Hawai'i Map Showing Infrastructure.

In 1904, $16,420.81 was spent on additions to the plantation railroad system, including "a three-mile addition to the Puuhi railroad and a short cut road to Maha'ulepu". Considering a laborer in the fields made about $17 per month, this was quite an expenditure (122).

While the Plantation owned all the land, they contracted parcels of fifty to one hundred acres to groups of approximately a dozen men. Koloa Plantation "…furnishes land, seed-cane, water, fertilizer, and tools, and performs such portions of the work as require expensive machinery, such as plowing, furrowing and hauling the cane to the mill" (97-98). These contractors took care of their parcels from planting to harvest, selling the cane to the plantation at a set price. This method kept the land under one owner, but provided the contractors incentive to raise a bountiful crop (123).

That the entire valley (project area) was under intensive sugar cane cultivation is evidenced by the infrastructure put into the valley through time. Early 20th century maps also document the extent of the fields throughout the Koloa area. Figure 11 depicts the extent of the sugar cane fields owned by Koloa Plantation in Māhā'ulepū Valley and environs in 1935. As evident, the entirety of the current project area, minus the 100 m extension, consists of sugar cane lands.

In 1948, Grove Farm Company purchased Koloa Plantation and continued to produce sugar cane until 1974, when it leased its Koloa lands and mill to McBryde Sugar Company (Donohugh 2001). Sugar production continued under McBryde until September, 1996 when the mill officially closed.

The Wilcox Family sold Grove Farms to S. Case in 2000. Until then, from early cultivation times to modern times, the lands extending from the valley to the sea would be extensively modified for the cultivation of sugar. Fields would be plowed, streambeds cleared, irrigation ditches excavated, reservoirs created, roads built, and wells drilled. The mill at Koloa went through modifications and expansion as more lands came under cultivation and machinery improved. The entirety of this effort was focused on the cultivation of sugar cane. Some lands

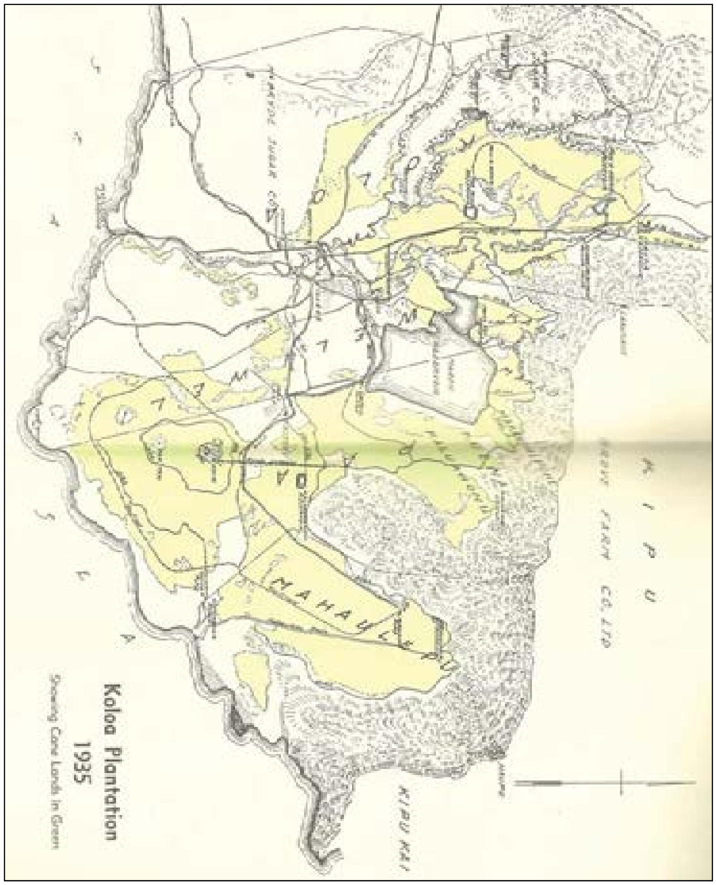

Figure 11. 1935 Map Showing Distribution of Koloa Plantation Lands.

were set apart as pasturage, but for the most part, land was used to feed sugar cane into the mill at Koloa. During the remainder of the Kingdom, then the Republic, through the Territorial Period, and into Statehood, sugar cultivation and Māhā‘ulepū would be synonymous. More recently, since sugar cane cultivation operations ceased, Māhā‘ulepū Valley has been the location of ranching (2002) and taro cultivation (2007), the latter being done through lease to W.T. Hara.

PREVIOUS ARCHAEOLOGY

There have been numerous archaeological studies along the coast of Māhā‘ulepū but archaeological studies within Māhā‘ulepū Valley and inland environs have been limited. Projects documented closer to the ocean include those conducted by Farley (1898), Thrum (1907) , Bennett (1931), Kikuchi (1963, 1980,1981, 1988-d), Ching et al. (1974), Neller (1981, Rosendahl (1988, 1989), Hammatt (1979, 1989a, b, 1990 a, b) Pietrusewsky (1990), Walker and Rosendahl (1991) and Firor and Rosendahl (1994).

The earliest study was by F.K. Farley in 1898. Petroglyphs were exposed beneath sand dunes at Keoneloa Beach. According to Farley, local residents knew of the petroglyphs and reported that they had been exposed previously.

In a 1906 study of *heiau* on Kaua‘i and O‘ahu, T.G. Thrum documented two *heiau* named Weliweli and Waiopili (Thrum 1907). The former was not accurately plotted on any map, while the latter is located along the stream of the same name. This stream descends from Māhā‘ulepū Valley, but is not named as such within the valley itself in any known documents. It may be that as the stream changed, exiting the valley and flowing through Kapunakea Pond on its way to the sea that the name was changed accordingly.

Within the valley Thrum identified a large *heiau* named Hanakalauea. It was reported to have been dismantled in the 1860s by a gentleman named Fredenberg, with the stones then used to build cattle pens (Thrum 1907). Thrum reports a fourth *heiau*, named Keolewa, on the crest of Mt. Ha‘upu (Bennett 1931 Site 90). It is not certain if Thrum or Bennett actually visited the site, but both did note it as having been a small *heiau* dedicated to a goddess named Laka (Thrum 1907; Bennett 1931).

The only previously documented archaeological site within Māhā‘ulepū Valley that was given an official state site number is Site -3094. This site is composed of a large boulder sitting isolated in a pasture at the northern end of the valley. Kikuchi (1963) notes it as occurring some 2 miles inland. Some twenty anthropomorphic figures, two pecked cups (4 inches deep), and a long groove are etched on the surface (Ching *et al*. 1974; McMahon 2007; see also Cox and

Stasack 1970). The groove may represent a stream, but interpretation is uncertain The site is discussed more below.

During an archaeological survey conducted in 1928-1929 Bennett (1931) located or re-located the *heiau* at Weliweli and Waiopili. The Keoneloa Beach petroglyphs were not exposed during this visit but he collected information about them from local residents. At this same Bennett recorded human burials within the sand dunes at Makahuene Point.

Archaeological investigations of coastal lands within the Koloa area were conducted by Kikuchi (1963). In addition to new sites, he re-located several sites described by Farley, Thrum, and Bennett. Site 96 (*Kane'aukai Heiau*), Site 97 (dune burials), Site 98 (Keoneloa Beach Petroglyph Field), Site 99 (Weliweli Heiau), Site 100 (Keoneloa Beach Walls), Site 101 (Makaweki Point petroglyphs) and Site 102 (a structure). Since this field work, there has been some confusion over site designations by both Kikuchi and subsequent work by Rosendahl. Site locations regarding these named sites has, in some cases, been changed. Indeed, some of the sites themselves, particularly Kane'aukai and Weliweli Heiau, may be the same structure. It could be that different names were recorded by different archaeologists (Kikuchi 1963, 1998a; Walker and Rosendahl 1990; Firor and Rosendahl 1994).

During surface survey of 1,100 acres along the coastal lands of Weliweli, Paa, and Māhā'ulepū *Ahupua'a*, Ching *et al.* (1974) wrote of Weliweli *Heiau* "no actual alignments or other features were noted at the reported location of this temple. This site has either been completely destroyed or is located elsewhere" (Ching *et. al*. 1974:81). During this project the archaeologists found and sketched the petroglyphs at Keoneloa (Site 84), found sand dune burials (Sites 3096, 3097 and 3024) and re-located Waiopili Heiau (Site 87). They also located Waiopii Pond and Kapunakea Spring, but these were not given site designations (Firor and Rosendahl 1994).

Kikuchi (1984) continued archaeological investigations along the coastline of Keoneloa Beach. Kikuchi documented numerous sites and features and at least one but possibly two cultural layers that extended along the length of Keoneloa Bay (Kikuchi 1998a). This was the beginning of an era of extensive archaeological excavations and monitored construction excavations in this area. Work by Neller (1981), Rosendahl (1988, 1989), Hammatt (1979, 1989a, b, 1990 a, b) Pietrusewsky (1990), Walker and Rosendahl (1991) and Firor and Rosendahl (1994) followed.

McMahon (1996) conducted an Archaeological Field Inspection of a c. 25,000 sq. ft. area on the southeast flank of Ha'upu ridge for potential installation of a radio tower. The project area

occurred at the 1,500 foot level. No sites were identified. Of interest was that no trails occurred along the ridgeline; the area was, as McMahon notes (1996), only accessible by helicopter.

Beginning in the 1990s, Burney and Kikuchi began excavating Maukawahi Cave and Sinkhole. "In a single stratigraphic sequence and encapsulated view of the full span of human occupation, including the millennia preceding human arrival, earliest human evidence, subsequent population increased and cultural change, European contact, and modern transformation" (Burney and Kikuchi 2006). Amongst the discoveries are bones of the Polynesian rat, which dated to 1039-1241 A.D. Because the rats were in the canoes with Polynesian voyagers, this is some of the earliest evidence for human occupation of this area. Excavations exposed intact cultural layers as well as culturally sterile deposits. Artifacts such as files, picks, scrapers, adzes, fish hooks, octopus lures, game stones, sling stones, and hammer stones were recovered. The preservative qualities of the deposits in the sinkhole are excellent. Fiber cordage, wooden fragments from canoes, paddles, and tool handles were also recovered. These materials came from three excavations. There is much potential for more information to be gained from this site (Burney and Kikuchi 2006).

Archaeological surveys and field work were conducted farther to the southwest along Waikomo Stream by Cultural Surveys, Hawaii, Inc. (Hammatt, *et. al*. 2004). The terrain this stream flows through is different from those which flow out of Māhā'ulepū Valley. Features originating during the pre-Contact era include agricultural terraces, habitation terraces and platforms, and irrigation a*uwai* along both crests and bases of long, low ridges. This complex of sites is designated the Koloa Field System.

The most recent comprehensive effort at documenting the biology, botany, geology, ecology, and archaeology of the region is that compiled by the National Park Service (NPS; 2008). "The Māhā'ulepū, Island of Kaua'i Reconnaissance Survey" published in 2008 consists of an effort by the NPS to re-identify multiple natural and cultural features in Māhā'ulepū Valley and environs. The goal was to argue for the importance of conducting a more thorough natural and cultural study of the area along the south east coast of Kaua'i from Koloa to Poipu, and northward along Māhā'ulepū, Kipu Kai, Niumalu, Nawilili Harbor and then to Lihue. Included in the study is Mt. Ha'upu and the ridgelines extending from it (NPS 2008). The study presents a summary of the natural and cultural features for the area and effectively argues for additional research.

SETTLEMENT PATTERN AND SITE EXPECTATIONS

Prior to European contact the rulers of the Hawaiian islands divided the landscape into political entities known as *ahupua*'*a*. These landholdings varied in size but shared a few common traits. Their boundaries extended from the mountains to the sea shore, with fishing rights extending to pelagic waters. Each *ahupua*'*a* was ruled by single *ali*'*i*, or noble, and the holdings were managed by *konohiki*, persons of slightly lesser status. The population was composed of farmers, fishermen, craftsmen, priests, rulers, and soldiers. Given the size and natural diversity of Māhā'ulepū Ahupua'a, there was probably a large population scattered throughout. Where possible, the boundaries incorporated natural features such as ridgelines and streams.

A PREDICTIVE MODEL OF TRADITIONAL SITE DISTRIBUTION.

Dega and Powell (2003) developed a landscape model of variation in physiographic and environmental *zones* in eastern Kaua'i as a way of predicting the general location of traditional sites and features, including buried sites. This model is being applied across Kaua'i. [Note, Hammatt *et a*l. have used a slightly different variation of this zone model idea in numerous reports (*e.g*. Masterson *et al*. 1994)]. This section describes the *zone model*, as defined by Dega and Powell, and modifies it slightly to more explicitly include the potential impact of historic activities on traditional sites (*e.g.* road cuts, utility excavations, irrigation ditches and pipelines, sugar cane cultivation), but also the preservation and protection of surface and/or buried traditional sites. These historic impacts are discussed in relatively broad terms here. Specific archaeological and historic data directly relevant to the project area are presented in the following section.

Particularly for traditional Hawaiians in pre-Contact times, resources and opportunities to exploit them were distributed unevenly across the landscape, and the archaeological record should reflect this. The model divides landforms into five general zones, and Dega and Powell (2003) integrate broad patterns in the known distribution of archaeological finds within these zones. This allows for more specific-and scientifically testable-predictions than simply the probability of finding sites in a given location. The model predicts, for example, not only that the coast and near-coast were more intensely inhabited than the foothills and plateaus, but also that the types of sites created in these zones would be different. The zone model is therefore based on empirical data documenting variation in the physical as well as the cultural landscape of Kaua'i. As stated, historic impacts on traditional sites should be considered, and some fairly general observations can be used to predict at least some of these. Here , only general references and broad trends in the archaeological record of Kaua'i are relevant.

SITE TYPE PREDICTIONS AND FREQUENCY BY ZONE

The model divides the landscape into five broad zones: Coast (I), Back Beach (II), Marsh (III), Hills/Plateau (IV), and Mountains and Steep Slopes (V). According to the model, the first three zones (coast to marsh) have been more or less continually utilized, in some way, from very early times into the present. Especially in traditional times, Zone II has been most important for habitation for two main reasons: (1) it straddles two highly productive and accessible ecozones (*i.e*., marine-coastal and pond-estuary), meaning that its inhabitants could easily exploit both areas; and (2) in geomorphological terms, Zone II is a relatively stable landform not prone to flooding from either the sea (as with Zone I) or the uplands (as with Zone III). Note that the model does not take into account population pressure or chiefly edicts that might cause people to settle in marginal areas or cause people to pursue less than optimal adaptive strategies.
Māhā'ulepū Ahupua'a contains all five zones with the project area primarily occurring in Zone 4.

Zone I (Coast)

Zone I consists of beach sands and adjacent coastal dunes, which include frontal accretion deposits, backslopes, the crest, and the slip face. Zone I includes the area from the high-tide water mark of the ocean to the lower portion of the slip face near the interdune area, or, where the backside of the dune becomes flat and expansive. Zone I sediments are primarily composed of beach sands. These sands are subject to variable sorting when energy depositional events such as storm surges or tsunamis lead to the deposition of coarser sand grains while low energy events can lead to well-sorted, often fine-grained, sedimentary deposition. This is a dynamic zone in terms of landscaped morphology as it constantly evolves through wind and tides, particularly if vegetation or modern impediments do not curtail dune migration.

Archaeological work in Zone I commonly yields habitation sites and features, but there are rarely the remains of permanent settlements. The potential difficulties of living permanently in Zone I include dangerous flooding, high winds, and shifting sand. Landscape features can be quickly buried and/or exposed in Zone I, where more temporary sites, such as fishing camps were located. Archaeological evidence of activity area, such as tool and gear workshops and maintenance sites, are also common in Zone I, but these tend to be relatively ephemeral because they are usually the result of short duration visits. Traditional Native Hawaiian burials are another important site type in Zone I sediments. Burials in this zone would been located at or above the typical high tide mare, *i.e*. near the transition to Zone II, rather than towards the seashore itself. Note: With the recent increase in beach erosion, burials have been found in more frequency in these tidal zones.

Historic impacts in Zone I include the construction of sea walls, jetties, and retaining walls. Sea walls and retaining walls, in particular, have the effect of stabilizing and sometimes burying zone I sediments, potentially locking in subsurface deposits. Much of the Māhā‘ulepū coast has been modified in this manner, especially at Poipu and Koloa.

Zone II (Back Beach)

Zone II occurs inland from Zone I, and represents a more stable land surface. This zone comprises the coastal plain or back beach environment. Like Zone I, Zone II primarily consists of calcareous sand beaches derived from the decomposition of coral and seashells. These deposits and associated coralline basements occur far inland in some areas, reflecting the Holocene high sea stand occurring between *c*. 5,500 years go and lasting until about 2,000 years ago (Fletcher and Jones 1996). Zone II represents an area that almost never floods, except in the rarest of conditions (*e.g.*, a 100 year event). Along the Māhā‘ulepū coast there are windblown modern dunes, and a fossil-rich lithified dune system. (NPS 2008).

Archaeological work in Zone II commonly yields permanent habitation sites and burials from traditional Native Hawaiian occupation. In fact, all manner of sites, and features associated with settled, near-coastal communities were located in Zone II, and large population centers were common.

Because Zone II landforms are stable, accessible, near-coastal settings, usually over relatively level terrain, historic impacts have been severe. These impacts include road building, residential and commercial construction, excavation for utility trenches, and mining of the sand for construction purposes.

Zone III (Marsh)

Zone III consists of wet marshland, or slightly depressed pond areas, inland of Zones I and II. Zone III is amenable to soil catchment (*i.e.* sedimentary deposition), and is located at or very near seal level, yet retains more terrigenous characteristics. This marshland does contain some sandy sediment, but alluvial silty clays and clays from the uplands dominate soil matrices. Zone III would have a unique econozone for hunting marsh birds for food and feathers, and the collecting of their eggs.

In traditional times, Zone III provided a near-coastal alternative for agricultural production normally only afforded at locations farther inland. Archaeological work in Zone III commonly yields evidence of traditional walls, ditches and terraces of the *lo‘i* (irrigated) field systems. Fishponds were sometimes located in this zone. Residents on either side of Zone III could utilize this area for agriculture, aquaculture, and wildlife harvest.

South of the project area, Māhā‘ulepū Ditch, formerly a natural stream, joins with a natural spring and the remnants of Kapunakea Pond, and regains a more natural appearance. It continues to the coast, re-named Waiopili Stream (NPS 2008). It flows near Waiopili Heiau, and a unique site in Hawaiian archaeology, Makauwahi cave. This is a limestone sinkhole with interior caves containing a complex stratigraphy with the different layers containing evidence of traditional Hawaiian occupation and the natural deposits accumulated prior to the arrival of the first voyagers.

Zone IV (Hills and Plateau)

Zone IV is characterized by hills, valleys, and grassy plateaus that lead into more mountainous terrain. Subsurface deposits are dominated by silty clays and clays derived from the decomposition of underlying basalt, as well as the deposition of alluvial and colluvial clays, particularly in valley areas. In many places, the soils are also rich in iron and other nutrients amenable to the cultivation of traditional food crops and historically for the industrial production of Kaua‘i’s most lucrative commercial crop, sugar cane.

Archaeological evidence has documented a number of site types in Zone IV. (1) Trails connecting lowland and upland sites and resource areas would vary in construction and size. (2) Agricultural plots, with terraces and retaining walls, for garden and/or medicinal plants, and terraces for dry land agriculture such as ‘*uala* (sweet potato) would be present within this zone. (3) Arboraculture would have flourished in this zone. The cultivation and maintenance of *ulu* (breadfruit) and other tree resources would take place here. (4) Permanent and temporary habitation sites. (5) *Heiau*.

The project area is located in Māhā‘ulepū Valley, on level ground that was utilized for sugar cane cultivation. The intensive transformation of the landscape through clearing, plowing, and harvesting has removed cultural sites and materials from the valley floor. However, at the base of slope there is what appears to be an agricultural *heiau*, and historically other *heiau*, since destroyed, were documented within the valley. Agricultural terraces were also located on the eastern slopes of the valley. Only a small area on the slopes of the valley was surveyed during this project.

Zone V (Mountains and Steep Slopes)

Zone V consists of the steep slopes of mountains and those of major drainages such as gullies and ravines. Lands classified as Zone V are typically rugged, remote areas of the terrain where human occupation and utilization are temporary and/or episodic. Soils and sediments in Zone V drive from the decomposition of the underlying bedrock. Because of the prevalence of steeps slopes in this zone, soils and sediments are relatively thin and subject to downslope movement. Cultural features such as retaining walls, terraces and trails are usually found in association with rock outcrops and caves. Erosion is the greatest threat to whatever cultural deposits might be found on these slopes.

Traditionally, Hawaiians did construct *heiau* at elevations, but in some instances a natural place could be considered sacred without an actual structure (*i.e*., Ha‘upu Ridge). Stone was quarried traditionally for tools of high grade basalt and the forests were harvested for building materials. Increasingly through the first four decades of the 19th Century sandalwood was collected until near extinction, which increased the risk of erosion in the mountains. Later in the 19th Century and into the 20th Century, irrigation infrastructure for the sugar cane industry was carved into the mountains and slopes.

SITE DISTRIBUTION AND CHRONOLOGY

Site distribution across these five zones is often determined by historic land use, when landowners and others utilized the same lands as were cultivated and occupied during pre-Contact times. Sometimes these earlier signatures are erased, depending upon the intensity of historic land alterations; sometimes, however, they are not, as evidenced by the many inland, pre-Contact sites occurring across southern Kaua`i. Pre-Contact sites are identified in coastal or near coastal areas, locations removed from intensive sugar cane production, but also in large valleys and uplands that were not disturbed through time. Heiau, as seen via this report, and fishponds, among other pre-Contact site classes, are also preserved inland. This pattern occurs beyond the south shore as well, where pre-Contact sites are preserved inland, such as in Waimea Canyon and Makaweli, for example. Typically, however, the earliest dates for initial settlement of an area, for this part of Kaua`i, occur at the coastline. This may because more archaeological work has been done in these areas than further upland, particularly in the Māhā‘ulepū area.

Dates from the coastline fall in the A.D. 1000-1200 range for this part of Kaua‘i, with expansion inland proposed to have been during the A.D. 1400-1600s, as was a pattern across the islands (see Kirch 1985). Agricultural field systems were created within inland areas, closer to fresh water resources and soil more amenable to *kalo* and sweet potato production. Permanent habitation locales were present from the coast to more inland areas, with ceremonial sites, walls, and other associated structures being built near the coast and far upland. Within the mountainous areas, such as at the back of Māhā‘ulepū Valley, temporary habitation loci would have been utilized by those gathering upland resources. The middle zone, such as Māhā‘ulepū, was ideal for agriculture and homesteads, as witnessed by the numerous LCA’s occurring in a small section of the valley. However, it appears that historic land use would have erased many of the archaeological signatures for such settlements/land use. This is evidenced by the presence of a

ceremonial site occurring outside the “plow zone” (Site -3094; see below). What is more apparent now in the archaeological record of Māhā‘ulepū is infrastructure associated with that intensive sugar cane production from the plantation period (see below).

METHODOLOGY

Several phases of fieldwork were undertaken as part of this project. Prior to fieldwork, a review of the archival record and previous archaeological work in the project area and environs was completed. This archival work was integral in determining the types and nature of sites that could be encountered, as well as to aid in determining trenching locations across the parcel.

FIELD METHODS

Fieldwork was conducted between July 7 through 25, 2014 and August 20 through 26, 2014 by Jeff Putzi, B.A., James Powell, B.A., Milton Ching, B.A., and Michael Dega, Ph.D (Principal Investigator). Fieldwork consisted of a systematic 100% pedestrian survey of the entire project area, survey of a 100-meter swath outside the project area, representative mechanical trenching on the valley floor, and manual excavation units placed at one site, the enclosure (Site -2259). Per survey, the crew was spaced a variable 5 m-10 m, depending upon ground visibility. Visibility was very good across the valley floor and good around the perimeter of the floor. When sites were identified, they were mapped to scale using tape and compass (except for the longer ditches), digitally photographed, and GPS recorded. The longer ditches were recorded using GPS (both terminal ends) and appear on most maps/aerial photographs for the area. Sites were recorded in detail to reflect their overall integrity, size, and location in the project area. As noted above, the SHPD-Kaua‘i requested extending the survey to include a 100-meter swath of land along the northern boundary of the project area to assess the presence/absence of historic properties. The SCS field crew surveyed from the project area out 100 meters along this swath, increasing the surveyed area by some 1,300 meters. As noted below, one site (Site -2259) was identified in this area.

In addition, a total of seventeen (17) stratigraphic trenches were mechanically excavated by backhoe across portions of the valley floor. Trenches were mostly focused on the cluster of LCAs in the central/eastern portion of the project area (see Figure 9) and second, through the area of the proposed effluent ponds. All trenches were examined, profiled, and photographed. Manual testing of nine (9) units was completed at -2250, the enclosure. This additional testing was also approved by the SHPD-Kaua‘i to further understand the function of the site. The number of units was increased to nine as no cultural materials were identified in the first several units. All sediment from the units was screened through 1/4” and 1/8” wire mesh screens, to recover any smaller cultural material fractions. All units were plotted on a site planview map, profiled, and back-filled. No units were left open at the end of each day.

LABORATORY METHODS

As only one artifact was recovered during surface survey, trenching, and testing, laboratory methods were primarily limited to drafting field site plan view maps, stratigraphic trench profiles, profiles of the test units, cataloguing all photographs and maps acquired during the project, and reporting. The single artifact, from a test unit outside Site -2250, was analyzed and catalogued. This artifact was returned to the site during a February 3, 2015 field visit with the SHPD and others. All field notes, maps, and photographs pertaining to this project are currently being curated at the SCS main laboratory in Honolulu.

CONSULTATION

Preliminary consultation was undertaken during the current AIS by the archaeological field crew. A more formal consultation, via a Cultural Impact Assessment, will be initiated in the near future and provide much more in-depth information and interviews on the project area. For the current project, the following individuals and groups were consulted:

State Historic Preservation Division-Kaua‘i Lead Archaeologist: The Lead Archaeologist for Kaua‘i was consulted prior to the commencement of fieldwork, during fieldwork, and post-fieldwork. Following one of two field visits to the project area, the Lead Kaua`i archaeologist recommended that survey be conducted not only of the immediate project area in the valley, but also up to the ridgeline. This would be done to assess the presence/absence of historic properties that could potentially be affected by this project. The presence of Keolewa Heiau, on Hu`apu Ridge, and a former *heiau*, Hanakalauea Heiau, within the valley, indicated that pre-Contact/Historic era trails may have connected the project area to the upper ridgeline. The presence of the agricultural *heiau* (Site -2250, see below) also indicated that additional pre-Contact sites could be present further upslope from the project area proper. The additional 100 meter survey swath around the northern section of the project area, while not extending to the ridgeline, was the result of negotiations between the SHPD and the current lease of those lands directly outside the project area.

Kaua‘i Historical Society: Research was undertaken here prior to fieldwork, during fieldwork, and following the completion of fieldwork. M. Ching and J. Powell, part of the field crew, researched old photographs and maps of the Māhā‘ulepū area, as well as text references (i.e., Bennett 1931) to further understand the sites they had documented during fieldwork.

Individuals: M. Ching conducted interviews with several local residents who lived and worked for decades in the Koloa-Māhā‘ulepū area. Discussions centered on land use through time and

their knowledge of any historic or cultural properties in the Māhā‘ulepū area. Their insight was invaluable per Plantation Era land use in the area, as well as the families who lived there. M. Ching talked primarily with Nelson Abreu (uncle to Russell, he is 84 years old) and Russell Abreu.

February 3, 2015 Field Visit

On February 3, 2015, SCS, a representative from the SHPD-Kauai (archaeology branch), land representatives, and community members met at the project area to conduct a field trip of the sites documented during this study and provide any insight on said sites to SCS. The secondary purpose was to get more overall feedback on the AIS, should they have any questions or comments. A total of 12 individuals, 7 being community members, joined the trip. The group first stopped at the petroglyph rocks and second, at the *heiau*. In both locations, Kalani Pike (Branch Harmony) conducted ceremonies to consecrate the sites. He also spiritually “closed” the *heiau*. The one artifact recovered during the AIS project, a lithic chopping tool (see below), was placed back in its original location, as witnessed by the group. Overall, the group visit was well received and the ceremonies accomplished goals set by many for being there. Both the petroglyphs and *heiau* were discussed in terms of the AIS, with these interpretations noted below.

ARCHAEOLOGICAL INVENTORY SURVEY RESULTS

A total of sixteen sites were identified during the Archaeological Inventory Survey (Figure 12 and Figure 13). Fifteen of the sites were newly identified during the current survey and one site, State Site 50-30-10-3094, was re-located. Three of these sites are believed to be associated with pre-Contact and/or early historic times, including an enclosure and two retaining wall remnants. The remaining sites consist of bridges, ditches, culverts, and a flume system dating from the 20th century and affiliated with sugar cane cultivation. Note that Sites -2251, -2252, -2253, and -2259 all appear to conform to the same ditch (Figure 14), with the Site -2258 reservoir also being present near the ditch line. The ditch as constructed following the creation of the reservoir may have followed the course of historic or pre-Contact *auwai*, but no evidence of such water ways along or perpendicular to the ditch were found during the survey. Sluice gates emptying into the valley were found, but there were no associated ditches, suggesting the gates may have been placed to deal with overflow or flooding, and not necessarily for the irrigation of a specific field. The flume with trestle bridge over the irrigation ditch appears to have been constructed after the ditch/reservoir system was built. The flume and trestle appears to have been constructed to continue the flow up water from streambeds off the ridgeline, into the natural water courses in the valley itself. In addition to survey, a total of seventeen trenches were mechanically excavated in various portions of the project area, with no cultural findings. Multiple test units were placed in the pre-Contact enclosure, which aided in refining functional interpretations.

Importantly, Site -3094 (petroglyphs) and Site -2250 (heiau) both occur off-site. They were documented during the current, expanded AIS fieldwork but do not occur in the proposed work area. Both sites, as discussed below, will be preserved in perpetuity in their present, off-site location.

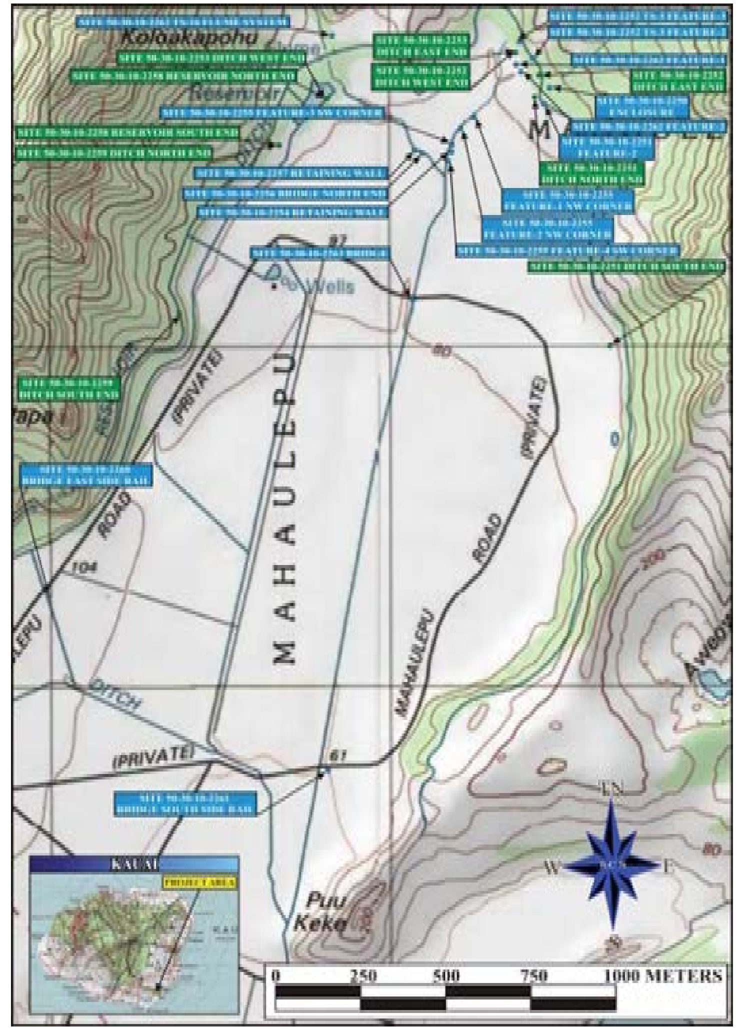

Figure 12. USGS Map Showing Location of Identified Historic Properties in the Project Area.

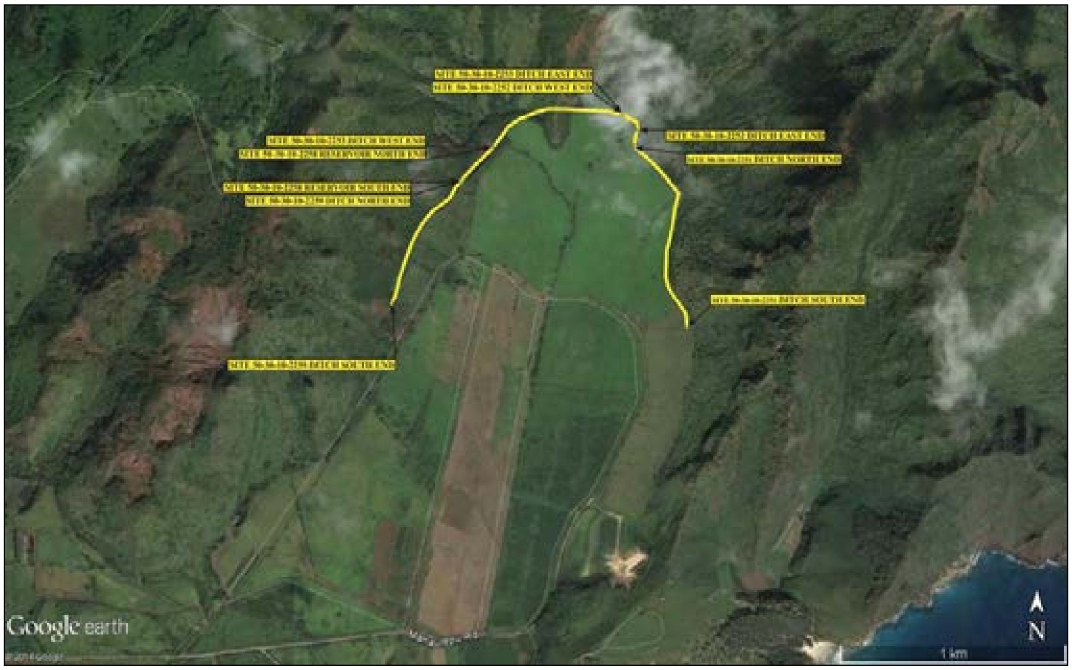

Figure 14. Aerial Photograph Showing Location of Ditch, Site -2251, -2252, -2253, -2254, and -2259.

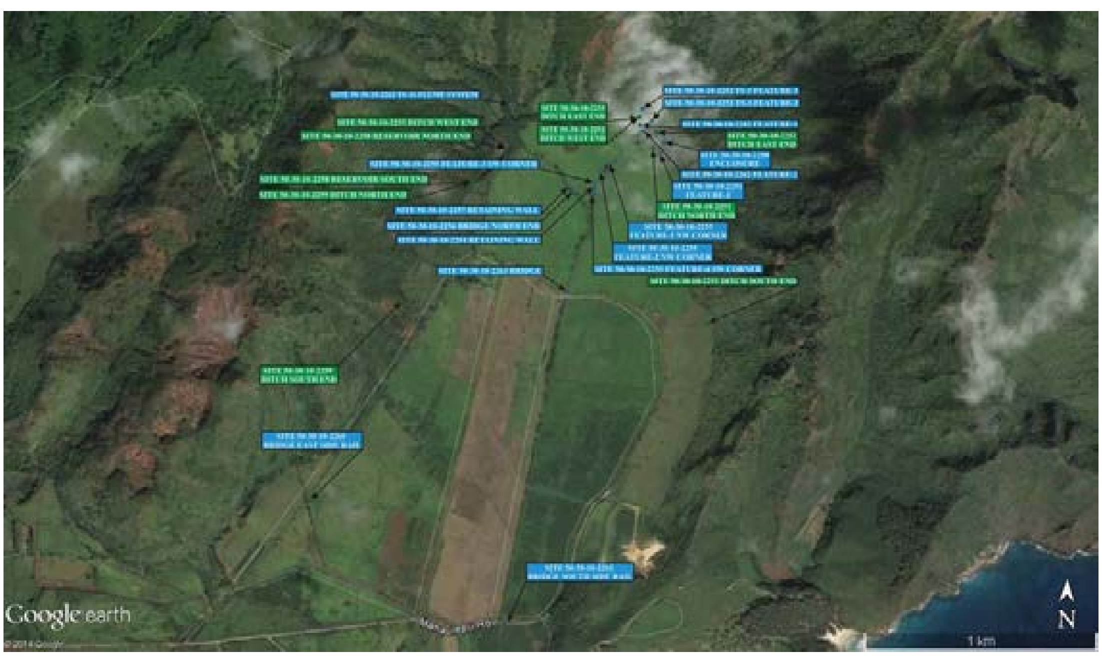

Figure 13. Aerial Photograph Depicting Location of Project Area Historic Properties.

STATE SITE NO. 50-30-10-2250 (TS-1)

Site -2250 consists of a rock enclosure located in Paddock P-163 (see Figure 4), in the northern corner of the project area c. 30 m off the valley floor (Figure 15). The enclosure is rectangular and measures 20 meters north-south by 9 meters east-west (180 m sq.; Figures 16 through 19). The corners of the enclosure all occur at cardinal directions. The northeast wall is constructed of an alignment of small basalt boulders, at least 0.5 m in diameter, all of them fairly uniform in size. Two taller, but not wider, boulders are upright in this alignment. There is an opening at the west side of the northern end, which appears to form a formal entrance/exit for the enclosure.

The southeast wall of the site is constructed of basalt cobbles and boulders stacked and piled two to three courses wide and two courses high (0.30 m above surface, average). The cobbles and boulders range in size from 0.2 m in diameter to 1.0 m in diameter. Some portions of this wall appear to have collapsed but on the whole, the enclosure wall is in good condition. At the south end of the site are two upright boulders approximately 0.60 m in diameter and up to 1.4 m high. These are adjacent to a very large boulder that forms the south corner of the enclosure.

One large boulder at the southern corner is pyramidal in shape. It measures 4.0 m by 3.0 m by 1.4 m tall. Test Unit 4 was placed against this boulder (see below) as it would have acted as a "catchment" for any eroding cultural materials from the slightly uphill, northern end of the site. Extending westward are several other large boulders. Overall, a few small boulders are piled but the majority of the enclosure wall along the southern flank is formed by these roughly aligned boulders.

The long western wall is constructed in much the same manner as the long east wall. However, the former extends northwest before turning northeast to the presumed entry/exit to the enclosure. An upright boulder is present south of the corner, with two more upright boulders occurring to the north of the corner (see Figure 16).

The area within the enclosure is mostly level but with a slight southward descent. The ground to the north is slightly higher in elevation. The site area is lightly forested with java plum,

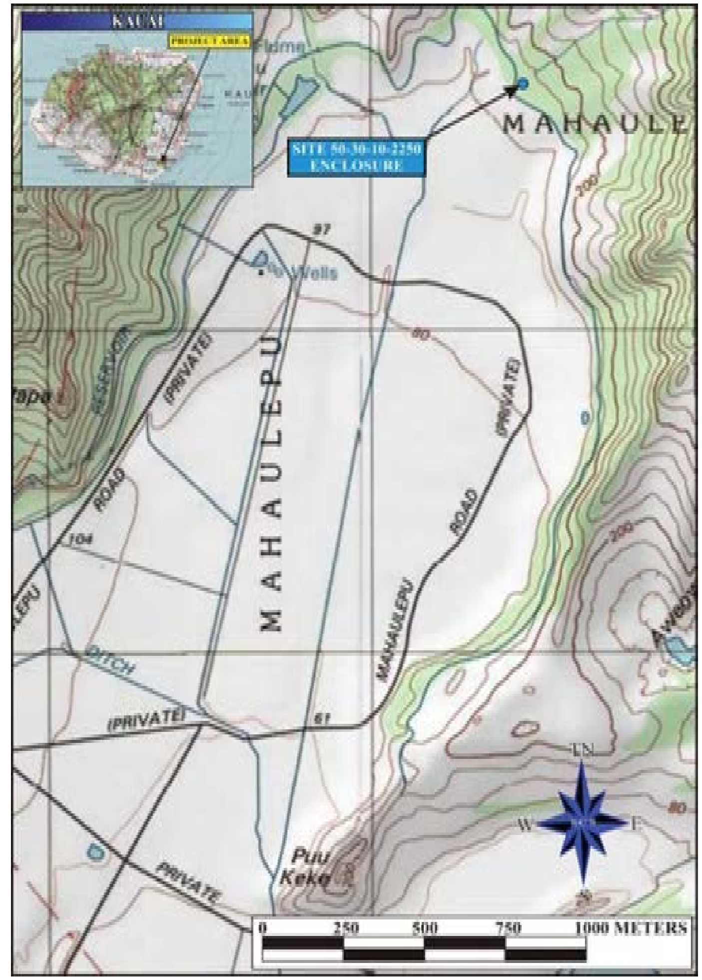

Figure 15. USGS Map Showing Location of Site -2250.

Figure 17. Photograph of Site -2250. View to South.

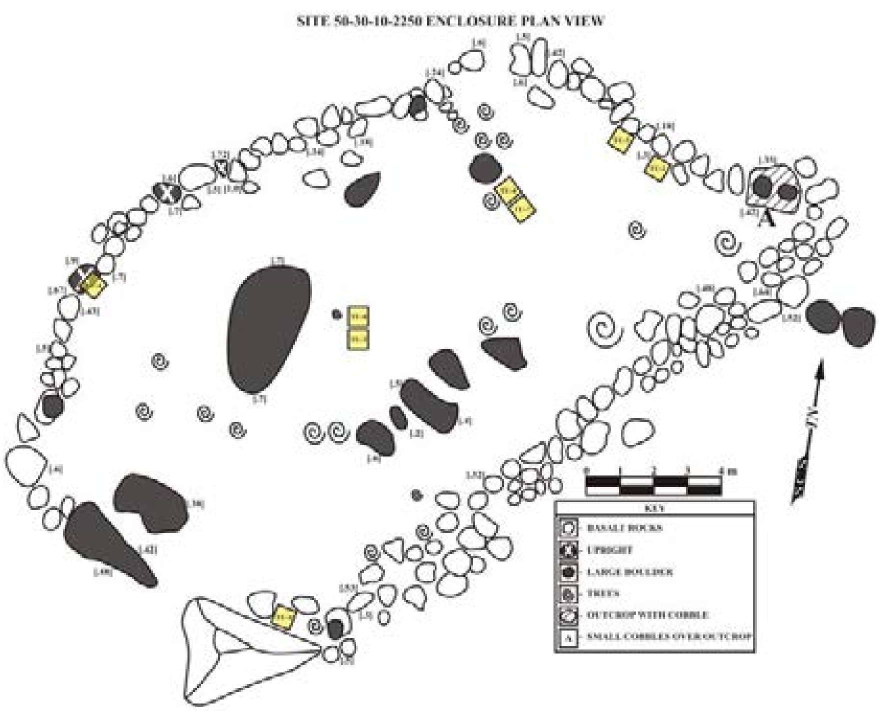

Figure 16. Planview Map of Site -2250.

Figure 18. Photograph of Site -2250. View to West.

Figure 19. Photograph of Site -2250. Note Uprights in Construction. View to West.

eucalyptus, and *haole koa*, but there is a dense grove of *hau* 25.0 meters to the southeast of the enclosure. There are no interior features within the site.

No cultural materials of any era were identified within the enclosure, its walls, or outside the enclosure. Given the size and shape of the site, its proximity to Māhāʻulepū Stream, its placement at the head of the valley, and the southern commanding view over the valley itself, the site was initially interpreted as either a large hale or an agricultural *heiau*. The site did not appear to be a traditional residence as these were most often multi-structural affairs spread over the landscape. None were found nearby. The site was also defined with each wall built in a different, distinct manner, with many upright boulders being incorporated into wall construction. Testing was needed to confirm or modify initial interpretations of the site.

Testing

A total of eight test units (TU) were excavated within the Site -2250 enclosure, with a ninth unit having been excavated 20 m to the Northwest. Shovel Test Units 1 and 2 were excavated during the initial field work in July, 2014 with the remainder excavated during the additional efforts in August, 2014. The large number of test units was necessary given initial site interpretations (significant site) and second, the lack of findings in the first few test units. Testing aided in refining the site function determination.

TU-1 measured 0.5 m by 0.5 m and was excavated to a depth of 0.38 m below ground surface (Figure 20). The unit was placed along the interior of the west wall, south of the corner where the wall turns from the northwest to the northeast. This corner is defined by two upright boulders north of the corner and one upright boulder south of the corner. The unit was placed along the base of the upright boulder south of the corner. Two strata were present in TU-1: Layer I (0-0.30 mbs) was composed of dark brown (10YR3/4) silty clay. Layer II (0.30-0.38 mbs) consisted of a layer of gravel and cobbles, with silty clay between them. Excavation ceased after exposing the surface of a deposit of small sub-angular basalt cobbles and gravels. The goal was to keep it intact to assess the presence/absence of other possible pavements at the same depth in the enclosure. Layer II represented a paving and/or a foundation for the upright and the west wall. No cultural materials were observed in the unit.

TU-2 measured 0.5 m by 0.5 m and was excavated to a depth of 0.3 m below the ground surface (Figure 21). This unit was placed midway along the length of the interior, north wall. The north wall is an alignment of small boulders with one cobble extending south into the interior of the enclosure. The TU was placed with the boulders of the wall to the north and the

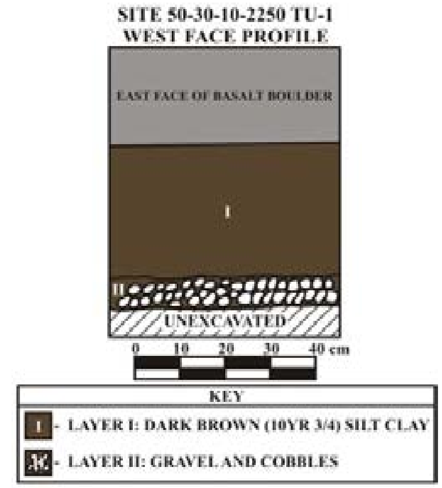

Figure 20. Site -2250, TU-1 Profile. West Face.

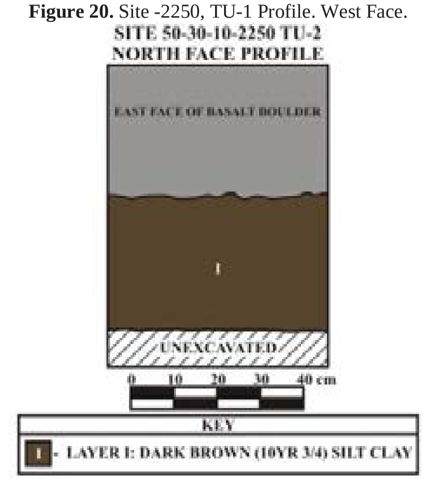

Figure 21. Site -2250, TU-2 Profile. North Face.

cobble to the east. Excavation extended to a depth below the boulders to determine the presence of any cultural materials, particularly charcoal to date site construction. One stratum was present in TU-2: Layer I (0-0.3 mbs) was composed of dark brown (10YR3/4) silty clay. Roots and rootlets were common from surface to the base of excavation. No cultural materials were observed. The unit was sterile.

TU-3 measured 0.7 m by 0.7 m and was excavated to a depth of 0.2 m below the ground surface. This unit was placed at the approximate center of the enclosure. One stratum was present in TU-3: Layer I (0-0.2 mbs) was composed of dark brown (10YR 3/4) silty clay. No evidence of paving or cultural materials were identified in the unit.

TU-4 measured 1.0 m by1.0 m and was excavated to a depth of 0.34 m below the ground surface. This unit was placed along the interior base of the large, pyramidal-shaped rock that forms the south corner of the enclosure (Figure 22). It was theorized that placement of the unit here would act as a “backstop” and could have been a location where midden/artifacts could have been culturally or naturally deposited. Large *in situ* boulders rendered the unit smaller so that by the base of excavation there was little soil to excavate. One stratum was present in TU-4: Layer I (0-0.32 mbs) was composed of dark brown (10YR 3/4) silty clay. Roots and rootlets were common from surface to the base of excavation. Clastics were not common but increased in frequency with depth. There represent natural deposits and were not representative of a paving or cultural formation. No cultural materials were observed in the unit.

TU-5 measured 0.7 m by 0.7 m and was excavated to a depth of 0.59 m below the ground surface (Figure 23 and Figure 24). This unit was placed along the interior of the north wall, approximately 0.7 m to the west of TU-2. Three strata were present in the unit. Layer I (0-0.07 m) consisted of dark reddish brown (2.5YR 3/3) silty clay. Layer II (0.07-0.29 m) was composed of reddish grey (5YR 5/2) silty clay with many cobbles and gravels. This layer was interpreted as a possible paving and/or a foundation for the north wall. Continuing below the cobbles and gravels was natural sediment, Layer III (0.29-0.59 m) composed of reddish brown (5YR 5/4) silty clay. Unlike the nearby TU-2, no roots were present. No cultural materials were observed in the unit.

TU-6 measured 0.7 m by 0.7 m and was excavated to a depth of 0.2 m below the ground surface. This unit was placed adjacent to TU-3 at the center of the enclosure. The surface of the boulder found in TU-3 was entirely exposed. The rock’s diameter measured 0.7 m and was interpreted as an isolated, natural stone. One stratum was present in TU-6: Layer I (0-0.2 mbs)

Figure 22. Photograph of TU-4 Location. View to South.

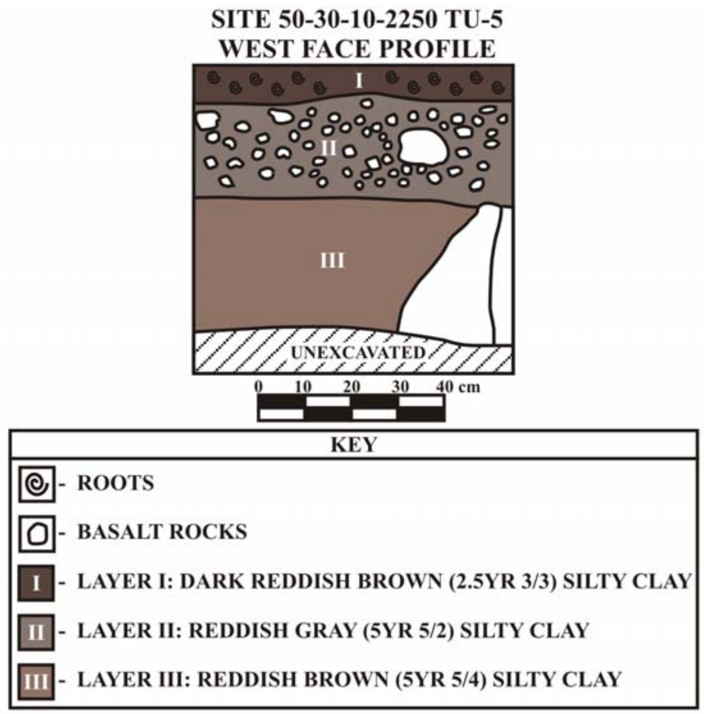

Figure 23. Site -2250, TU-5 Profile. West Face.

Figure 24. Photograph of TU-5 at Base of Excavation. View to West.

was composed of dark brown (10YR 3/4) silty clay. No evidence of paving cobbles and no cultural materials were observed in the unit.

TU-7 measured 0.5 m by 0.6 m and was excavated to a depth of 0.2 m below the ground surface. This unit was placed within the interior of the enclosure approximately 5.0 m south of the passageway at the northern corner. TU-7 was placed 6.0 m north of TU-3 and 3.0 m south of TU-5. One stratum was present in TU-7: Layer I (0-0.2 mbs) was composed of dark brown (10YR 3/4) silty clay. Roots and rootlets were common from surface to the base of excavation. No evidence of paving cobbles and no cultural materials were observed. The unit was sterile.

TU-8 measured 0.4 m by 0.4 m and was excavated to a depth of 0.3 m below the ground surface. This unit was placed to the north of TU-7. Excavation exposed the surface of a deposit of small, sub-angular basalt cobbles and gravels. These were originally thought to represent a paving such as was exposed in TU-2 and TU-5. However, TU-8 is not adjacent to any wall and the stones appear to represent a natural deposition. One stratum was present in TU-8: Layer I (0-0.3 mbs) was a dark brown (10YR 3/4) silty clay. No roots were present here, as compared to the nearby TU-7. No cultural materials were observed in the unit.

TU-9 measured 0.70 m by 0.70 m and was excavated to a depth of 0.20 m below the ground surface. This unit was placed 20 m to the northwest of the enclosure. The unit was excavated amidst a scattering of large and small boulders to assess if they were natural or an extension of the -2250 enclosure. At 0.17 m below ground surface, a small cobble-sized basalt chopper was recovered (Figure 25). The basalt tool has a fractured end, which may have been a deliberately formed edge. There are no signs of pecking or flaking, and no signs of wear, but it may have been a tool formed specifically for one task and then discarded. No other cultural materials were observed in the unit. The scattered boulder area was determined not to be an extension of the enclosure itself, even though one artifact was present. The rocks were mis-aligned and did not connect to the enclosure. These rocks were also not a separate site; only the presence of the isolated artifact shows cultural use of the area.

Figure 25. Photograph of Chopper Tool from TU-9. Note: This artifact was taken back to the site in February, 2015 and placed in the same location where it was discovered.

Results of Testing

A total of eight test units were excavated within the Site -2250 enclosure, with a ninth unit excavated 20 m to the northwest. No cultural materials were observed in any test units within the enclosure, only one chopping tool having been recovered from TU-9 outside the site. TU-1, placed against the interior of the west wall, at the base of an upright basalt boulder, and TU-5, placed against the interior of the north wall, both exposed a deposit of sub-angular basalt cobbles and gravels that is interpreted as a paving, a foundation for their respective walls, or a combination of both. TU-8, placed approximately 5.0 m south of the entrance at the north corner of the enclosure, also exposed a similar deposit. TU-2 was placed along the interior of the north wall, but did not expose this cobble and gravel deposit. TU-4, TU-7, and TU-9 did not expose the cobble and gravel deposit. TU-3 and TU-6 together exposed the flat surface of a boulder, but it was determined to be a natural occurrence. Excavation of TU-4 was halted due to tightly packed naturally-deposited boulders.

The deposit of sub-angular basalt cobbles and gravels exposed along the walls in TU-1 and TU-5 appear to be a paving and/or a foundation for the walls. A similar deposit exposed in TU-8 appears to be a paving. TU-8 was placed 5.0 m south of the entry/exit, at the northern corner and 3.0 m south of TU-5 along the interior of the north wall. TU-9 yielded the only artifact, a small, smooth, oblong basalt cobble that could have been utilized as a chopper.

The site is interpreted to be an agricultural *heiau*. The enclosure is large (180 m sq), with single-course, well-constructed walls that are in excellent condition. In planview, the enclosure is rectilinear and the four corners are at the cardinal directions. There is a formal passageway at the north corner of the structure. One very large boulder forms the corner of the east and south walls, and several large boulders form the south wall, which faces into Māhā‘ulepū Valley. There are no surface features within the enclosure but there are several large boulders. The ground within the enclosure is flat with a slightly descending slope to the south. Trees are scattered throughout the site area, including a grove of *hau* trees to the southwest. The interior of *heiau* were often paved, but the extent of the paving varied. The absence of cultural materials in all of the test units suggests that this structure was not associated with the everyday tasks attributed to a *kau hale* or habitation complex. The uprights appear to distinguish this site even more.

STATE SITE NO. 50-30-10-2251 (TS-2)

Site -2251 is composed of two plantation-era features, both in fair condition. Feature 1 is a sugar cane irrigation ditch approximately 2.0 m wide and ranges from 0.5 m to 1.5 m deep (Figure 26). The feature is approximately 800 meters long and extends along, and just above, the base of the northern project area slope. The feature alternates between being covered by high

Figure 26. Photograph of Site -2251, Feature 1 Ditch and Feature 2 Sluice Gate. View to Southeast.

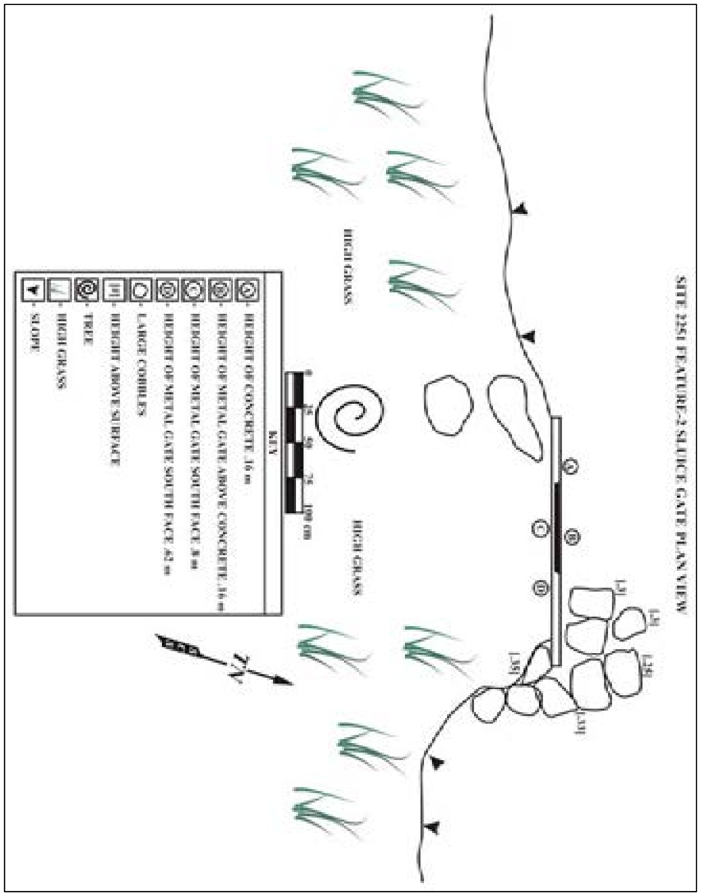

Figure 27. Planview of Site -2251, Feature 2 Sluice Gate.

grasses and also passing through and along the edge of the tree line. The ditch passes south and west of -2250 (enclosure) and terminates at the streambed which forms the eastern side of -2252 (ditch, sluice gates). On plantation maps, the feature extends northward from P-154 to P-163.

Feature 2 consists of a plantation-era sluice gate directly affiliated with Feature 1 (Figure 27 and Figure 28). The feature is located 25 m southeast of the -2250 enclosure and is built on the southern side of the main ditch. The gate is composed of an upright, concrete slab 1.5 m long by 0.06 m thick. The exterior face is 0.75 m high but the interior is 0.20 m high, the latter portion obscured by the main ditch filling with eroded and water-born soils and detritus. The concrete slab has an interior slot on its top that contains an iron door for the gate. Basalt cobbles are aligned along the interior of the ditch on either side of the concrete. Approximately 1.0 m east of the gate, on both sides of the ditch, are two retaining components built of metal posts and sheet metal. These components worked in conjunction with the main gate. Neither the ditch nor the sluice gate have been maintained for some time.

STATE SITE NO. 50-30-10-2252 (TS-3)

Site -2252 is composed of three historic irrigation features, all directly related to sugar cane production. Feature 1 consists of an irrigation ditch measuring approximately 2.0 m wide and is a variable 1.0 m to 1.5 m deep (Figure 29). This ditch connects to, and is perpendicular with, two southward descending streambeds, which are approximately 100 m apart. Within the valley, these two streams join and form the Main East Ditch. Feature 1 is the same ditch as -2251, Feature 1 to the east and Site -2253, to the west. These features received different site numbers as they are broken in places. The ditch is identifiable but partially collapsed and filled with soil and detritus.

Feature 2 consists of a Plantation era sluice gate, similar to described above at Site -2251, and having been identified in the southern face of Feature 1 and 30 m east of the western stream (see Figure 28). The feature is 70 m west of Feature 3. This feature is in good condition.

Feature 3 consists of another sluice gate, present in the south face of Feature 1 and 10 m west of the east stream (Figure 30). The feature is 70 m east of Feature 2. This feature is in poor condition: the metal door is missing and the concrete is weathered.

Figure 28. Photograph of Site -2252, Feature 2 Sluice Gate. View to Northwest.

Figure 29. Photograph of Site -2252, Feature 1 Ditch and Feature 2 Sluice Gate. View to South.

Figure 30. Photograph of Site -2252, Feature 3 Sluice Gate. View to Southwest.

STATE SITE NO. 50-30-10-2253 (TS-4)

This site consists of a single feature: a sugar cane Plantation era irrigating ditch that extends west and southwest from the western stream at Site -2252. The ditch terminates at Site -2258, Māhāʻulepū Reservoir. The ditch is entirely earthen and measures 2.0 m wide by up to 1.5 m deep. Site -2253 measures approximately 2,007 feet long and is in poor condition, having been neglected and filled with eroding soils and rocks.

STATE SITE NO. 50-30-10-2254 (TS-5)

The site is a single-feature site consisting of a retaining wall that was constructed of dry stacked, sub-angular basalt cobbles and boulders (Figure 31). Site -2254 was built into the east bank of the east stream descending from above Site -2252. While the features comprising Site -2255 (Plantation era culvert bridges) occur to both the north and south of -2254, this retaining wall could predate them, perhaps being associated with late prehistoric and/or early historic times. The retaining wall measures 7.3 m long by 1.8 m high and the visible ground surface width is up to 1.0 meter. The wall is 6 to 8 courses high, two courses wide, and was built on an earthen bench, the latter being a remnant of the original stream bank and bed. This bench or terrace extends 4.0 m north and 4.0 m south from the ends of the wall (Figure 32). The bench extends 1.0 m out from the base of the wall. Both upstream and downstream from Site -2254, the sides of the stream have been excavated so as to make them nearly vertical. Such modifications did not occur at the Site -2254 locale as the wall has kept the slope vertical through time. This suggests that the site predates whatever stream modifications were undertaken later. No artifacts of any era were present within the wall. Also, there was no concrete or coral-based mortar used on this wall. The short wall segment is in fair condition.

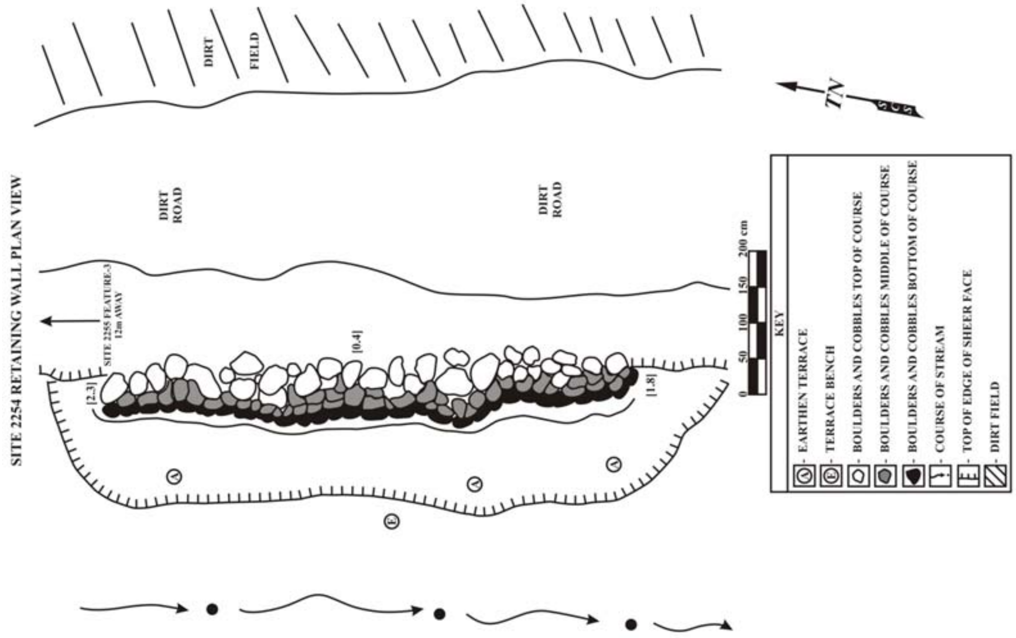

Figure 32. Planview of Site --2254 Retaining Wall.

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Figure 31. Photograph of Site -2254 Retaining Wall. View to East.

STATE SITE NO. 50-30-10-2255 (TS-6)

Site –2255 is composed of four (4) culvert bridges crossing over the east stream that descends from above Site -2252. These culverts were designated as Features 1, 2, 3, and 4, with Feature 1 being the most northern of the group. Features 1 and 2 are present to the north of Site -2254 (retaining wall) and Features 3 and 4 are south of the wall.

Each culvert was constructed in the same way. A corrugated metal pipe, measuring 1.3 m in diameter, is placed directly at the base of the ditch. Packed earth extends from each bank to the pipe, to a height of 0.50 m, with the remainder composed of small boulder-sized, quarried basalt.

Feature 1 measures 6.5 m north-south by 6.0 m and is 2.0 m high from the road surface to the base of the ditch. The bridges long axis is 340 degrees. From the southwest corner of Feature 1 to the southeast corner of Feature 2, the distance is 52 m.

Feature 2 measures 5.8 m east-west by 4.5 m north-south and is 2.4 m high from road surface to the base of the ditch (Figure 33 and Figure 34). The bridge long axis is 90 degrees.

Feature 3 measures 6.1 m east-west by 5.8 m north-south and it is 2.4 m high from road surface to the base of the ditch (Figure 35). The bridge long axis is 90 degrees. Feature 3 is present 44 m from Feature 4.

Feature 4 measures 6.0 m east-west by 5.6 m north-south and it is 2.9 m high from road surface to the base of the ditch. The bridge long axis is 90 degrees. Feature 4 is approximately 25 m north of the junction of the two streams that pass to either side of Site -2252 (ditch, sluice gates).

Figure 33. Photograph of Site -2254 and -2255, Feature 2. View to North.

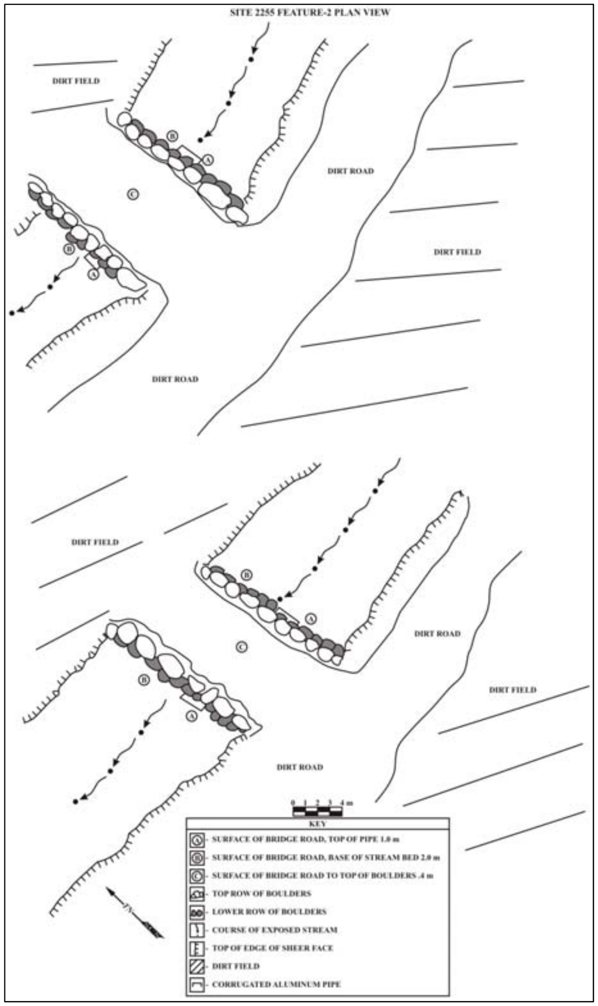

Figure 34. Planview of Site -2255, Feature 2.

Figure 35. Photograph of Site -2255, Feature 3. View to South.

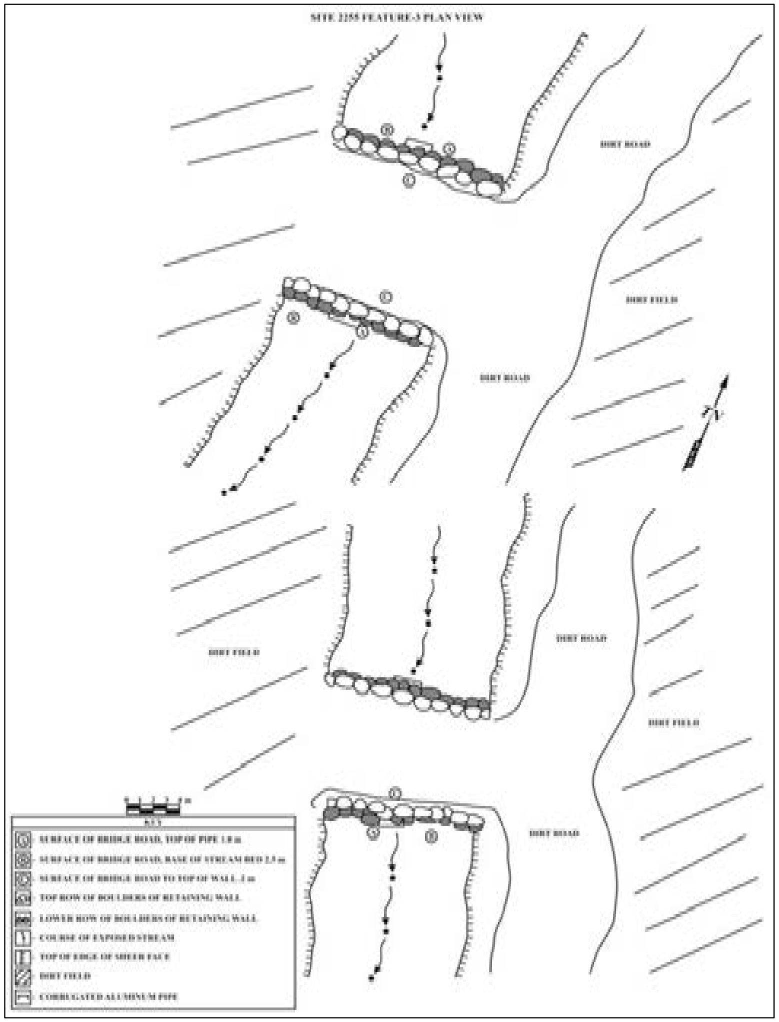

Figure 36. Planview of Site -2255, Feature 3.

STATE SITE NO. 50-30-10-2256 (TS-7)

Site -2256 is composed of a concrete bridge crossing over the west stream that descends from above Site -2252. The bridge itself was manufactured of poured and formed concrete, with a 0.2 m raised curb along each edge. The bridge measures 5.3 m north-south by 5.0 m east-west. The height from the top of the curb to the base of the stream is 3.6 m. The long axis of the bridge is 20 degrees (Figure 37).

Both stream banks have retaining walls supporting the bridge (Figure 38). These are constructed of boulder-sized, quarried basalt and are mortared or cemented together. The wall faces are 3.6 m apart. The base of the west end, of the northern wall is weathered. A surprisingly large tree root is protruding out of the south wall's face. There are no trees remaining on the surface in this area, but there are several dead or cut trees rooted in the stream bed and banks in the immediate vicinity.

The stream bed of the western stream, north and south from the bridge, is deeper and not as modified as the eastern stream. Also, the western stream bed is nearly covered by both water worn basalt and sub-angular basalt. The eastern branch had perhaps 10% of these materials. The eastern branch may have had these materials removed during plantation maintenance. The mix of materials in the west branch suggests that not only was this a flowing stream, but that the other materials may have been pushed into the stream when fields were being cleared. It is possible that those materials were from traditional features such as walls, mounds, or terraces and platforms. The junction of the two streams is 110 m and 150 degrees from Site -2256.

STATE SITE NO. 50-30-10-2257 (TS-8)

Site -2257 is a retaining wall similar to Site -2254 but is not in as a well preserved condition (Figure 39). The feature is constructed of dry stacked, sub-angular basalt cobbles and boulders and is 7.5 meters northwest to southeast, built into the south bank of the Main East ditch's western stream. The width of the surface is approximately 1.0 m. However, the terminus of the southeastern end has partially collapsed and stacked cobbles and boulders are visible in the collapsed bank, suggesting that the internal width is greater than that of the surface. The retaining wall is 4.0 m tall, extending from ground surface to stream bottom. As with Site -2254, there is a bench or terrace present upon which the wall was built. This short segment also appears to pre-date Plantation-era modifications to shore up the ditch in this area as it continued to function well through time, at least until present times. It is presumed to be associated with late prehistoric and/or early historic times and is in very poor condition.

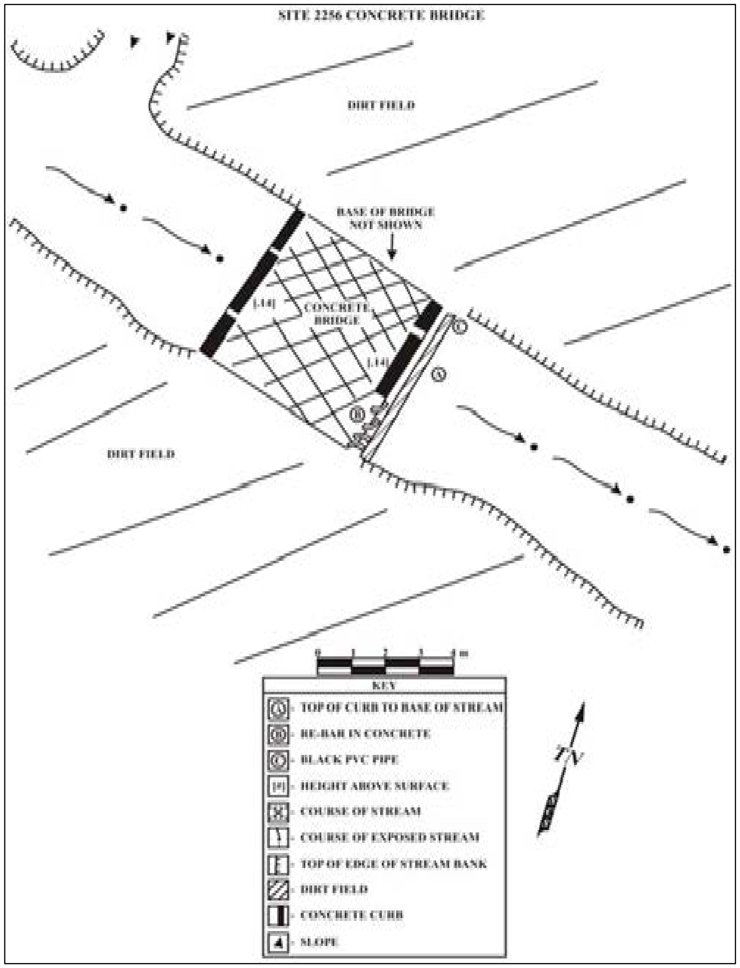

Figure 37. Planview of Site -2256 Bridge Concrete Deck and Floor.

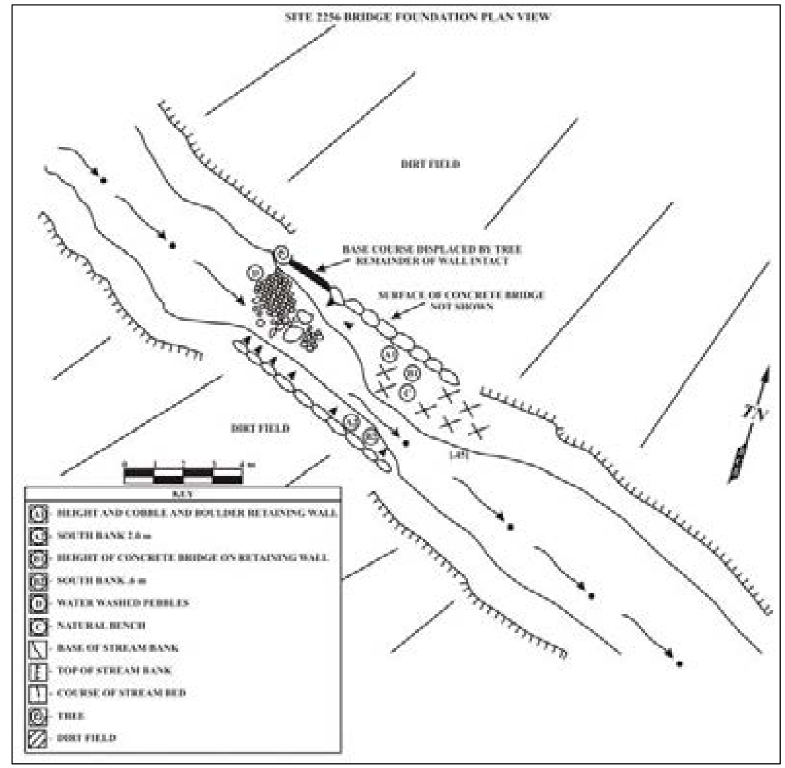

Figure 38. Planview of Site -2256 Bridge Retaining Walls.

Figure 39. Photograph of Site -2257 Retaining Wall Remnant. View to Southwest.

STATE SITE NO. 50-30-10-2258 (TS-9)

Site -2258 consists of the Māhā‘ulepū Reservoir (Figure 40). Built early in the 20th century, it is unknown if there was a spring at this location. The reservoir is large, at least 200 m in diameter. During the time of the field survey in July, 2014 the water level appeared low. The south and east sides of the reservoir are bordered by high, long, and wide dikes or levees. The ground level ascends to the north and west and so additions were not required on these sides. A metal catwalk extends from the southern dike into the reservoir. This is part of the irrigation pipe and pump system that releases water into the Main western ditch that feeds the taro fields at the south end of the valley.

STATE SITE NO. 50-30-10-2259 (TS-10)

Site -2259 consists of a Plantation-era irrigation ditch that extends southward from Site -2258 along the base of a slope at the western side of Māhā‘ulepū Valley. The earthen ditch is c. 2 m wide and extends along the northern borders of Paddock 112 to P-105 (Figure 41; see Figure 6). The feature is similar in design, measurement, and function to Site -2251. The ditch measures 2.0 m wide and the depth varies up to 2.5 m deep. The length of the ditch is approximately 1,020 m (3,323 ft.) and extends south from the reservoir.

STATE SITE NO. 50-30-10-2260 (TS-11)

Site -2260 is an historic bridge that crosses over a natural stream that enters Māhā‘ulepū Valley from the western ridge (Figure 42). The stream originates between named peaks, Kalaeakohani to the south and Kolopa to the north. Like the streams entering the valley from the north, this watercourse has been modified upon its entrance into the valley. The bridge surface is comprised of two concrete slabs measuring 7.5 m north-south by 3.0 m east-west and are 0.2 m thick. The long axis is oriented at 210 degrees and the slabs have a 0.1 m gap between them. The west side of the bridge is not modified. The east side of the bridge has a concrete curb that extends 6.8 m and 0.31 m wide. The interior height of the bridge is 0.56 m, while the exterior height is 0.89 m. An iron railing is affixed to the top of the curb. This railing appears to be a from the narrow gauge railroad that once extended along the southwestern flank of Māhā‘ulepū Valley. Within the stream bed, there are remnants of dry stacked basalt cobble retaining walls on the north and south banks of the west side of the bridge. Inscribed on the exterior face of the curb is the number or date “1951”, with a flourish on the upper bar of the 5 (Figure 43 through Figure 45).


Figure 41. Photograph of Site -2259 Ditch. View to West.

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Figure 40. Photograph of Site -2258 Reservoir. View to North.

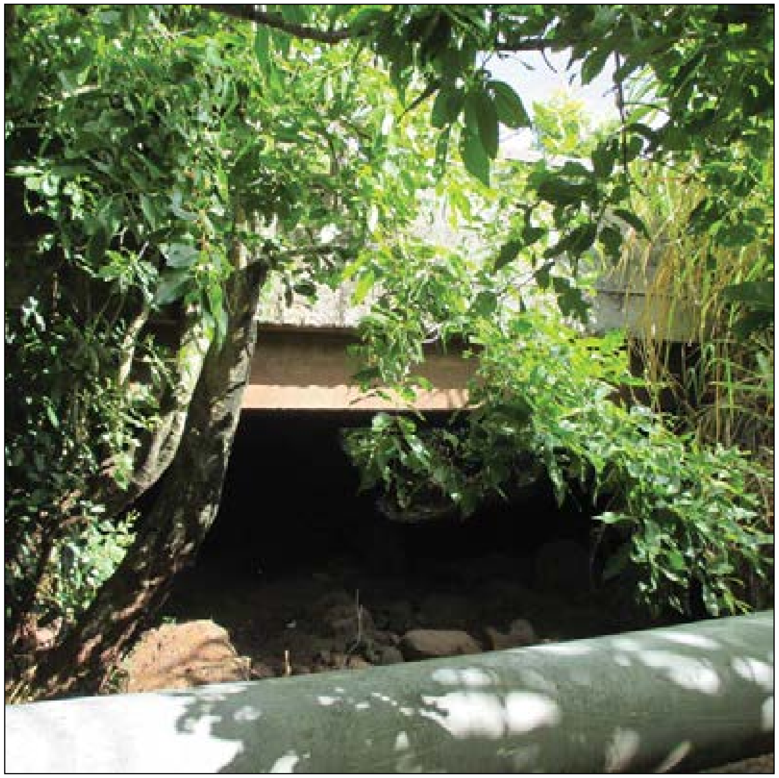

Figure 42. Photograph of Site -2260 Bridge. View to West.

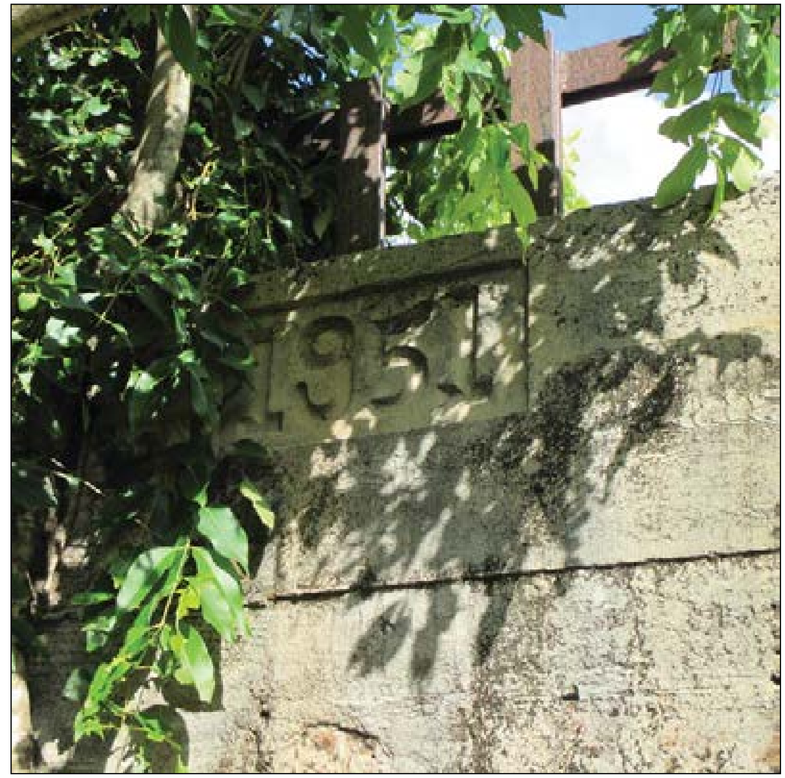

Figure 43. Photograph of Site -2260 Bridge Date. View to Southwest.

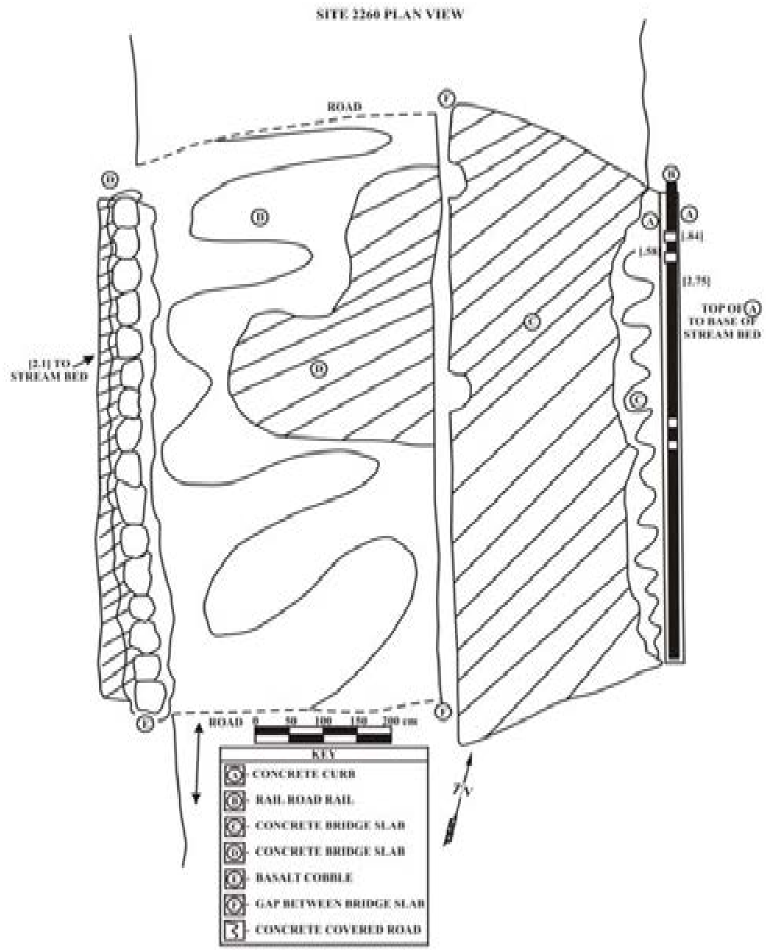

Figure 44. Planview of Site -2260 Bridge Attributes.

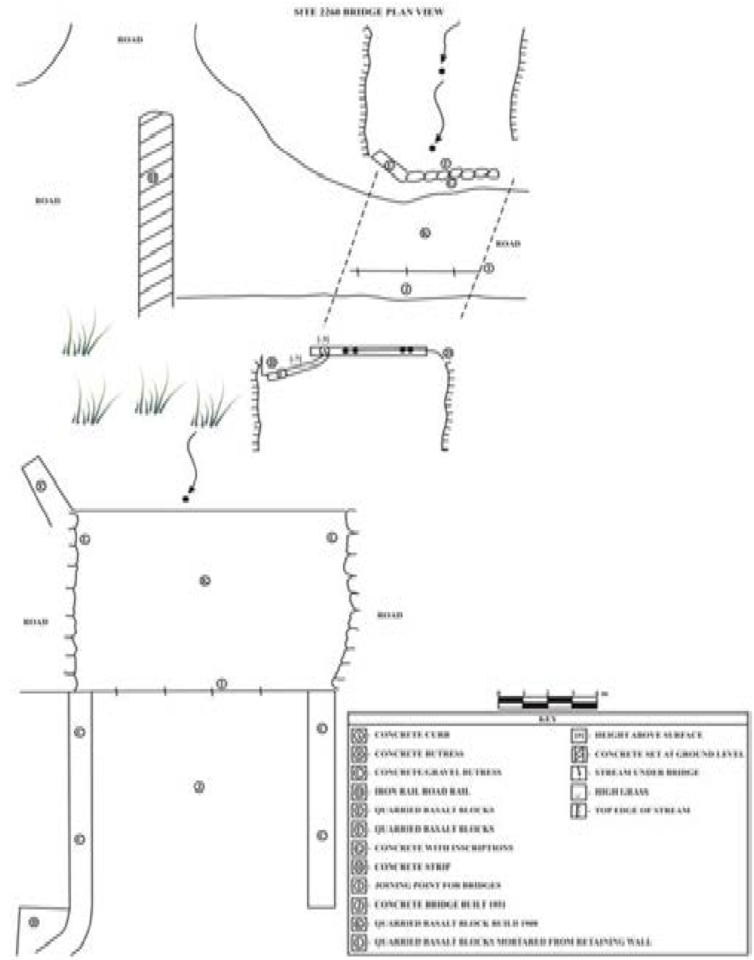

Figure 45. Planview of Site -2260 Bridge.

STATE SITE NO. 50-30-10-2261 (TS-12)

Site -2261 consists of a bridge crossing over the Main East ditch at the southern end of the project area. Māhā‘ulepū Road crosses the bridge (Figure 46). This bridge is unique to the project area in that it shows two distinct phases of construction. The bridge measures 10 meters east-west by 8.5 m north-south, with each style of construction composing approximately half of the bridge.

The northern half of the bridge is constructed of boulder-sized, quarried basalt which are mortared into place to form retaining walls on the east and west stream banks, as well as the north and south flanks. The northern side is clearly visible from the fields and road to the north but the southern side must be viewed from within the stream bed. Both of these sides show an artisan’s flair in that there is an arch to the bridge that is not seen on any other feature within the valley. On the north edge of the bridge surface there is a concrete curb with a basalt cobble alignment upon it. Inscribed in the surface of the concrete is “July 30, 1908”. There is 0.35 m of gravel and dirt forming the road above the concrete. From road surface to the base of the stream bed measures 2.4 meters.

The southern half of the bridge is constructed entirely of concrete. Concrete retaining walls line both banks of the watercourse. These descend 1.9 m to an extended 0.5 m foundation on the stream bed. On the southern side of the concrete bridge is a concrete curb which is 0.9 m high and extends to the surface of the concrete retaining walls. An iron rail is affixed to its surface, which is similar to that at Site -2260. Clearly, the narrow gauge railroad along the southern portion, of the western half of the valley, was dismantled. Salvaged materials were utilized for other plantation projects. On the southern face of the concrete curb there is the inscription “1951”, again with a flair on the upper bar of the 5 (Figure 47). “1951” appears to be the year in which many modifications occurred on the plantation. No other bridge found during the AIS shows such obvious evidence of additional phases of construction.

[Note: Temporary Site 13 was assigned to the Site -3094 petroglyph boulders and has been deleted herein; the petroglyph boulders are designated under Site -3094 below).

Figure 46. Photograph of Site -2261 Bridge, Showing 1908 Section and 1951 Section. View to Northeast.

Figure 47. Photograph of Site -2261 Bridge Date. View to South.

STATE SITE NO. 50-30-10-2263 TS-14)

Site -2263 consists of a bridge crossing over the Main East Ditch, on the east-west extent of Māhā‘ulepū Road. The bridge is adjacent to, and northwest of, the many LCA awards at the center of the valley. The site is a culvert bridge which appears to have been built in stages (Figure 48). The base within the streambed consists of 3 to 4 courses of boulder-sized, quarried basalt which are mortared on either side of a concrete culvert, the latter which measures 1.0 m in diameter. The culvert appears to be younger in origin than the walls to either side. The mortared blocks extend halfway up the side of the concrete culvert. On them are dry stacked, sub-angular, vesicular basalt boulders which extend from 0.5 m to 1.5 m above the stream bed. On top of this are boulders of a similar type which are mortared together and extend from 1.5 m to 2.0 m above the stream bed (Figure 49). Additionally, along the western side of the large culvert are two smaller concrete culverts, one above the other. This culvert bridge appears to have been constructed and provided with additions over time.

STATE SITE NO. 50-30-10-2264 (TS-15)

Site -2264 is the remnant of an irrigation pipe that appears to have crossed over the Main East Ditch, immediately south of the location where the east and west streams that pass Site -2252 join together. There is a partially collapsed concrete foundation on the east side of the ditch, with a corrugated metal pipe 0.6 m in diameter extending 0.9 m from it (Figure 50). The intact remnant of the concrete foundation measures 2.2 m north-south by 1.0 m east-west and is 0.6 m high. On the far bank, concrete rubble is present. Upstream from this point, the stream beds are dry, but downstream there is an increasing water flow. It is unclear at present if the source of the flow is from the pipe or from a spring within the stream bed.

Figure 48. Photograph of Site -2263 Bridge. View to South.

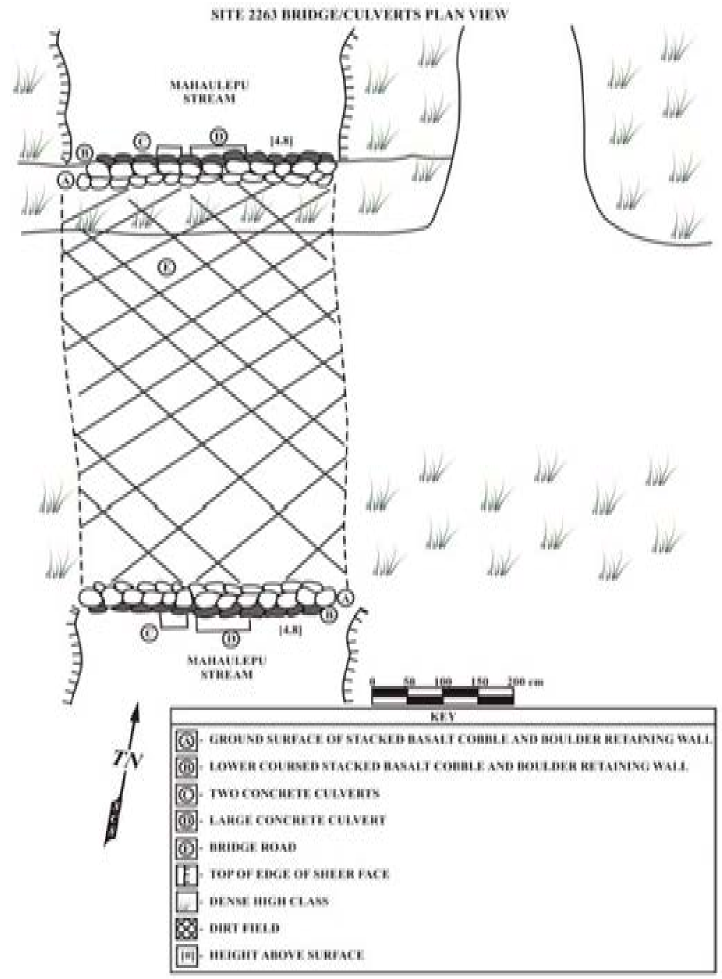

Figure 49. Planview of Site -2263, Retaining Walls and Culverts.

Figure 50. Photograph of Site -2264 Culvert and Pipe. View to Northeast.

STATE SITE NO. 50-30-10-2262 (TS-16)

Site -2262 is composed of three features and was identified in the northwestern portion of Māhā‘ulepū Valley, just outside the current 580-acre project area (see Figure 12; Figure 54). This site was identified during August, 2014 sweeps of a 100 m zone past the current project area limits. Field personnel were kindly given a right-of-entry permit by Grove Farms to conduct the additional survey work.

Feature 1 consists of an irrigation flume constructed of concrete foundations, a trestle of wooden beams, a concrete bridge, a concrete wall that extends east and west from the southern end of the bridge, and an open-topped metal culvert (Figure 55 through Figure 58). The overall length of the entire structure is 14.0 m and the overall width is 2.3 meters. The culvert measures 14.0 m long by 1.0 m wide and is 0.5 m deep. The supporting concrete bridge is 14.0 m long by 1.5 m wide and is 0.2 m thick. The southern concrete foundation measures 2.0 m long by 0.45 m wide and is 0.85 m tall. The long axis is oriented east-west. The southern foundation contains a trestle of wooden beams on top that support the base of the concrete bridge. The northern concrete foundation measures 2.3 m long by 0.45 m wide and is 2.5 m tall. The north foundation directly supports the base of the concrete bridge. The base of the concrete bridge is 3.2 m above the base of the irrigation ditch (Site -2253) that the flume crosses over. The ends of the flume are within a stream course which descends from the north into the valley. This stream course eventually braids with the two courses to the east and forms Māhā‘ulepū Ditch. Each branch of the concrete wall extending east and west from the south end of the concrete bridge measures 2.0 m long by 0.45 m high and is 0.15 m thick. Feature 2 extends from the eastern flank of the east wall.

Feature 2 consists of a concrete sluice gate. The overall length is 3.0 m, with the central opening measuring 1.0 m wide. The concrete side walls measure 1.0 m long by 0.45 m tall and are 0.15 m thick. Where the walls face each other, the concrete is grooved vertically, but there is no remnant of a metal or wooden gate. The opening faces east, On top of the south wall “J Torre” is inscribed into the concrete. On top of the north wall is the inscription “1924”.

Feature 3 consists of a pair of sluice gates located to the south of, but not contiguous with Feature 2. They are placed at the end of a short ditch extending away from the stream course. The walls of this ditch are paved with concrete. At the gates, there is a central concrete pillar separating the openings, as well as concrete walls extending away from the opening. Basalt cobbles support the exterior of the concrete walls. A narrow gauge railroad rail is incorporated into the top of, but not on top of, both walls and the column. Each gate opening measures 0.6 m wide by 0.9 m tall, from the base of the ditch to the top of column. The column measures 0.2 m on each side and is 0.9 m tall. Each concrete wall measures 0.7 m long by 0.2 m wide by 0.9 m tall. The ends of the concrete walls facing the column and the corresponding faces of the column are grooved vertically but there is no remnant of a metal or wooden gate. Inscribed into the concrete surface of the north wing wall is “Koloa Plantation, April 12/24 By D.S.K.”.

Site -2262 crosses over Site -2253, to the northeast of Site -2258, Māhāʻulepū Reservoir. Site -2253 is an irrigation ditch which terminates at the reservoir on its south end and connects to Site -2252 on its north end. The north and south ends of Site -2262 are within a streambed that descends from the north. Site -2262 was built after the excavation of Site -2253. Site -2262 has multiple functions: to carry stream water over the irrigation ditch and continue its flow into the valley as a source for Māhāʻulepū Ditch. With three mountain born water sources braided together at the north end of the valley floor, the original Māhāʻulepū Stream, later modified to become Māhāʻulepū Ditch, would have been a substantial water course even prior to the sugar cane industry.

The sluice gates of Features 2 and 3 face eastward. Flow from the stream would have emptied into Site -2253, the irrigation ditch and presumably carried it to Site -2258, Māhāʻulepū Reservoir. The date of the inscriptions at both gates gives the year “1924”. This shows that excavation of the ditch that incorporates Sites -2251, -2252, -2253, and -2259 predates the construction of -2262. The concrete bridge of Feature 1 is collapsed upon the northern concrete foundation. The wooden trestle is standing but the beams are rotting.

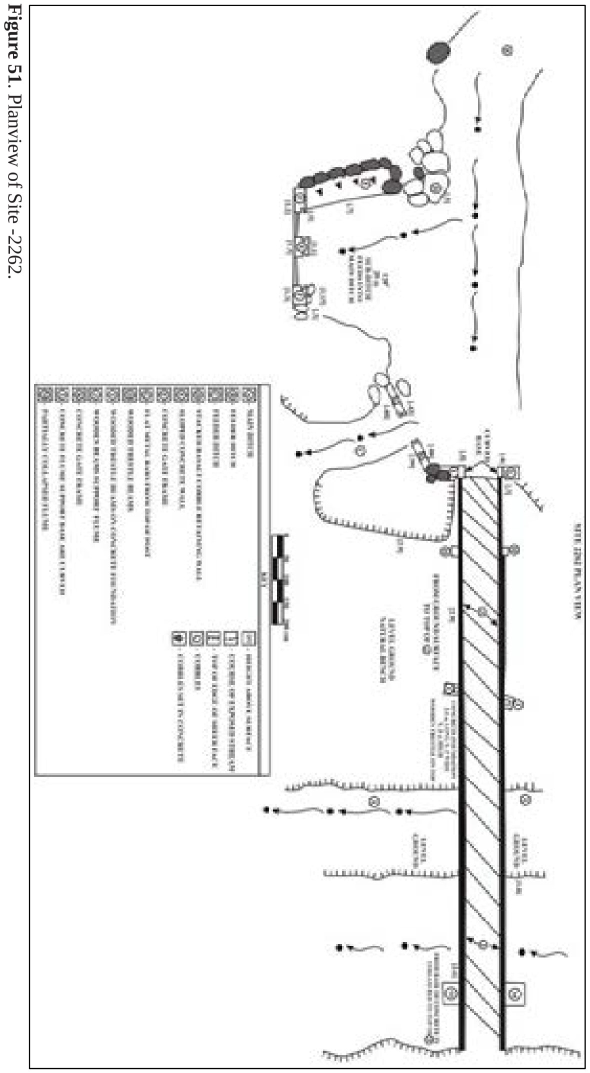

Figure 51. Planview of Site -2262.

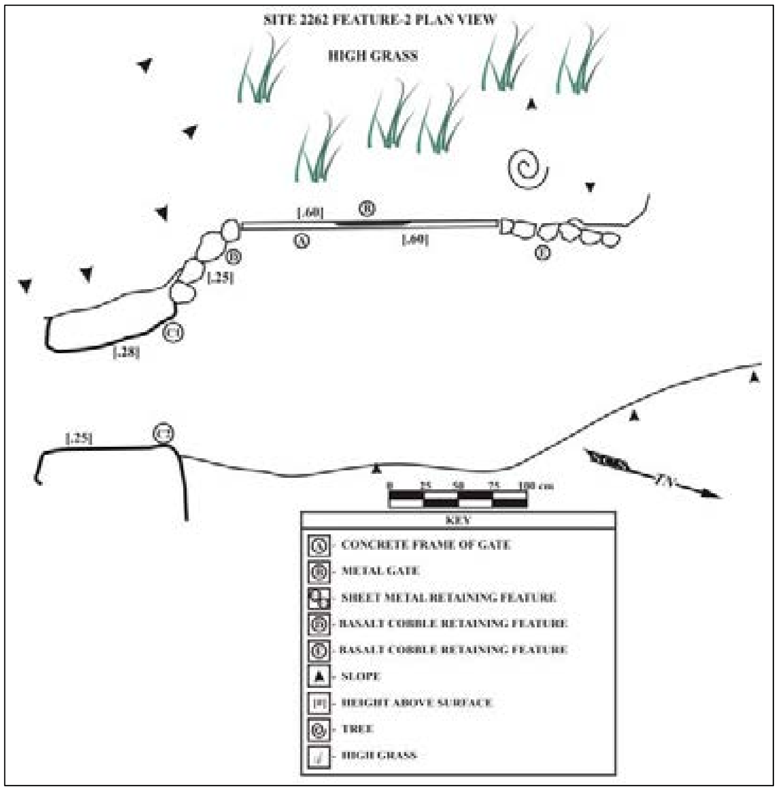

Figure 52. Planview of Site -2262, Feature 2 Retaining Features.

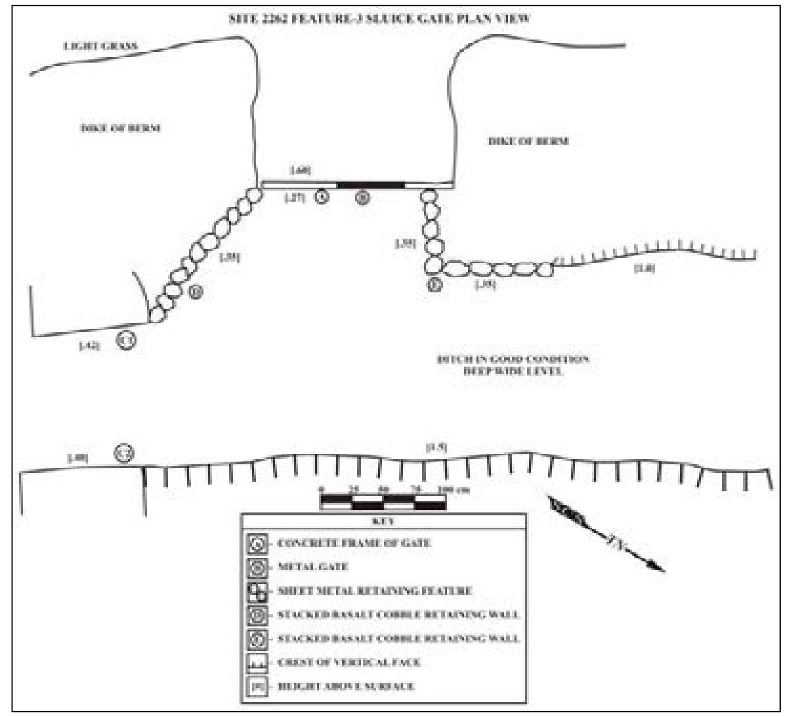

Figure 53. Planview of Site -2262, Feature 3 Retaining Walls.

Figure 55. Photograph of Site -2262 Structural Supports of the Flume. View to East.

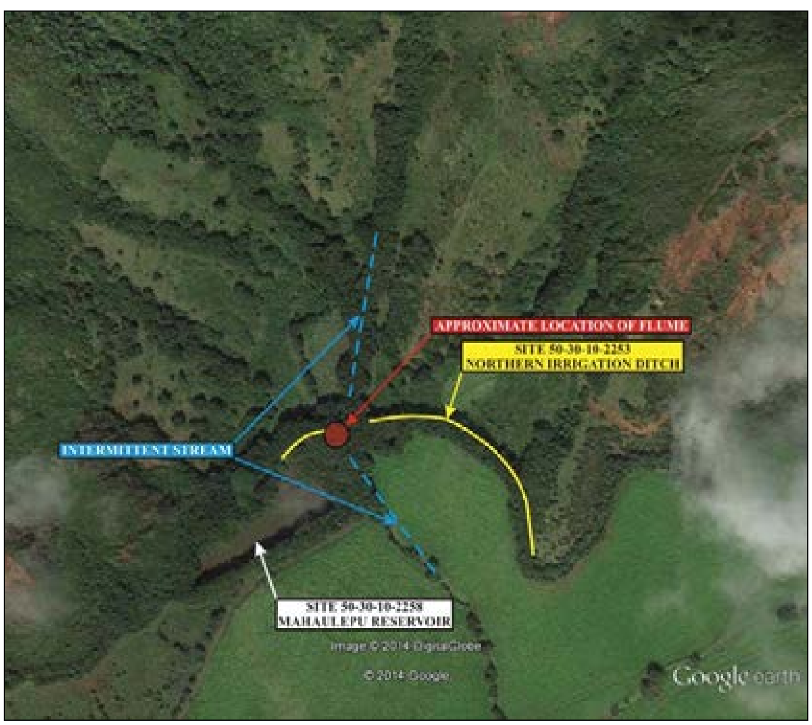

Figure 54. Google Earth Aerial Showing Location of Site -2262 in Relation to the Project Area and Sites -2253 and -2258.

Figure 57. Photograph of Site -2262 Flume System. View to Northeast.

Figure 56. Photograph of Site -2262 North Bank Foundation. View to North.

Figure 58. Photograph of Site -2262 Double Gate with Cement and Rock Wall to Prevent Erosion. View to North.

STATE SITE NO. 50-30-10-3094

Site -3094 consists of a previously identified petroglyph rock, with two other petroglyph rocks (designated as Feature 2 and Feature 3), having been identified during the current survey. Feature 3 was identified by the SHPD-Kauai representative during a field visit in 2014. Feature 1 is a large petroglyph boulder. Feature 2 is either exposed bedrock or a buried boulder with two petroglyphs visible located 20 m southeast from, and in the same clearing as Feature 1. Feature 3 is located approximately 70 m to the northeast of Feature 1, and is at the base of the wooded slope.

Feature 1 consists of a large boulder on the ground surface of Paddock 120 in the north/northeastern portion of the project area (Figure 59). The paddock is currently covered by tall grasses (Figure 66). Excavation of test trenches during this project showed that the ground east, north, and west of the boulder had been plowed for the cultivation of sugar cane. To the south, however, the test trench exposed an intact natural stratigraphy. The area south from the boulder extends to one branch of the southward flowing Mahaulepu Stream. This confined area, the absence of disturbed soils, and the absence of any signs of impact by machinery on the boulder indicate that care had been taken not to disturb the boulder.

The boulder measures 4.0 m long by 3.8 m wide, with the long axis north to south. The boulder is 1.1 m high at its northern end, 1.3m at its center, and ranges from 0.6 to 0.8 m high at the southern end. The eastern, northern and southern faces are vertical, while the southern end slopes steeply in the ground surface. The ground to the south is at a slightly higher elevation than the boulder, and the ground slopes away from the boulder in the other directions. The high center of the boulder is an east to west extending ridge across the top of the boulder. From this crest the top surface of the boulder is smooth and descends gradually northward. On the east and northwest sides of the surface, the surface slopes slightly before turning into vertical faces. The remaining sides of the boulder are all vertical to the top surface.

South from the crest the slope is shorter, steeper, and the surface is rough and pockmarked from natural causes.

At the crest of the ridge is a pecked cup or basin measuring 0.1 m in diameter and is 0.1 m deep. From this cup is a pecked groove approximately 0.03 m wide and approximately 0.01 m deep that descends northward in a gradual curve across the surface of the boulder, ending at the northwest side. Parallel to this groove is a natural bifurcated fissure that descends with one branch ending at the northwest end of the boulder next to the groove and the other branch ending at the northeast end.

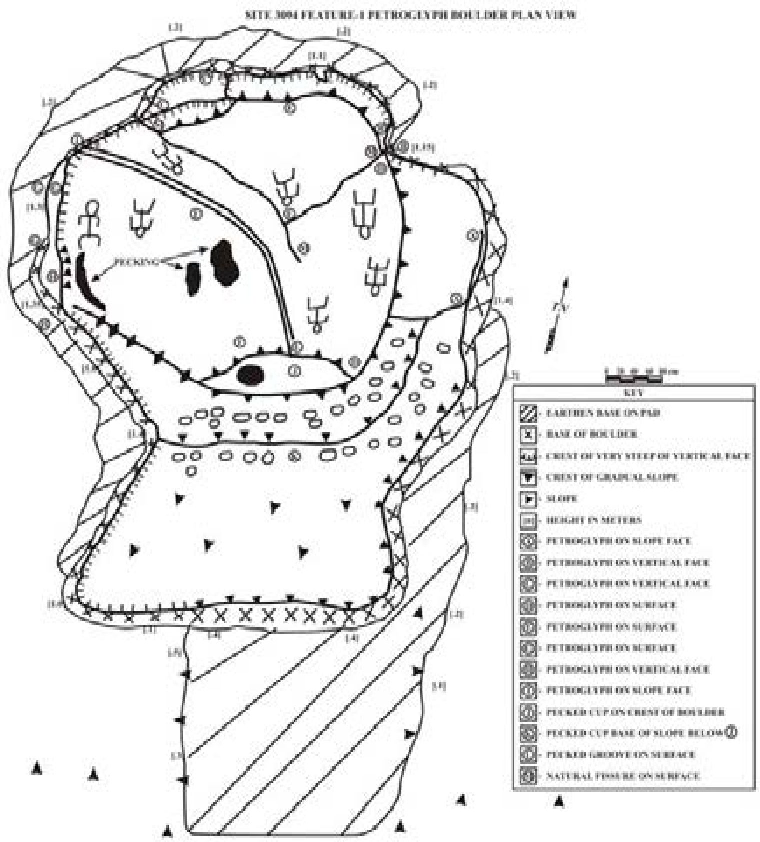

Figure 59. Planview of Site -3094, Feature 1 Overview.

Petroglyphs representing human figures are pecked in to four vertical faces, two sloped faces, and the top surface of the north end of the boulder. On the top surface, there are figures on either side of the groove, and all sides of fissure, and one is placed between the groove and the fissure. These were documented and illustrated as separate panels but the panels are regarded as being part of the whole entity of the boulder (Figure 60 through Figure 69).

The vertical and sloped panels each have between one and three figures, while the top surface has a total of seven figures. Some panels have pecked areas and/or lines as well. What these pecked areas represent is not currently understood. The petroglyphs are stick figured and limbed, with round heads. There are figures with extensions at the ends of limbs and at least one has male genitalia represented. The figures vary in size but do not exceed 0.3 m in length or width.

There are no figures on the slope south from the crest but there is a second pecked basin or cup, this one at the base of the slope. It has the same dimensions as the one at the crest, but there are no associated figures, grooves, or fissures.

The meaning of these petroglyphs and their placements on the boulder is open to interpretation. One interpretation is that, despite being oriented in the opposite direction, the crest represents Ha`upu Ridge, and Mount Ha`upu, and the groove represents Mahaulepu Stream as it descends and curves to the coast. The basins may represent head waters to streams. The petroglyphs may represent population centers, chieftains or the divine. The fissure, being natural, may represent either another stream course, or perhaps a ridgeline. Another interpretation is that these are all representing someplace on Kauai where a stream actually does flow north. It may be that all of this represents some facet of navigation, ceremony, cosmology, or documentation of events which we do not as of yet understand.

During the current AIS, a second feature with petroglyphs was identified. The feature was identified by the backhoe driver as he was clearing grasses in the area to conduct trenching around the Feature 1 boulder. Feature 2 is located 20 m (at 140 degrees) from the Feature 1, originally discovered boulder. This second "boulder" is only slightly exposed at ground surface and may actually be a natural basalt outcrop. Feature 2 measures 1.5 m in diameter and rises only 0.2 m above the current ground surface. The exposed rock measures 1.72 m (north flank) by 1.98 m (east side). The figures are different from those of the other boulder. Figures on the second boulder are not as clearly defined. There is a stick-figured human standing legs apart and wide-armed, holding what appears to be a spear upright in his right hand. Perpendicular to this is a three-leafed image on a staff, possibly a *kahili* image. Neither of these are as clearly defined as those on the larger Feature 1 boulder, which is not surprising considering it occurs on the surface of the fields. Other scratches on the boulder surface are indistinct (Figure 70).

Because Feature 2 is at ground surface level, and because there are fewer, less distinct images, it appears these were etched for a different purpose than from that of the larger boulder. If the figure is a *kahili*, then this could indicate the area being decreed *kapu*. A *kapu* could be seasonal, periodical, or eternal. This may explain why the main boulder was left intact and *in situ* throughout the Kingdom and the modern era. The figure that appears to be holding a staff or spear is not as distinct as those figures on Feature 1. None of the Feature 1 figures appear to be holding anything.

Feature 3 is located some distance from Features 1 and 2 near the fence line, some 70 m to the north/northeast of Features 1 and 2. Feature 3 consists of several human figures with stick torsos and limbs. These are located on the *mauka* face of a large, slab-like boulder. This boulder measures 2.5 m by 2.1 m by 1.7 m tall, with its long axis northeast to southwest (Figure 71). The figures of Feature 3 are slightly larger than those of Feature 1. The meaning and purpose of Feature 3 is open for interpretation but likely represents individuals of the area.

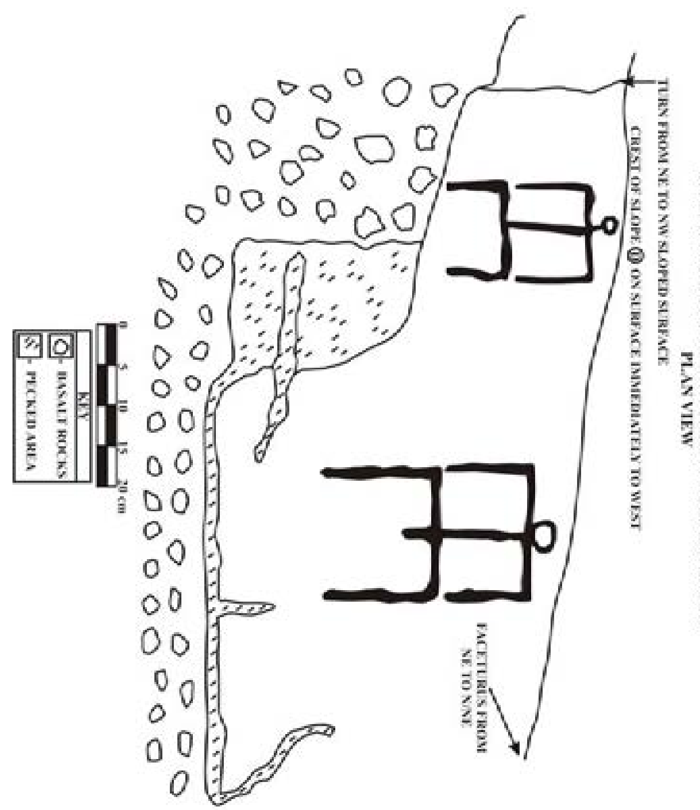

Figure 60. Planview of Site -3094, Feature 1 Panel A.

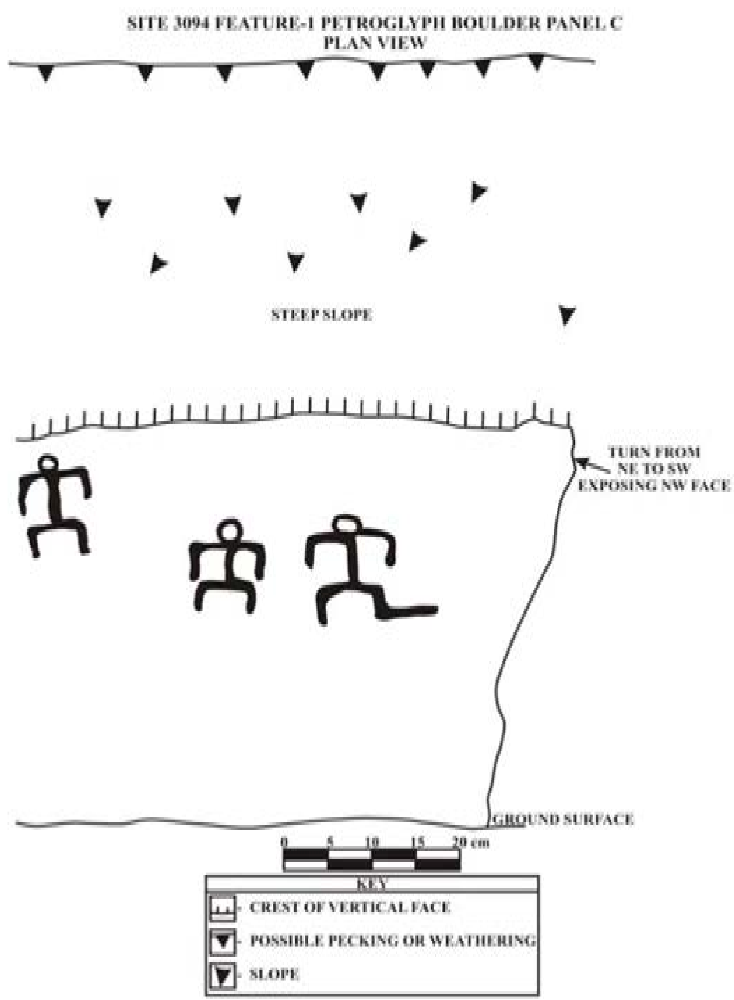

Figure 61. Planview of Site -3094, Feature 1 Panel C.

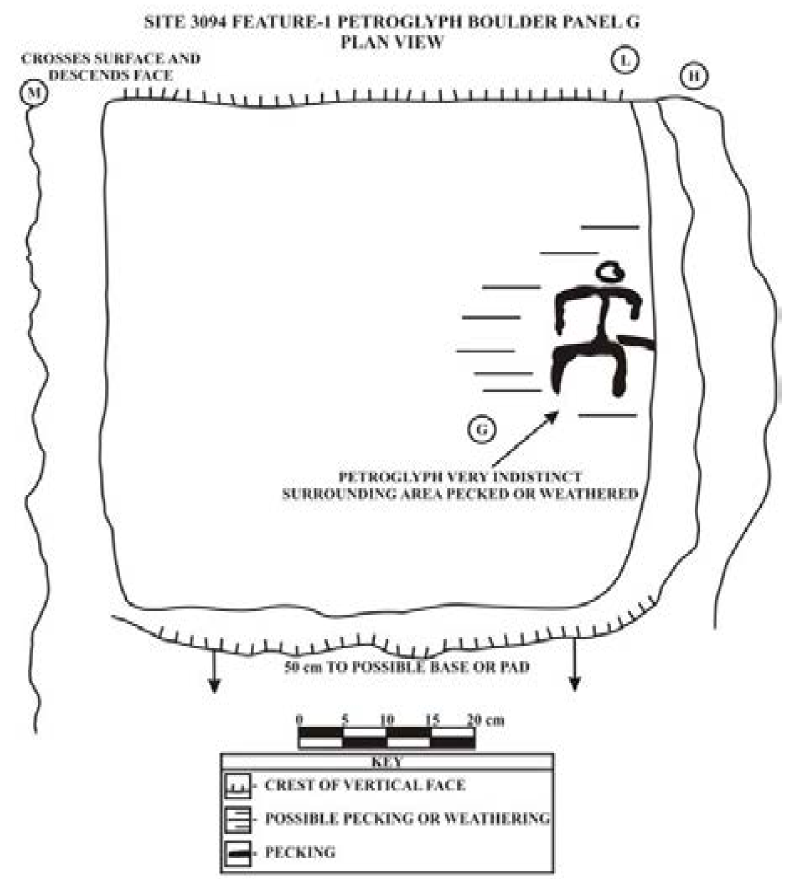

Figure 62. Planview of Site -3094, Feature 1 Panel G.

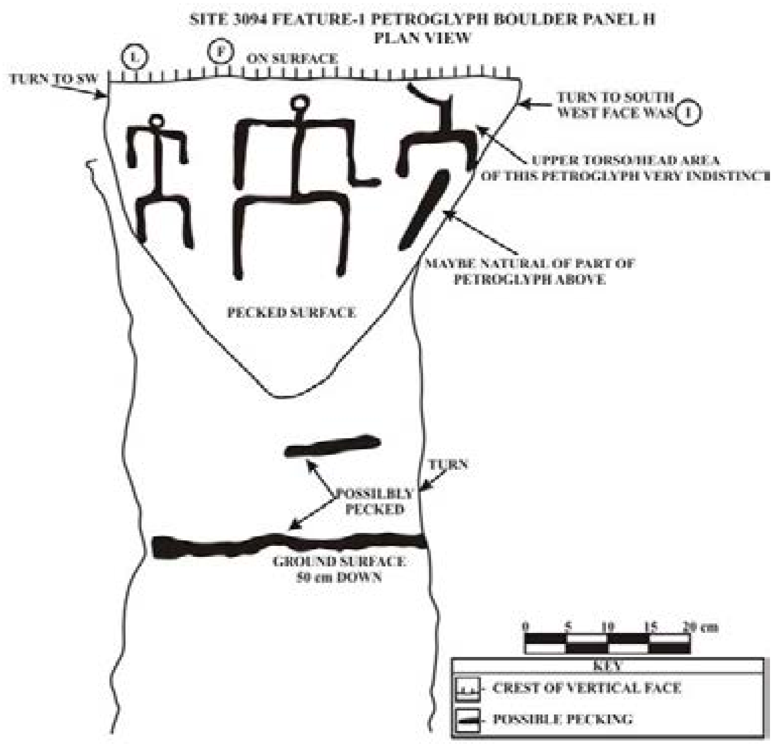

Figure 63. Planview of Site -3094, Feature 1 Panel H.

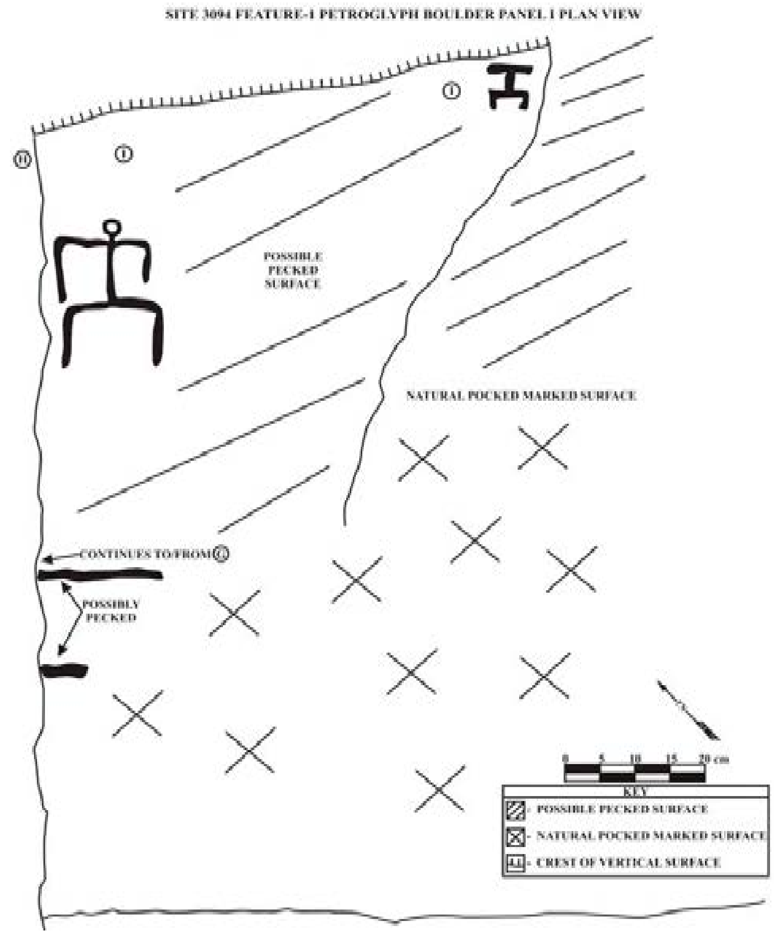

Figure 64. Planview of Site -3904, Feature 1 Panel I.

Figure 66. Photograph of Site -3094 Petroglyph Boulder in Field. View to East..

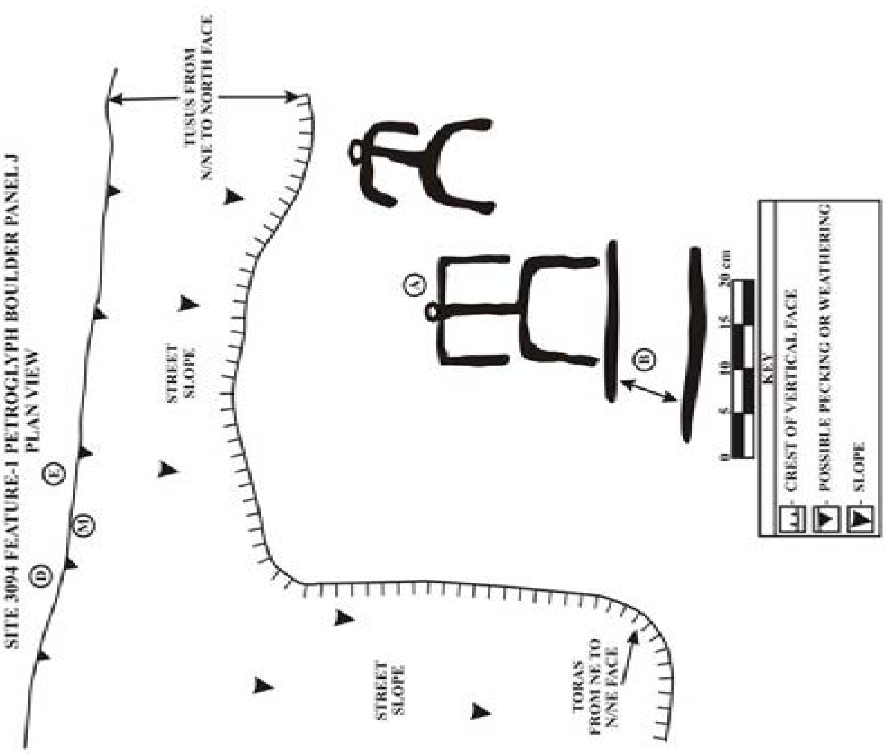

Figure 65. Planview of Site -3094, Feature 1 Panel J.

Figure 67. Photograph of Site -3094 Surface of Petroglyph Boulder. Note Groove down Center and Anthropomorphic Figures on Either Side of Groove. View to South.

Figure 68. Photograph of Site -3094 Petroglyphs, North Side of Boulder. View to South.

Figure 69. Photograph of Site -3094 Petroglyphs and Pecked Cup at East End of Boulder. View to West.

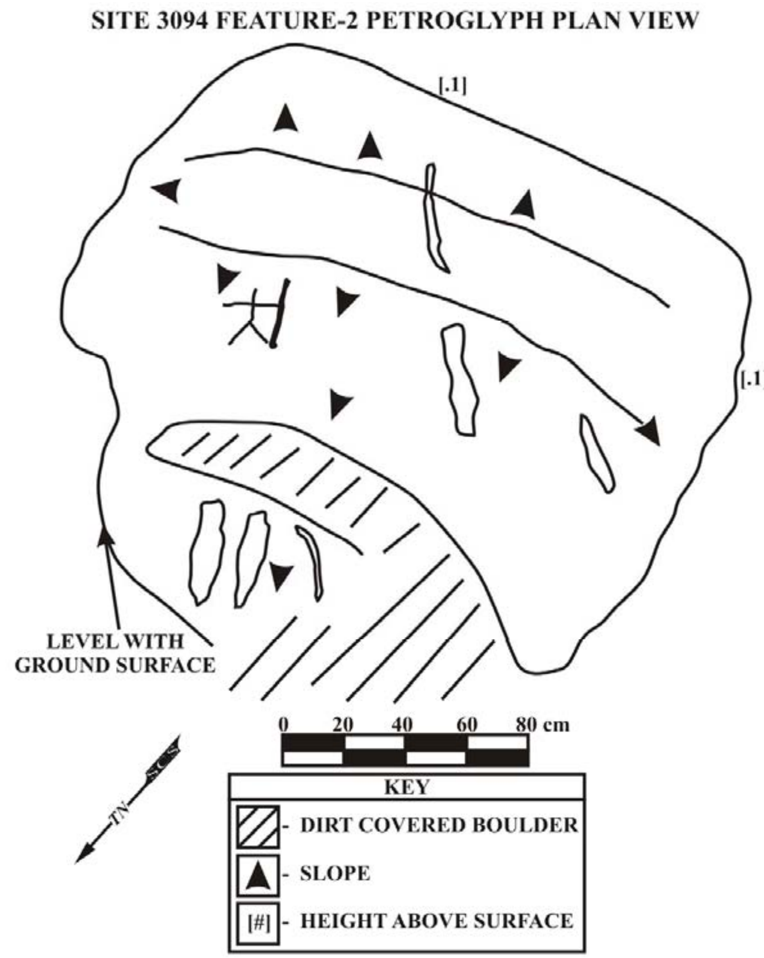

Figure 70. Planview of Site -3094, Feature 2 Petrogylph Panel.

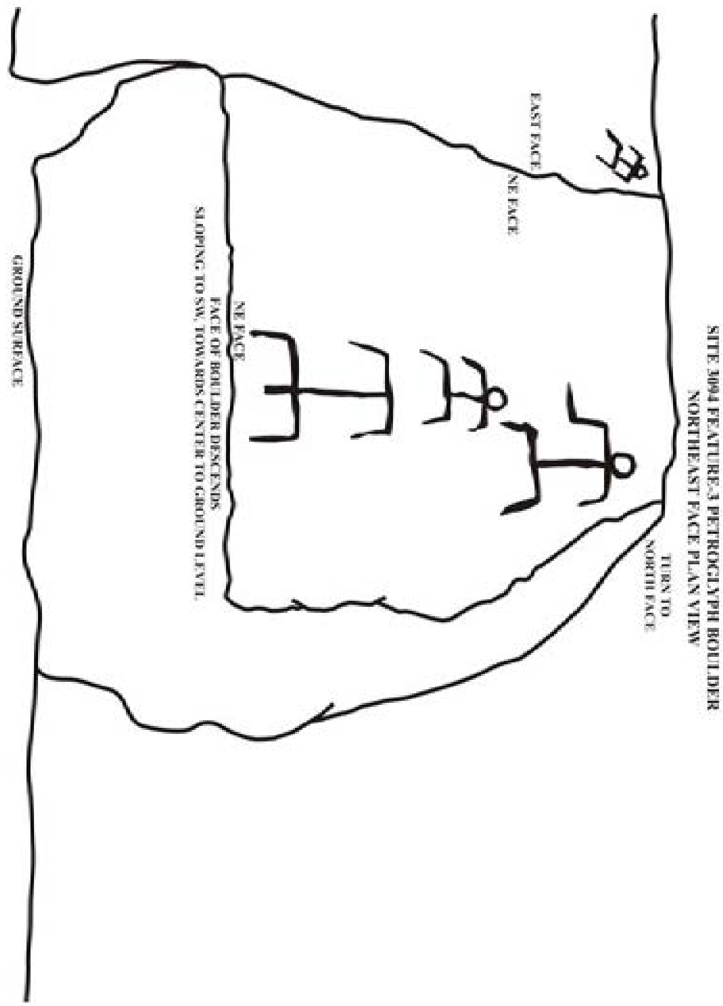

Figure 71. Planview of Site -3094, Feature 3 Petroglyph Panel.

STRATIGRAPHIC TRENCH EXCAVATIONS: OVERVIEW

Stratigraphic trench excavations were conducted mechanically (backhoe) in areas within and around historically interesting areas, one known site (Site -3094), and proposed effluent ponds along the western flank of the project area (Figure 72 and Figure 73). Primary among these areas tested were the cluster of LCA's located on the east side of the Main East Ditch. These LCAs were awarded during the Great Mahele in 1848 and were occupied and/or utilized until approximately the 1880s, when individual ownerships passed over to group and corporate development for the Koloa Sugar Cane Plantation.

A total of nine (9) trenches were mechanically excavated within the exact location of the former LCA cluster area (see Figure 47). The trenches, designated Stratigraphic Trenches (ST) were numbered sequentially and excavated in rows of three. The southernmost row, ST-1 to ST-3 was excavated west to east. The middle row, ST-4 to ST 6, was excavated east to west. The northernmost row, ST-7 to ST-9, was excavated east to west. This area is identified on the soils map (see Figure 6) as P-131 through P-134. To the east from this point, P-135 to P-137 is currently marshland and an excavator could not safely be brought in to excavate. The previously noted soils map identified the soils exposed by ST-1 through ST-9 as KavB or Kaena Clay, Brown Variant.

The next area of excavation occurred around Site -3094, the petroglyph boulder. Four (4) trenches were mechanically excavated here. This area is identified on the soils map as P-120. The soils map identified the soils exposed by ST-10 through ST-13 as HsD or Hanamaulu Silty Clay.

A single trench was excavated east of the -2254 retaining wall in an attempt to find remnants of a historic household that is shown on older maps of the area. This area is identified on the soils map as P-161 and P-162. The soils map identified these soils as KavB or Kaena Clay, Brown Variant.

Trenches were desired on a small knoll at the northwest turn of Māhā‘ulepū Road. However, a trench with water lines is present alongside the road and prevented access to this area. On older maps of the area, this location is designated as "Camp", but no further explanation is provided. Instead, two trenches were excavated to the southeast of the knoll, in the fields south of existing pump station structures. These structures service a series of wells known as Māhā‘ulepū 14, drilled during the 20th century to service irrigation for the plantation. This area is identified on the soils map as P-103. The soils map identified the soils as KavB or Kaena Clay, Brown Variant.

Figure 73. Google Earth Aerial Photograph Showing Stratigraphic Trench Locations.

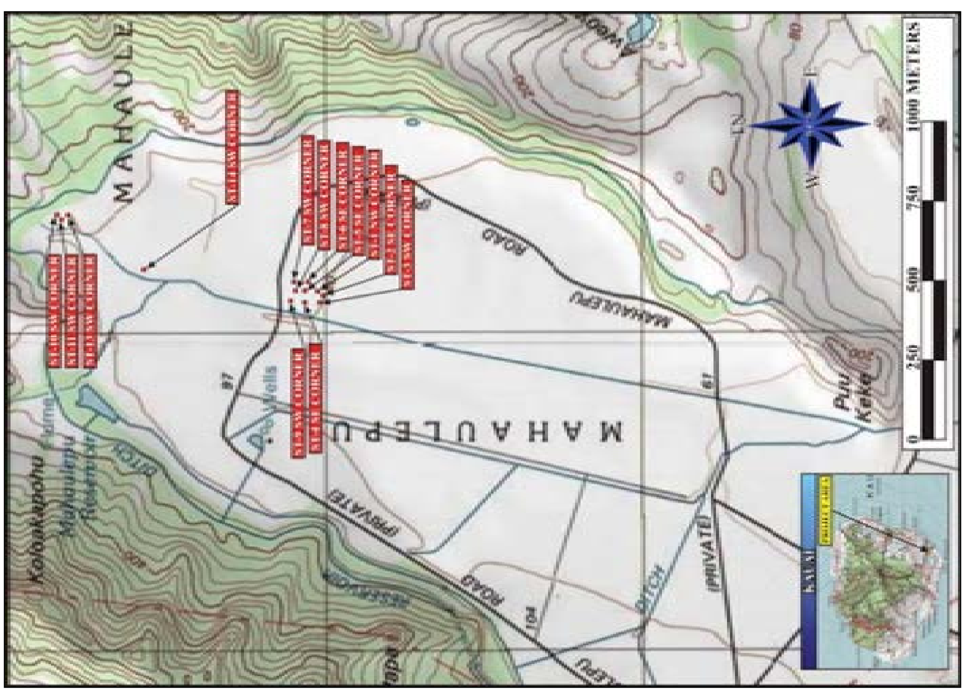

Figure 72. USGS Map Depicting Stratigraphic Trench Locations.

A final trench was excavated within the area of the Effluent Ponds and other infrastructure to be constructed for the proposed dairy. This area is identified on the soils map as P-201 and soils are also identified as KavB or Kaena Clay, Brown Variant.

Specific Trenching Methods and Data

All trenches were excavated with use of a small, tracked, excavator. Each trench was 10.0 m long (9.14 m being the average open space, the remaining 0.86 consisting of the ramp into the trenches) and the width of the bucket, 0.75m wide. Depth of the trenches varied, depending on the water table. If the table was encountered, excavation was halted. If the water table was not encountered, excavation extended to 2.0 m below the ground surface for the first 2.0 m of the trench, and then was reduced to 1.5 m for the remainder. In every trench, the uppermost 0.2 to 0.8 m below ground surface was composed of grey brown loam with fine grass roots. This was identified as a disturbed plow zone. The trenches excavated in rows (LCA area) were 20 m apart and the rows were approximately 40 m apart. Each trench was documented with soil descriptions, profiles, written descriptions, and photographs.

At each trench location, an area approximately 15 m wide and long was cleared by the excavator down to the ground surface. This was done to allow complete views of the interior of the trench, to expose areas around it in the event of additional excavations, and in order to facilitate greater ease and access when back filling was undertaken.

A total of seventeen stratigraphic trenches were mechanically excavated. The greatest concentration of these was within the area identified as containing numerous LCA properties. The second largest concentration was around Site -3094. In the end, and to encourage the reader to rifle through the next few pages, no cultural materials or features were exposed by any of these excavations. Appendix A provides stratigraphic profiles and representative photographs of the trenches.

Stratigraphic Trench 1 (ST-1)

ST-1 measured 9.14 m long, 0.6 m wide, and was oriented at 120/300 degrees. The trench was excavated to a maximum depth of 1.52 m at the north end and 1.8 m at the south end. Three stratigraphic layers were identified. Layer I (0.0-0.16 mbs) is composed of dark brown (10YR 3/5) silty clay that was structureless, slightly plastic, and included roots, rootlets, and less than 1% gravel. Lower boundary was abrupt and wavy. Layer II (0.16-0.56 mbs) is a dark grayish brown (10YR 4/2) clay, structureless, plastic, less than 1% roots and gravel. Layer III (0.56-1.5/1.8 mbs) consisted of dark grayish brown (10YR 4/2) clay that was structureless, plastic, with no roots and no gravel. The water table was exposed at the base of the excavation. This

trench was located in the center of the project area, east of Māhāʻulepū Ditch, and south of Māhāʻulepū Road.

Stratigraphic Trench 2 (ST-2)

ST-2 measured 9.14 m long and 0.6 m wide and was oriented at 180/360 degrees. The trench was excavated to a maximum depth of 1.52 m at the north end and 1.8 m at the south end. Three stratigraphic layers were identified. Layer I (0.0-0.16 mbs) is a dark brown (10YR 3/5) silty clay that was structureless, slightly plastic, and included roots, rootlets, and less than 1% gravel. Lower boundary was abrupt and wavy. Layer II (0.16-0.56 mbs) is a dark grayish brown (10YR 4/2) clay that is structureless, plastic, less than 1% roots and gravel. The lower boundary was clear and wavy. Layer III (0.56-1.5/1.8 mbs) consisted of dark grayish brown (10YR 4/2) clay that was structureless, plastic, with no roots and no gravel. The water table was exposed at the base of this excavation. This trench was located in the center of the project area, east of Māhāʻulepū Ditch and south of Māhāʻulepū Road.

Stratigraphic Trench 3 (ST-3)

ST-3 measured 9.14 m long and 0.6 m wide and was oriented at 180/360 degrees. The trench was excavated to a maximum depth of 1.52 m at the north end and 1.8 m at the south end. Three stratigraphic layers were identified. Layer I (0.0-0.16 mbs) is composed of a dark brown (10YR 3/5) silty clay that was structureless, slightly plastic, and included roots, rootlets, and less than 1% gravel. Lower boundary was abrupt and wavy. The lower boundary was clear and wavy. Layer II (0.16-0.56 mbs) was a dark grayish brown (10YR 4/2) clay that was structureless, plastic, less than 1% roots and gravel. The lower boundary was clear and wavy. Layer III (0.56-1.5/1.8 mbs) consisted of dark grayish brown (10YR 4/2) clay that was structureless, plastic, with no roots and no gravel. The water table was exposed at the base of this excavation. The trench was located in the center of the project area, east of Māhāʻulepū Ditch and south of Māhāʻulepū Road.

Stratigraphic Trench 4 (ST-4)

ST-4 measured 9.14 m long and 0.6 m wide and was oriented at 20/160 degrees. The trench was excavated to a maximum depth of 1.52 m at the north end and 1.8 m at the south end. Three stratigraphic layers were identified. Layer I (0.0-0.16 mbs) is composed of a dark brown (10YR 3/5) silty clay that was structureless, slightly plastic, and included roots, rootlets, and less than 1% gravel. The lower boundary was abrupt and wavy. Layer II (0.16-0.56 mbs) is a dark grayish brown (10YR 4/2) clay that was structureless, plastic, less than 1% roots and gravel. The lower boundary was clear and wavy. Layer III (0.56-1.5/1.8 mbs) consisted of dark grayish brown (10YR 4/2) clay that was structureless, plastic, and with no roots and no gravel. The water table was exposed at the base of this excavation. This trench was located in the center of the project area, east of Māhāʻulepū Ditch and south of Māhāʻulepū Road.

Stratigraphic Trench 5 (ST-5)

ST-5 measured 9.14 m long and 0.6 m wide and was oriented at 90/270 degrees. The trench was excavated to a maximum depth of 1.52 m and exposed two stratigraphic layers. Layer I (0.0-0.3m) was a dark brown (10YR3/5) silty clay that was structureless, slightly plastic, and includes roots, rootlets, and less than 1% gravel. The lower boundary was abrupt and wavy. Layer II (0.3-1.52m) was a dark brown (10YR 3/3) clay with no roots and no gravel. The water table was exposed at the base of this excavation. This trench was located in the center of the project area, east of Māhāʻulepū Ditch and south of Māhāʻulepū Road.

Stratigraphic Trench 6 (ST-6)

ST-6 measured 9.14 m long and 0.6 m wide and was oriented at 180/360 degrees. The trench was excavated to a maximum depth of 1.52 m and exposed five stratigraphic layers. Layer I (0.0-0.3m) was composed of dark brown (10YR3/5) silty clay that was structureless, slightly plastic, and included roots, rootlets, and less than 1% gravel. The lower boundary was abrupt and wavy. Layer II (0.3-0.6 m) is a dark brown (10YR 4/2) clay that was structureless, plastic and had no roots or gravel. The lower boundary was clear and wavy. Layer III (0.6-1.0 m) is a brown (10YR4/3) clay that was structureless, plastic, and had no roots or gravel. The lower boundary was clear and wavy. Layer IV (1.0-1.2 m) is a dark grayish brown (10YR 4/2) clay that was structureless, plastic, and had no roots and no gravel. The lower boundary was clear and smooth. Layer V (1.2-1.5 m) is a brown (10YR 4/3) clay that was structureless, plastic, and had no roots and no gravel. The water table was reached at 0.9 m below the ground surface. This trench was located in the center of the project area east of Māhāʻulepū Ditch and south of Māhāʻulepū Road.

Stratigraphic Trench 7 (ST-7)

ST-7 measured 9.14 m long and 0.6 m wide and was oriented at 90/270 degrees. The trench was excavated to a maximum depth of 1.52 m and exposed four stratigraphic layers. Layer I (0.0-0.2 m) is a dark brown (10YR3/5) silty clay that was structureless, slightly plastic, and included roots, rootlets, and less than 1% gravel. The lower boundary was abrupt and wavy. Layer II (0.2-0.5 m) is a yellow brown (10YR 5/4) clay that was structureless, plastic, and had no roots and no gravel. The lower boundary was abrupt and wavy. Layer III (0.5-0.73 m) is a black clay that was structureless, plastic, and had no roots and no gravel. The lower boundary was abrupt and wavy. Layer IV (0.73-1.52 m) is a brown (10YR4/3) clay that was structureless, plastic, and had no roots or gravel. The water table was exposed at the base of the excavation. This trench was located in the center of the project area east of Māhāʻulepū Ditch and south of Māhāʻulepū Road.

Stratigraphic Trench 8 (ST-8)

ST-8 measured 9.14 m long and 0.6 m wide and was oriented at 180/360 degrees. The trench was excavated to a maximum depth of 1.8 m and exposed three stratigraphic layers. Layer I (0.0-0.2 m) is a dark brown (10YR4/3) silty clay that was structureless, slightly plastic, and included roots, rootlets, and less than 1% gravel. The lower boundary was abrupt and wavy. Layer II is a yellowish brown (10YR5/6) clay that was structureless, plastic, and had no roots or gravel. The lower boundary was clear and smooth. Layer III was a bluish gray (Gley 2 5/1) clay exposed, with the water table, at the base of the excavation. This color clay was not exposed in any other excavation and simply represents water saturated soils. This trench was located in the center of the project area east of Māhāʻulepū Ditch and south of Māhāʻulepū Road.

Stratigraphic Trench 9 (ST-9)

ST-9 measured 9.14 m long and 0.6 m wide and was oriented at 90/270 degrees. The trench was excavated to a maximum depth of 1.8 m and exposed two stratigraphic layers. Layer I (0.0-0.2 m) is composed of dark brown (10YR4.3) silt that was structureless, slightly plastic, and includes roots, rootlets, and less than 1% gravel. The lower boundary was abrupt and wavy. Layer II (0.2-1.5 m) is a yellowish dark brown (10YR4/4) clay that was structureless, plastic and had no roots or gravel. The water table was exposed at the base of the excavation. This trench was located in the center of the project area east of Māhāʻulepū Ditch and south of Māhāʻulepū Road.

Stratigraphic Trench 10 (ST-10)

ST-10 measured 9.14 m long and 0.6 m wide and was oriented at 100/280 degrees. The trench was excavated to a maximum depth of 1.8 m and exposed two stratigraphic layers. Layer I (0.0-0.4 m) is composed of a dark brown (10YR4/3) silt that was structureless, slightly plastic, and included grass roots and no gravel. The lower boundary was abrupt and smooth. Layer II (0.4-1.8 m) is a yellowish brown (10YR5/8) silt that was fine, slightly plastic, and had no roots or gravel included. The water table was not exposed in this excavation. This trench was located to the north of the petroglyph boulder at Site -3094.

Stratigraphic Trench 11 (ST-11)

ST-11 measured 9.14 m long and 0.6 m wide and was oriented at 180/360 degrees. The trench was excavated to a maximum depth of 1.8 m and exposed two stratigraphic layers. Layer I (0.0-0.4 m) was composed of dark brown (10YR4/3) silt that was structureless, slightly plastic, and included grass roots and no gravel. The lower boundary was abrupt and smooth. Layer II (0.4-1.8 m) is a yellowish brown (10YR5/8) silt that was fine, slightly plastic, and had no roots or gravel included. The water table was not exposed in this excavation. This trench was located to the west of the petroglyph boulder at Site -3094.

Stratigraphic Trench 12 (ST-12)

ST-12 measured 9.14 m long and 0.6 m wide and was oriented at 100/280 degrees. The trench was excavated to a maximum depth of 1.8 m and exposed two stratigraphic layers. Layer I (0.0-0.4 m) was composed of dark brown (10YR4/3) silt that was structureless, slightly plastic, and included grass roots and no gravel. The lower boundary was abrupt and smooth. Layer II (0.4-1.8 m) is a yellowish brown (10YR5/8) silt that was fine, slightly plastic, and had no roots or gravel included. The water table was not exposed in this excavation. This trench was located to the south of the petroglyph boulder at Site -3094.

Stratigraphic Trench 13 (ST-13)

ST-13 measured 9.14 m long and 0.6 m wide and was oriented at 40/220 degrees. The trench was excavated to a maximum depth of 1.8 m and exposed two stratigraphic layers. Layer I (0.0-0.4 m) was composed of dark brown (10YR4/3) silt that was structureless, slightly plastic, and included grass roots and no gravel. The lower boundary was abrupt and smooth. Layer II (0.4-1.8 m) is a yellowish brown (10YR5/8) silt that was fine, slightly plastic, and had no roots or gravel included. The water table was not exposed in this excavation. This trench was located to the east of the petroglyph boulder at Site -3094.

Stratigraphic trench 14 (ST-14)

ST-14 measured 9.14 m long and 0.6 m wide and was oriented at 20/200 degrees. The trench was excavated to a maximum depth of 1.8 m and exposed two stratigraphic layers. Layer I (0.0-0.4 m) was composed of dark brown (10YR4/3) silty clay that was structureless, slightly plastic, and included no roots and less than 1% gravel.. The lower boundary is abrupt and wavy. Layer II (0.4-1.8 m) is a dark yellowish brown (10YR3/6) clay that was structureless, plastic and contained no roots or gravel. The water table was not exposed in this excavation. This trench was located to the east of the fork in the Māhā‘ulepū Ditch.

Stratigraphic Trench 15 (ST-15)

ST-15 measured 9.14 m long and 0.6 m wide and was oriented at 180/360 degrees. The trench was excavated to a maximum depth of 1.8 m and exposed three stratigraphic layers. Layer I (0.0-0.1 m) was composed of dark brown (10YR4/3) silty clay that was structureless, slightly plastic, and included roots, rootlets, and less than 10% gravel. The lower boundary is abrupt and wavy. Layer II (0.1-0.46 m) is a dark grayish brown (10YR4/6) clay that was structureless, plastic, and had no roots and less than 1% gravel. The lower boundary is clear and wavy. Layer III (0.46-1.52 m) is a dark grayish brown (10YR4/2) clay that was structureless, plastic, and had no roots or gravel. Layer III was moist but the water table was not exposed in this excavation. This trench was located immediately south of the pumping station of the “Māhā‘ulepū 14” wells at the northwest end of the property where Māhā‘ulepū Road turns to the east.

Stratigraphic Trench 16 (ST-16)

ST-16 measured 9.14 m long and 0.6 m wide and was oriented at 0/360 degrees. The trench was excavated to a maximum depth of 1.8 m and exposed three stratigraphic layers. Layer I (0.0-0.16 m) was composed of dark brown (10YR4/3) silty clay that was structureless, slightly plastic, and included roots, rootlets, and less than 10% gravel. The lower boundary is clear and wavy. Layer II (0.16-0.82 m) is a dark grayish brown (10YR4/2) clay that was structureless, plastic, and had no roots and less than 1% gravel. The lower boundary is clear and wavy. Layer III (0.82-1.52 m) is a dark grayish brown (10YR4/2) clay that was structureless, plastic, and had no roots or gravel. The water table was not exposed in this excavation. This trench was located in the proposed Effluent Pond area along the western side of the property.

Stratigraphic Trench 17 (ST-17)

ST-17 measured 9.14 m long and 0.6 m wide and was oriented at 0/360 degrees. The trench was excavated to a maximum depth of 1.8 m and exposed four stratigraphic layers. Layer I (0.0-0.05 m) was composed of dark brown (10YR4/3) silty clay that was structureless, slightly plastic, and included roots, rootlets, and less than 10% gravel. The lower boundary is clear and wavy. Layer II (0.05-0.4 m) is a mottled gray (10YR5/2) and dark brown (10YR4/3) clay that was structureless, slightly plastic, and included roots, rootlets, and less than 10% gravel. The lower boundary is clear and wavy. Layer III (0.4-0.88 m) is a dark yellowish brown (10YR4/6) clay that was structureless, plastic, and had no roots or gravel. The lower boundary was clear and wavy. Layer IV (0.88-1.52 m) is a dark gray (10YR4/2) clay. The sediment was structureless, plastic, and included no roots or gravel. The water table was not exposed in this excavation. This trench was located in the proposed Effluent Pond area along the western side of the property.

DISCUSSION AND CONCLUSIONS

A total of sixteen sites were identified during the Archaeological Inventory Survey in the 580-acre Māhāʻulepū project area and a 100 m wide extension of the survey northward on to Grove Farm lands. Fifteen of the sites were newly identified during the current survey and one site, a boulder with petroglyphs designated State Site 50-30-10-3094, was re-located. During the survey of the main parcel a buried boulder or exposed bedrock outcrop with petroglyphs was identified 20 m to the southeast of the primary boulder. During the survey of the 100 m extension, approximately 70 m northeast of the primary boulder, a third feature, a large boulder with vertical faces and petroglyphs of human figures was found. These two new features are added to Site -3094.

State Sites 50-30-10-2250, -2254, and -2257 are believed to be associated with pre-Contact and/or early historic occupation. An enclosure, State Site 50-30-10-2250, has been identified as an agricultural *heiau*. Multiple test units were placed at this site. No cultural materials were found within the enclosure. However, excavations at several locations along the north and west walls did expose what appear to be foundations for the walls at these locations. Built of sub-angular gravel and cobble sized basalt these were directly associated with the walls. Excavations within the interior of the enclosure exposed no such deposit, so it is thought that rather than a paving, the deposit represents is a construction or engineering component of the *heiau*. Given the location of Site -2250 at the base of the slope off of Ha`upu Ridge, where rain water runoff would have flowed, it would be necessary for walls to have a foundation base course component.

Site -2250 has been interpreted herein as an agricultural *heiau* due to its size, construction (uprights, paved foundation), location, and lack of cultural materials normally indicative of a *kau hale* or community *hale*. This interpretation was also supported by community member Kalani Pike (Branch Harmony), during a February, 2015 field visit. An agricultural *heiau*, also referred to as *mapele* or Hale O Lono (the god of fertility) is directly associated with ceremonies to insure the fertility of the crops. These *heiau* are often utilized for prayer and meditation, which could explain the lack of cultural materials recovered during excavations of the site. Examples of agricultural *heiau* include Kaneaki Heiau in Makaha (Oʻahu) and Pahua Heiau in Hawaii Kai (Oʻahu). The differences between these agricultural *heiau* and the one documented herein are quite vast though, in terms of monumental construction. While the size of each may be similar, the actual construction was vastly different. Most *heiau*, including the ones mentioned for Oʻahu above, consist of massive amounts of rocks, multiple courses of rocks piled many meters high, and which stand out in complexity and breadth. The current Site -2250 enclosure is rather

compact and its outline is clearly defined. The north, east and west walls are two to three courses wide and two to three courses high. Located at the north corner entrance and the bend in the western wall both are upright, small boulders. In terms of energy expenditure, what is viewed today would not have taken much labor to create. However, the structure is solidly constructed and is at present in good condition. The walls are too low for this to have served as an animal pen. *Heiau* in the area, as noted above, were deconstructed to create cattle pens, pens with much higher walls and greater enclosure space. Land Commission Award settlements were primarily combined several hundred meters to the south of the *heiau*. It is possible that Site -2250 is associated with some activity from those households. However, Site -2250 is placed at the base of the slope off the ridge, amidst a scattering of boulders that may have been too numerous to move, or that moving them was unnecessary as they were located within a woodland valued for its resources. The structure being built in this location, where it was unnecessary and impractical to dismantle, as well as a healthy respect by residents for something built by their ancestors, may have led to the preservation of this site. That the archaeological record of the site did not allow for dating, due to the lack of cultural materials, charcoal, coral, or midden, will undoubtedly ensure some conversation on the chronology of the site. This site will be preserved in perpetuity.

Site -3094 consists of a previously identified petroglyph rock, with two other petroglyph rocks (designated as Feature 2 and Feature 3), having been identified during the current survey. Feature 1 is a large petroglyph boulder. Feature 2 is either exposed bedrock or a buried boulder with two petroglyphs visible located 20 m southeast from, and in the same clearing as Feature 1. Feature 3 is located approximately 70 m to the northeast of Feature 1, and is at the base of the wooded slope, with several pecked figures. The petroglyphs are interpreted to be pre-Contact features. Feature 1 is perhaps the most interesting, having a large number of petroglyphs around the rock faces, as well as mortars and carved lines on the top of the rock. During a community site visit in February, 2105, a gentleman (K. Pike) noted that the curved lines on the top of the rock, leading from a circular mortar, could indeed be a map of a water spring in the area, with the curved lines representing a drainage. He stated that it could also be that offerings were placed in the mortar, and would “flow” down the curves and back into the lands. Both were viable interpretations and could be equally appropriate. All three petroglyph rocks will be preserved in perpetuity.

The two retaining walls, Sites -2254 and -2257, are located within two different stream bed branches upstream of where the two braid together forming the main course of Mahaulepu Stream. Both are walls constructed of dry stacked sub-angular basalt cobbles and boulders built into the face of the stream bank and upon earthen terraces at the base of slope into their respective stream beds. Site -2254 appears to be primarily intact. Site -2257 has partially collapsed at its western end but the remainder appears solid. Whenever these walls were built, they have weathered the course of time well. Of note is that the stream bed containing Site -2254 has been modified in recent years by the construction of Site -2255, four culvert bridges for the conveyance of agricultural equipment. This stream bed was nearly empty of gravels, cobbles, or boulders.

The stream bed containing Site -2257 on the other hand, had a historic era feature, Site -2256, a concrete bridge with retaining walls of boulder sized quarried basalt blocks mortared together with concrete. These retaining walls may predate the bridge but appear to post-date Site -2257. Additionally, the stream containing Sites -2256 and -2257 has an abundance of water worn gravels and cobbles, and sub-angular basalt cobbles and boulders strewn along the bed, from where the stream enters the valley to its junction with the other branch of the stream. The mixture of water worn and sub-angular basalt suggests that this stream bed was not so thoroughly modified during plantation operations, and that the sub-angular cobbles and boulders may be from traditional structures cleared from the valley floor during other plantation operations. It is possible that the function of both of these retaining walls may be related to mid-19th century LCA activities in the valley. The walls may predate this era or could be even be associated with the earliest activities for the development of Koloa Plantation

The remaining sites consist of features constructed during various phases of the development of sugar cane cultivation within Mahaulepu Valley. State Site 50-30-10-2261 is a good example of this. The northern component of the bridge is constructed of boulder sized quarried basalt blocks, with an inscription into its concrete surface giving the date “1908”. The southern component is constructed of concrete, with an inscription on the southern face of the curb giving the date “1951”. Furthermore, this southern curb has a metal rail constructed of a narrow gauge rail road rail. A similar rail is affixed to Site -2260, a bridge that also has the date “1951” inscribed into face of its concrete curb. As stated above, Site -2257 has two components, retaining walls of boulder sized quarried basalt blocks mortared together, and a concrete bridge mounted upon them.

All of these are examples of development of the plantation infrastructure proceeding through phases. Quarried basalt walls mortared together post-date traditional dry stacked construction utilizing sub-angular basalt cobbles and boulders. These walls built of quarried basalt in turn pre-date infrastructure built of concrete, but could, as in the case of Sites -2257, and more dramatically, Site -2261, be incorporated into more recent efforts to up date the infrastructure of the plantation. Similarly, the utilization of rail road rails into these updates is telling. The steam driven sugar cane railroads were utilized during the late 19th and early 20th

centuries, post-dating the use of draft animals. The rail road lines were designed to be transported and laid into fields where needed during harvest. The use of the rail coincided with the use of steam-powered tractors, which also took over from draft animals. The age of steam came to an end in the third decade of the 20th Century, and was replaced by gas, diesel and oil powered vehicles. The use of trucks required the improvement of the infrastructure, in the form of more bridges and roads. As the 20th Century proceeded, so too did the improvement in size and power of these vehicles, once again requiring the improvement of the infrastructure. While rail roads were no longer necessary, the rails could still be used in new ways.

The date “1951” inscribed on two bridges is another indicator of change. The plantation flourished with the world economy, doing well in the early 20th century up until The Great Depression. Followed by the tumult of World War II, it would have been a leaner decade for landowner Koloa Plantation than hoped for. This may have led to the sale of the plantation from Koloa Plantation to Grow Farms in 1948. Improvement of the infrastructure by the new owners is marked by the inscription of the date, “1951” during which some of these improvements occurred.

The development of fuels for engines beyond steam power also allowed for improvements to irrigation. Not having to rely on gravity, rainfall, wind power or steam engines, wells could be drilled and the water pumped from well stations into places such as Site -2258, the Mahaulepu Reservoir. From the Reservoir, ditches, probably existing from earlier phases, were improved to carry increased flow along the valley edges and directed into desired areas.

That the valley was intensively transformed for the industrial-level of sugar cane cultivation is well documented. The many bridges, culverts, ditches, and sluice gates all speak to the incredible management, especially of water to the thirsty sugar cane, needed to produce such a crop. While the landscape contains such infrastructure, it was also destructive to the earlier archaeological record. Such massive landscape changes often results in the destruction of earlier sites, such as *kuleana* walls, mounds, enclosures, and other residential structures. Such is the tide of change. The importance of the Plantation era to the economics and lifestyle of the 19th and 20th centuries in Māhāʻulepū and the greater Koloa region is vastly important to understanding the entire chronology and land use of the area.

The primary 20th Century modification to the valley was the drilling of wells to feed the Mahaulepu Reservoir. Ditches discovered during the current project led to and from the northern and southern ends of the reservoir, with pipelines extending to the ditch that paralleled the Mahaulepu stream course. Clearly, the reservoir was taking water out of the valley to other fields of the Koloa area plantation. There is no evidence that these modifications were built on the backs of historic or traditional irrigation systems. It must be kept in mind that the intensity of sugar cane cultivation operations erased a great deal of evidence of previous occupation.

Sugar cane cultivation required plowing operations that could reach depths of up to 1 meter below ground surface. Nearly one hundred years of these operations have scoured the Māhā‘ulepū Valley floor. No cultural materials of any era were found during pedestrian survey of the valley floor. Areas identified on historic maps as having been wells and pumping stations, as well as Land Commission Award settlements had no materials or artifacts which could be attributed to the former occupants.

However, it has been borne out by the current research, in some areas, the deeper past is preserved, both within the fields and on their outer reaches. Site -3094 and Site -2250 remain intact and are thought to represent pre-Contact ceremonial pursuits in a valley rich with history. That the Site -3094 boulder was preserved, when all around it sugar cane was cultivated, speaks to its importance. Intensive transformation occurred in the valley, which is why Feature 2 of Site -3094 was such an interesting find: it occurred beneath the grasses, in the only location which mechanical stratigraphic test trenching showed not to have been impacted by sugar cane cultivation.

Finally, the Kaua`i archaeologist (SHPD) emphasized the need to consider potential trails in the area, particularly those that would lead to the top of the ridgeline to the east. Given the reported presence of Keolewa Heiau, on Ha`upu Ridge, and a former *heiau*, Hanakalauea Heiau, within the valley, this could indicate that pre-Contact/Historic era trails may have connected the project area to the upper ridgeline. Despite written reports of the presence of Keolewa Heiau, there are no first hand accounts of the presence of such a religious structure, and it may be that the crest of the mountain was regarded as holy, but no structure was ever constructed and sanctified through ceremony to make it so. A place so spectacular as a mountain top does not need a man made structure to make it consecrated.

Formal survey was conducted of a 100 meter swath outside the project area boundaries and informal survey along the base of the valley’s slopes and up toward the ridgeline to ascertain the presence/absence of trails to the ridgeline. The crew hiked to just below the summit of the ridgeline, which proved to be inaccessible from this location.

Overall, there was no evidence on the ground for any trails connecting the project area to the eastern ridgeline. Only sporadic pig trails were present. Given that pedestrian traffic up and along ridgelines would have been the norm, it is certainly possible that what are today animal trails are the current usage of traditional paths. However, there are easier ways to gain the heights

of the ridge, and traditional occupants may not have found it necessary to modify their environment. This interpretation was supported during a February, 2015 field visit with community members. No one trail was clearly identified in the vicinity of the project area.

Older maps also do not show access routes up to the ridgeline (see above). It is worth noting that when a survey was conducted of the ridgeline itself, no trails were evident and archaeologists had to be dropped by helicopter and cleared their way through the survey area (McMahon 1996). However, while no information on possible trails has been obtained yet via maps and informal ground survey, there is the possibility that older generations may recall trails in the area. This will be one component of the soon to be started Cultural Impact Assessment (CIA) for this project, with the CIA author also interviewing OHA staff to see if they may provide more information on trails in the area.

Overall, the findings of the AIS were as somewhat predicted, given the intensive land use during the 19^{th} and 20^{th} centuries in the project area. It was also interesting to note that the *heiau* was identified, and occurred in non-cleared areas above the project area flat lands. Plantation-era features dominate the current landscape, as expected, given the industrial nature of the cultivation and process.. It is within this vein that the proposed project would move forward, also potentially utilizing the soils and infrastructure (ditches, etc.) created during this large-scale land alteration period.

SIGNIFICANCE ASSESSMENTS

All sixteen sites documented (and re-identified) during the current AIS have been evaluated for significance according to the criteria established for the State and National Register of Historic Places. The five criteria are listed below:

Criterion A: Site is associated with events that have made a significant contribution to the broad patterns of our history;

Criterion B: Site is associated with the lives of persons significant to our past;

Criterion C: Site is an excellent site type; embodies distinctive characteristics of a type, period, or method of construction, or represents the work of a master, or possesses high artistic values, or represents a significant and distinguishable entity whose components may lack individual construction;

Criterion D: Site has yielded or has the potential to yield information important in prehistory or history;

Criterion E: Site has cultural significance; probable religious structures or burials present (State of Hawai‘i criteria only).

Table 1 provides descriptive information on the sites, their significance, and recommendations.

Table 1. Site Descriptive Data, Significance, and Recommendations.

SIHP No. 50-30-10-	Site Type	Function	# Features	Age	Significance, Recommendations
2250	Enclosure	Ceremonial	1	Pre-Contact	D, E; Preservation
2251	Ditch, Gate	Irrigation	2	Historic	D; *NFW
2252	Ditch, Gates	Irrigation	3	Historic	D; NFW
2253	Ditch	Irrigation	1	Historic	D; NFW
2254	Retaining Wall	Soil Retention	1	Pre-Contact or early historic	D; NFW
2255	Culvert Bridges	Irrigation	4	Historic	D; NFW
2256	Bridge	Transport	1	Historic	D; NFW
2257	Retaining Wall	Soil Retention	1	Pre-Contact or early historic	D; NFW
2258	Reservoir	Water Storage	1	Historic	D; NFW
2259	Ditch	Irrigation	1	Historic	D; NFW
2260	Bridge	Transport	1	Historic	D; NFW
2261	Bridge	Transport	1	Historic	D; NFW
2263	Bridge	Transport	1	Historic	D; NFW
2264	Pipe/Foundation	Irrigation	1	Historic	D; NFW
2262	Flume, Gates	Irrigation	3	Historic	D; NFW
3094	Petroglyphs	Ceremonial	2	Pre-Contact	D, E; Preservation

*NFW=No Further Work

RECOMMENDATIONS

A total of sixteen historic properties occur in the 580-acre project area and 100 meter zone along the northern flank of the project area. Two of the sixteen sites have been evaluated as significant under multiple criteria herein and are recommended for preservation. Both the Site -2250 enclosure and the Site -3094 petroglyphs are recommended for preservation. Both of these sites occur off-site, not within the proposed footprint of the proposed dairy. A Preservation Plan for these two sites should be prepared and submitted to the SHPD for approval, to preserve these sites in perpetuity. Fourteen of the sixteen sites are associated with Plantation-era sugar cane cultivation. A majority of these sites are in fair-good condition. While representing an interesting time period in the history of the Koloa-Māhāʻulepū area, no further work is recommended for these sites. In addition, trenching failed to yield any cultural materials in the most likely locations of past habitation. No monitoring is recommended during any ground altering work in the project area.

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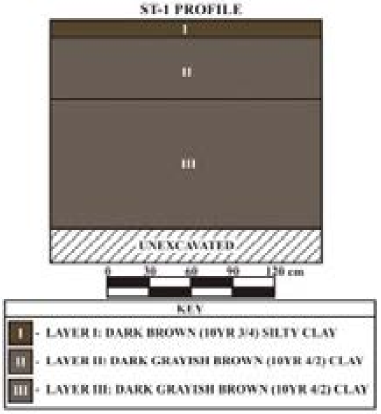
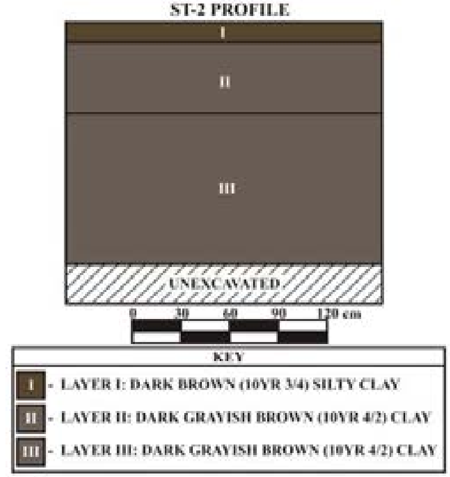
APPENDIX A: STRATIGRAPHIC PROFILES AND REPRESENTATIVE TRENCH PHOTOGRAPHS

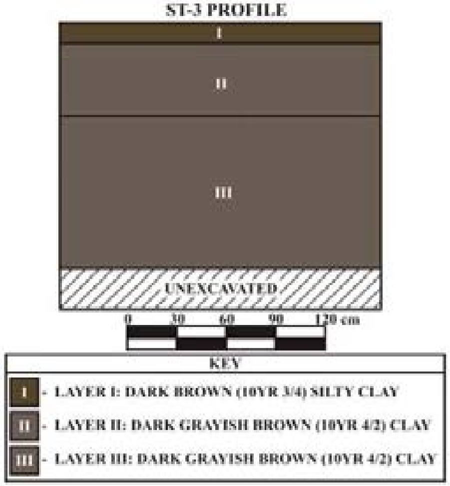
ST-1 Trench



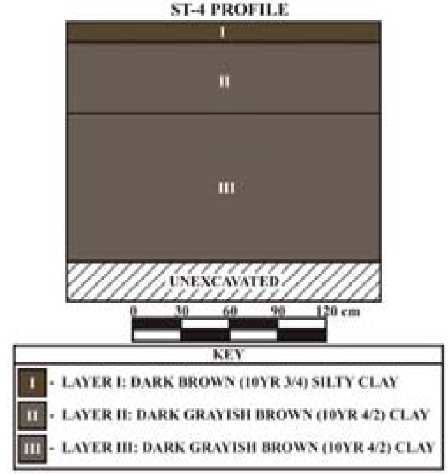
ST-2 Trench



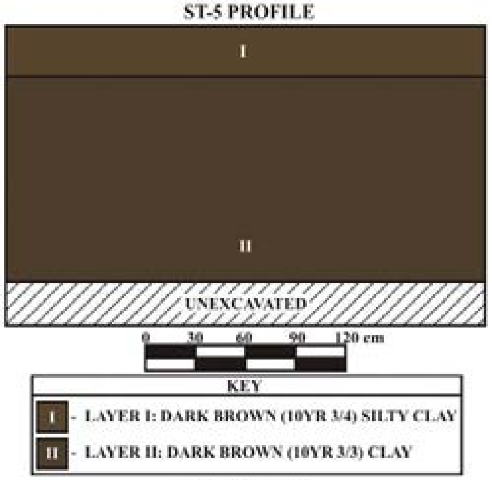
ST-3 Trench


ST-3 PROFILE
I
II
III
UNEXCAVATED
0 30 60 90 120 cm
KEY
I - LAYER I: DARK BROWN (10YR 3/4) SILTY CLAY
II - LAYER II: DARK GRAYISH BROWN (10YR 4/2) CLAY
III - LAYER III: DARK GRAYISH BROWN (10YR 4/2) CLAY

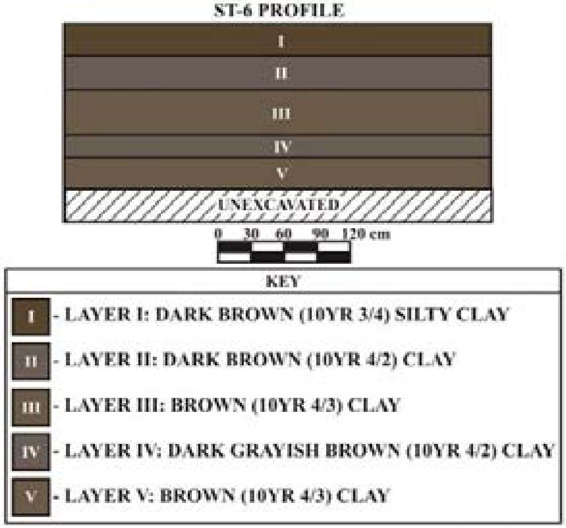
ST-4 Trench


ST-4 PROFILE
I
II
III
UNEXCAVATED
0 30 60 90 120 cm
KEY
I - LAYER I: DARK BROWN (10YR 3/4) SILTY CLAY
II - LAYER II: DARK GRAYISH BROWN (10YR 4/2) CLAY
III - LAYER III: DARK GRAYISH BROWN (10YR 4/2) CLAY

ST-5 PROFILE

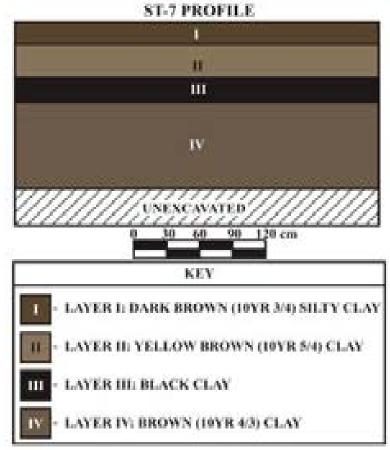


ST-6 PROFILE



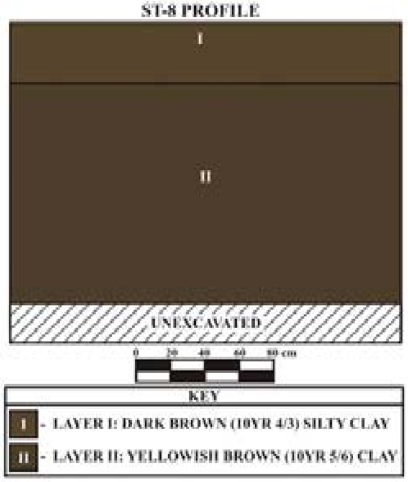
ST-7 Trench West Wall

ST-7 PROFILE

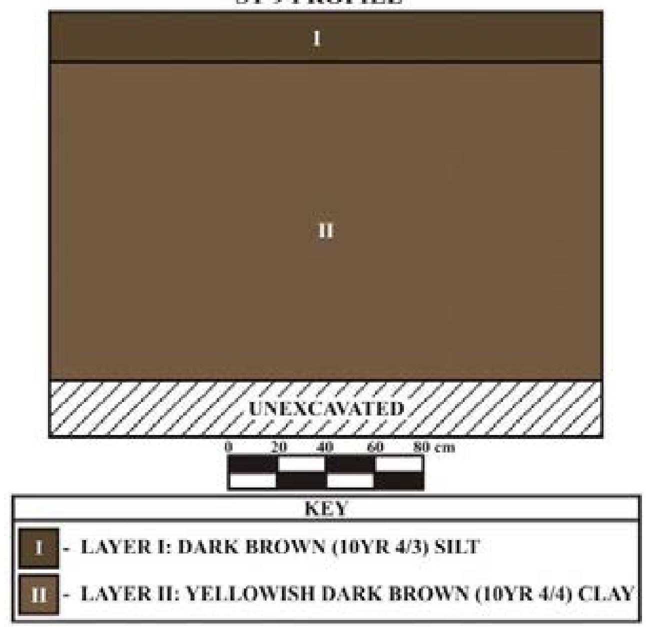


ST-8 Trench

ST-8 PROFILE

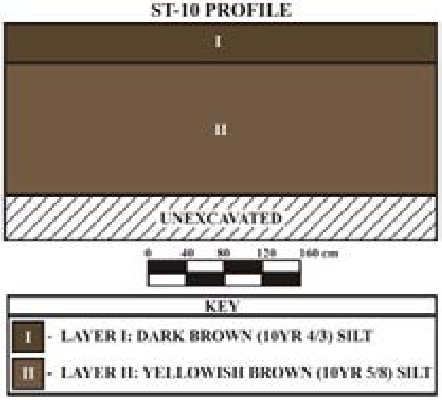


ST-9 PROFILE



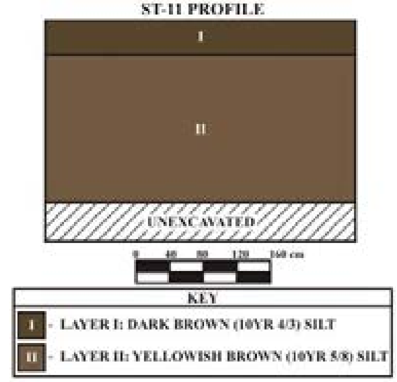
ST-10 Trench

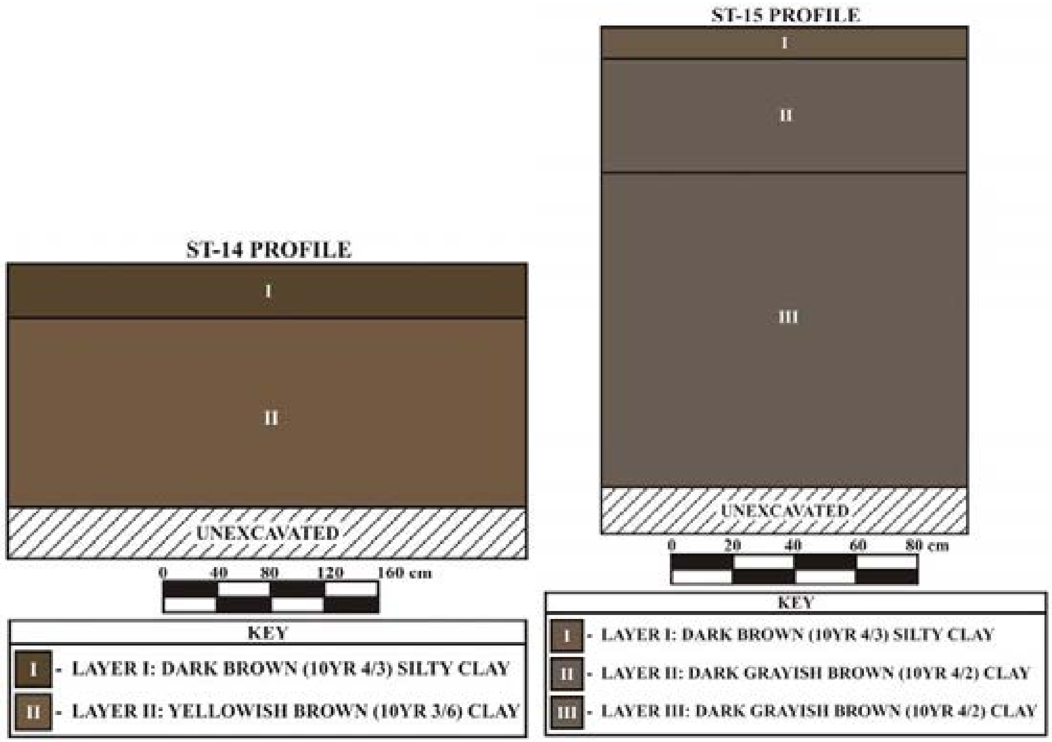
ST-10 PROFILE

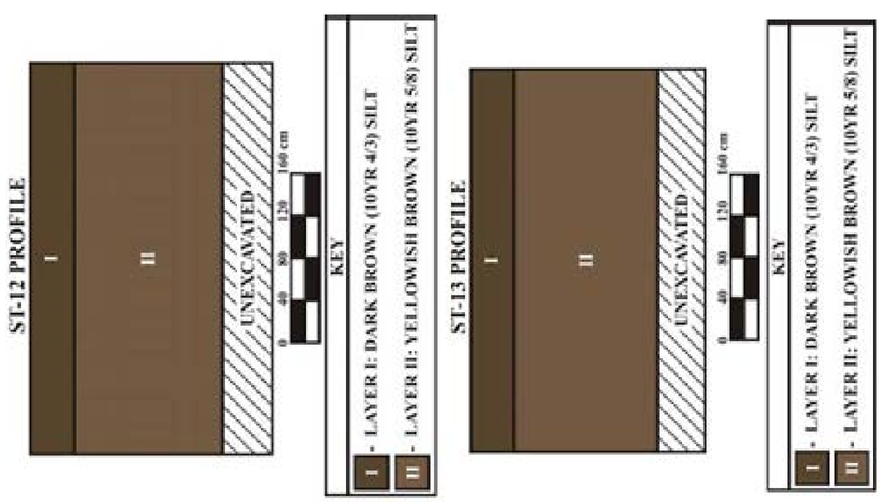


ST-11 Overview with Site -3094

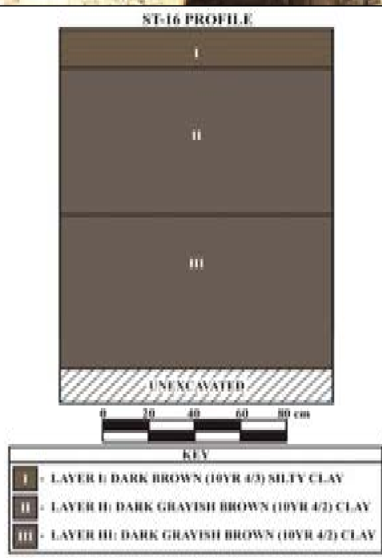
ST-11 PROFILE



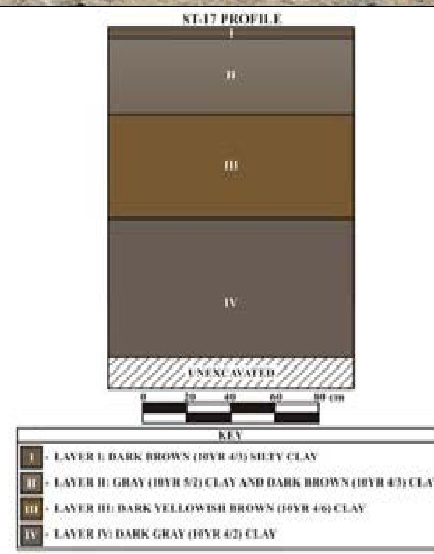

ST-14 PROFILE
I
II
UNEXCAVATED
0 40 80 120 160 cm
KEY
I - LAYER I: DARK BROWN (10YR 4/3) SILTY CLAY
II - LAYER II: YELLOWISH BROWN (10YR 3/6) CLAY
ST-15 PROFILE
I
II
III
UNEXCAVATED
0 20 40 60 80 cm
KEY
I - LAYER I: DARK BROWN (10YR 4/3) SILTY CLAY
II - LAYER II: DARK GRAYISH BROWN (10YR 4/2) CLAY
III - LAYER III: DARK GRAYISH BROWN (10YR 4/2) CLAY


ST-12 PROFILE
I
II
UNEXCAVATED
0 40 80 120 160 cm
KEY
I - LAYER I: DARK BROWN (10YR 4/3) SILT
II - LAYER II: YELLOWISH BROWN (10YR 5/8) SILT
ST-13 PROFILE
I
II
UNEXCAVATED
0 40 80 120 160 cm
KEY
I - LAYER I: DARK BROWN (10YR 4/3) SILT
II - LAYER II: YELLOWISH BROWN (10YR 5/8) SILT

ST-16 Trench North Wall



ST-17 Trench West Wall



DAVID Y. IGE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE HISTORIC PRESERVATION DIVISION
KAKUHIHEWA BUILDING
601 KAMOKILA BLVD, STE 555
KAPOLEI, HAWAII 96707

April 13, 2015

Hawaii Dairy Farms, LLC
737 Bishop Street, Suite 2360
Honolulu, HI 96813

LOG NO: 2015.01404
DOC NO: 1504MN05
Archaeology

Dear Mr. or Ms.:

SUBJECT: **Chapter 6E-42 Historic Preservation Review -**
Revised Archaeological Inventory Survey of 580 Acres in Māhāʻulepū Ahupuaʻa
Māhāʻulepū Ahupuaʻa, Koloa District, Island of Kauaʻi
TMK: (4) 2-9-003:001 por. and 006 por.; 2-9-001:001 por.

Thank you for submitting the revised subject draft plan entitled *Archaeological Inventory Survey of 580-Acres in Māhāʻulepū Ahupuaʻa, Koloa District, Kauaʻi Island, Hawaiʻi [TMK: (4) 2-9-003:001 por. and 006 por; 2-9-001:001 por.]* J. Putsi., M. Ching, J. Powell, M. Dega, Ph.D. We received the initial draft on September 25, 2014, which was received on December 3, 2014 (*Log No. 2014.04405, Doc. No. 1410MN02*). We received the revised copy February 20, 2015, and apologize for the delay in review.

The archaeological inventory survey (AIS) of the 580 acre subject property was conducted at the request of the landowner, Hawaii Dairy Farms, LLC. The project area defined by the landowner includes the valley floor of Māhāʻulepū Valley, a relatively level plain framed by Mt. Haʻūpu Ridge and Mountain to the north, and two ridges on the east and west, forming a large, natural amphitheater. The east and west ridges also serve as ahupuaʻa dividing lines, with Kipu Kai to the east, and Paʻa on the west. Based on the geological formation of the ridgeline framing the project area, the State Historic Preservation Division (SHPD) Kauaʻi section initially recommended that the project area be defined as the entire area from the ridgeline down. After subsequent negotiations, Scientific Consultant Services (SCS) and the landowner agreed to expand the project area approximately 100 meters upslope in all directions. SHPD continues to have concerns that the project area does not include indirect effects of the proposed dairy on historic properties upslope.

The commercial dairy will require the modification of existing dirt roads, grading of ground surfaces for the construction of buildings, the excavation of effluent ponds, and the excavation of pipelines for the watering of cattle. According to conversations with SCS staff, we understand about 499 head of cattle will be retained in the project area.

The AIS newly identified 16 historic properties within the project area, and relocated State Site 50-30-10-3094, a large boulder with at least 20 anthropomorphic characters represented, as well as two pecked "cups" or basins. The report states that SCS located a second petroglyph rock associated with Site 3094, which is identified in the report as Feature B. A third petroglyph boulder, referenced in the report as Feature C, is approximately 70 meters from Site 3094. Sites 2251 through 2262 are associated with plantation-era infrastructure and include irrigation ditches, two bridges, a reservoir, retaining wall, and sluice gates. Site 2250 is located on the slopes below Mt. Haʻupu and included in the revised, expanded project area. The site is an enclosure which the report concludes is an agricultural *heiau* due to the absence of artifacts during subsurface testing, and proximity to LCAs associated with agricultural

Exhibit C

encampments. Seventeen backhoe trenches were excavated within various portions of the property and partly informed by consultation with SHPD; these included subsurface testing within previous known LCA encampments, and near Site 2250 and Site 3094. A single artifact was recovered, a chopper tool within Site 2250.

The plantation-era sites are assessed for significance under Criteria "d" of HAR §13-284-6, with potential to yield data important for research on prehistory or history, and Sites 2250 (a ceremonial enclosure) and 3094 (petroglyph boulders) are recommended as significant under Criteria "d" and "e," which states the Site (s) "has an important value to the native Hawaiian people or to another ethnic group of the state due to associations with cultural practices once carried out, or still carried out, at the property or due to association with traditional beliefs, events or oral accounts – these associations being important to the group's history and cultural identity." Sites 2250 (Enclosure) and 3094 are recommended for preservation, with preparation of a preservation plan, and Sites 2251-2262 are recommended for "no further work." In addition, the report states that "no archaeological monitoring is recommended" during any ground altering work in the project area.

Additional revisions are necessary to meet the requirements of HAR§13-276 prior to approval of the AIS. Māhāʻulepu ahupuaʻa remains culturally significant and contains unusual pre-Contact sites (the petroglyph boulders) as well as several *heiau*, although most have been destroyed. The Office of Hawaiian Affairs has produced documentation referring to Mt. Haʻupu as a traditional cultural property (TCP), and numerous individuals have provided consultation to the cultural importance of this area. Please expand on this in the discussion and conclusion. In addition to the recommendations for preservation, please provide potential mitigations for indirect effects of the proposed dairy on these sites. Attached please find a list of revisions or requests for clarification prior to the acceptance of the AIS. An electronic revised copy may be submitted to the Kauaʻi section. Please contact Kauaʻi archaeologist Mary Jane Naone at (808) 271-4940 or Maryjane.naone@hawaii.gov if you have any questions regarding this letter.

Aloha,

Susan A. Lebo

Susan A. Lebo, PhD
Oahu Lead Archaeologist
Acting Archaeology Branch Chief

cc. Mike Dega, Scientific Consultant Services (mike@scshawaii.com)

ATTACHMENT

Comments and Questions: Revised *Archaeological Inventory Survey of 580-Acres in Māhā'ulepū Ahupua'a, Koloa District, Kaua'I Island, Hawai'i [TMK: (4) 2-9-003:001 por. and 006 por; 2-9-001:001 por.]*
J. Putsi., M. Ching, J. Powell, M. Dega, Ph.D.

Introduction

1. Starting with cover, revise throughout to present TMK in numerical order to facilitate filing which is by TMK; TMK: (4) 2-9-001:001 por., 2-9-003:001 por., 2-9-003:006 por.
2. The landowner must be identified, pursuant to HAR§13-276-5(a)(2). The last copy stated that Hawaii Dairy Farms, LLC (HDF) was leasing the property; this copy refers to HDF as the landowner. Please verify in the final copy.

Traditional and Historic Setting

3. Were any historic photographs located for the project area?
4. The assertion that "pre-Contact sites have been most commonly identified in coastal or near coastal areas, locations removed from intensive sugar cane production" is misleading. As stated in our previous request for revisions, Kaua'i contains a multitude of inland pre-Contact sites that defy this assertion: including extensive agricultural complexes inland in areas such as Waimea Canyon and Makaweli, inland habitation sites, Heiau at significant locales on the interior of the islands, and numerous loko wai and loko i'a-kala, inland fishponds. In fact, sugar cane cultivation often followed cultivation of previous crops dating back to pre-Contact times. There is not sufficient data to analyze archaeology within areas of intensive sugar cane cultivation, particularly in Kaua'i, where previously cultivated fields have been largely un-surveyed, based on the assumption that there's nothing there. In addition, if coastal sites have been more commonly identified, it's likely a result of modern land use (coastal areas being more desirable for development) rather than an indication that pre-Contact peoples did not use the interior or the island. The text illustrates this later – in the section "Site distribution and chronology" (pg 41).

Previous Archaeology

5. The description of Site 3094 within this section refers to a large boulder sitting "isolated" in a pasture. Actually, two additional boulders containing petroglyphs are within the immediate area.
6. Please provide a graphic within this section to show the relationship of the sites identified within the project area to the larger landscape.
7. Please provide a graphic or table showing the location of previous studies nearby the project area.

Consultation

8. Please list the several people that Milton Ching conducted consultation with.
9. Is Kalani Pike the correct name? I've seen Kalanikumai, Branch Harmony, or Zachariah Harmony. All of the individuals that have provided insight on the AIS should be included within the consultation section.

Archaeological Inventory Survey Results

10. On page 45, the text notes that Site 3094 and Site 2250 occur "off-site", but the Site description for Site 2250 says that the site occurs in Paddock P-163.
11. Please include Sites 2250 and 3094 within the maps showing the locations of historic properties.
12. When consulted over the placement of test units within the structure, believed originally to be a kauhale, SHPD Kaua'i Lead Archaeologist agreed that 2-3 shovel test pits were appropriate for assessing subsurface stratigraphy and the presence or absence of cultural deposits. An increase in the number of test units should have been informed by SHPD; a 1x1 test unit can be perceived as "data recovery" and is not appropriate for an archaeological inventory survey, unless explicitly agreed upon.
13. Please provide some context for the interrelation of the irrigation ditches. Are historic maps or photographs showing the ditches available? How would the ditch configuration provide irrigation to the project area, and if the ditch segments connected continuously over time, or were used differently during various periods of cultivation. A map of the project area, overlaid with the actual course of the irrigation ditches, would provide context for their historical use.
14. Please provide plan view drawings for the features within Site 2252, in accordance with HAR13-276-5 (4) f.
15. As previously noted, there is no photograph or site map for Site 2253.
16. Please describe the size of the rocks within the dry set features, and the number of courses.

17. There is no attempt to specifically provide context for either the reservoir, the bridges or the irrigation ditches. One of the bridges has been altered from its original construction in 1908, and the bridges contain hand rails made from iron, narrow gauge rails from the previous cane railroad. When were these constructed, and by whom? Who constructed the reservoir, and why?
18. The site description for Site 2258 (the reservoir) lacks a description of the construction and other basic information stipulated in §HAR13-276-5(4).
19. Site 2262 has no photograph or map, and features an irrigation flume, as well as two sluice gates, one which has incorporated part of a former railroad rail. Please provide photographs and maps for the features.
20. Feature 3 of Site 3094 is 70 meters away and no rationale is provided justifying it's inclusion in Site 3094. Please prepare a site number request, GIS coordinates, and site description for Feature 3 and include the new site number in the revised copy, as a separate site.
21. Site 3094 Feature 2 was not included in the site requests that SCS made for this project. Please prepare documentation and provide GIS coordinates for Feature 2 and submit to SHPD. Please provide sufficient rationale for why Feature 2 is associated with Feature 1 and belongs to the same site.

Discussion and Conclusions

22. During consultation throughout this project, the Kaua'i archaeologist emphasized the need to consider potential trails to the ridgeline, as well as discuss the cultural importance of the ridgeline, which was deemed a traditional cultural property (TCP) in an Office of Hawaiian Affairs (OHA) letter report included in the National Park Service survey of the Māhā'ulepu coast (2008). We recommended contacting OHA to get more information about the report, as well as sources for this information. We understand SCS will be preparing a cultural impact assessment, but please provide additional discussion of these aspects of the project area and what your findings were in the conclusion.
23. These statement is incorrect "Most *heiau*… consist of multiple courses of rocks piled many meters high, and which stand out in complexity and breadth". While it's true many Heiau have those characteristics, there are also many examples of Heiau throughout Hawaii that do not fit these criteria (reference "The Significance of Heiau Diversity in Site Evaluations", C. Cachola-Abad, *Cultural Resource Management* Volume 19, No 8, 1996).
24. Please include a brief description of the sole artifact and its relationship to Site 2250.

Recommendations

23. The recommendations section states that Sites 2250 and 3094 should be preserved via a preservation plan.
 Please provide information on what is being proposed for the remainder of the sites. Will these be "passively preserved", or are they slated for alteration, modification or destruction? What affect will the proposed dairy have on these sites? Please indicate if the reservoir and traditional irrigation systems will be used by the dairy, and how.

Exhibit 21

GOODSILL ANDERSON QUINN & STIFEL
A LIMITED LIABILITY LAW PARTNERSHIP LLP

LISA A. BAIL

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(808) 547-5787

INTERNET:
lbail@goodsill.com

June 4, 2015

VIA CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Michael Moule, P.E.
Chief, Engineering Division
County of Kaua'i
Department of Public Works
4444 Rice Street, Suite 275
Lihu'e, Kaua'i, HI 96766

Re: Rescission of Agricultural Exemption for Hawai'i Dairy Farms – Endangered Species

Dear Mr. Moule:

This office represents Kawailoa Development LLP ("Kawailoa Development"). Kawailoa Development is the owner of the Grand Hyatt Kaua'i and the Poipu Bay Golf Course, which are located close to Hawai'i Dairy Farms' proposed dairy ("Dairy"). Enclosed please find our request, together with exhibits, to the U.S. Department of Agriculture, Natural Resources Conservation Service ("NRCS") and the West Kaua'i Soil & Water Conservation District ("West Kaua'i SWCD") for rescission of approval of Hawai'i Dairy Farm's Soil Conservation Plan ("Plan") in its entirety based on endangered species issues identified by the United States Fish and Wildlife Service ("USFWS"). These endangered species issues were raised in USFWS' comments dated February 23, 2015 regarding Hawai'i Dairy Farms' Environmental Impact Statement Preparation Notice, a copy of which is enclosed with our May 22, 2015 letter to NRCS and West Kaua'i SWCD. Kawailoa Development incorporates by reference into this letter its request to the NRCS and the West Kaua'i SWCD.

Because the County exempted the Dairy's grading, grubbing and stockpiling operations based upon the West Kaua'i SWCD's now apparent incorrect approval of that Plan, we request that the County of Kaua'i likewise rescind its agricultural exemption, which was expressly predicated upon approval of the Plan by NRCS and West Kaua'i SWCD.

Regardless of whether either the NRCS or the West Kaua'i SWCD in fact rescinds their approval of the Plan, however, we request that the County rescind its agricultural exemption on the additional ground that endangered species have already been impacted by

Hawai'i Dairy Farms ground-disturbing activities as set forth in our May 22, 2015 letter to NRCS and West Kaua'i SWCD.

Moreover, the Kaua'i County Code Title VIII, Chapter 22, Article 7 § 22-7.22(a) requires that whenever the County Engineer determines that existing grading, grubbing, or stockpiling is or may become a hazard to public health and safety, endangers property or natural resources, or adversely affects the safety, use, or stability of a public way or drainage channel, the owner or other person in control of the property upon which the hazardous condition arose, upon receipt of notice in writing from the County Engineer, shall commence correction of the hazardous condition within twenty-four (24) hours.

This letter therefore requests that the County rescind the Dairy's agricultural exemption and issue a notice to Hawai'i Dairy Farms to cease all activities on the property in order to protect endangered species.

Very truly yours,

Lisa A. Bail

LAB

Enclosure: Letter dated May 22, 2015 to the U.S. Department of Agriculture, Natural Resources Conservation Service and the West Kaua'i Soil & Water Conservation District

cc (w/encl.): Lyle Tabata
Maunakea Trask, Esq.
Patricia McHenry, Esq.
Kendall J. Moser, Esq.
Jun Fukada, Kawailoa Development LLP

GOODSILL ANDERSON QUINN & STIFEL
A LIMITED LIABILITY LAW PARTNERSHIP LLP

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May 22, 2015

VIA CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Peter Tausend, Chairman
West Kaua'i Soil & Water Conservation District
4334 Rice Street, Room 104
Lihue, HI 96766-1801

Jenna Dunn
District Conservationist
NRCS Service Center
4334 Rice Street, Room 104
Lihue, HI 96766-1801

Re: Rescission of Approval of Hawai'i Dairy Farms' Soil Conservation Plan – Endangered Species

Dear Mr. Tausend and Ms. Dunn:

This office represents Kawailoa Development LLP ("Kawailoa Development"). Kawailoa Development is the owner of the Grand Hyatt Kaua'i and the Poipu Bay Golf Course, which are located close to Hawai'i Dairy Farms' proposed dairy. The purpose of this letter is to request that the West Kaua'i Soil & Water Conservation District ("West Kaua'i SWCD") and the U.S. Department of Agriculture Natural Resources Conservation Service ("NRCS") rescind their approval of the Dairy's soil conservation plan ("Plan") due to impacts identified by the U.S. Fish & Wildlife Service ("USFWS") to endangered species on the subject property.

Hawai'i Dairy Farms began its ground-disturbing activity last year, is conducting field trials (including mowing activities), and has already installed its irrigation systems. *See* photographs enclosed as Exhibit A. Hawai'i Dairy Farms' activities have endangered the following species identified by the USFWS: endangered Hawaiian black-necked stilt, endangered Hawaiian moorhen, endangered Hawaiian coot, endangered Hawaiian duck, endangered Hawaiian goose, endangered Hawaiian hoary bat, endangered Hawaiian petrel, threatened Newell's shearwater, and the band-rumped storm-petrel, which is a candidate for listing. Additionally, the proposed project area is in the vicinity of designated critical habitat for two endangered arthropods, the Kaua'i cave wolf spider and the Kaua'i cave amphipod, as well as the endangered plant, ohai.

Upon review of the Dairy's Environmental Impact Statement Preparation Notice ("EISPN"), U.S. FWS sent a comment letter to Hawai'i Dairy Farms on February 23, 2015, a copy of which is attached as Exhibit B. The comment letter requires the following actions to avoid and minimize project impacts to listed species, candidate species, and critical habitat:

- The effluent ponds should be covered or enclosed to minimize the attraction of waterbirds and geese.
- Electric fencing should not be used as part of the dairy.
- Clostridium botulinum, a bacteria commonly occurring in nutrient-rich substrate, may result in paralysis and most often in mortality when ingested by Hawaiian waterbirds or Hawaiian geese. The spraying of pastures with decaying animal materials will increase the risk for avian botulism.
- A biological monitor should conduct Hawaiian waterbird and Hawaiian goose nest surveys <u>prior</u> to project initiation, and a biological monitor should be present "during all construction activities, earth moving activities, land clearing/disking activities, and mowing of pastures to ensure that waterbirds or geese nests are not adversely impacted."
- Barbed wire should not be used for fencing because Hawaiian hoary bats can become entangled.

Based on the fact that the Dairy undertook its ground-disturbing activities prior to receipt of the USFWS letter, Kawailoa Development believes that the Dairy failed to have a biological monitor conduct nest surveys, and failed to have a biological monitor present "during all construction activities, earth moving activities, land clearing/disking activities, and mowing of pastures to ensure that waterbirds or geese nests are not adversely impacted."

It is therefore apparent that there are a multitude of issues related to endangered species that have yet to be resolved between Hawai'i Dairy Farms, U.S. FWS and the public. It is also clear that the Dairy failed to implement any of the measures required by USFWS before undertaking its onsite activities, including grading and grubbing work, subsurface construction of its irrigation system and implementation of its field trials. The issues related to endangered species constitute new information and resource concerns that merit the immediate halt of any and all construction activities.

Approval of the conservation plan by NRCS and West Kauai SWCD triggered consultation requirements under Section 7 of the Endangered Species Act ("ESA"). Pursuant to Section 7(a)(2) of the ESA, if the proposed project is funded, authorized, or permitted by a Federal agency, then that agency must consult with U.S. FWS. That is, <u>each federal agency</u> shall insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined to be critical. 16 USC § 1536(a)(2). The approval by NRCS and West Kauai SWCD of the Dairy's conservation plan authorized the action. "Action," pursuant to 50 CFR § 402.02, refers to all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies in the United States. Examples include, but are not limited to actions directly or indirectly causing modifications to the land, water, or air. 50 CFR § 402.02.

Additionally, according to the NRCS website, NRCS is an agency that provides technical and financial assistance to private land users on a voluntary basis and as such is considered an "action agency" with regard to compliance under ESA. NRCS is required by the ESA to protect and conserve federally listed species and species proposed for listing. This responsibility includes, but is not limited to research, protection, habitat acquisition, restoration, enhancement and maintenance.[1] NRCS and West Kaua'i SWCD failed to fulfill ESA requirements when they approved the Dairy's conservation plan.

The December 17, 2013 West Kauai SWCD soil conservation plan approval letter states,

> In issuing this conservation plan, the West Kauai Soil & Water Conservation District relies on the information and data which you provided to us. If, subsequent to the issuance of this approved conservation plan, such information and data prove to be false, incomplete or inaccurate, this approval may be modified, suspended or revoked.

The NRCS planning process also requires that the planner must "[r]evisit earlier steps if new objectives or resource concerns are identified." USDA, NRCS National Planning Procedures Handbook ("NPPH") at 600-C.16, 600-C.24 (Jan. 2013). We are copying Department of Land and Natural Resources Chair Suzanne Case on this letter because West Kaua'i SWCD is part of the Department of Land and Natural Resources, as constituted under Hawaii Revised Statues Chapter 180.

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1 http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/plantsanimals/fishwildlife/?cid=stelprd b1042231

The information related to endangered species constitutes new information and resource concerns that require rescission by NRCS and West Kaua'i SWCD of the December 2013 Plan approval.

Very truly yours,

Lisa A. Bail

LAB

Enclosures: Exhibit A, Photographs of the Dairy site taken by the Hawai'i Department of Health, dated November 2014

Exhibit B, Comment letter from U.S. Fish and Wildlife Service dated February 23, 2015

cc (w/encls.): Aaron Nadig, Biologist, U.S. Fish & Wildlife Service
Michael Moule, P.E., Chief, Engineering Division, County of Kaua'i
Suzanne Case, Esq., Chairperson, Hawai'i Department of Land and Natural Resources
Patricia McHenry, Esq.
Kendall J. Moser, Esq.

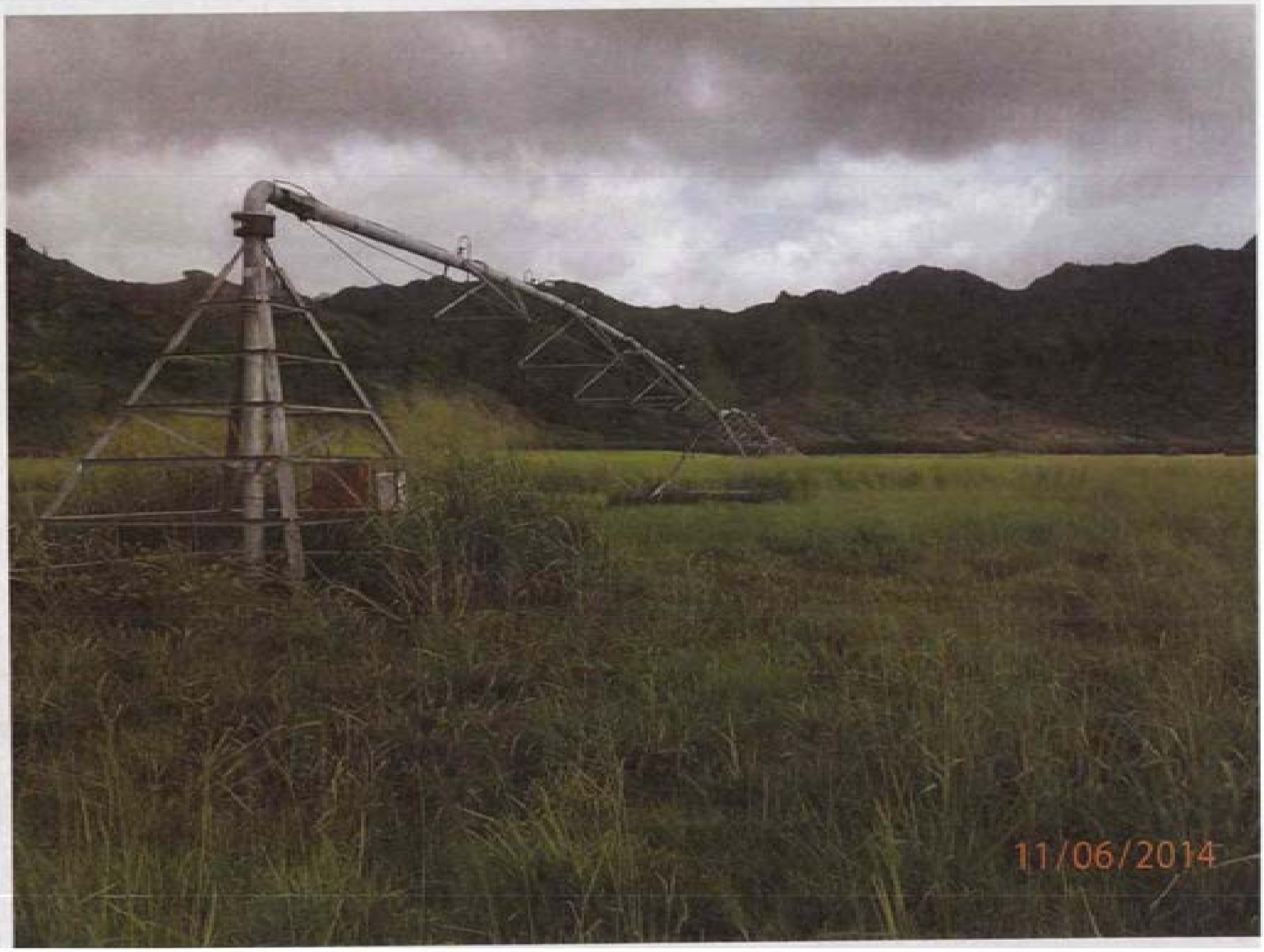
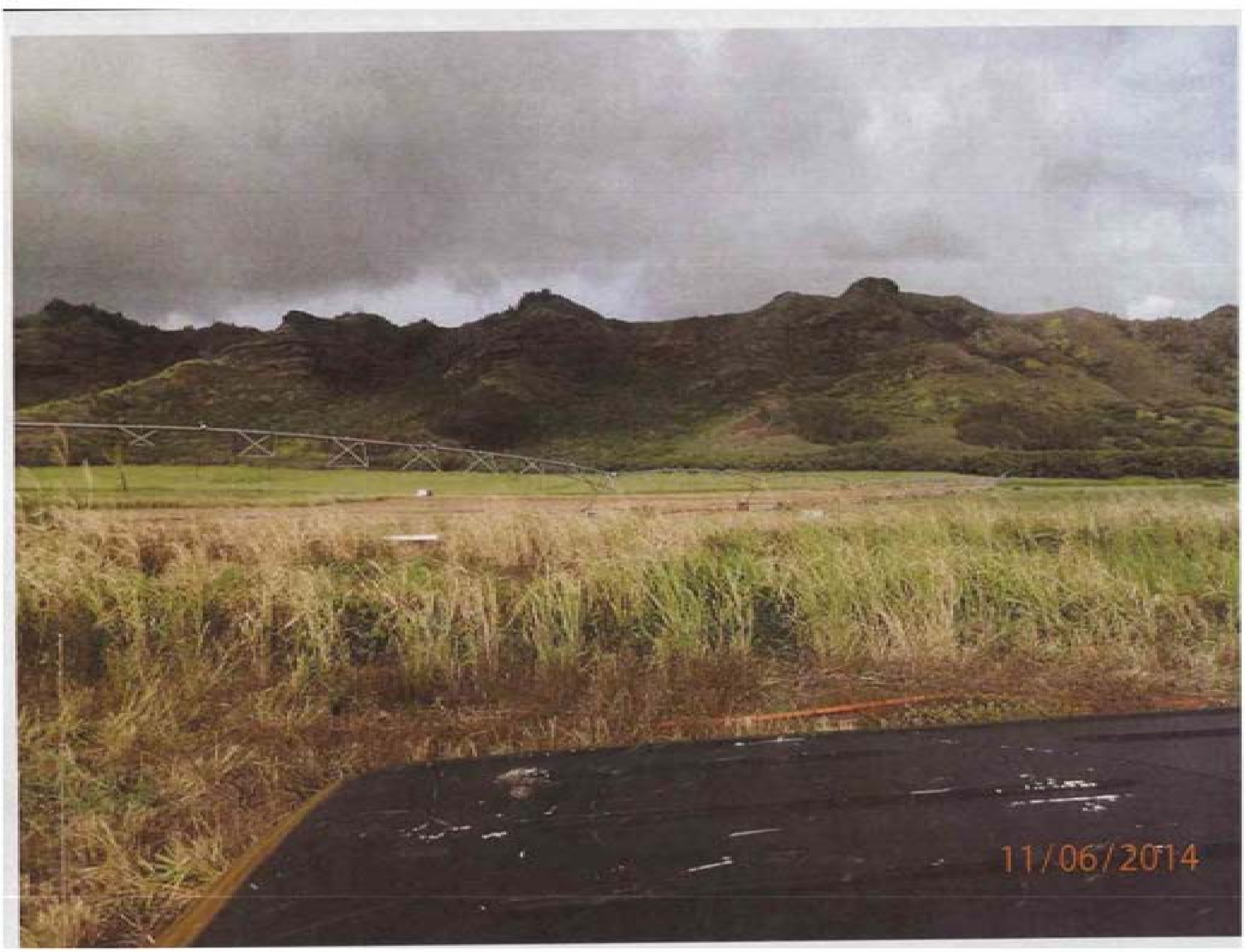


Exhibit A


11/06/2014


11/06/2014

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122
Honolulu, Hawai'i 96850

In Reply Refer To:
2015-TA-0138

FEB 23 2015

Jeffrey H. Overton
Group 70 International, Inc.
925 Bethel Street, Fifth Floor
Honolulu, Hawaii 96813

Subject: Technical Assistance for the Proposed Hawaii Dairy Farms, Kauai

Dear Mr. Overton:

The U.S. Fish and Wildlife Service (Service) received your letter, dated January 26, 2015, requesting our comments on the Notice of Preparation of Environmental Impact Statement (EISPN) for the proposed Hawaii Dairy Farms (HDF) on the island of Kauai. Hawaii Dairy Farms, LLC proposes to establish and operate a grass-fed diary, capable of supporting 2,000 dairy cows, including commercial dairy facilities and pastures managed for Kikuyu and Kikuyu-Guinea grasses. The proposed dairy facilities consist of barn and milking parlor, cow walkways, farm roads, effluent settling and storage ponds, water distribution system and tanks, operations buildings, and associated infrastructure (electrical power, wastewater, and communications). The pasture design will include approximately 118 fenced paddocks (~4.5 to 5.0 acres each). The development will be located on approximately 578 acres consisting of portions of three larger parcels (TMK (4) 2-9-003:001 and 006 portion; TMK (4) 2-9-001:001) adjacent to Mahaulepu Road, east of Koloa town. We offer the following comments to assist you in the preparation of the draft Environmental Impact Statement (EIS). Our comments are provided under the authorities of the Endangered Species Act of 1973 (ESA), as amended (16 U.S.C 1531 *et seq.*), and the Fish and Wildlife Coordination Act of 1934 (FWCA), as amended (16 U.S.C. 661 *et seq.*; 48 Stat. 401).

We reviewed the information you provided and pertinent information in our files, including data compiled by the Hawaii Biodiversity and Mapping Program, as it pertains to federally listed species and designated critical habitat. The following species are known to occur or transit through the proposed project area: the endangered Hawaiian black-necked stilt (*Himantopus mexicanus knudseni*), Hawaiian moorhen (*Gallinula chloropus sandvicensis*), Hawaiian coot (*Fulica alai*), Hawaiian duck (*Anas wyvilliana*) (hereafter collectively referred to as Hawaiian waterbirds);the endangered Hawaiian goose (*Branta sandvicensis*); the endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*); and the endangered Hawaiian petrel (*Pterodroma sandwichensis*), the threatened Newell's shearwater (*Puffinus auricularis newelli*), and a candidate for listing the band-rumped storm-petrel (*Oceanodroma castro*) (hereafter collectively referred to as seabirds). The proposed project area is in the vicinity of designated critical habitat

Exhibit B

for the following species: two endangered arthropods, the Kauai cave wolf spider (*Adelocosa anops*) and the Kauai cave amphipod (*Spelaeorchestia koloana*) (hereafter collectively referred to as arthropods); and an endangered plant, ohai (*Sesbania tomentosa*). We provide the following comments which include recommendations to avoid and minimize project impacts to listed species, candidate species, and critical habitat.

Hawaiian Waterbirds and Hawaiian Goose
The EISPN states that Hawaiian waterbirds and Hawaiian geese are known to utilize water features around the HDF parcel. Our information suggests that considerable numbers of Hawaiian waterbirds frequent the project area. The Service recommends you incorporate the following measures into your project description to avoid and minimize impacts to Hawaiian waterbirds and Hawaiian geese.

Waterbirds and geese may be attracted to the effluent settling and storage ponds as well as managed pastures. Waterbirds and geese attracted to sub-optimal habitat may suffer adverse impacts, such as predation and/or reduced reproductive success, and thus the project may create an attractive nuisance. Measures to minimize their attraction to ponds, such as covering or enclosing the ponds, should be considered. To minimize predation and/or reduced breeding success of waterbirds and geese using pastures, a predator control program should be implemented to control non-native predators, such as feral cats and rats.

Injury or mortality of adults and juveniles may potentially occur due to entanglement or collision with fencing and/or collision with vehicles on farm roads. Additional details on fencing are necessary to assess potential impacts to Hawaiian waterbirds and Hawaiian geese. Electric fencing (commonly used to control movement of cows in pastures) should not be used for fencing as part of the proposed project. To minimize potential collision with vehicles, the Service recommends you install signage near roadways to warn drivers (e.g., farm workers and visitors) to be wary of birds in the areas.

Under certain environmental conditions, *Clostridium botulinum*, a bacteria commonly occurring in nutrient-rich substrate, may produce toxins that when ingested by Hawaiian waterbirds or Hawaiian geese results in paralysis and most often mortality (referred to as avian botulism). The EISPN states that 100% of manure from up to 2,000 dairy cows will be treated and applied to fertilize pasture grasses. The spraying of pastures with decaying animal materials will promote a nutrient-rich bacterial substrate. We recommend you work with our office so that we may assist you in developing measures to avoid fostering conditions that promote avian botulism and a monitoring plan for early detection and response.

Displacement and/or loss of nests may potentially occur during project construction and operation (e.g., clearing areas, disking, and/or mowing of pastures). To minimize and avoid impacts due to displacement and/or loss of nests, we recommend the following measures:

- A biological monitor should conduct Hawaiian waterbird and Hawaiian goose nest surveys at the proposed project site prior to project initiation.
- Any documented nests or broods within the project vicinity should be reported to the Service within 48 hours.

- A 100-foot buffer should be established and maintained around all active nests and/or broods until the chicks have fledged. No potentially disruptive activities or habitat alteration should occur within this buffer.
- The Service should be notified immediately prior to project initiation and provided with the results of pre-construction Hawaiian waterbird and Hawaiian goose surveys.
- A biological monitor(s) should be present on the project site during all construction activities, earth moving activities, land clearing/disking activities, and mowing of pastures to ensure that waterbirds or geese nests are not adversely impacted.
- If a Hawaiian waterbird or Hawaiian goose is observed within the project site, or flies into the site while activities are occurring, the biological monitor should halt all activities within 100 feet of the individual(s). Work should not resume until the Hawaiian waterbird(s) or goose leave the area on their own accord.
- A post-construction report should be submitted to the Service with 30 days of the completion of the project. The report should include the results of surveys, the location and outcome of documented nests, and any other relevant information.

We suggest the draft EIS provide additional information on effluent ponds (e.g., number, location, and sizes), fencing materials and site layout, fertilization practices (e.g., effluent treatment, application amounts, frequency), outline measures to avoid and minimize the various potential impacts described above, and examine potential impacts that may occur as a result of establishment and operation of the HDF project.

Hawaiian Hoary Bat
The Hawaiian hoary bat roosts in both exotic and native woody vegetation and, while foraging, will leave young unattended in "nursery" trees and shrubs when they forage. If trees or shrubs suitable for bat roosting are cleared during the breeding season, there is a risk that young bats could inadvertently be harmed or killed. To minimize impacts to the endangered Hawaiian hoary bat, woody plants greater than 15 feet (4.6 meters) tall should not be disturbed, removed, or trimmed during the bat birthing and pup rearing season (June 1 through September 15). Site clearing should be timed to avoid disturbance to Hawaiian hoary bats in the project area.

Additionally, Hawaiian Hoary bats forage for insects from as low as three feet to higher than 500 feet above the ground. When barbed wire is used for fencing, Hawaiian hoary bats can become entangled. Barbed wire should not be used for fencing as part of the proposed project.

Seabirds
Seabirds, including the Newell's shearwater, Hawaiian petrel, and band-rumped storm petrel fly at night and are attracted to artificially-lighted areas resulting in disorientation and subsequent fallout due to exhaustion. Seabirds are also susceptible to collision with objects that protrude above the vegetation layer, such as utility lines, guy-wires, and communication towers. Additionally, once grounded, they are vulnerable to predators and are often struck by vehicles along roadways. We recommend the following minimization measures be incorporated into your project description:

- Construction activities should only occur during daylight hours. Any increase in the use of nighttime lighting, particularly during peak fallout period (September 15 through December 15), could result in additional seabird injury or mortality.

- If exterior facility lights cannot be eliminated due to safety or security concerns, then they should be positioned low to the ground, be motion-triggered, and be shielded and/or full cut-off. Effective light shields should be completely opaque, sufficiently large, and positioned so that the bulb is only visible from below.

The draft EIS should examine potential impacts to the Newell's shearwater, Hawaiian petrel, and band-rumped storm petrel that may occur as a result of construction and the operational use . exterior lights associated with the proposed project.

Utility poles and overhead lines may constitute a collision hazard for seabirds as they traverse between the ocean and their breeding colonies. Additional information on the design of the proposed utility system for the development, including the number of utility poles, length of powerline, configuration of powerlines, and height of utility poles and overhead powerlines, in the area is necessary to assess the potential impacts to seabirds. We suggest the draft EIS provide this additional informational as well as determine whether undergrounding power lines in the proposed development area is feasible to avoid impacts to seabirds. If it is not feasible to underground power lines or install power lines at or the below the vegetation layer, other measures to minimize the potential for seabird collision should be analyzed in the draft EIS (e.g., vertical versus horizontal arrays, etc.).

Arthropods
The Kauai cave wolf spider and the Kauai cave amphipod are found only on the island of Kauai in the Koloa area from four to six caves respectively. They occur in small, subterranean spaces, voids, and cracks, requiring a woody debris food source. Cave ecosystems are threatened by contamination from surface sources of toxic chemicals from spills, pesticides, and waste disposal which enter caves via streams and/or ground-water seepage. The proposed HDF site is hydrologically linked to the sensitive cave habitats. We recommend the draft EIS address any project components that have the potential to impact the critical habitat (e.g., wastewater and pasture fertilization practices) and minimize potential disturbance.

Sesbania tomentosa
Sesbania tomentosa occurs on the coast located southeast of the HDF site. The primary threat to the species on the island of Kauai is habitat degradation caused by competition with various introduced plant species, including but not limited to buffelgrass (*Cenchrus ciliaris*), swollen fingergrass (*Chloris barbarta*), sourgrass (*Digitaria insularis*), and haole koa (*Leucaena leucocephala*). Other threats include lack of adequate pollination, fire, destruction by off-road vehicles, other human disturbances, and storms. The Service recommends that your draft EIS address any project components that have the potential to impact the critical habitat and minimize potential disturbance.

Under the ESA, take is defined to mean "...to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in any such conduct." Harass is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. Harm is defined by the

Service to include significant habitat modification or degradation that results in death or injury to listed species by impairing behavioral patterns including breeding, feeding, or sheltering.

When additional information on the proposed project description becomes available, we recommend you contact our office early in the planning process so that we may further assist you with ESA compliance. If it is determined that the proposed project may affect federally listed species or critical habitat, the project proponent(s) should coordinate with us under section 10 of the ESA or consult with us pursuant to section 7 of the ESA as follows. If the proposed project is funded, authorized, or permitted by a Federal agency, then that agency should consult with us pursuant to section 7(a)(2) of the ESA. If no Federal agency is involved with the proposed project, the applicant should apply for an incidental take permit under section 10(a)(1)(B) of the ESA. A section 10 permit application must include a habitat conservation plan that identifies the effects of the action on listed species and their habitats, and defines measures to minimize and mitigate those adverse effects.

Additionally, we recommend you incorporate the attached best management practices into your project description to avoid and minimize impacts to water resources that have the potential to occur during establishment and construction of the proposed project.

We appreciate your efforts to conserve protected species. If you have questions regarding this letter, please contact Adam Griesemer, Endangered Species Biologist (phone: 808-285-8261).

Sincerely,

Aaron Nadig
Island Team Manager
Oahu, Kauai, North Western Hawaiian Islands, and American Samoa

cc: Laura McIntyre, HDOH

U.S. Fish and Wildlife Service
Recommended Standard Best Management Practices

The U.S. Fish and Wildlife Service (USFWS) recommends the following measures to be incorporated into project planning to avoid or minimize impacts to fish and wildlife resources. Best Management Practices (BMPs) include the incorporation of procedures or materials that may be used to reduce either direct or indirect negative impacts to aquatic habitats that result from project construction-related activities. These BMPs are recommended in addition to, and do not over-ride any terms, conditions, or other recommendations prepared by the USFWS, other federal, state or local agencies. If you have questions concerning these BMPs, please contact the USFWS Aquatic Ecosystems Conservation Program at 808-792-9400.

1. Authorized dredging and filling-related activities that may result in the temporary or permanent loss of aquatic habitats should be designed to avoid indirect, negative impacts to aquatic habitats beyond the planned project area.

2. Dredging/filling in the marine environment should be scheduled to avoid coral spawning and recruitment periods, and sea turtle nesting and hatching periods. Because these periods are variable throughout the Pacific islands, we recommend contacting the relevant local, state, or federal fish and wildlife resource agency for site specific guidance.

3. Turbidity and siltation from project-related work should be minimized and contained within the project area by silt containment devices and curtailing work during flooding or adverse tidal and weather conditions. BMPs should be maintained for the life of the construction period until turbidity and siltation within the project area is stabilized. All project construction-related debris and sediment containment devices should be removed and disposed of at an approved site.

4. All project construction-related materials and equipment (dredges, vessels, backhoes, silt curtains, etc.) to be placed in an aquatic environment should be inspected for pollutants including, but not limited to; marine fouling organisms, grease, oil, etc., and cleaned to remove pollutants prior to use. Project related activities should not result in any debris disposal, non-native species introductions, or attraction of non-native pests to the affected or adjacent aquatic or terrestrial habitats. Implementing both a litter-control plan and a Hazard Analysis and Critical Control Point plan (HACCP – see *http://www.haccp-nrm.org/Wizard/default.asp*) can help to prevent attraction and introduction of non-native species.

5. Project construction-related materials (fill, revetment rock, pipe, etc.) should not be stockpiled in, or in close proximity to aquatic habitats and should be protected from erosion (*e.g.*, with filter fabric, etc.), to prevent materials from being carried into waters by wind, rain, or high surf.

6. Fueling of project-related vehicles and equipment should take place away from the aquatic environment and a contingency plan to control petroleum products accidentally spilled during the project should be developed. The plan should be retained on site with the person responsible for compliance with the plan. Absorbent pads and containment booms should be stored on-site to facilitate the clean-up of accidental petroleum releases.

7. All deliberately exposed soil or under-layer materials used in the project near water should be protected from erosion and stabilized as soon as possible with geotextile, filter fabric or native or non-invasive vegetation matting, hydro-seeding, etc.

Exhibit 22

GOODSILL ANDERSON QUINN & STIFEL
A LIMITED LIABILITY LAW PARTNERSHIP LLP

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June 4, 2015

VIA CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Michael Moule, P.E.
Chief, Engineering Division
County of Kaua'i
Department of Public Works
4444 Rice Street, Suite 275
Lihu'e, Kaua'i, HI 96766

Re: Rescission of Agricultural Exemption for Hawai'i Dairy Farms – Historic Properties

Dear Mr. Moule:

This office represents Kawailoa Development LLP ("Kawailoa Development"). Kawailoa Development is the owner of the Grand Hyatt Kaua'i and the Poipu Bay Golf Course, which are located close to Hawai'i Dairy Farms' proposed dairy ("Dairy"). Enclosed please find our request, together with exhibits, to the U.S. Department of Agriculture, Natural Resources Conservation Service ("NRCS") and the West Kaua'i Soil & Water Conservation District ("West Kaua'i SWCD") for revocation of approval of Hawai'i Dairy Farm's Soil Conservation Plan ("Plan") in its entirety based on newly identified and documented information regarding historic properties. Kawailoa Development incorporates by reference into this letter its request to NRCS and West Kaua'i SWCD.

Because the County exempted Hawai'i Dairy Farms' grading, grubbing and stockpiling operations based upon West Kaua'i SWCD's now apparent premature approval of that Plan, we request that the County of Kaua'i likewise rescind its agricultural exemption, which was expressly predicated upon approval of the Plan by NRCS and West Kaua'i SWCD.

Regardless of whether either NRCS or West Kaua'i SWCD in fact rescinds their approval of the Plan, however, we request that the County rescind its agricultural exemption on the additional ground that previously undisclosed, but nonetheless significant historic properties have yet to be addressed in an approved archaeological inventory survey or compliance with Chapter 6E, Hawaii Revised Statutes or its accompanying administrative rules.

Kaua'i County Code, Section 22-7.6, prohibits the County engineer from granting agricultural exemptions unless "[t]he applicant submits a copy of the conservation plan to the County Engineer, accompanied by written verification that the Soil and Water Conservation District Board approved the plan, and a copy of the State Department of Land and Natural Resources Historic Preservation Division's comments to the plan[.]" (Emphasis added).

The Hawai'i State Historic Preservation Division ("SHPD") did not comment upon the Plan or if comments were purportedly provided, such comments were incomplete.[1] SHPD in fact only recently sent a review letter on April 13, 2015 to Hawai'i Dairy Farms with comments on the Archaeological Inventory Survey ("AIS") prepared by Hawai'i Dairy Farms. A copy of SHPD's April 13, 2015 review letter is attached to our enclosed June 4, 2015 letter to NRCS and West Kaua'i SWCD. The Draft AIS has identified at least 16 significant historic properties and cultural resources (including heiau, petroglyphs) that may be at risk if the agricultural related activities are permitted to continue.

In summary, SHPD has raised a number of concerns and has required revisions to the Hawai'i Dairy Farms' AIS based upon a multitude of archaeological issues that have yet to be resolved between Hawai'i Dairy Farms, SHPD and the public. The ordinances of the County of Kaua'i require that SHPD's review and comment precede any action by the County Engineer. SHPD did not comment until recently. In addition to such procedural irregularities, of equal significance are the historic properties referenced in SHPD's letter constituting new information and resource concerns that merit the immediate halt of any and all construction activities until proper studies and outreach to descendants and Native Hawaiian organizations have been conducted.

This letter therefore requests that the County rescind the Dairy's agricultural exemption.

Very truly yours,

Lisa A. Bail

LAB

Enclosure: Letter dated June 4, 2015 to the U.S. Department of Agriculture, Natural Resources Conservation Service and the West Kaua'i Soil & Water Conservation District

[1] In any event, the letter approving the agricultural exemption does not reflect or reference any such comments by SHPD.

cc (w/encl.): Lyle Tabata
Maunakea Trask, Esq.

cc (w/o encl.): Jun Fukada, Kawailoa Development LLP
Patricia McHenry, Esq.
Kendall J. Moser, Esq.

Exhibit 23

GOODSILL ANDERSON QUINN & STIFEL
A LIMITED LIABILITY LAW PARTNERSHIP LLP

LISA A. BAIL

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June 24, 2015

VIA HAND DELIVERY

Charley Ice
Hydrologist, Hawai'i Water Commission
Hawai'i Water Commission
Kalanimoku Building
1151 Punchbowl Street, Room 227
Honolulu, HI 96813

Re: Hawai'i Dairy Farms' Well Construction Permits

Dear Mr. Ice:

This office represents Kawailoa Development LLP ("Kawailoa Development"). Kawailoa Development is the owner of the Grand Hyatt Kaua'i and the Poipu Bay Golf Course, which are located close to Hawai'i Dairy Farms' proposed dairy ("Dairy"). The purpose of this letter is to request that the Hawai'i Commission on Water Resource Management ("Water Commission") either rescind its approval of the Dairy's well construction permits or impose penalties as allowed by the Water Commission's rules.

As set forth in further detail below, the basis for this request is as follows. First, the Dairy made a material misstatement in its application, indicating that it is not constructing a wastewater treatment unit as part of its proposed project and that Hawai'i Revised Statues Chapter 343 does not apply. Second, there has been a material change of circumstances existing at the time the permit was issued in that earlier this year the United States Fish and Wildlife Service ("USFWS") identified significant concerns regarding threatened and endangered species and the need for compliance under the Endangered Species Act. Third, the Dairy failed to timely submit its well completion reports. Finally, we are concerned that the required review by the Department of Health did not occur. Under these circumstances, the Water Commission's may revoke a permit as follows:

> (i) The commission may modify, suspend, or revoke a permit, after notice and hearing, on any of the following grounds:
>
> (1) Material misstatement or misrepresentation in the application for a permit;

> (2) Failure to comply with the provisions set forth in the permit;
>
> (3) Willful disregard or violation of any provision of this part or any rule adopted pursuant thereto; or
>
> (4) Material change of circumstances or conditions existing at the time the permit was issued.

Hawai'i Administrative Rules ("HAR") § 13-168-12(i). Alternatively, the rules allow imposition of penalties as follows:

> Any person who violates any provision of this chapter or any permit condition or who fails to comply with any order of the commission may be subject to a fine imposed by the commission. Such fine shall not exceed $1,000 per violation. For a continuing offense, each day's continuance is a separate violation.

HAR § 13-169-3(a).

Hawai'i Dairy Farms' proposed 577.9 acre dairy project is of significant public interest. Not only will the project affect the over 1,000 employees at the Grand Hyatt Kaua'i and Poipu Bay Golf Course, but adverse consequences resulting from the Dairy's operations will be a concern for all who visit, live or work in the Po'ipū and Koloa area. The full-scale operations of the Dairy have already been acknowledged by the Dairy to be a Concentrated Animal Feeding Operation ("CAFO"), and at 2,000 cows, or even 699 cows (HDF's purported first phase), the Dairy will be one of the largest and most concentrated in the State. As the U.S. Environmental Protection Agency has stated, "The concentrations of waste from these animals increase the potential to impact air, water, and land quality." Given such potential impacts, a careful and deliberate review of the environmental impacts is imperative before permits are granted.

Hawai'i Dairy Farms steadfastly maintains, to the doubt of the local community, that it is a "zero discharge" facility. The Dairy's well permit applications indicate its concession that groundwater impacts may occur. Kawailoa Development is therefore pleased that Hawai'i Dairy Farms will monitor groundwater impacts, especially in light of concerns raised by the Kauai Department of Water ("DOW") regarding impacts to DOW's Koloa Well F.[1] Although groundwater monitoring is a step in the right direction, Kawailoa Development's position is that Hawai'i Dairy Farms must comply with all legal requirements, including those relating to well construction permits.

[1] The DOW concerns are described in Tom Nance's email to the Water Commission dated March 23, 2015, which email is contained in the Water Commission's file.

A. Material Misstatements Were Made in the Well Construction Permit Applications

Hawai'i Dairy Farms' three well construction permit applications were received by the Water Commission on October 28, 2014.[2] In each of its applications, the Dairy averred that its project did not propose any of actions triggering Hawai'i Revised Statutes ("HRS") Chapter 343. Specifically, the Dairy did not disclose that its project included a wastewater treatment unit. This is a material misstatement, given that the Dairy's Waste Management Plan includes an entire section on its wastewater treatment unit. Exhibit A at 41-42.

The Dairy's proposed wastewater treatment unit consists of two effluent ponds, a settling pond and a storage pond, which will be constructed "for effluent collection, management and proper utilization of nutrients available from livestock waste." *Id.* at 45. Approximately 1.76 acres of land and improvements will drain to the effluent ponds. *Id.* The drained areas include the calf sheds and concrete gutter, the uncovered holding pens and yards, the uncovered loading areas, and the settling and storage pond areas. *Id.* at 46. The holding yard and milking parlor will be washed twice a day after each milking, and all of the manure and contaminated water produced in these areas will be washed out and transferred to the settling pond. *Id.* at 42. The milk storage tanks located within the milking parlor will be washed out after milk is pumped to tanker trucks for delivery, and this contaminated water will also be transferred to the settling pond. *Id.* As all the wastewater is first transferred to the settling pond, this pond will remain full "in normal steady state," and a stirrer pump will operate for two hours per day to break up the solids in the settling pond. *Id.* at 43. The accumulated sludge in the settling pond will be pumped out every 45 days. *Id.* The minimum settling pond volume will include 45 days of sludge storage, plus an appropriate mixing volume of liquid required for stirring and pumping for application to the pastures. *Id.* The liquid effluent in the settling pond then overflows into the storage pond, where the wastewater is diluted before it is applied onto the pastures. *Id.* Plainly this is critical information that should have been provided to the Commission as part of the applications.

Chapter 343 is triggered when a proposed action falls within one of nine categories set forth in HRS § 343-5(a). The categories of actions covered by Chapter 343 include actions that "[p]ropose any wastewater treatment unit, except an individual wastewater system or a wastewater treatment unit serving fewer than fifty single-family dwellings or the equivalent." HRS § 343-5(a)(9)(A). Chapter 343 requires that, for actions that propose a

[2] The Dairy submitted applications for HDF-1, HDF-2 and HDF-3 in October 2014. In April 2015, the Water Commission approved a new location for HDF-3, and a new well, HDF-4. The Dairy failed to submit both an application on forms provided by the commission and the requisite $25 filing fee for HDF-4, as required by HAR § 13-168-12(a) and (b). An application for HDF-4 should have stated the manner of sealing of plugging the abandoned well, and should have been reviewed by the department of health. HAR § 13-168-12(f).

wastewater treatment unit, an environmental assessment must be prepared "at the earliest practicable time" to determine whether an environmental impact statement shall be required. HRS § 343-5(b). Unless the project is exempt under HRS § 343-6,[3] "preparation of an environmental assessment is <u>mandatory</u>." *Kahana Sunset Owners Ass'n v. County of Maui*, 86 Hawai'i 66, 71, 947 P.2d 378, 383 (1997) (emphasis added).

Kawailoa Development has filed a lawsuit in the Circuit Court of the Fifth Circuit regarding Hawai'i Dairy Farms' noncompliance with Chapter 343. Hawai'i Dairy Farms has admitted in its Waste Management Plan and its answer to Kawailoa Development's First Amended Complaint that it proposes to construct and operate a wastewater treatment unit. Where the Dairy's proposed action includes a wastewater treatment unit, compliance with Chapter 343 is required.

Hawai'i Dairy Farms made a public announcement in November 2014 that it would prepare an after-the-fact Environmental Impact Statement. Kawailoa Development maintains that this after-the-fact document does not comply with Chapter 343 because the Dairy obtained several permits and approvals before making this announcement. It is well-settled that the purpose of Chapter 343 is informed decision making. HRS § 343-1 ("It is the purpose of this chapter to establish a system of environmental review which will ensure that environmental concerns are given appropriate consideration in decision making along with economic and technical considerations."). Hence, the Hawai'i Environmental Impact Statement ("EIS") Law requires that, "the agency initially receiving and agreeing to process the request for approval shall require the applicant to prepare an environmental assessment of the proposed action at the earliest practicable time." In any event, plainly complete information concerning compliance with Chapter 343 should have been provided to the Commission as part of the applications.

In sum, the applications contain two material misstatements: first, that there is no wastewater treatment unit, and second, that Chapter 343 does not apply to the project at hand.

B. Information from the USFWS regarding Threatened and Endangered Species is a Material Change of Circumstances

Hawai'i Dairy Farms' well construction activities may endanger the following species identified by the USFWS: endangered Hawaiian black-necked stilt, endangered Hawaiian moorhen, endangered Hawaiian coot, endangered Hawaiian duck, endangered

[3] There is no exemption applicable to this wastewater treatment unit. *See* HAR § 11-200-8, Exempt Classes of Action. Even if there were an applicable exemption, an environmental assessment would nonetheless be required. "All exemptions under the classes in this section are inapplicable when the cumulative impact of planned successive actions in the same place, over time, is significant, or when an action that is normally insignificant in its impact on the environment may be significant in a particularly sensitive environment." HAR § 11-200-8(b).

Hawaiian goose, endangered Hawaiian hoary bat, endangered Hawaiian petrel, threatened Newell's shearwater, and the band-rumped storm-petrel, which is a candidate for listing. Additionally, the proposed project area is in the vicinity of designated critical habitat for two endangered arthropods, the Kaua'i cave wolf spider and the Kaua'i cave amphipod, as well as the endangered plant, ohai.

Upon review of the Dairy's EIS Preparation Notice, USFWS sent a comment letter to Hawai'i Dairy Farms on February 23, 2015, a copy of which is attached as Exhibit B. The comment letter requires the following actions to avoid and minimize project impacts to listed species, candidate species, and critical habitat:

- The effluent ponds should be covered or enclosed to minimize the attraction of waterbirds and geese.
- Electric fencing should not be used as part of the dairy.
- Clostridium botulinum, a bacteria commonly occurring in nutrient-rich substrate, may result in paralysis and most often in mortality when ingested by Hawaiian waterbirds or Hawaiian geese. The spraying of pastures with decaying animal materials will increase the risk for avian botulism.
- A biological monitor should conduct Hawaiian waterbird and Hawaiian goose nest surveys prior to project initiation, and a biological monitor should be present "during all construction activities, earth moving activities, land clearing/disking activities, and mowing of pastures to ensure that waterbirds or geese nests are not adversely impacted."
- Barbed wire should not be used for fencing because Hawaiian hoary bats can become entangled.

There is no indication that the Dairy either had a biological monitor conduct nest surveys in advance of its well construction activities, or that it had a biological monitor present "during all construction activities, earth moving activities, land clearing/disking activities, and mowing of pastures to ensure that waterbirds or geese nests are not adversely impacted."

It is therefore apparent that there are a multitude of issues related to endangered species that have yet to be resolved between Hawai'i Dairy Farms, USFWS and the public. It is also clear that the Dairy failed to implement any of the measures required by USFWS before undertaking its onsite activities, including grading and grubbing work, subsurface construction of its irrigation system and implementation of its field trials. The issues related to endangered species constitute a "material change of circumstances or conditions existing at the time the

permit was issued." In light of the comments of the USFWS, any and all construction activities should be halted until their concerns have been addressed.

In addition, Hawai'i Dairy Farms has failed to consult with the USFWS as required by Section 7 of the Endangered Species Act. Approval of the Dairy's conservation plan by NRCS and West Kauai Soil and Water Conservation District triggered consultation requirements under Section 7 of the Endangered Species Act ("ESA"). Pursuant to Section 7(a)(2) of the ESA, if the proposed project is funded, authorized, or permitted by a Federal agency, then that agency must consult with U.S. FWS. That is, each federal agency shall insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined to be critical. 16 USC § 1536(a)(2). Hawai'i Dairy Farms' noncompliance with the ESA precludes issuance of a well construction permit. HAR § 13-168-12 (c) ("The commission may issue or cause to be issued a permit only if the proposed construction complies with all applicable laws, rules, and standards.")

C. Hawai'i Dairy Farms Failed to Comply with its Permit Provisions and the Applicable Administrative Rules

Hawai'i Dairy Farms completed wells HDF-1 and HDF-2 by March 23, 2015, as set forth in email correspondence from Tom Nance to the Water Commission on that date.[4] The Dairy, however, failed to submit its well completion reports on or before the deadline of April 22, 2015. As set forth in HAR § 13-168-13, well completion reports must be filed with the Water Commission "within thirty days after the completion of any well."[5] (Emphasis added).

[4] Mr. Nance's email does not indicate which two wells were completed. No additional information is available about completion of the wells HDF-3 and HDF-4. We note that although Mr. Nance indicated on March 23, 2015 that the Dairy would like to drill HDF-3 in its new proposed location "now . . . and then move to HDF-4," that the amended permit for the new location for HDF-3 and the new HDF-4 was not accepted by the driller until April 13, 2015. It is unknown whether construction of wells HDF-3 and HDF-4 commenced before the amended permit was issued.

[5] Although HAR 13-168-12(e) requires that well construction permits direct the well driller to file a well completion report within the thirty day period provided by HAR 13-168-13, the amended permit issued to Hawai'i Dairy Farms on April 15, 2015 requires that the well completion report "be submitted to the Chairperson within sixty (60) days after completion of work." The terms of a permit, however, may not extend the thirty day deadline set by rule. Assuming, *arguendo*, that 60 days were allowed for the well completion report, it would have been due May 22, 2015. Well completion reports were not contained in the Water Commission's file which I reviewed on June 12, 2015.

D. The Applications Were Not Reviewed by Department of Health

In the Water Commission files that I reviewed on June 12, 2015, there was no indication that the Dairy's well construction applications were reviewed by the Department of Health. As set forth in HAR § 13-168-12(c), "Before an application for a well construction permit is approved, the commission shall cause such application to be reviewed by the department of health for compliance with their rules and standards concerning, among other things, the appropriateness of the well location." There is no indication that the Dairy's well construction permit applications were either offered to the Department of Health for review, nor is there an indication that the Department of Health actually reviewed the applications before the permit was issued, as required by rule.

E. Remedies

As set forth above, the Water Commission has the authority to modify, suspend, or revoke a permit pursuant to HAR § 13-168-12(i). The commission also has the authority to impose penalties of $1,000 per violation, with each day of a continuing offense constituting a separate violation. We request that the commission both revoke the existing permits and impose penalties as appropriate.

Should you have any questions regarding the foregoing, please do not hesitate to contact me at (808)547-5787.

Very truly yours,

Lisa A. Bail

LAB

Enclosures
A Hawai'i Dairy Farms Wastewater Management Plan
B USFWS comment letter to Hawai'i Dairy Farms dated February 23, 2015

cc: Suzanne Case, Esq., Chairperson, Hawai'i Department of Land and Natural Resources
W. Roy Hardy, P.E., Water Commission Acting Deputy Director
Patricia McHenry, Esq.
Kendall J. Moser, Esq.
Jun Fukada, Kawailoa Development LLP

Exhibit 24

DATE: June 12, 2014

MEMO TO: The State of Hawaii and the County of Kauai

FROM: Patricia J. McHenry

RE: The "Wastewater Treatment Unit" Trigger for the Preparation of Environmental Assessments in Hawaii Revised Statutes Chapter 343

Kawailoa Development, LLP has sent a letter to the State of Hawaii and County of Kauai permitting agencies stating that Hawaii Revised Statutes Chapter 343 applies to the dairy farm being planned for Maha'ulepu Valley and that the development of the dairy farm cannot proceed in the absence of an environmental assessment ("EA"). The letter focuses on the settling pond that the dairy farm plans to use to treat effluent from its milk production area and contends that the settling pond constitutes a "wastewater treatment unit." A "wastewater treatment unit" is one of the triggers listed in Chapter 343 for the preparation of an EA.

Chapter 343 defines "wastewater treatment unit" as "any plant or facility used in the treatment of wastewater." If an effluent pond is indeed a facility used in the "treatment" of wastewater and if the settling pond is therefore subject to Chapter 343, that conclusion would have serious implications for virtually all plans for new animal husbandry operations in the State of Hawaii because most animal husbandry operations use some form of settling pond. That conclusion would have similar serious implications for all plans to increase the size of existing settling ponds.

The preparation of an EA is expensive and takes many months. The preparation of an expensive and time-consuming EA is not something that an individual or company thinking about a sub-commercial operation can afford. It would even give companies planning large-scale animal husbandry operations or desiring to expand existing operations considerable pause.

The net result is that the "wastewater treatment unit" trigger in Chapter 343 has and will have a significant chilling effect on the development of sustainable agriculture in the State. It is noteworthy that neither federal law nor the laws of other states have a similar chilling effect because neither federal law nor the laws of other states have the "wastewater treatment unit" or similar trigger. Hawaii is unique in imposing this additional burden on agriculture.

It is therefore vital that a careful and thorough analysis be done as to whether a settling

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pond is a facility used in the "treatment" of wastewater because of the profound effects that a conclusion that a settling pond triggers Chapter 343 would have. A very preliminary analysis as to the interpretation of "treatment" and the need for additional research on the issue follows:

I. <u>WHAT CONSTITUTES "TREATMENT" UNDER HRS CHAPTER 343?</u>

Hawai'i Revised Statutes ("HRS") § 343-5(a) provides that "an environmental assessment shall be required for actions that: . . . (9) Propose any: (A) Wastewater treatment unit, except an individual wastewater system or a wastewater treatment unit serving fewer than fifty single-family dwellings or the equivalent . . . ." The term "wastewater treatment unit" is defined as "any plant or facility used in the treatment of wastewater." HRS § 343-2. Chapter 343, however, does not contain a definition of the key term "treatment."

The legislative history for the 2005 amendment to Chapter 343 that added "wastewater treatment unit" to the list of EA triggers indicates that the term should be interpreted pursuant to the Hawaii's waste water systems rules. 2005 Haw. Sess. Laws Act 130 (H.B. 408). Those rules define "wastewater" as "any liquid waste, whether treated or not, and whether animal, mineral or vegetable, including agricultural, industrial and thermal wastes." Hawai'i Administrative Rules ("HAR") § 11-62-3. The effluent from the milk production area would clearly meet this definition. The wastewater systems rules further define "[t]reatment unit" as "any plant, facility, or equipment used in the treatment of wastewater including the necessary pumps, power equipment, blowers, motors, holding tanks, flow splitter, and other process equipment." <u>Id</u>. However, the wastewater systems rules also do not define the key term "treatment."

Hawaii case law provides no guidance either with respect to "wastewater treatment unit" or "treatment." No Hawaii case interprets either term in the context of Chapter 343 or of the wastewater systems rules.

In the absence of clear definitions in state environmental statutes or rules or of case law on point, it is common in environmental matters for courts in Hawaii to look to the United States Environmental Protection Agency ("EPA") and federal law in general for guidance. In its glossary "Terms of Environment, the EPA defines "treatment" as "[a]ny method, technique, or process designed to remove solids and/or pollutants from solid waste, waste-streams, effluents, and air emissions." However, based on preliminary research, we have been unable to locate any case law in which the above definition has been applied in the context of livestock agriculture operations.

In another context—that of the EPA rules applicable to "sewage sludge," the EPA has defined "[t]reat or treatment of sewage sludge [as] the preparation of sewage sludge for final use or disposal. This includes, but is not limited to, thickening, stabilization, and dewatering of sewage sludge. This does not include storage of sewage sludge." 40 CFR § 503.9(z). The single case citing to the definition of "treatment" in the sewage sludge rules is not helpful because the court ultimately relied on another definition—that of "domestic septage"—for its decision. In U.S. v. Hagberg, 207 F.3d 569 (9th Cir. 2000), the issue was whether material removed from a septic tank and dumped onto a stretch of road was material removed from a "treatment works treating domestic septage." Although the court referred to the definitions of "treatment" and "treatment works" in the sewage sludge rules, the court held that those definitions, by themselves, left room for argument as to whether treatment had occurred inside the septic tank. It was only by taking those definitions together with other definitions, notably that for "domestic septage," that the court was able to conclude that "treatment" had occurred in the septic tank.

> [I]t is clear that a domestic septic tank is necessarily a "treatment works" . . . . This is so because the definition of "domestic septage" at [CFR] section 503.9(f) says that it is material removed from "a septic tank, cesspool, portable toilet, Type III marine sanitation device, or *similiar* [*sic*] treatment works. . . ." 40 C.F.R. § 503.9(f) (emphasis added).

Id. .

In any event, the definition of "treatment" and "treatment works" in the federal sewage sludge rules appears to be of limited value in the wastewater context because HAR § 11-62-41.1 provides that even if wastewater sludge generation, treatment, preparation, storage, hauling, application, placement, use or disposal are "allowed under [the EPA rules on sewage sludge]," they shall not be conducted unless allowed under this chapter [the Hawaii rules on wastewater systems].

Beyond the EPA definition and the EPA rules on sewage sludge, we have, to date, been able to locate very little federal law defining the term "treatment" in the context of wastewater and/or effluent.

We have also begun to look at the rules on wastewater systems from all forty-nine other states but need additional time to complete that research. However, preliminarily, we note that the little research we have been able to complete indicates that at least some other states have broader definitions that expressly include settling ponds. For example, West Virginia includes settling ponds in its definition of "treatment work."

> 'Treatment works' shall mean any plant, facility, means, system, disposal field, lagoon, pumping station, constructed drainage ditch or surface water intercepting ditch, diversion ditch above or below the surface of the ground, settling tank or pond, earthen pit, incinerator, area devoted to sanitary landfills or other works not specifically mentioned herein, installed for the purpose of treating, neutralizing, stabilizing, holding or disposing of sewage, industrial wastes or other wastes or for the purpose of regulating or controlling the quality and rate of flow thereof;

Rayle Coal Co. v. Chief, Div. of Water Res., State Dept. of Nat. Res., 401 S.E.2d 682, 685 (W.Va. 1990).

In sum, the research that we have been able to complete provides little regulatory or case law guidance on the term "treatment" in the wastewater context. We are still completing the research with respect to the rules and case law from the other forty-nine states.

II. NO STATUTORY OR REGULATORY EXEMPTIONS ALLEVIATE THE EA BURDEN

If the settling pond is a "wastewater treatment unit" under Chapter 343, the only escape from the burden of conducting an EA would be if a statutory or regulatory exemption applied. However, as stated in greater detail below, no current exemption applies to the scale of livestock agriculture contemplated by the dairy.

A. Statutory Exemptions to EA Requirement.

HRS § 343-5(a)(9)(A) provides a statutory exemption from the requirement to perform an EA for an "individual wastewater system or a wastewater treatment unit serving fewer than fifty single-family dwellings or the equivalent." Any wastewater system used in animal agriculture cannot qualify as an "individual wastewater system." The wastewater systems rules limit potential wastewater systems that could fall within this definition to those systems dealing with domestic wastewater:

> "Individual wastewater system" means a facility which is used and designed to receive and dispose of no more than one thousand gallons per day of ***domestic wastewater***. Each individual wastewater system includes all connected plumbing, treatment (if any), and disposal components that could, if not connected, serve as separate wastewater systems.

HAR § 11-62-3 (emphasis added). That same regulation defines "domestic wastewater" to mean

> waste and wastewater from humans or household operations that:
>
> (1) Is discharged to or otherwise enters a treatment works; or
>
> (2) Is of a type that is usually discharged to or otherwise enters a treatment works or an individual wastewater system.

Id. "[W]astewater from agricultural, commercial, or industrial activities or operations," however, is included within the definition of "***non-domestic wastewater***." See HAR § 11-62-07.1(b)(1).

Any wastewater system used in a sizeable animal husbandry operation is also unlikely to fit within the statutory exemption from the EA requirement for "a wastewater treatment unit serving fewer than fifty single-family dwellings or the equivalent." Although equating the size of any water treatment unit to one used for fewer than fifty single-family dwellings would be an inherently factual and case-specific endeavor, any wastewater system relating to any sizeable agricultural operation would in all probability not meet this threshold. Wastewater systems used in dairy operations, in particular, have virtually no chance of being equivalent in size to a system serving less than fifty single-family dwellings. "An average 1,000-pound milk cow produces approximately eighty-two pounds of wet manure per day—twenty times that of an adult human." Larry C. Frarey & Staci J. Pratt, Environmental Regulation of Livestock Production Operations, 9 WTR Nat. Resources & Env't 8 (Winter 1995); see also EPA, What's the Problem?, Animal Waste, (last visited Jun. 7, 2014), www.epa.gov/region9/animalwaste/problem.html ("The waste produced per day by one dairy cow is equal to that of 20-40 people."). Even if the wastewater system only needed to process the waste from dairy cows generated during daily two-hour milking sessions, a dairy operation would be limited to a relatively small number of cows to stay below the equivalent of fifty single-family dwellings. Using rough estimates, any dairy with more than 120 cows would exceed the threshold.

Reviewing statutes outside of HRS Chapter 343, it is apparent that all states, including Hawai'i, have enacted some form of the Right to Farm law. See HRS § 165-1; see also Natural Agricultural Lands Study (NALS), The Protection of Farmland: A Reference Guidebook for State and Local Governments 98 (1981). Section 165-3 declares that the "preservation and promotion of farming is declared to be in the public purposes and deserving of public support." The provisions of the Right to Farm Act, however, do not exempt agricultural businesses from any environmental laws. Rather, its purpose is to protect agriculture from nuisance lawsuits by creating a "rebuttable presumption that a farming operation does not constitute a nuisance." HRS § 165-4.

No other provisions in the Hawaii Revised Statutes appear to provide any exemption for agricultural businesses from environmental laws.

B. Regulatory Exemptions to Requirement to Perform an Environmental Assessment

HRS § 343-6 empowers the Environmental Council to create and define exemptions to the EA requirement. HAR § 11-200-8(a) contains eleven classes of actions that are exempt from the requirement to prepare an EA "because they will probably have minimal or no significant effect on the environment." It does not appear that any of these exemptions would apply to new

animal agriculture projects. Three of the eleven exemptions can be ruled out because they apply only to existing operations and facilities:

> (1) Operations, repairs, or maintenance to existing structures, facilities, equipment, or topographical features, involving negligible or no expansion or change of use beyond that previously existing;
>
> (2) Replacement or reconstruction of existing structures and facilities where the new structure will be located generally on the same site and will have substantially the same purpose, capacity, density, height, and dimensions as the structure replaced.
>
> . . .
>
> (6) Construction or placement of minor structures accessory to existing facilities.

Id. § 11-200-8(a)(1)–(2) & (6).

Six more of the eleven exemptions do not appear to relate to new animal agriculture projects in any meaningful way:

> (5) Basic data collection, research, experimental management, and resource evaluation activities which do not result in a serious or major disturbance to an environmental resource;
>
> . . .
>
> (7) Interior alterations involving things such as partitions, plumbing, and electrical conveyances;
>
> (8) Demolition of structures, except those structures located on any historic site as designated in the national register or Hawaii register as provided for in the National Historic Preservation Act of 1966, Public Law 89-665, 16 U.S.C. § 470, as amended, or chapter 6E, HRS;
>
> (9) Zoning variances except shoreline set-back variances;
>
> (10) Continuing administrative activities including, but not limited to purchase of supplies and personnel-related actions; and
>
> (11) Acquisition of land and existing structures, including single or multi-unit dwelling units, for the provision of affordable housing, involving no

> material change of use beyond that previously existing, and for which the legislature has appropriated or otherwise authorized funding.

Id. § 11-200-8(a)(5) & (7)–(11).

The remaining two exemptions are only available to small facilities or minor alterations in the conditions of the land, and it is difficult to envision any scenario in which these exemptions would apply to a new animal agriculture project:

> (3) Construction and location of single, new, small facilities or structures and the alteration and modification of the same and installation of new, small, equipment and facilities and the alteration and modification of the same, including, but not limited to:
>
> (A) Single-family residences less than 3,500 square feet not in conjunction with the building of two or more such units;
>
> (B) Multi-unit structures designed for not more than four dwelling units if not in conjunction with the building of two or more such structures;
>
> (C) Stores, offices, and restaurants designed for total occupant load of twenty persons or less per structure, if not in conjunction with the building of two or more such structures; and
>
> (D) Water, sewage, electrical, gas, telephone, and other essential public utility services extensions to serve such structures or facilities; accessory or appurtenant structures including garages, carports, patios, swimming pools, and fences; and acquisition of utility easements.
>
> (4) Minor alterations in the conditions of land, water, or vegetation.

Id. § 11-200-8(a)(3)–(4).

In addition to the eleven exemptions set forth above, HAR § 11-200-8(d) mandates that each state agency must develop its own list of specific types of actions which fall within the exempt classes:

> (d) Each agency, through time and experience, shall develop its own list of specific types of actions which fall within the exempt classes, as long as these lists are consistent with both the letter and intent expressed in these exempt classes and chapter 343, HRS. These lists and any amendments to

> the lists shall be submitted to the council for review and concurrence. The lists shall be reviewed periodically by the council.

Id.

The Environmental Council accepted the most recent Comprehensive Exemption List from DOH on March 12, 2003. The Department of Agriculture's ("***DOA***") Comprehensive Exemption List was accepted by the Environmental Council on September 17, 2008. Both exemption lists track the structure of the eleven exemptions in § 11-200-8(a) and offer specific items within the eleven exemption classes. Neither agency's list contains any specific item that would appear to apply to new animal agriculture project. Interestingly, both lists do include "waste treatment facility" in exemption class (1), which applies to "operations, repairs, and maintenance of existing structures, facilities, equipment, or topographical features." Thus, once a wastewater treatment system is installed, any maintenance of the system would be exempt from the EA requirement.

Moreover, § 11-200-8(b) renders all of the regulatory exemptions inapplicable when there is a significant cumulative impact on the environment, or if the project impacts a "particularly sensitive environment":

> (b) All exemptions under the classes in this section are inapplicable when the cumulative impact of planned successive actions in the same place, over time, is significant, or when an action that is normally insignificant in its impact on the environment may be significant in a particularly sensitive environment.

Id.

C. **Judicial Review of Agency Exemption Determinations May Create Additional Hurdles.**

Even if one of the eleven regulatory exemptions or an item on the DOH or DOA's exemption list applied to an animal agriculture project, additional hurdles remain. In Kahana Sunset Owners Ass'n v. County of Maui, 86 Hawai'i 66, 947 P.2d 378 (1997), the Hawai'i Supreme Court explained that "the exemption approved by the council . . . must be consistent with both the letter and intent contained within the administrative rule exemption." Id. at 71, 947 P.2d at 383. Thus, any individual exemption determination by a state agency may also have to withstand judicial scrutiny with regard to whether it falls within the "letter and intent of HEPA and its regulations." Id.

In addition, the Hawai'i Supreme Court held in Sierra Club v. Department of Transportation, 115 Hawai'i 299, 167 P.3d 292 (2007), that "when an agency considers an exemption it must determine that the action will probably have minimal or no significant effects on the environment, . . . [and] in addition to the direct site of impact the agency must also consider other incidents that are 'incident to and a consequence of the primary impact.'" Id. at 342, 167 P.3d at 335 (quoting McGlone v. Inaba, 64 Haw. 27, 636 P.2d 158 (1981)). In Sierra Club, the Hawai'i Department of Transportation ("DOT") determined that minor upgrades to Kahului Harbor to accommodate the Superferry project were exempt from the EA requirement. The Hawai'i Supreme Court held that the DOT's exemption determination failed to account for the secondary impacts of the harbor improvements arising out of the harbor's increased capacity to accommodate the Superferry. Id. at 343–43, 167 P.3d at 335–36. These secondary impacts that the Department of Transportation failed to consider included potential air quality, noise, or water quality impacts caused by boats using the harbor's increased capacity (*i.e.*, the Superferry), as well as potential impacts of the Superferry on humpback whales. This judicial mandate that state agencies must examine potential secondary and indirect effects when making exemption determinations renders the availability of a regulatory exemption to the EA requirement even more unlikely.

Exhibit 25

May 25, 2016

RECEIVED
JUN 01 2016
WASTEWATER BRANCH

State of Hawai'i
Department of Health
P.O. Box 3378
Honolulu, HI 96801-3378

Attn: Ms. Sina Pruder, Chief, Wastewater Branch

Subject: **Hawai'i Dairy Farms**
Waste Management Plan - Updates for Review
Māhā'ulepū, Kaua'i, Hawai'i
TMK: (4) 2-9-003: 001 por and 006 por & (4) 2-9-001: 001 por

Dear Ms. Pruder,

As you have been aware, in late 2013, Ulupono Initiative made the investment to fund Hawai'i Dairy Farms, the first pasture-based rotational-grazing dairy in the state. Hawai'i Dairy Farms, LLC (HDF) was formed as a positive step toward the island state's food security, economic diversity, and sustainability. At steady-state production with 699 milking cows, the farm will produce roughly 1.2 million gallons annually at market price.

The farm will be based on the most successful island dairy models in the world, and will utilize a sustainable, pasture-based rotational-grazing system and 21st century technology. The farm will be very different from conventional feedlot dairy farms found elsewhere in the state.

HDF is committed to establishing a herd of up to 699 mature dairy cows, and demonstrating the pasture-based system as an economically and environmentally sustainable model for Hawai'i. With proven success at a herd size of 699, HDF will contemplate the possibility of expanding the herd in the future to up to 2,000 productive milking cows. Permit process compliance would be followed at such time HDF may decide to pursue an expanded operation.

The State of Hawai'i, Department of Health (DOH), Wastewater Branch has previously reviewed HDF's submitted Waste Management Plan (WMP) for an operation of 699 mature dairy cows, as required by the "Guidelines for Livestock Waste Management". In the WMP, HDF detailed the operations and management of the effluent ponds, which will be used to store effluent and manure for re-use as a primary nutrient source for growing Kikuyu grass, the cows' main food source. With the final review of the WMP by DOH in October 2014, HDF obtained their required building permit and approval to construct the dairy facility.

In the course of this effort, opponents to the dairy filed a lawsuit against HDF, claiming that an Environmental Impact Statement (EIS) was required prior to use of the agricultural land that HDF is situated upon. While HDF strongly disagrees with that requirement, HDF has *voluntarily* agreed to prepare and submit an EIS

pursuant to HRS Chapter 343. The purpose of the EIS is to evaluate potential environmental impacts of a pasture-based, rotational-grazing dairy system at 699 mature dairy cows and up to 2,000 mature dairy cows in Māhā'ulepū Valley, Kaua'i.

While the EIS process was progressing, on-going technical studies and field trials were continued for various dairy components, including and not limited to groundwater and surface water quality assessments, historical and archeological studies, nutrient management calculations, and forage trials. Refinements to the dairy operation, including and not limited to adjustments to the total available pasture area, physical setbacks, inclusion of calves in the nutrient model, and current forage data, improved the nutrient mass balance analysis within the WMP previously submitted to DOH. The following attachment consists of an executive summary and description of those changes.

HDF would like to emphasize that the pasture-based, rotational-grazing dairy system, including the design of the effluent ponds, is fundamentally the same and has not changed. At 699 mature dairy cows, the updates to the mass balance analysis have minimal effect on the effluent ponds as the farm's infrastructure had been sized for up to 2,000 mature dairy cows. The expected percentage of the nutrient demand for healthy pasture productivity which will be provided by the animals is 30.5% for nitrogen and 35.8% for phosphorus, both of which show that the nutrients applied from the animals (at the 699 mature dairy cow herd size) are only about one-third of what the grass crop requires.

Please feel free to let me know if you have any questions or comments regarding these changes or the information presented herein or in the attachment. Please also let me know if any additional information or copies are required. Thank you for your consideration and review.

Sincerely,

Paul T. Matsuda, PE
Principal/Director of Civil Engineering
Group 70 International

Attachment(s): Update to Waste Management Plan, Hawai'i Dairy Farms

Copy: Kyle Datta, Hawai'i Dairy Farms
Jim Garmatz, Hawai'i Dairy Farms
Jenna Dunn, NRCS District Conservationist, Pacific Island Area, Lihue Service Center
Adam Reed, NRCS State Agronomist, Pacific Island Area, State Office

ATTACHMENT

UPDATES TO WASTE MANAGEMENT PLAN HAWAI'I DAIRY FARMS

MĀHĀ'ULEPŪ, KAUA'I, HAWAI'I

Prepared By:

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Dated:

May 25, 2016

EXECUTIVE SUMMARY

The Waste Management Plan (WMP) for Hawai'i Dairy Farms, focusing on a pasture-based, rotational-grazing dairy system with 699 mature dairy cows located in Maha'ulepu, Kaua'i, was submitted to DOH on July 23, 2014. Subsequently, the WMP was reviewed by the State of Hawai'i, Department of Health (DOH), Wastewater Branch (WWB).

On October 24, 2014, the DOH-WWB indicated that HDF has addressed all of DOH-WWB comments from their review of the WMP and that there were no further comments on the WMP. DOH-WWB indicated there would be no further action on the WMP at that time, signaling that HDF had met the requirements of the "Guidelines for Livestock Waste Management" for effluent pond systems in the State of Hawai'i.

However, before construction was able to commence, HDF voluntarily agreed to prepare and submit an Environmental Impact Statement (EIS) pursuant to HRS Chapter 343. Based upon current environmental regulations and confirmed by the State of Hawaii Department of Health, the preparation of an EIS was not required, but was requested by neighboring developments and a select group of the public. Nevertheless, HDF agreed to conduct the environmental assessment with the State of Hawaii, Department of Health agreeing to be the accepting authority.

While the EIS process was progressing, previously on-going technical studies and field trials continued and discussions with other regulatory agencies were held. Forage productivity sampling was conducted to provide current data for nutrient management consideration. This updated information, specific to the project site, requires refinements to the WMP previously reviewed by DOH-WWB.

HDF would like to emphasize that the pasture-based, rotational-grazing dairy system, including the design and sizing of the effluent ponds, is fundamentally the same and has not changed. Simply put, field-tested and proven data, based on ground-level trials and studies, can improve the basis of the WMP.

#	Current WMP	Proposed Change	Justification
1	174 calves on site	150 calves on site	No more than 150 calves will be kept on site at any time, based on size and age.
2	Nutrient Mass Balance Table is populated by the Dairy New Zealand Model.	Nutrient Mass Balance Table is updated with the Cornell Model.	The Cornell Net Carbohydrate Protein System Model is a United States industry-recognized nutrient and milk production model. While HDF recognizes the success of the Dairy New Zealand model for evaluation of nutrients, HDF ultimately believes that the United States standard is best suited for operation on Kaua'i.
3	Project Boundary	Reduced Project Boundary	The boundary has slightly adjusted along the perimeter of the farm.
4	Receiving Water Body State Water Quality = Class A Marine Waters / Class 1 Critical Habitat	Receiving Water Body State Water Quality = Class A Marine Waters	The State of Hawai'i has recently updated its water quality classifications for this region.
5	Water Wells = 14	Water Wells = 14 original, 3 remaining.	Most of Well Battery 14 was abandoned, with only 3 wells remaining.
6	Total Lease Area = 577.9 acs	Total Lease area = 556.8 acs	Field conditions and negotiations with Mahaulepu Farm (landowner) have resulted in a defined and measureable lease area.
7	Grazing Area = 517.3 acs	Grazing Area = 469.9 acs	Area has been set aside for project buffers, setbacks, raceways, and other areas not available for pasture grazing.
8	Land Use Summary Table	Revised Land Use Summary Table	With revisions to the project boundary, the total farm acreage has changed, including the pasture acreage, facility acreage, and open space acreage.
9	Total Paddocks = 118	Total Paddocks = 119	With the revision to the farm area, paddock layouts were slight altered, resulting in 1 new paddock formed. Though the farm area decreased, several paddocks were divided to create additional paddocks near the calf sheds for housing the calves.
10	Area Percentages	Revised Area Percentages	Percent areas for the dairy facility, effluent ponds, etc. compared to the total farm area have changed due to the change in leased area.

11	Access Road and Tanker Truck Turnaround	New Location for Access Road and Tanker Truck Turnaround moved to east side of facility	The new location makes access to the facility both safer and cost effective, as the steep downhill grade on the west side of the facility is avoided.
12	Drip Irrigation in areas outside of the pivot extent	Gun Irrigation in areas outside of the pivot extent	Drip irrigation tubing and infrastructure would likely be destroyed often by grazing cows and require significant repair.
13	Irrigated Area Percentages	Revised Irrigated Area Percentages	Percent areas for irrigated farm areas versus non-irrigated farm areas, etc. compared to the total farm area have changed due to the change in leased area.
14	Irrigation Demand Summary	Revised Irrigation Demand Summary	Revised amounts of irrigated areas and non-irrigated areas results in changes in demand.
15	Section 6.1 - Irrigation Schedule	Renumbered Section 6.1 to Section 6.6	Duplicate section heading number to be renumbered for clarity and to avoid confusion.
16	Wastewater Treatment Section	Wastewater Management Section	Public comments on the original WMP correctly indicated that the ponds are not treatment systems, as the original WMP did not indicate any wastewater treatment systems for the effluent. Wastewater is stored and not treated in the effluent ponds.
17	Cow Weight = 1,210 lbs	Cow Weight = 1,200 lbs	Same cow but parameter has changed, with switch to Cornell Model
18	Manure Production = 143 lbs per day	Manure Production = 90.8 lbs per day	Manure production is affected by the nutrient content and chemical composition of the forage. With updated forage testing incorporated into the Cornell Model, manure production values have been updated and are consistent with the USDA/NRCS Agricultural Waste Management Field Handbook (March 2008), which utilizes established American Society of Agricultural Engineers (ASAE) values for manure production per cow per day.
19	Effluent / Manure Volume	Revised Effluent / Manure Volume for Calves	Added in generation of manure from calves and updated based on total manure produced. Increased daily generation effluent due to increase in wash water projections at 699 cows.
20	Minimum Effluent Storage = 23 days	Minimum Effluent Storage = 25 days	Incorporated 2 days of storage before forecasted rain event. No effect as total storage provided is still 30 days.
21	Effluent Totals within Storage Pond Volume	Revised Effluent Totals within Storage Pond Volume	NOTE: The sizes of the ponds have not changed. Because of the increase in daily wastewater generation, more volume is required in storage

			pond at 699 cows. However, since the pond is designed for up to 2,000 cows, the increase has no impact.
22	Grass Yield Goal = 20 tons DM per acre per year	Grass Yield Goal remains the same. However, calculations are based upon ongoing grass trials = 16.3 tons DM per acre per year	HDF has committed to studying the operation of the farm at current grass trial levels. While HDF expects the yield goal to realize, existing trial data guarantees that 16.3 tons DM per acre per year can be produced by the current field and system.
23	Nutrient Mass Balance Tables	Revised Nutrient Mass Balance Tables	Balance based upon revised manure numbers, revised pasture acreage, & revised grass yields
24	Soil Sampling Frequency = Every Three Years	Soil Sampling Frequency = Every Year	Allows for better and more efficient farm management. Sampling the soil for nutrient content and fertility recommendations more often ensures that nutrients are 1) not over applied but 2) not wasted.

DESCRIPTION OF CHANGES

A description of the changes above is detailed by item number below, with the corresponding section reference to the original WMP in bold.

1) **Letter to DOH from Group 70 International, "Hawaii Dairy Farm, Waste management Plan – Review Comments", Dated June 23, 2014:** The number of calves on-site has been evaluated to consist of, at most, 150 calves on site, instead of 174 calves as shown in the original WMP. Calves will be managed to be moved off-site after 90 days or after they reach 150 lbs. At 699 calves, this equates to 150 calves.

2) **Section 1.0 – Project Overview:** The Cornell Net Carbohydrate Protein System (CNCPS) model is being used for the basis of estimating nutrient content of the manure, based upon grass inputs. The nutritional content of the grass has also been analyzed within field trials and actual grass grown on the Māhā'ulepū site has been input into the CNCPS model to determine the nutritional value to the animals, and ultimately the nutrient content of their manure. While the original WMP previously utilized the Dairy New Zealand model, HDF believes each model is comparable and ultimately will be used to provide the same information, but the CNCPS model is recognized in the United States. It allows for easier comparison of farm-specific data with other farms in the State of Hawaii and throughout the country. Just as significant, the inputs into the model are now based upon field trials.

3) **Figure 2 – Project Location Map:** The project boundary has been slightly altered. The taro farm within the center of the project will occupy more area than anticipated in the original WMP. Additionally, the perimeter boundary has been updated based upon a topographic survey performed for the project by Red Barn Consulting.

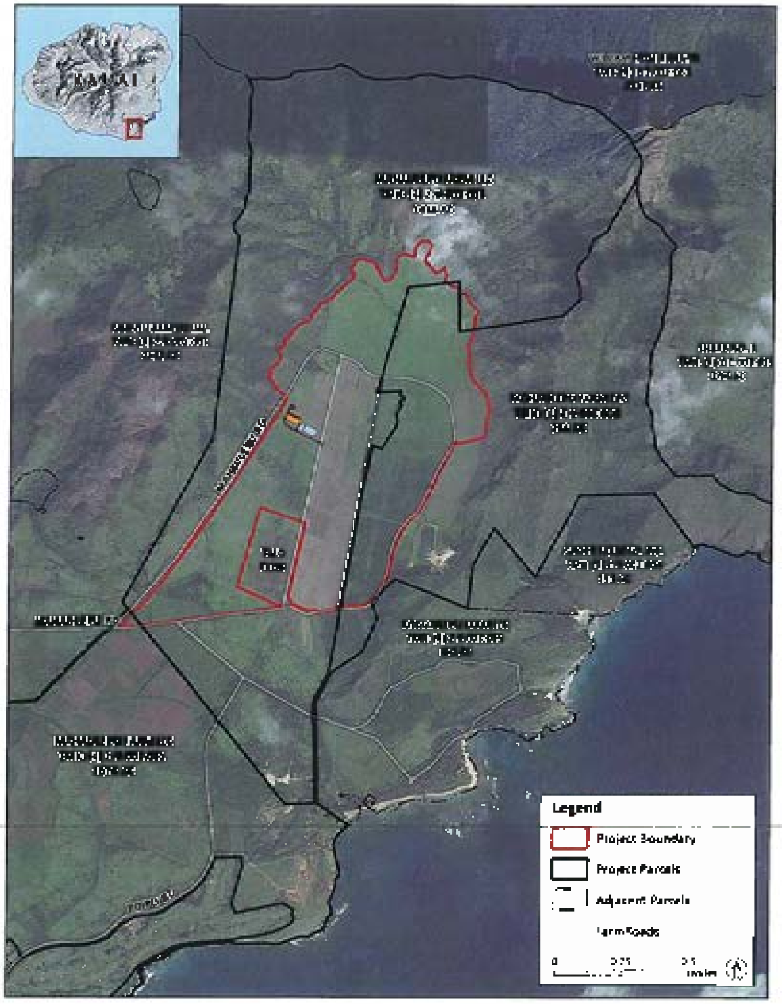


Figure 2 – Project Location Map

4) **Section 2.2.1 – Receiving Water Body State Water Quality:** The Water Quality Maps available from the State of Hawai'i Department of Health are no longer applicable to the project site, and State Water Body Quality is now available only within HAR §11-54. The WMP will now state that this stretch of open coastal waters is classified as Class A for water quality standards in HAR §11-54.

5) **Section 2.2.3 – Water Wells:** The existing private water wells on-site were described. Further field study has indicated that of the original 14 wells in the Māhā'ulepū 14 Well Battery, only 3 remain. These wells will be used for potable water use, a backup source, and for groundwater monitoring.

6) **Section 3.0 – Land Use Summary:** As the project boundaries have changed, the total lease area agreed upon between HDF and Mahaulepu Farms (Owner) has reduced from 577.9 acres to 556.8 acres. As mentioned, more area was reserved for the taro farm and area was removed based upon the topographic survey of the site, which identified perimeter roads and the tree line.

7) **Section 3.0 – Land Use Summary:** At 699 mature dairy cows, the original WMP included setbacks and project buffers, raceways, etc., but did not specify its total area within the pasture area calculations. The total area of the setbacks and buffers is now calculated, and the available grazing and pasture area is now 469.9 acres. Setbacks and buffers include:

   - 35-foot setback (fencing) from water resources on the farm
   - 1,000-foot setback (fencing) from the County of Kaua'i Koloa F Well.
   - 16-foot to 20-foot wide raceways

   The addition of the 1,000-foot setback from the County of Kaua'i Kōloa F Well was requested by the County of Kauai Department of Water following submission and review of the original WMP. HDF has agreed to provide this setback and the WMP must be updated to reflect the change in available pasture areas.

8) **Section 3.0 – Land Use Summary:** Changes in the land use table are required as the project boundary, pasture acreage, and other farm features have been incorporated into the WMP:

Land Use	Acres
Farm	
Paddocks / Pasture	469.9
Cow Races, Farm Roads, Drainage Ways & Setbacks / Vegetated Buffers	77.2
Subtotal	547.1
Headquarters / Dairy Facility	
Milking Parlor, Yards, Sheds, Road, Ponds	9.7
Subtotal	9.7
TOTAL	556.8

9) **Section 3.0 – Land use Summary:** The net total amount of paddocks has been revised. With reconfiguration to the project area and boundaries, the paddocks and cow raceway layouts were updated. Several paddocks were created in the mauka sections of the farm, while several paddocks were removed to maintain a 1,000 foot setback from the Koloa F County Well, which was agreed to by the County of Kauai and HDF. Several paddocks near the calf sheds were divided into smaller paddocks to allow better management of the grazing calves. The net number of paddocks, therefore, increased by one (1).

Field	Acres	Field	Acres	Field	Acres	Field	Acres
P 101	3.62	P 133	4.26	P 202	3.60	P 234	4.64
P 102	1.12	P 134	4.73	P 203	3.99	P 235	4.62
P 103	4.47	P 135	4.74	P 204	3.40	P 236	4.67
P 104	4.56	P 136	4.78	P 205	6.03	P 237	5.04
P 105	3.08	P 137	4.81	P 206	6.04	P 238	6.14
P 106	2.94	P 138	5.26	P 207	4.17	P 239	7.63
P 107	3.02	P 139	5.53	P 208	4.41	P 301	3.29
P 108	2.91	P 140	6.57	P 209	0.55	P 302	3.94
P 109	3.69	P 141	4.76	P 210	0.59	P 303	3.65
P 110	2.83	P 142	4.93	P 211	0.63	P 304	3.97
P 111	3.04	P 143	4.32	P 212	0.52	P 305	4.01
P 112	4.19	P 144	3.94	P 213	0.51	P 306	4.36
P 113	4.32	P 145	3.67	P 214	0.66	P 307	4.11
P 114	3.80	P 146	3.43	P 215	4.24	P 308	4.02
P 115	4.51	P 147	3.69	P 216	4.54	P 309	4.55
P 116	4.29	P 148	3.88	P 217	4.64		
P 117	3.29	P 149	4.11	P 218	4.20		
P 118	4.54	P 150	4.17	P 219	4.41		
P 119	3.06	P 151	4.23	P 220	4.32	P 313	3.40
P 120	3.49	P 152	3.44	P 221	4.30	P 314	3.01
P 121	3.17	P 153	4.03	P 222	4.29	P 315	3.41
P 122	4.25	P 154	4.46	P 223	4.35	P 316	3.02
P 123	3.53	P 155	3.94	P 224	4.41	P 317	3.78
P 124	3.90	P 156	4.46	P 225	4.38	P 318	3.64
P 125	3.89	P 157	4.14	P 226	4.42	P 319	4.34
P 126	3.24	P 158	3.24	P 227	4.46	P 320	4.29
P 127	4.59	P 159	4.49	P 228	4.50		
P 128	4.38	P 160	4.56	P 229	4.47		
P 129	4.35	P 161	4.52	P 230	3.69		
P 130	4.10	P 162	3.56	P 231	3.39		
P 131	4.02	P 163	3.43	P 232	4.26		
P 132	3.94	P 201	4.47	P 233	4.55	Total	469.9

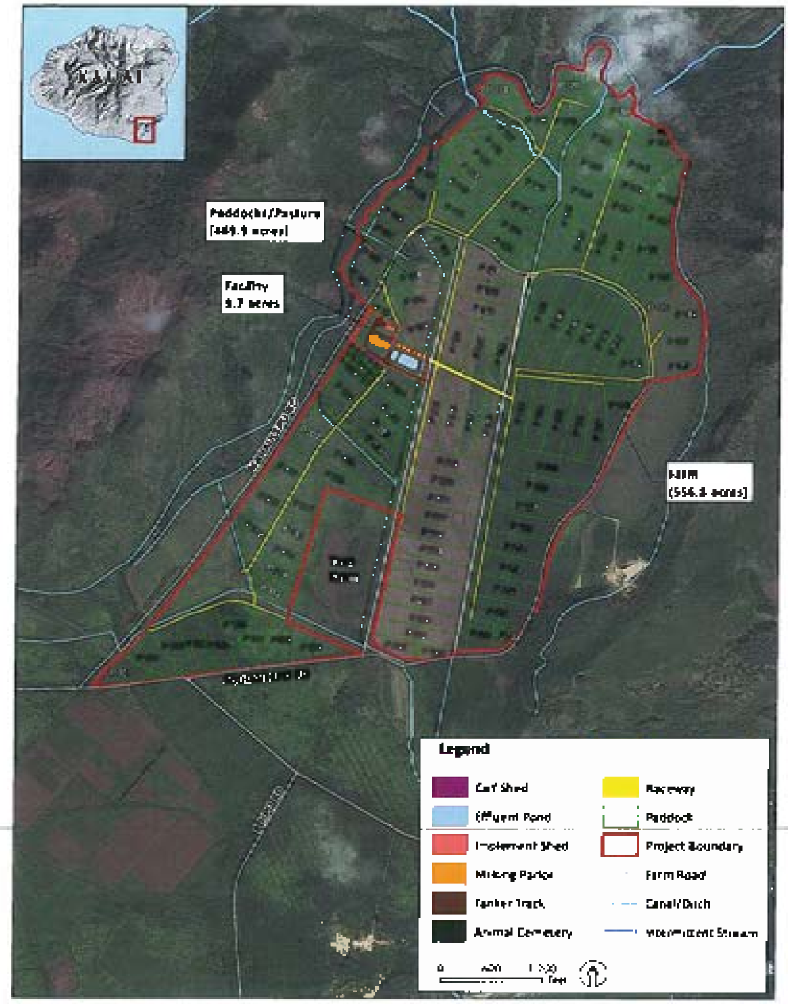


Figure 6 - Paddock Map

10) **Section 4.0 – Farm Description:** The original WMP noted several percentage calculations of areas for specific facilities with respect to the overall farm area. These numbers have been updated as the total farm boundary has been updated and the overall area specified as the "dairy facility" has been slightly altered to 9.7 acres (change in "open space" to paddocks)

The majority of the dairy farm area (i.e. ~83%) is dedicated to pasture. Much of the remaining area is dedicated to access roads, cow races, the dairy facility, and waterway setback / buffers. The dairy facility including the parlor, effluent ponds and secondary containment areas is contained within a 9.7-acre area, which represents about 1.7% of the entire farm. The corresponding building areas are under 0.1% of the total farm area.

11) **Section 4.2.6 – Access Road and Tanker Truck Turnaround:** Access to the dairy facility was provided off of Māhā'ulepu Road on the western side of the facility in the original WMP. Due to steeper terrain and the condition of Mahā'ulepu Road along the western side of the valley, access was relocated to one of the main farm roads in the center of the valley. The existing farm road, which passes by the taro farm and Pivot #2, is flat and is the current, operational access road to the various parts of the farm. Relocation of the access will save on construction costs and improve safety for tanker trucks to the facility. The configuration of the tanker truck turnaround adjacent to the implement shed will remain the same as in the original WMP.

12) **Section 6.2 – Drip Irrigation System:** The original WMP called for drip irrigation features in the makai areas of the farm where the center pivots could not reach. HDF has decided it will install a gun irrigation system instead, to allow for better management of the system and reduce required upkeep, as maintenance of drip irrigation facilities in active pastures where cows are grazing is expected to be more intense. The gun irrigation design will utilize a hard-hose reel gun nozzle on a cart, which attaches to hydrants, but can be moved around the area to provide even irrigation coverage.

13) **Section 6.5 – Irrigation Demand:** With the reconfiguration of the paddock layout on the farm, irrigated area totals have changed from the original WMP. Percentages of the farm that are irrigated versus non-irrigated have been updated.

Irrigated Pasture Areas:

Irrigated Pasture Area	Acres
Irrigation Pivot #1 (Full Circle)	164.7
Irrigation Pivot #2 (Partial Circle)	120.4
Subtotal	285.1
Gun Irrigation Area	61.4
Total Irrigated Pasture Area	346.5

Non-Irrigated Pasture Areas:

Non-Irrigated Pasture Area	Acres
Pasture Area within 50' Pivot Irrigation Setback	13.8
Remaining Non-Irrigated Pasture Area	109.6
Total Non-Irrigated Pasture Area	123.4

14) **Section 6.5 – Irrigation Demand:** With changes in the irrigation areas, the overall irrigation demand from the grass crop has changed. A reduction in irrigated area results in less irrigation water demand per day. The upper-end irrigation demand estimate, used for planning purposes, will be 2.26 MGD in lieu of 2.93 MGD as indicated in the original WMP.

15) **Section 6.1 – Irrigation Schedule** on page 37 of the original WMP should be renumbered to Section 6.6 – Irrigation Schedule for clarity and to avoid confusion.

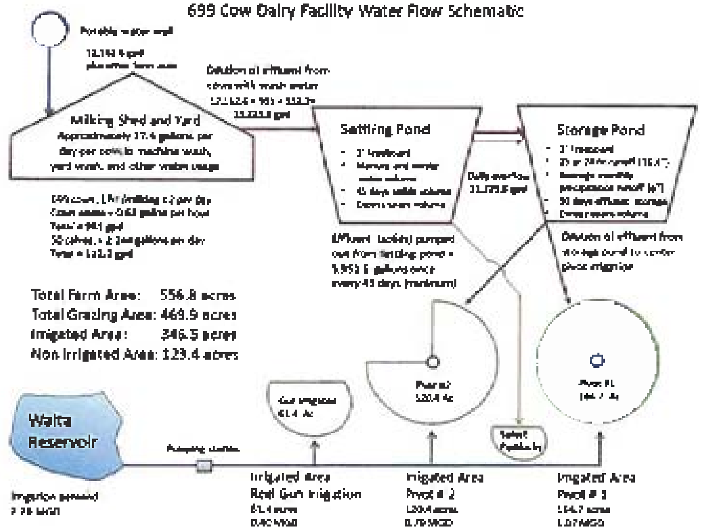
16) **Section 7.0 – Wastewater Treatment:** Public comments on the original WMP correctly indicated that the ponds are not treatment systems, as the original WMP did not indicate any wastewater treatment systems for the effluent. To avoid confusion and for added clarity, Section 7 – Wastewater Treatment in the original WMP should be renamed to Section 7 – Wastewater Management.

17) **Section 7.1 – Effluent / Manure Volume:** The mature cow's weight has been slightly adjusted from 1,210 lbs to 1,200 lbs.

18) **Section 7.1 – Effluent / Manure Volume:** Manure production per mature dairy cow has reduced from 143 lbs per day to 90.8 lbs per day. The change incorporates actual grass trials and forage testing data from grass grown on the farm. Manure production is affected by the nutrient content and chemical composition of the forage. With the updated forage testing data incorporated into the Cornell Model, manure production values have been updated and are consistent with the USDA / NRCS Agricultural Waste Management Field Handbook (March 2008), which utilizes established American Society of Agricultural Engineers (ASAE) values for manure production per cow per day.

19) **Section 7.1 – Effluent / Manure Volume:** The original WMP did not account for calves in the volume projections for sizing of the effluent ponds. Because the calves produce very little manure per day (19 lbs per day) and only a fraction of the calves are within the sheds which ultimately discharge to the effluent ponds, calves are typically not required to be taken into account for nutrient management purposes. However, HDF has updated the WMP to include manure production for calves, meaning there is a slight increase in the daily wastewater generation collected by the ponds. Additionally, wash water projections were increased at 699 mature dairy cows from 10,667 gpd to 12,162.6 gpd based upon an estimated requirement of 17.4 gpd of wash water per mature dairy cow. See revised waterflow schematic:

699 Cow Dairy Facility Water Flow Schematic



20) **Section 7.1 – Effluent/Manure Volume:** The original WMP noted that the required storage period, utilized to size the storage pond, was 23 days, including 17 days for the longest recorded consecutive day rainfall event on record, 4 days between scheduled irrigation of effluent, and 2 days for a forecasted storm event. The total storage period was then set to 30 days to provide additional capacity. 2 additional days are added into the 23 day total for pasture dry time following a significant rain event, bringing the total required minimum storage period to 25 days. However, the 30 day storage period will remain the same and will still provide additional buffer capacity.

21) **Section 7.2 – Effluent Ponds:** Overall storage pond volumes shown in the original WMP have remained the same. However, because of increased storage requirements – due to increased projections in wash water usage (10,667 gpd to 12,162.5 gpd) at 17.4 gpd per mature dairy cow as well as due to the inclusion of calves in the pond sizing calculations, more effluent is shown to be entering into the storage pond at 699 animals. However, since the pond is designed for up to 2,000 cows, there is no impact to the pond sizes.

Design Criteria/Assumption	699 Mature Dairy Cows	2,000 Mature Dairy Cows	Pond
Daily Wastewater Generation	[illegible] gpd	[illegible] gpd	
Percentage of Solids	1%	1%	Settling
Volume of Accumulated Solids for 45-day Period Between Application	5,951.6 gal	17,052.6 gal	Settling
Daily Flow to Storage Pond	[illegible] gpd	[illegible] gpd	
Minimum Volume of Effluent for 30-day Design Volume Period	396,774 gal	1,136,841 gal	Storage
Depth of 25-Year, 24 Hour Storm	10.4 inches	10.4 inches	Storage
Depth of Normal Precipitation for 30-day Design Volume Period	6 inches	6 inches	Storage

22) **Section 8.2 – Pasture Based Dairy:** Grass yields in the original WMP were projected for 20 tons of dry matter (DM) per acre per year and were the basis for all nutrient application rates and nutrient management planning.

HDF has approximately 18 months of grass trial data, for grass growth on over 70 acres of pasture on the project site. The grass trials simulate an expected grazing and 18-day rest period that a paddock would be subject to on the operational dairy. Current yields (as of 2015) indicate a production of 16.3 tons of DM per acre per year, only after 18 months of trials. Once the pasture is established and has matured, yields of 20 tons of DM per acre per year, or even greater, are anticipated. However, for the purposes of the WMP, HDF has elected to utilize the current grass yield at 16.3 tons of DM per acre per year as the basis of the nutrient management section, as physical trials have proven that the field is at least capable of producing this much forage.

23) **Section 8.4.2 – Nutrient Mass Balance:** With the use of 16.3 tons of DM per acre per year in the nutrient mass balance calculations, the nutrient demand of the grass crop is reduced. In the overall farm ecosystem, less production of grass means that fewer nutrients are required from the crop. However, because the quantity of nutrients supplied by 699 mature dairy cows and 150 calves is minimal on the 469.9 acres of pasture, the nutrient mass balance of the farm is not significantly impacted by the reduction in the grass yield to current data from a yield goal of 20 tons of DM per acre per year. Commercial fertilizer is still required to fulfill the grass nutrient need and maintain high productivity and soil health.

Method Application	Area (acres)	Nitrogen Applied (lbs/year)	Phosphorus Applied (lbs/year)
Manure As-Excreted	469.9	129,556	26,966
Liquid Effluent	255.1	11,980.8	2,586.7
Slurry Application	42.0	7,987.2	1,724.4
Total		149,524	31,277
Plant Nutrient Demand		490,200	87,317
Percentage from Animals		30.5%	35.9%
Required Chemical Fertilizer		340,676	56,040
Percentage Demand from Fertilizer		69.5%	64.2%

Month	N Collected In Pond (lbs-N/mo)	P Collected In Pond (lbs-P/mo)	N Excreted on Pasture (lbs-N/mo)	P Excreted on Pasture (lbs-P/mo)	N Total Deposited on Farm (lbs-N/mo)	P Total Deposited on Farm (lbs-P/mo)	N Total Uptake from Farm (lbs-N/mo)	P Total Uptake from Farm (lbs-P/mo)	N Deficit (lbs-N/mo) (Fertilizer Need)	P Deficit (lbs-P/mo) (Fertilizer Need)
January	1,696	366	11,003	2,290	12,699	2,656	41,633	7,416	28,934	4,760
February	1,532	331	9,939	2,069	11,470	2,399	37,604	6,698	26,134	4,299
March	1,696	366	11,003	2,290	12,699	2,656	41,633	7,416	28,934	4,760
April	1,641	354	10,648	2,216	12,290	2,571	40,290	7,177	28,001	4,606
May	1,696	366	11,003	2,290	12,699	2,656	41,633	7,416	28,934	4,760
June	1,641	354	10,648	2,216	12,290	2,571	40,290	7,177	28,001	4,606
July	1,696	366	11,003	2,290	12,699	2,656	41,633	7,416	28,934	4,760
August	1,696	366	11,003	2,290	12,699	2,656	41,633	7,416	28,934	4,760
September	1,641	354	10,648	2,216	12,290	2,571	40,290	7,177	28,001	4,606
October	1,696	366	11,003	2,290	12,699	2,656	41,633	7,416	28,934	4,760
November	1,641	354	10,648	2,216	12,290	2,571	40,290	7,177	28,001	4,606
December	1,696	366	11,003	2,290	12,699	2,656	41,633	7,416	28,934	4,760
Annual Total	19,968	4,311	129,556	26,966	149,524	31,277	490,200	87,317	340,676	56,040

24) **Section 8.8.1 – Soil Testing Frequency**: In the original WMP, soil sampling was expected every three years. However, based upon the public's input as well as additional soils testing by Dr. Russell Yost, with the University of Hawai'i, soil sampling and testing for nutrient content and fertility recommendations will be conducted yearly. Increased testing will ensure that nutrients are not over-applied past the grass nutrient demand, and HDF will benefit from more frequent testing to ensure that nutrients are not wasted.

SUMMARY

HDF believes that the changes made above improve the original Waste Management Plan, submitted to DOH on July 23, 2014, which was subsequently reviewed. These changes not only address public concern over the proposed dairy (with the addition of calves, reduction in available pasture area, etc.), but also are grounded in scientific reality with the additional incorporation of field-tested and site-specific, proven data (grass yields and soils analysis) and technical studies conducted within the last year.

HDF would like to emphasize that the pasture-based, rotational-grazing dairy system, including the design and sizing of the effluent ponds, is fundamentally the same and has not changed. Simply put, better and more current data, based on ground-level trials and studies, can improve the basis of the WMP.

Exhibit 26

STATE OF HAWAII
DEPARTMENT OF HEALTH
P. O. BOX 3378
HONOLULU, HI 96801-3378

June 15, 2015

Mr. Paul I. Matsuda, P.E.
Principal/Director of Civil Engineering
Group 70 International
925 Bethel Street, 5th Floor
Honolulu, Hawaii 96813-4307

Dear Mr. Matsuda:

Subject: Hawaii Dairy Farms (HDF)
Waste Management Plan – Updates for Review
Mahaulepu, Kauai, Hawaii
TMK: (4) 2-9-003 001 por and 006 por & (4) 2-9-001.001 por

The Department of Health reviewed the updates for the subject Waste Management Plan and has the following comment. In reviewing the plan, we noted that HDF plans on replacing the drip irrigation in areas outside of the pivot extent with gun irrigation. This is approximately 61.4 acres. Please confirm that water from the Waita Reservior will be used to irrigate this area. Wastewater effluent from the storage pond should not be used to irrigate this area if gun irrigation is proposed.

Should you have any question, please feel free to contact me at 586-4294

Sincerely,

SINA PRUDER, P.E., CHIEF
Wastewater Branch

SP:lmj

Exhibit 27

Table 11. **Cattle and Calves – Inventory and Sales: 2012 and 2007**

[For meaning of abbreviations and symbols, see introductory text.]

Item	Hawaii	Hawaii	Honolulu	Kauai	Maui
INVENTORY					
Cattle and calves .... farms, 2012	1,314	917	60	133	204
2007	1,142	762	61	129	190
number, 2012	133,957	98,059	4,708	14,777	16,413
2007	151,479	108,093	5,961	12,486	24,939
Farms by inventory:					
1 to 9 .... farms, 2012	652	467	24	51	110
2007	477	312	13	57	95
number, 2012	2,706	1,931	76	245	454
2007	2,067	1,364	66	268	369
10 to 19 .... farms, 2012	236	176	11	15	34
2007	197	132	7	22	36
number, 2012	3,065	2,269	(D)	(D)	426
2007	2,710	1,851	72	311	476
20 to 49 .... farms, 2012	175	110	8	30	27
2007	181	131	15	18	17
number, 2012	5,057	3,161	306	870	720
2007	5,317	3,658	(D)	(D)	599
50 to 99 .... farms, 2012	97	64	5	13	15
2007	96	61	9	11	15
number, 2012	6,745	4,516	365	892	972
2007	6,322	3,937	580	750	1,055
100 to 199 .... farms, 2012	57	34	8	9	6
2007	79	53	8	7	11
number, 2012	7,542	4,632	1,142	1,089	679
2007	10,628	7,170	860	892	1,706
200 to 499 .... farms, 2012	41	29	3	5	4
2007	61	41	8	5	7
number, 2012	12,546	8,761	1,157	1,650	978
2007	17,796	11,253	2,970	1,223	2,350
500 or more .... farms, 2012	56	37	1	10	8
2007	51	32	1	9	9
number, 2012	96,296	72,789	(D)	(D)	12,184
2007	106,639	78,860	(D)	(D)	18,384
Cows and heifers that calved .... farms, 2012	1,181	832	50	121	178
2007	864	592	46	94	132
number, 2012	73,875	55,553	2,479	7,546	8,297
2007	88,296	65,835	3,112	6,599	12,750
Beef cows .... farms, 2012	1,173	829	45	121	178
2007	853	589	43	93	128
number, 2012	(D)	(D)	2,464	7,546	8,297
2007	86,000	(D)	(D)	(D)	12,746
2012 farms by inventory:					
1 to 9 .... farms	666	480	18	57	111
number	2,366	1,662	46	261	397
10 to 19 .... farms	189	139	9	13	28
number	2,390	1,779	122	156	333
20 to 49 .... farms	144	89	6	29	20
number	4,280	2,595	214	897	574
50 to 99 .... farms	76	56	5	7	8
number	5,128	3,877	300	466	485
100 to 199 .... farms	28	18	4	3	3
number	(D)	(D)	403	425	429
200 to 499 .... farms	33	21	2	8	2
number	10,407	6,351	(D)	2,705	(D)
500 or more .... farms	37	26	1	4	6
number	43,237	34,494	(D)	2,636	(D)
Milk cows .... farms, 2012	12	7	5	-	-
2007	15	7	3	1	4
number, 2012	(D)	(D)	15	-	-
2007	2,296	(D)	(D)	(D)	4
2012 farms by inventory:					
1 to 9 .... farms	10	5	5	-	-
number	35	20	15	-	-
10 to 19 .... farms	-	-	-	-	-
number	-	-	-	-	-
20 to 49 .... farms	-	-	-	-	-
number	-	-	-	-	-
50 to 99 .... farms	-	-	-	-	-
number	-	-	-	-	-
100 to 199 .... farms	-	-	-	-	-
number	-	-	-	-	-
200 to 499 .... farms	-	-	-	-	-
number	-	-	-	-	-
500 or more .... farms	2	2	-	-	-
number	(D)	(D)	-	-	-
Other cattle (see text) .... farms, 2012	903	610	48	100	145
2007	855	545	51	101	158
number, 2012	60,082	42,506	2,229	7,231	8,116
2007	63,183	42,258	2,849	5,887	12,189
2012 farms by inventory:					
1 to 9 .... farms	518	366	17	42	93
number	1,970	1,469	42	143	316
10 to 19 .... farms	126	91	8	16	11
number	1,569	1,122	(D)	(D)	130
20 to 49 .... farms	114	61	12	18	23
number	3,526	1,891	390	568	677
50 to 99 .... farms	55	29	8	11	7
number	3,539	1,905	514	731	389
100 to 199 .... farms	27	23	1	1	2
number	3,509	3,005	(D)	(D)	(D)
200 to 499 .... farms	40	26	1	8	5
number	12,474	8,205	(D)	2,394	(D)
500 or more .... farms	23	14	1	4	4
number	33,495	24,909	(D)	(D)	4,823

--continued

Table 11. **Cattle and Calves – Inventory and Sales: 2012 and 2007** (continued)

[For meaning of abbreviations and symbols, see introductory text.]

Item	Hawaii	Hawaii	Honolulu	Kauai	Maui
INVENTORY - Con.					
Cattle and calves - Con.					
Cattle on feed (see text) .... farms, 2012	-	-	-	-	-
2007	15	5	-	10	-
number, 2012	-	-	-	-	-
2007	225	(D)	-	(D)	-
2012 farms by inventory:					
1 to 19 .... farms	-	-	-	-	-
number	-	-	-	-	-
20 to 49 .... farms	-	-	-	-	-
number	-	-	-	-	-
50 to 99 .... farms	-	-	-	-	-
number	-	-	-	-	-
100 to 199 .... farms	-	-	-	-	-
number	-	-	-	-	-
200 to 499 .... farms	-	-	-	-	-
number	-	-	-	-	-
500 or more .... farms	-	-	-	-	-
number	-	-	-	-	-
SALES					
Milk from cows (see text) .... farms, 2012	10	5	5	-	-
2007	(NA)	(NA)	(NA)	(NA)	(NA)
$1,000, 2012	(D)	(D)	90	-	-
2007	(NA)	(NA)	(NA)	(NA)	(NA)
Cattle and calves sold .... farms, 2012	711	472	39	82	118
2007	713	465	47	90	111
number, 2012	56,159	41,357	2,681	5,259	6,862
2007	70,567	47,332	6,860	5,054	11,321
$1,000, 2012	37,825	26,824	1,794	3,975	5,231
2007	44,011	30,476	5,178	2,667	5,689
2012 farms by number sold:					
1 to 9 .... farms	371	238	23	32	78
number	1,308	869	92	86	261
10 to 19 .... farms	105	77	2	12	14
number	1,407	1,068	(D)	141	(D)
20 to 49 .... farms	90	58	6	17	9
number	2,889	1,914	193	545	237
50 to 99 .... farms	56	41	3	5	7
number	3,961	3,009	176	291	485
100 to 199 .... farms	34	22	4	7	1
number	4,561	2,789	(D)	(D)	(D)
200 to 499 .... farms	28	15	-	7	6
number	8,526	4,407	-	2,201	1,918
500 or more .... farms	27	21	1	2	3
number	33,507	27,301	(D)	(D)	(D)
Calves weighing less than 500 pounds, sold .... farms, 2012	424	299	23	46	56
2007	475	307	35	55	78
number, 2012	28,275	22,877	909	2,541	1,948
2007	43,102	34,075	1,359	2,878	4,790
2012 farms by number sold:					
1 to 9 .... farms	189	139	11	8	31
number	724	555	47	35	87
10 to 19 .... farms	70	44	4	13	9
number	911	573	57	174	107
20 to 49 .... farms	68	49	2	12	5
number	2,109	1,594	(D)	334	(D)
50 to 99 .... farms	46	33	3	4	6
number	2,985	2,176	196	239	374
100 to 199 .... farms	20	12	2	4	2
number	2,715	1,655	(D)	475	(D)
200 to 499 .... farms	19	10	1	5	3
number	5,653	3,146	(D)	1,284	(D)
500 or more .... farms	12	12	-	-	-
number	13,178	13,178	-	-	-
Cattle, including calves weighing 500 pounds or more, sold .... farms, 2012	513	327	28	60	98
2007	457	297	24	63	73
number, 2012	27,884	18,480	1,772	2,718	4,914
2007	27,465	13,257	5,501	2,176	6,531
2012 farms by number sold:					
1 to 9 .... farms	303	180	16	35	72
number	891	520	47	97	227
10 to 19 .... farms	79	58	4	5	12
number	1,087	803	(D)	(D)	158
20 to 49 .... farms	60	41	6	8	5
number	1,903	1,355	(D)	261	(D)
50 to 99 .... farms	27	24	-	1	2
number	1,879	1,644	-	(D)	(D)
100 to 199 .... farms	16	6	1	8	1
number	2,358	864	(D)	(D)	(D)
200 to 499 .... farms	16	10	-	2	4
number	5,193	3,113	-	(D)	(D)
500 or more .... farms	12	8	1	1	2
number	14,573	10,181	(D)	(D)	(D)

--continued

Table 11. **Cattle and Calves – Inventory and Sales: 2012 and 2007** (continued)

[For meaning of abbreviations and symbols, see introductory text.]

Item	Hawaii	Hawaii	Honolulu	Kauai	Maui
SALES - Con.					
Cattle and calves sold - Con.					
Cattle, including calves weighing 500 pounds or more, sold - Con.					
Cattle on feed sold (see text) ....farms, 2012	-	-	-	-	-
2007	57	31	2	15	9
number, 2012	-	-	-	-	-
2007	292	156	(D)	(D)	17
2012 farms by number sold:					
1 to 19 .... farms	-	-	-	-	-
number	-	-	-	-	-
20 to 49 .... farms	-	-	-	-	-
number	-	-	-	-	-
50 to 99 .... farms	-	-	-	-	-
number	-	-	-	-	-
100 to 199 .... farms	-	-	-	-	-
number	-	-	-	-	-
200 to 499 .... farms	-	-	-	-	-
number	-	-	-	-	-
500 or more .... farms	-	-	-	-	-
number	-	-	-	-	-

Exhibit 28

United States Department of Agriculture
National Agricultural Statistics Service

Pacific Region
PRESS RELEASE

Cooperating with the Hawaii Department of Agriculture
Hawaii Field Office · P.O. Box 50026 · Honolulu, HI 96850 · (808) 973-2907 · www.nass.usda.gov/hi

Media Contact: Kathy King, 1-808-973-2907 · February 2, 2015

HAWAII CATTLE INVENTORY UP 2 PERCENT FROM JANUARY 1, 2014

HONOLULU, HI -- All cattle and calves in Hawaii as of January 1, 2015 totaled 135,000 head, two percent above the 133,000 on January 1, 2014.

All cows and heifers in Hawaii that have calved, at 72,000, were down 3 percent from the 74,000 on January 1, 2014.

- Beef cows, at 69,800, were down 3 percent from January 1, 2014.
- Milk cows, at 2,200, were unchanged from January 1, 2014.

Other class estimates for January 1, 2014 and the change from January 1, 2014, are as follows for Hawaii:

- All heifers 500 pounds and over, 17,000, up 21 percent.
- Beef replacement heifers, 11,000, up 22 percent.
- Milk replacement heifers, 1,000, unchanged.
- Other heifers, 5,000, up 20 percent.
- Steers weighing 500 pounds and over, 9,000, up 29 percent.
- Bulls weighing 500 pounds and over, 4,000, unchanged.
- Calves under 500 pounds, 33,000, down 3 percent.

The 2014 calf crop was estimated at 56,000 head, down 7 percent from 2013.

All cattle and calves in the United States as of January 1, 2015, totaled 89.8 million head, 1 percent above the 88.5 million on January 1, 2014.

# # #

Exhibit 29

From: Eisen, Thomas H.
To: Segundo, Leslie; Bohlen, Edward G
Cc: Glenn, Scott J.; McIntyre, Laura
Subject: RE: dairy farm distr matrix
Date: Wednesday, March 30, 2016 13:06:51

I quite agree with you, that the EIS would be subject to challenge per 343-7, even if it were processed as a "voluntary" EIS; the real question (at least in my mind) would be, if the (voluntary) EIS were challenged, could the proponents then voluntarily choose to ditch the EIS process and continue on to project implementation, while the legal challenge becomes a legally irrelevant side-show?

-----Original Message-----
From: Segundo, Leslie
Sent: Wednesday, March 30, 2016 1:00 PM
To: Eisen, Thomas H. <Thomas.Eisen@doh.hawaii.gov>; Bohlen, Edward G <Edward.G.Bohlen@hawaii.gov>
Cc: Glenn, Scott J. <scott.glenn@doh.hawaii.gov>; McIntyre, Laura <Laura.McIntyre@doh.hawaii.gov>
Subject: RE: dairy farm distr matrix

Irrespective of what the document is called, the use of the adjective "voluntary", in my thinking does not obviate the possibility of any legal challenges to the document under Section 7 of HEPA.

les

-----Original Message-----
From: Eisen, Thomas H.
Sent: Wednesday, March 30, 2016 12:53 PM
To: Bohlen, Edward G <Edward.G.Bohlen@hawaii.gov>
Cc: Glenn, Scott J. <scott.glenn@doh.hawaii.gov>; Segundo, Leslie <Leslie.Segundo@doh.hawaii.gov>; McIntyre, Laura <Laura.McIntyre@doh.hawaii.gov>
Subject: FW: dairy farm distr matrix

Ted, we received this "preliminary distribution list" for the Hawaii Dairy Farm draft EIS, for our review and comment.

So things are apparently starting to move forward on this controversial project. We note, however, Group 70's Letter of Transmittal refers to the project as a "voluntary" EIS in their description of the transmitted document. I was under the impression they were quite aware of our reluctance to process a voluntary EIS; perhaps this was merely a clerical oversight, as the term "voluntary" was not used in the next paragraph.

Our thoughts are to notify them that they'll need to resubmit the document without any reference to "voluntary" for us to be able to process their request.

What do think about this situation?

Mahalo, Tom

-----Original Message-----
From: DeLisle, Margaret A.
Sent: Wednesday, March 30, 2016 12:39 PM
To: Eisen, Thomas H. <Thomas.Eisen@doh.hawaii.gov>
Subject: Fw: dairy farm distr matrix

From: oeqc@doh.hawaii.gov <oeqc@doh.hawaii.gov>
Sent: Wednesday, March 30, 2016 12:10 PM
To: DeLisle, Margaret A.
Subject: dairy farm distr matrix

Please open the attached document. It was scanned and sent to you using a Xerox multifunction device.

Attachment File Type: pdf, Multi-Page

multifunction device Location: machine location not set Device Name: XRX0000AAD456F8

For more information on Xerox products and solutions, please visit http://www.xerox.com

Exhibit 30

From:	Glenn, Scott J.
To:	Eisen, Thomas H.; McIntyre, Laura; Bohlen, Edward G
Cc:	Segundo, Leslie
Subject:	RE: HDF developments
Date:	Friday, April 15, 2016 09:49:02

Thanks, Tom, I think that captures the main points. They clearly want to be careful about going through the process and to meet all legal requirements.

From: Eisen, Thomas H.
Sent: Thursday, April 14, 2016 2:04 PM
To: McIntyre, Laura ; Bohlen, Edward G
Cc: Glenn, Scott J. ; Segundo, Leslie
Subject: HDF developments

As you may know, Group 70 is closing in on their planned submission of a DEIS for the Hawaii Dairy Farm. Recently they submitted a request for us to review their Distribution List, per the requirement in the HAR. In submitting the DList to us, they referred to the DEIS as voluntary; we responded by saying we would not process any request related to a voluntary EIS.

Today, FYI, in a teleconference with Jeff & Barrie of G70 and Scott, Les & I, they readily agreed to drop any reference to "voluntary" in materials related to the EIS. They will soon resubmit the DList to our office for our verification. To be clearly legal, they will follow up their electronic submission with a hardcopy version.

Further, we discussed the level of detail in their responses to Prep Notice comments (verbiage in their responses could be "summary" in nature, as long as they included references to detailed discussion of relevant points in the body of the DEIS), as well as the timing of their response letters (mailing them out to coincide with the publication in TEN of the availability of the DEIS).

Scott & Les, did I omit anything else of signficance that arose in the call?

Tom Eisen, Planner
Office of Environmental Quality Control
Department of Health
State of Hawai'i
(808) 586-4185

NOTE: OEQC's role is to facilitate Hawai`i's environmental review process and to provide advice to agencies, applicants, consultants and the public. OEQC is not authorized to make determinations on exemptions, EA or EIS documents. Pursuant to Chapter 343, HRS, all such determinations are made by relevant agencies, county Mayors or the Governor. Upon request, OEQC may make a recommendation as to the acceptability of a Final EIS.

Exhibit 31

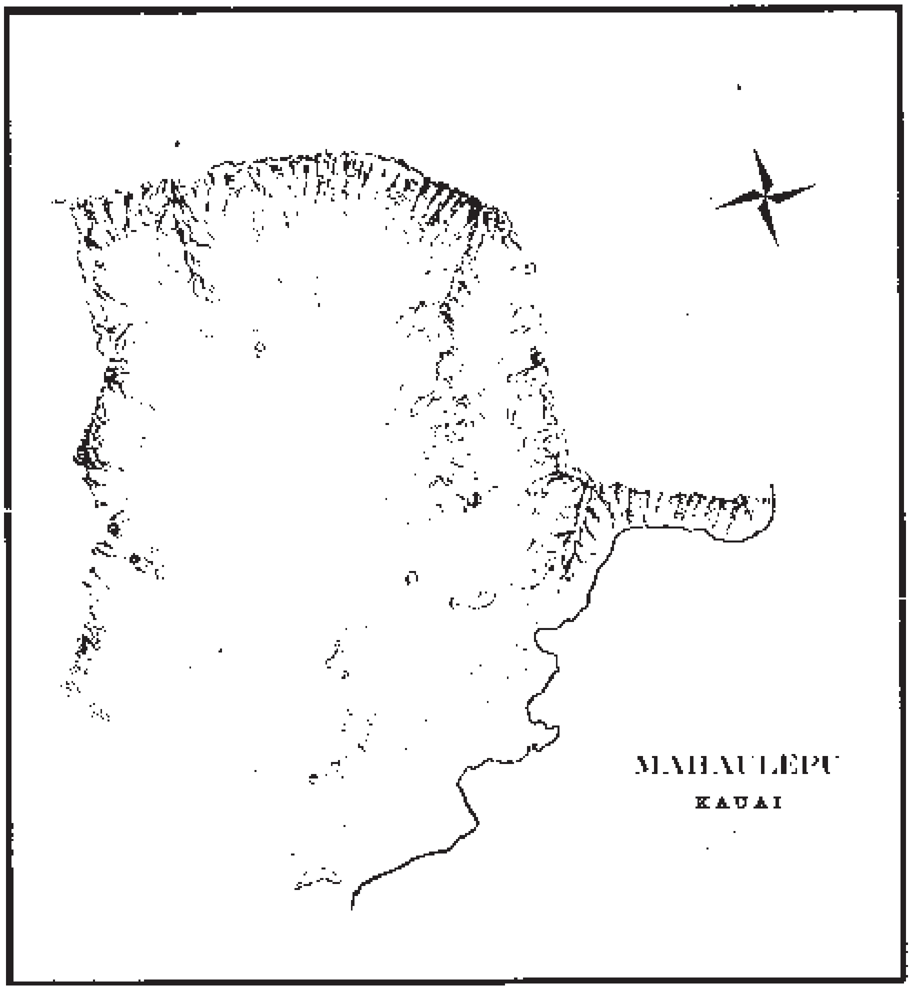

MAHAULEPU
KAUAI

Exhibit 32

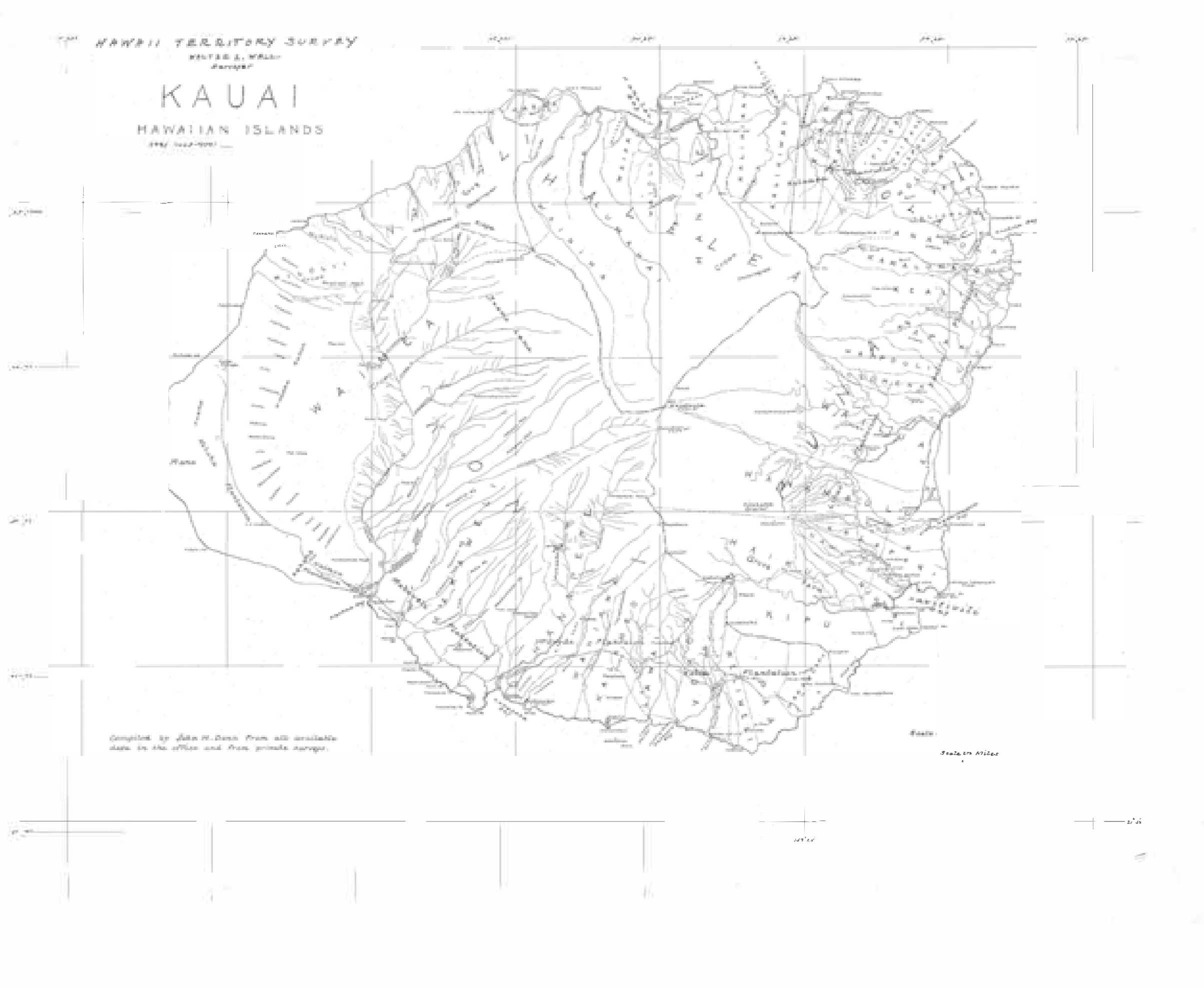

HAWAII TERRITORY SURVEY
KAUAI
HAWAIIAN ISLANDS
Compiled by John M. Donn from all available
data in the office and from private surveys.

Exhibit 33

DAVID Y. IGE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE HISTORIC PRESERVATION DIVISION
KAKUHIHEWA BUILDING
601 KAMOKILA BLVD, STE 555
KAPOLEI, HAWAII 96707

SUZANNE D. CASE
CHAIRPERSON

KEKOA KALUHIWA
FIRST DEPUTY

JEFFREY T. PEARSON
DEPUTY DIRECTOR - WATER

July 15, 2015

Amy Hennessy
Hawaii Dairy Farms, LLC
737 Bishop Street, Suite 2360
Honolulu, HI 96813
amy@ulupono.com

IN REPLY REFER TO:
LOG NO: 2016.01324
DOC NO: 1607MN04
Archaeology

SUBJECT: **Chapter 6E-42 Historic Preservation Review -**
Revised Archaeological Inventory Survey of 557 Acres in Māhā'ulepū Ahupua'a
Māhā'ulepū Ahupua'a, Koloa District, Island of Kaua'i
TMK: (4) 2-9-001:001 por.; (4) 2-9-003:001 por., 006 por.

Thank you for submitting the third draft of the report entitled *"Archaeological Inventory Survey of 580-Acres in Māhā'ulepū Ahupua'a, Koloa District, Kaua'i Island, Hawai'i [TMK: (4) 2-9-003:001 por. and 006 por; 2-9-001:001 por.]* (Putsi et al, May 2016). The original submittal was received in the Honolulu office on September 25, 2014. SHPD reviewed and requested revisions on December 3, 2014 (Log No. 2014.04405, Doc No. 1410MN02); received a revised draft on February 20, 2015 and requested revisions on April 13, 2015 (Log No. 2015.01404, Doc No.1504MN05). SHPD received the third draft on June 1, 2016 (Log No. 2016.01324).

The archaeological inventory survey (AIS) of the 580-acre subject property was conducted at the request of the lessee, Hawaii Dairy Farms, LLC. The landowner is Grove Farms, LLC. The project area includes the valley floor of Māhā'ulepū Valley, a relatively level plain framed by Mt. Ha'ūpu Ridge and Mountain to the north, and two ridges on the east and west, forming a large, natural amphitheater. The east and west ridges also serve as ahupua'a boundaries, with Kipu Kai to the east, and Pa'a on the west. Based on the geological formation of the ridgeline framing the project area, SHPD initially recommended that the project area be defined as the entire area from the ridgeline down. After subsequent discussions, Scientific Consultant Services (SCS) and the landowner agreed to expand the project area approximately 100 meters upslope in all directions. SHPD remains concerned that the project area does not include indirect effects of the proposed dairy on historic properties upslope.

The commercial dairy will require the modification of existing dirt roads, grading ground surfaces for the construction of buildings, the excavation of effluent ponds, and the excavation of pipelines for the watering of cattle. The initial scope of work for the project referenced a herd size of 499 head of cattle, but the current report states that future operations could include up to 2000 head of cattle. The revised report contains references to recent infrastructure improvements. While SHPD conducted review of well installation on the parcel, no other infrastructure improvements have been reviewed by this Division.

The archaeological inventory survey (AIS) newly identified 16 historic properties within the project area, and relocated Site 50-30-10-3094, a large boulder with at least 20 anthropomorphic characters represented, as well as two pecked "cups" or basins. The report states that SCS located a second petroglyph rock associated with the site, which is identified in the report as Feature B. A third petroglyph boulder, referenced in the report as Feature C, is approximately 70 meters from the other features comprising Site 3094. Sites 2251 through 2262 are associated with plantation-era infrastructure and include irrigation ditches, two bridges, a reservoir, a retaining wall, and sluice gates. Site 2250 is located on the slopes below Mt. Ha'upu and is included in the expanded project area. The site is an enclosure, which the report concludes is an agricultural Heiau due to the absence of artifacts during subsurface testing, and proximity to LCAs associated with agricultural encampments. Seventeen backhoe trenches were excavated within various portions of the property which were partly determined in consultation with SHPD; these

included subsurface testing within previous known LCA encampments, and near Site 2250 and Site 3094. A single artifact was recovered within Site 2250, a chopper tool.

The plantation-era sites are assessed for significance under Criterion d of HAR §13-284-6, with potential to yield data important for research on prehistory or history, and Sites 2250 (a ceremonial enclosure) and 3094 (petroglyph boulders) are recommended as significant under Criterion d as well as Criterion e, which states the Site(s) has/have "an important value to the native Hawaiian people or to another ethnic group of the state due to associations with cultural practices once carried out, or still carried out, at the property or due to association with traditional beliefs, events or oral accounts – these associations being important to the group's history and cultural identity.". Sites 2250 (enclosure) and 3094 (petroglyphs) are recommended for preservation, requiring preparation of a preservation plan. Sites 2251-2262 are recommended for "no further work." In addition, the report states that "no archaeological monitoring is recommended" during any ground altering work in the project area. SHPD concurs with the significance assessments, but does not concur with the recommendations based on a lack of basic information.

The draft has improved significantly from previous versions. However, **additional revisions (in addition to the previous unaddressed revisions) are necessary to meet the requirements of HAR§13-276 prior to SHPD acceptance of the AIS.**

In addition to the attached revisions, these general issues need to be addressed:

- The report lacks information about the historic sites that is essential to evaluating the recommendations, particularly where SCS has recommended "no further work." This includes inclusion of easily accessible historic maps and aerial photographs, as well as required plan views and photographs.
- Despite extensive community interest in the site, consultation is limited to a few individuals, despite SHPD's repeated request to consult with Office of Hawaiian Affairs. Māhā'ulepū ahupua'a remains culturally significant and contains unusual pre-Contact sites (the petroglyph boulders) as well as several Heiau. SHPD has repeatedly requested direct consultation with OHA regarding these properties, and the report indicates this request is still outstanding. Consultation with OHA and other interested parties is a requirement where sites are assessed as significant under Criterion e of HAR§13-284-6, which states the site "has an important value to the native Hawaiian people or to another ethnic group of the state due to associations with cultural practices once carried out, or still carried out, at the property or due to association with traditional beliefs, events or oral accounts – these associations being important to the group's history and cultural identity."
- Additional research into interpretation of the traditional Hawaiian sites is necessary, including reference to primary sources regarding petroglyphs in Hawaii.
- There is limited discussion of the details of the project, the impacts of the project on the sites, and recommendations for mitigation measures.

An electronic revised copy may be submitted to dlnr.intake.shpd.hawaii.gov. Please contact Kaua'i Lead Archaeologist Mary Jane Naone at (808) 271-4940 or Maryjane.naone@hawaii.gov if you have any questions regarding this letter.

Aloha,

Susan A. Lebo

Susan A. Lebo, Ph.D.
Archaeology Branch Chief
State Historic Preservation Division

cc: Robert Spear, Ph.D., Scientific Consultant Services (bob@scshawaii.com)
Mike Dega, Ph.D., Principal Investigator, Scientific Consultant Services (mike@scshawaii.com)
Jeff Overton, Group 70 International, Inc. (jeff@group70int.com)

ATTACHMENT

Comments and Questions: *"Archaeological Inventory Survey of 580-Acres in Māhā'ulepū Ahupua'a, Koloa District, Kaua'i Island, Hawai'i [TMK: (4) 2-9-003:001 por. and 006 por; 2-9-001:001 por.]*
(Putsi et al., May 2016)

Abstract

1. Consistently use Hawaiian diacritics throughout the text, including Māhā'ulepū, which is presented using the correct diacritics in the title but not within the text.
2. The abstract and introduction delineate between the "project area" and "extended survey area" requested by SHPD. As previously noted, the SHPD Kaua'i Lead Archaeologist initially requested that the project area be defined as the entire area from the ridgeline down. After subsequent negotiations, Scientific Consultant Services (SCS) and the lessee agreed to expand the project area approximately 100 meters upslope in all directions. We retain concerns that the project area does not include indirect effects of the proposed dairy on historic properties upslope, particularly when the project description on page 8 references future plans to bring in "up to 2000 productive dairy cows". In accordance with §13-284-2, "'project area' means the area the proposed project may potentially affect, either directly or indirectly. It includes not only the area where the proposed project will take place, but also the project's area of potential effect". The project area is within a natural amphitheater framed by the topography. The impacts of the proposed construction and animal husbandry will not only be within the physical footprint on the ground, but will affect the topography framing the current fields, particularly where pre-Contact sites were clearly related to each other.

Introduction

3. In the project description on page 8, the summary states that "HDF will contemplate the possibility of extending the size of the herd in the future" and later references bringing in "up to 2000 productive dairy cows". Please detail if this will be within the existing project area or the expanded project area. What infrastructure changes will this require? Please detail the project plans so that we can adequately assess impacts on the identified sites.
4. The APE (project area) is listed as 557 acres, but the previous report listed 580 acres. How does an expanded herd size on less land affect the impacts of the proposed project on historic properties?
5. The authors assert that the "leased property will be fully enclosed by a fencing system that will ensure that all impacts of the project are maintained within the leased area". Does this include indirect effects? Again, it's unlikely that a project of this magnitude contained within a valley would not include effects on the slopes.
6. Since the previous version of the AIS, SHPD has been notified of construction or alteration of the project area. We provided a response to Group 70 for a request to review a pig exclusion fence in a letter dated January 22, 2016 (*Log No. 2015.04155, Doc No. 1512MN18*) stating that we are not prepared to comment on the effects of proposed projects prior to the acceptance of the AIS. Aside from well installation, which was reviewed by the Kaua'i archaeologist at the request of the Water Commission and included a site visit, SHPD has not received any building permits or county permits for the project area. Please provide details on what has been constructed on the property to date, and what potential impacts these may have had on historic properties.
7. As previously requested, please include historic photographs located for the project area.

Traditional and Historic Setting

8. Please provide primary source references for the statement introducing this section that reads "Given the size of Māhā'ulepū Valley, Māhā'ulepū was highly valued".
9. In our April 13, 2015 letter, SHPD wrote "The Office of Hawaiian Affairs has produced documentation referring to Mt. Ha'upu as a traditional cultural property (TCP), and numerous individuals have provided consultation to the cultural importance of this area". Yet the revised text still fails to address the significance of the area in terms of the Heiau within the valley and on the ridge, and the context of the valley relative to numerous highly significant sites along the coastline. Please provide context for the sites within the traditional Hawaiian landscape pre-Mahele.
10. Provide a discussion of the residents of the LCAs, and also the role that Victoria Kamāmalu had in land ownership at Māhā'ulepū.
11. Text asserting facts about the past requires references. Please provide primary references for the discussions within the Traditional and Historic Setting section.

12. Please discuss how sandalwood was transported from the ridge of Mt. Ha'upu.
13. Putzi (2014) is cited in the text but not within the references.

Previous Archaeology

14. The text states "There have been numerous archaeological studies along the coast of Māhā'ulepu, but archaeological studies within Māhā'ulepu Valley and nearby inland environs have been limited. Please include in your graphic the previous archaeology in the surrounding vicinity (coast) as well as the project area, particularly as contemporaneous traditional Hawaiian sites along the coastline were related to sites within the valley.
15. As previously requested, provide a graphic showing the location of previously identified sites in the vicinity of the project area (including the coastline). It is now standard practice within archaeological inventory survey reports to provide a table which chronologically lists the authors, location, and previously identified sites in the surrounding vicinity of the project area, as well as a graphic showing previously identified sites.
16. References cited within the text are not included in the reference section. For example, Farley, Thrum, Kikuchi (inconsistent between text and reference section)…Please review all of the references in the text for consistency with your references section.
17. Reference the site numbers for the sites you are describing – for instance, Makawauhi Cave, State Inventory of Historic Places (SIHP) Site 50-30-10-3097.
18. Provide references for the radiocarbon dates collected from the coastline.

Methods

19. When consulted over the placement of test units within the structure, believed originally to be a kauhale, SHPD Kaua'i Lead Archaeologist agreed that 2-3 shovel test pits were appropriate for assessing subsurface stratigraphy and the presence or absence of cultural deposits. An increase in the number of test units would need to be informed by consultation with SHPD; a 1x1 test unit can be perceived as "data recovery" and is not appropriate for an archaeological inventory survey, unless explicitly agreed upon. The statement that "The additional testing was also approved by the SHPD-Kaua'i…." is not accurate. The lead archaeologist Mary Jane Naone approved 2-3 shovel test pits, not nine, and also told Archaeologist Jeff Putzi that she did not support putting in additional units as this was not a data recovery project. The statement regarding SHPD's direction on testing is erroneous and needs to be removed.

Consultation

20. Following the release of the second draft, several individuals came forward with additional information about the history of the project area. Describe how additional consultation was assimilated into your report and findings, particularly concerning the speculative findings within your report, such as the petroglyphs, the Heiau, and the presence of trails within the project area. Discuss SCS's efforts to locate descendants of the former valley inhabitants identified in the Land Commission Award records.
21. Specifically address how consultation informed survey efforts, and recommendations for mitigations. Specifically, address whether there was research with LCA resident's descendants to potentially locate grave sites, or a cemetery associated with the settlement, as concern has been expressed by the community to that effect.
22. In the consultation section, please specify that the SHPD representative is the SHPD Kaua'i Lead Archaeologist.
23. Grove Farm has retained historic records and maps of the sugar industry, which show the locations of historic irrigation ditches, railroads, fields, etc. Was Grove Farm consulted for historic information?

Archaeological Inventory Survey Results

24. SHPD remains unconvinced that trails within the project area, or linking the project area to Mount Ha'upu have been thoroughly researched. Trails would have been necessary to connect the valley to the Keolewa Heiau, and would have had to be used in historic times for the transport of sandalwood, as discussed in the text. The conclusion states that the term "path" on the registered survey map (#1898) "may simply have referred to a survey point on the ditch" does not seem plausible. When was the ditch constructed and did it obliterate the former path?
25. What efforts were made to understand Site 2250 in context to the other Heiaus that have been identified within Māhā'ulepū, including Waiopili Heiau, Keolewa Heiau, and Hanakalauea Heiau? Discuss your research relative to the function and interpretation of these Heiau.

26. The maps on page 55 and 56 are not clear; please provide clearer or enlarged text.
27. Please provide a vertical scale for the stratigraphic profile so that the layers can be understood relative to their depth.
28. Please provide an explanation on why the shallow excavations were terminated at these depths, and whether these shallow excavations provided adequate findings.
29. Provide historic maps showing the location of the irrigation ditches, which will demonstrate the extent of Site 2252. There is no plan view for Site 2252, which is required in HAR§13-276-5 (4) f.
30. As previously requested, provide some context for the interrelation of the irrigation ditches, including historic maps and aerial photographs. Grove Farm has produced historic field system maps for other areas of the island; this information is likely available. Discuss how the ditch configuration provided irrigation to the project area, and discuss whether the ditch segments were constructed at the same time, or were constructed during various periods of cultivation. A map of the project area, overlaid with the actual course of the irrigation ditches would provide some context in understanding the interrelation of the sites.
31. As previously noted, there is no photograph or site map for Site 2253.
32. Please describe the size of the rocks within the dry set features, and the number of courses.
33. There is no attempt to specifically provide context for either the reservoir, the bridges or the irrigation ditches. One of the bridges has been altered from its original construction in 1908, and the bridges contain hand rails made from iron, narrow gauge rails from the previous cane railroad. When were these constructed, and by whom? Who constructed the reservoir, and why?
34. The site description for Site 2258 (the reservoir) lacks a description of the construction and other basic information stipulated in §HAR13-276-5(4). "It is not known if the reservoir is at its original size or was expanded through time" (pg 91). This information shouldn't be hard to find, by consulting with Grove Farm, potentially the Department of Agriculture, etc.
35. Site 2258 and Site 2259 lack plan views, photographs, or historic maps.
36. As previously noted, Feature 3 of Site 3094 is 70 meters away and no rationale is provided justifying it's inclusion in Site 3094. Please prepare a site number request, GIS coordinates, and site description for Feature 3 and include the new site number in the revised copy, as a separate site.
37. As previously noted, Site 3094 Feature 2 was not included in the site requests that SCS made for this project. Please prepare documentation and provide GIS coordinates for Feature 2 and submit to SHPD. An alternative is to provide sufficient rationale for why Feature 2 is associated with Feature 1 and belongs to the same site.
38. Petroglyphs are a unique and significant site type in Hawaii; provide some discussion of the anthropomorphic figures and interpretation of the context of these petroglyphs within the project area; cite primary sources. Some discussion based on previous research would be preferable to "It may be that all of this represents some facet of navigation, ceremony, cosmology, or documentation of events which we do not as of yet understand". While interpretation of the petroglyphs at all three sites may be difficult, minimally provide some context citing previous research on petroglyphs in Hawaii. Is there potentially a connection to the petroglyphs within the project area and the petroglyphs previously identified at Keoneloa (Site 84)?
39. Where are the stratigraphic profiles for the trenches?

Discussion and Conclusions

40. During consultation throughout this project, the Kaua'i archaeologist emphasized the need to consider potential trails to the ridgeline, as well as discuss the cultural importance of the ridgeline, which was deemed a traditional cultural property (TCP) in an Office of Hawaiian Affairs (OHA) letter report included in the National Park Service survey of the Māhā'ulepu coast (2008). We recommended contacting OHA to get more information about the report, as well as sources for this information.
41. In its discussion of 20th century plantation infrastructure, the text states that "There is no evidence that these modifications were built on the backs of historic or traditional irrigation systems". Describe what research would be helpful in exploring this, and what efforts SCS took to research the evidence.
42. Please include a brief description of the sole artifact and its relationship to Site 2250.

Recommendations

43. This section is inadequate. The recommendations section states that Sites 2250 and 3094 should be preserved. Please specify how this will be enacted. What will preservation look like for these sites? How will preservation of these sites maintain the integrity of the site's location within the cultural landscape? In

Exhibit 34

DEPARTMENT OF THE ARMY
HONOLULU DISTRICT, U.S. ARMY CORPS OF ENGINEERS
FORT SHAFTER, HAWAII 96858-5440

October 22, 2014

SUBJECT: Clean Water Act Exemption for Proposed Maintenance of Existing Drainage Ditches of the Hawaii Dairy Farm in Mahaulepu, Island of Kauai, Hawaii

Mr. Ryan Char, PE
Group 70 International
925 Bethel Street, 5th Floor
Honolulu, Hawaii 96813-4307

Dear Mr. Char:

We have received your letter dated June 24, 2014, requesting a determination of permitting requirements for the proposed maintenance of existing drainage ditches on an existing farm located at the proposed Hawaii Dairy Farm location in Mahaulepu, Island of Kauai, Hawaii. We have assigned your request Department of the Army (DA) file number **POH-2014-00128**. Please reference this number in all future correspondence concerning this project.

We have reviewed your submittal pursuant to Section 10 of the Rivers and Harbors Act of 1899 (Section 10) and Section 404 of the Clean Water Act (Section 404). Section 10 requires that a DA permit be obtained for certain structures or work in or affecting navigable waters of the United States, prior to conducting the work (33 U.S.C. 403). Section 404 requires that a DA permit be obtained for the discharge of dredged and/or fill material into waters of the U.S., including wetlands and navigable waters of the U.S, prior to conducting the work (33 U.S.C. 1344).

Based on our review of the information you furnished, and assuming your project is conducted only as set forth in the information provided, this office has determined that although your proposed activity may result in the discharge of dredged or fill material in a water of the U.S., the resulting discharges you have described are not prohibited by or otherwise subject to regulation under Section 404 in accordance with 33 CFR Part 323.4. Therefore, **a DA permit will not be required**.

Although a permit is not required from this office, we recommend use of Best Management Practices to avoid and minimize adverse impacts to the aquatic resource. It is your responsibility to ensure that your project complies with all other Federal, State, or local statutes, ordinances and regulations.

Additionally, by subsequent email correspondence dated September 5, 2014, you indicated that additional activities may occur on site which could affect the drainage

ditches or other aquatic resources such as the construction of farm roads, animal walkways, stream crossings, etc. At this time, you have not requested the Honolulu District Corps of Engineers Regulatory Office to determine if these activities are also exempt from the need to obtain a permit under Section 404. Please be aware that if it were determined that the proposed discharges of dredged and/or fill material are associated with normal farming, silviculture, or ranching activities and, in accordance with the March 25, 2014, Interpretive Rule, these activities would also be exempt from Section 404, provided the establishment that the activities in question are part of an on-going operation. As recently explained in the Interpretive Rule, activities that are implemented in accordance with one or more of the 56 specific Natural Resources Conservation Service (NRCS) national conservation practice standards are considered exempt under Clean Water Act section 404(f)(1)(A) and a Section 404 permit is not required.

You may find the 56 specifically exempted conservation practice standards at: http://water.epa.gov/lawsregs/guidance/wetlands/agriculture.cfm. Information regarding NRCS's conservation practices in general may be found at: http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/home/?cid=nrcs143_026849 . If technical assistance is needed to better understand a conservation practice, you should contact your local NRCS office by using the site locator at: http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/contact/local/. Of course, information requests or questions about Clean Water Act jurisdiction under section 404 should be addressed to our project manager.

Thank you for your cooperation with the Honolulu District Regulatory Program. Should you have any questions related to this determination, please contact the Regulatory Office at 808-835-4303 or via e-mail at CEPOH-RO@usace.army.mil. You are encouraged to provide comments on your experience with the Honolulu District Regulatory Office by accessing our web-based customer survey form at http://corpsmapu.usace.army.mil/cm_apex/f?p=136:4:0.

Sincerely,

Michelle Lynch

Michelle R. Lynch
Chief, Regulatory Office

Exhibit 35

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, HONOLULU DISTRICT
FORT SHAFTER, HAWAII 96858-5440

REPLY TO ATTENTION OF:

October 17, 2014

Office of Counsel

SUBJECT: Freedom of Information Act (FOIA) Request No. 14-45 from Christine A. Terada of Goodsill Anderson Quinn & Stifel

Christine A. Terada
Goodsill Anderson Quinn & Stifel
First Hawaiian Center, Suite 1600
999 Bishop Street
Honolulu, Hawaii 96813

Dear Ms. Terada:

This is an interim response to your letter dated September 24, 2014, in which you requested under FOIA, copies of documents pertaining to Hawaii Dairy Farms' development of a dairy farm in Maha'ulepu on the Island of Kauai.

As agreed to by you and Donna Kanetake of my office, I am providing you copies of documents in our file other than those that you are already in possession of or a party to a particular correspondence.

We are currently in the process of forwarding a document to a correspondent for comments on releaseability. After considering any comments received back, I will make a final determination on release. I anticipate that to be in approximately 3-5 weeks.

Thank you for your patience. Should you have any questions, you may contact Donna Kanetake at 835-4429.

Sincerely,

Robyn U. Au
Acting District Counsel

Encl

Kanetake, Donna H POH

From: Ryan M. Char [rchar@group70int.com]
Sent: Wednesday, September 24, 2014 3:12 PM
To: Stevens, Emilee R POH
Subject: [EXTERNAL] RE: Hawaii Dairy Farm - Mahaulepu, Kauai - Corps File No. POH-2014-00128 (UNCLASSIFIED)

Thanks Emilee, anything you can do to help us get the response sooner rather than later would be appreciated.

Group 70 International

Architecture | Civil Engineering | Interior Design | Planning & Environment | Technology

Ryan M.K. Char, PE, LEED AP
Associate, Project Engineer

808.441.2174 (direct)

rchar@group70int.com

From: Stevens, Emilee R POH [mailto:Emilee.R.Stevens2@usace.army.mil]
Sent: Wednesday, September 24, 2014 2:04 PM
To: Ryan M. Char
Subject: RE: Hawaii Dairy Farm - Mahaulepu, Kauai - Corps File No. POH-2014-00128 (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

Hi Ryan,

I have not, unfortunately, had a chance to get back to this determination request to draft up the letter response. I've had several projects designated priority by management that have been taking up all my time this past month. Hoping to get you the letter as soon as possible.

Thank you,

Emilee R. Stevens

Regulatory Biologist

US Army Corps of Engineers

Honolulu District

Building 230, CEPOH-RO

Fort Shafter, HI 96858-5440

o: (808) 835-4310

f: (808) 835-4126

http://www.poh.usace.army.mil/Missions/Regulatory.aspx

From: Ryan M. Char [mailto:rchar@group70int.com]
Sent: Tuesday, September 23, 2014 2:25 PM
To: Stevens, Emilee R POH
Subject: [EXTERNAL] RE: Hawaii Dairy Farm - Mahaulepu, Kauai - Corps File No. POH-2014-00128
(UNCLASSIFIED)

Hi Emilee,

I wanted to check in with you to see if you had any status on a response from the Army Corps, regarding the Dairy Farm project. Please let me know.

Thanks,

Group 70 International

Architecture | Civil Engineering | Interior Design | Planning & Environment | Technology

Ryan M.K. Char, PE, LEED AP
Associate, Project Engineer

808.441.2174 (direct)

rchar@group70int.com

From: Ryan M. Char
Sent: Friday, September 05, 2014 11:41 AM
To: 'Stevens, Emilee R POH'
Cc: Paul Matsuda
Subject: RE: Hawaii Dairy Farm - Mahaulepu, Kauai - Corps File No. POH-2014-00128
(UNCLASSIFIED)

Emilee,

Thanks again for your help yesterday. I did want to clarify our project's scope, status, and answer some of the questions you had below:

1. Project has and continues to coordinate with NRCS local office. Contact: Ben Vinhateiro and Adam Reed. We understand though that Ben may have recently left the district. We have not heard from his replacement. Attached is our approval from NRCS on our conservation plan. As mentioned, our conservation plan will be updated with specific BMP's to be used on the dairy farm. The BMP's will be designed to and installed per appropriate NRCS Conservation Practice Standards, included in the recent IR and MOU. We can provide a copy of the updated conservation plan to you when we get approval, for your information.

2. Project is currently an existing farm and will be used as a dairy farm, i.e. agriculture use will remain the same. As listed in the IR and MOU, several NRCS Conservation Practice Standards dealing with ongoing farming operations are exempt from Section 404 permitting. This is also the understanding of the Corps who is implementing this IR and MOU.

3. Many of the ditches within the site boundaries are intended for maintenance but not necessarily all of them. Again, will update you with our conservation plan when available. Maintenance will be in accordance with RGL 07-02.

4. Ponds may also be maintained, under NRCS Practice Standards.

5. The wetland at the southernmost tip of the project is not within the project boundary and will not be impacted. An existing roadway separates the farm from this wetland, so no earthwork or maintenance is expected near this area. Other roadways, animal walkways, stream crossings, etc. within the site will be constructed under NRCS Practice Standards.

6. New culverts will only be installed per NRCS Practice Standards for stream crossings.

Generally speaking, the scope of work at the dairy farm has not changed from our original letter dated June 24, 2014. The dairy will consist of a facility and pastures, and include farm roads and access roads, cow races, walkways, fencing, BMP's, and utility systems. Work within the ag. ditches will be incidental to the dairy construction. Maintenance of the ditches will also occur. A setback from water resources will be provided to protect water resources per our conservation plan. Work will be performed under applicable RGL's or NRCS Practice Standards.

As discussed, it would be great if we could get a response to our original letter, with a confirmation of our understanding from yesterday's conversation and this email also included in regards to the IR and MOU. Please let me know if you have any questions.

Thanks,

Group 70 International

Architecture | Civil Engineering | Interior Design | Planning & Environment | Technology

Ryan M.K. Char, PE, LEED AP
Associate, Project Engineer

808.441.2174 (direct)

rchar@group70int.com

From: Stevens, Emilee R POH [mailto:Emilee.R.Stevens2@usace.army.mil]
Sent: Friday, July 25, 2014 3:17 PM
To: Ryan M. Char
Subject: Hawaii Dairy Farm - Mahaulepu, Kauai - Corps File No. POH-2014-00128 (UNCLASSIFIED)

Classification: UNCLASSIFIED

Caveats: NONE

Aloha Ryan,

My apologies for just now getting back to you. I have been in and out of the office and wanted a chance to review all the information you had provided prior to getting in touch with you.

Based on my initial review of the information you submitted, it does appear that the proposed maintenance work of the ditches would be exempt under Section 404 of the Clean Water Act for

discharges of fill material. However, prior to finalizing this determination, I will need a bit more information about the proposed project site.

1. Are all ditches within the site boundaries intended for maintenance? To better understand the scope of the work, it would be helpful if an exhibit similar to Figure 5 were modified to show exactly which areas are intended for work.

2. Are any other water features (i.e. ponds) intended for maintenance activities?

3. Per Figure 5, the southern boundary crosses the northern tip of what is designated as a wetland per the National Wetland Inventory map. Is this, or any other wetland areas, to be impacted by earthwork or maintenance activities for the proposed dairy farm? I understand that grading and grubbing activities in preparation for new roads may be occurring. I want to ensure that no other activities occurring at the project site would require a permit outside of the irrigation/drainage ditches.

4. Are any new culverts proposed in addition to the maintenance activities described?

Please let me know if you have any questions about this information.

Thank you,

Emilee R. Stevens

Regulatory Biologist

US Army Corps of Engineers

Honolulu District

Building 230, CEPOH-EC-R

Fort Shafter, HI 96858-5440

o: (808) 835-4310

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http://www.poh.usace.army.mil/Missions/Regulatory.aspx
<http://www.poh.usace.army.mil/Missions/Regulatory.aspx>

Classification: UNCLASSIFIED

Caveats: NONE

Classification: UNCLASSIFIED
Caveats: NONE

West Kauai
Soil & Water Conservation Districts

December 17, 2013

Hawaii Dairy Farms LLC
737 Bishop St Ste 2360
Honolulu, HI 96813

Dear Hawaii Dairy Farms LLC:

We approved your conservation plan for the **TMK: (4)2-9-003:001 portion (approx 581.5 acre)** at the West Kauai Soil and Water Conservation District Board meeting on December 17, 2013. Your copy of the conservation plan will be sent to you by the NRCS. Please notify us if the TMK # shown in this letter is incorrect or if you notice any other errors that need to be corrected. By completing a conservation plan, you are demonstrating a commitment to soil and water conservation, and we appreciate that.

In issuing this conservation plan, the West Kauai Soil & Water Conservation District relied on the information and data which you provided to us. If, subsequent to the issuance of this approved conservation plan, such information and data prove to be false, incomplete or inaccurate, this approval may be modified, suspended or revoked, in whole or in part. Before you do anything to your property that is not included in your plan, it is to your advantage to notify us. We can assist you in revising your conservation plan.

It is your responsibility to make sure that no historic sites are damaged by your activities. Your NRCS soil conservationist can advise you when a historic preservation review is required, if you are applying for federal assistance programs. In the event any unanticipated sites or remains such as shell, bone or charcoal deposits, human burials, rock or coral alignments, pavings or walls are encountered, you and/or your contractors shall stop work and contact the State Historic Preservation Division (SHPD) immediately by calling 808-692-8015.

This conservation plan does not supersede any Kauai County, State and Federal ordinances or regulations. It is your responsibility to obtain any required permits, and to comply with any zoning requirements. If you are applying for an agricultural exemption to Kauai County's Sediment and Erosion Control Ordinance, obtain an application form from Kauai County Department of Public Works. Note that if your plan proposes to use the land in the same way as it has been used in the past (limited to the same acreage, depth of tilling, and proposed use types), the agricultural exemption does not require a SHPD review of your plan. Implementation of conservation practices scheduled in your plan may require additional engineering design and specifications. This assistance can be provided by the USDA-NRCS office or by a private consultant.

We wish you success in your agricultural endeavors! If you have any questions, please contact the West Kauai District office at 245-6513, ext. 117.

Sincerely,

Peter Tausend

Peter Tausend, Chairman
West Kauai SWCD

cc: USDA-NRCS, Kaua'i County Department of Public Works, Kaua'i County Planning Department, and SHPD

4334 Rice Street, Room 104 / Lihue, HI 96766 / Telephone: (808) 245-6513 / Facsimile: (808) 246-4639

Kanetake, Donna H POH

From: Stevens, Emilee R POH
Sent: Wednesday, September 24, 2014 3:11 PM
To: 'Wiltse, Wendy'
Subject: RE: ditches (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

Hi Wendy,

In short, yes to your first question. Under 33 CFR 323.4(a)(3) "Discharges not requiring permits," the discharge of dredged or fill material associated with the construction or maintenance of irrigation ditches, or the maintenance (not construction) of drainage ditches is exempt from needing a 404 permit, thereby assuming that while the ditch may be jurisdictional as a water of the U.S., the activity is exempt.

Even if the dairy farm conducted maintenance activities already, so long as they are solely maintenance activities in drainage ditches, the activity would be exempt with or without a verification letter from our office i.e. there is no requirement that correspondence confirming the exemption is required prior to start of the maintenance activities.

Hope that helps clarify!
Emilee

From: Wiltse, Wendy [mailto:Wiltse.Wendy@epa.gov]
Sent: Wednesday, September 24, 2014 2:46 PM
To: Stevens, Emilee R POH
Subject: [EXTERNAL] ditches

Emilee, some after thoughts and questions....

Is ditch maintenance exempt even if the ditches are WUS and connect with surface water? Has the dairy done ditch maintenance before receiving your verification and is that a problem for COE? A violation?

Mahalo,
Wendy

EPA Region 9 - PICO
300 Ala Moana Blvd. Box 50003
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Ph: 808-541-2752
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wiltse.wendy@epa.gov

Classification: UNCLASSIFIED
Caveats: NONE

Exhibit 36

Glenn, Scott J.

From: Glenn, Scott J.
Sent: Friday, June 3, 2016 2:42 PM
To: Eisen, Thomas H.
Subject: Re:

Thank you

Please excuse any typos; sent from a mobile device.

On Fri, Jun 3, 2016 at 5:36 PM -0700, "Eisen, Thomas H." <Thomas.Eisen@doh.hawaii.gov> wrote:

Jeff called, seemed ok with the blandness of "To Be Determined" or "HRS 343-5"

Tom Eisen, Planner
Office of Environmental Quality Control
Department of Health
State of Hawai'i
(808) 586-4185

NOTE: OEQC's primary role is to facilitate Hawai`i's environmental review process by providing advice to agencies, applicants, consultants and the public. OEQC is not authorized to make determinations on exemptions, EA or EIS documents. Pursuant to Chapter 343, HRS, all such determinations are made by relevant agencies, county Mayors or the Governor. Upon request, OEQC may make a recommendation as to the acceptability of a Final EIS.

HAWAIʻI DAIRY FARMS
RESPONSE TO COMMENTS PROVIDED BY KAWAILOA DEVELOPMENT

GROUP 70 INTERNATIONAL

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January 11, 2017

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Subject: Hawai'i Dairy Farms Final Environmental Impact Statement (EIS)
Māhā'ulepū, Kōloa District, Kaua'i, Hawai'i
Response to Comments on Draft EIS
On behalf of Kawailoa Development LLP

Dear Ms. Lisa A. Bail:

Thank you for your comment letter with eight appendices and additional enclosures dated July 25, 2016 regarding the Hawai'i Dairy Farms (HDF) Draft Environmental Impact Statement. The following responses are offered to your comments.

Group 70 International, Inc. (Group 70) is responsible for the preparation and processing of the Hawai'i Dairy Farms Environmental Impact Statement (EIS). The EIS was prepared in accordance with the requirements of Chapter 343 Hawai'i Revised Statutes and the "Environmental Impact Statement Rules" (Chapter 200 of Title 11, Hawai'i Administrative Rules).

I. Executive Summary

Revitalize dairy in Hawai'i utilizing a sustainable system

Hawai'i Dairy Farms is committed to establishing a sustainable, pastoral rotational-grazing dairy farm to increase current local milk production, bolster Hawai'i's declining dairy industry, and reduce reliance on imported milk from the mainland United States. The HDF project objectives include protection and enhancement of the area's natural, cultural, social and economic environment through sound agricultural planning, reservation of open space and protection of sensitive resources, and development of economic benefit (EIS Section 2.3.3 *Project Objectives*.).

Precedence of Dairies and Cattle in Hawai'i

The assertion that the proposed dairy is without precedent ignores the current beef and dairy industry in Hawai'i, and does not consider the huge decline in the State's dairy industry over the past 30 years. In 1984, approximately 12,100 cows produced all of the milk consumed in the State. Since then, 20 of the 22 dairies have closed, and Hawai'i imports 90 percent of its milk. In 1984, the State's population was approximately 1.23 million residents and visitors. Today, the current *de facto* population is approximately 1.58 million people, an increase of approximately 28 percent. If Hawai'i had remained self-sufficient in milk, an additional 699 dairy cows would amount to an increase of less than 5 percent; with the contemplated herd size of up to 2,000 dairy cows, the increase would be under 13 percent (Plasch, EIS Volume 5, Appendix A-A).

Hawai'i currently has a large number of beef cows: according to Hawai'i Farm Facts, milk and beef cows totaled approximately 80,000 head as of 2012. Thus, should HDF expand to the full contemplated herd of 2,000 dairy cows, the increase would represent a 2.5 percent increase of the cattle inventory in the State (Plasch, EIS Volume 5, Appendix A-A).

In the Public Interest

The project's purpose and need is supported by the fact that between 1984 and 2015, importation of milk to Hawai'i rose from 0 to 90 percent (EIS Section 2.3.2 Project Need). The recent announcement by Hawai'i Governor Ige at the 2016 World Conservation Congress in Honolulu, referred to as "Double Local Food Production", emphasizes the State's focus to advance the agricultural self-sufficiency of Hawai'i. HDF can play a role in contributing to the Statewide projected benefit: replacing just 10 percent of imported food with locally produced food is estimated to generate a Hawai'i economy-wide impact of $188 million in indirect sales, $47 million in earnings, $6 million in state tax revenues, and more than 2,300 jobs (EIS Section 2.3.2).

Agricultural project on agricultural lands implemented and operated with private funds do not require environmental disclosure. HDF agreed to prepare an EIS to evaluate and disclose potential effects in response to public interest. The EIS was prepared per the requirements of Hawai'i Administrative Rules Title 11 Chapter 200 (HAR §11-200), implementing Hawai'i Revised Statutes Chapter 343 (HRS 343). HRS 343 and HAR §11-200 specify that environmental statements are prepared at the earliest practicable time in the planning and decision-making process. Therefore, EISs are often conducted prior to the full design phase.

HDF initiated the EIS process at the earliest practicable time and worked with its technical service provider, knowledgeable in Natural Resources Conservation Service (NRCS) practices and other consultants, to advance design in order to address relevant issues and questions for analyses in the EIS. HDF has conscientiously designed the dairy to minimize impacts to soil and water resources using best management practices.

In fact, results of the EIS analyses show no impacts reach beyond surrounding agricultural lands to affect resort, residential or recreation areas. The prognosis of "ecological disaster" in your letter is unsubstantiated and based on incorrect assumptions and, in some cases, incorrect data. The economic benefits include perpetuation of the agricultural heritage with which the Kōloa region is associated. The dairy will grow 70 percent or more of its feedstock – pasture grass – on site where cows have access to natural light and fresh air for 22 hours of each day. The herd will be managed in social groups mimicking the natural social order of bovines.

Accounting for Numbers of Animals, Productivity and Feed

The potential maximum herd size has consistently been represented as the number of cows that reflects the carrying capacity of the land as guided by results of regular, ongoing nutrient balance analyses (EISPN Section 2.3 *Proposed Action*; EIS Section 1.2 *Proposed Project*). The distinction between the herd sizes and different permit requirements is explained in the EIS Section 2.4 *Planned Dairy Development on Māhā'ulepū Agricultural Lands*.

The rotational-grazing method utilizes manure as a resource and utilizes 100 percent of manure as nutrients to grow the majority of the forage for the herd. Benefits of pasture grazing include, but are not limited to, improved soil health, and increased animal health and productivity.

Use of Māhā'ulepū Valley

Māhā'ulepū refers to a land division shaped by island geography following the natural boundaries of the watershed, known in Hawai'i as an ahupua'a. These land divisions were identified as areas that contained all the resources needed by a human community, from the ocean to the mountains. The approximate size of the Māhāʻulepū ahupuaʻa as documented in the State of Hawaiʻi geographic information system is 2,724 acres. Hawaiʻi Dairy Farms leases just 20 percent of that area: 557 acres on the valley floor.

Use of the site for dairy operations does not preclude future conservation use of the wider region, such as examined by the U.S. National Park Service (NPS, 2008) reconnaissance study (EIS Section 4.26.4 *Irreversible and Irretrievable Commitments of Resources*). The purpose of the reconnaissance study was to determine whether a full NPS special resource study should be conducted. The reconnaissance study's recommendation for authorization of a Special Resource Study included "<u>so long as it focuses on non-traditional management alternatives that a) involve local partners and b) include options for continued farm and ranch operations on private agricultural lands</u>" (emphasis added).

The proposed dairy farm would be within the active Māhāʻulepū agricultural area. Māhāʻulepū has been an agricultural center on Kauaʻi for centuries. Farming occupied the low slope areas in Māhāʻulepū, and ranching used the uncultivated areas surrounding the valley for grazing. Since the demise of sugarcane in the 1990s, most former agricultural fields have been under-utilized or vacant.

HDF reflects a viable approach to apply use of Important Agricultural Lands to agricultural self-sufficiency and food production. The project represents a continued commitment by the landowner to support farming and local food production, and to aid in the resurrection of Hawaiʻi's dairy industry. HDF is consistent with applicable policies and plans set forth in the various Federal acts, laws and plans of the State of Hawaiʻi, and the plans and ordinances of the County of Kauaʻi. Chapter 5 of the EIS presents the proposed project's consistency with the Hawaiʻi State Plan, Hawaiʻi Functional Plans, Hawaiʻi 2050 Sustainability Plan, State of Hawaiʻi Water Policies, Hawaiʻi Land Use Districts, and Hawaiʻi Coastal Zone Management Act. The project is consistent with County of Kauaʻi plans and policies, including the County General Plan, South Kauaʻi Community Plan, and Comprehensive Zoning Ordinance (EIS Chapter 5 *Consistency with Government Plans and Policies*).

<u>Impacts Do Not Reach Resort, Commercial, Residential or Recreational Areas</u>

The odor report prepared by Exponent and attached to your letter assumed both irrigation and slurry would be applied simultaneously, which is incorrect. In addition, the threshold of odor detection used by Exponent was inappropriate. HDF considered other comments provided by Exponent to the odor modeling contained in the Draft EIS. Based on Exponent's report, HDF's odor consultant, Arcadis, refined the odor model to depict different irrigation dilutions depending on field conditions, and adapted manure odor data used by Exponent. The revised model for HDF is contained in Volume 2, Appendix I of the EIS. The Arcadis response to the Exponent odor report is Appendix B-B of Volume 5.

Results of the revised odor report show that any odor, which may be detectable by 50 percent of the sensitive population just 44 hours of each year under the worst case scenario of no winds, remains on adjacent agricultural lands and does not extend to resort, commercial, residential or recreational areas.

The range a fly can travel is also not the range a fly will travel. More realistic than any theoretical calculations of fly expansion is modern experience in the Islands. Parker Ranch has been upwind of the Mauna Kea Beach Hotel and two other coastal Kohala Resorts sited from Puakō to Waikoloa since they were built decades ago, and the lack of dung fly complaints arising from Parker Ranch is solid evidence that cattle flies overwhelmingly remain close to livestock habitats.

<u>No Negative Economic Impact</u>

The economic analysis conducted by HDF's Hawaiʻi-based consultant has concluded there will be no adverse economic impacts due to nuisance issues from the dairy. Primary economic benefits include increased milk self-sufficiency, well-paying farm jobs, and preservation of the sites as a well-maintained green, open space. Additionally, the review of property values adjacent to beef cattle operations in the region reveals newer homes with large square footage in a luxury residential community with 2016 assessed values of $1,297,150 for a lot, to $2,893,100 for a lot with home. The conclusion is that clearly, beef cattle operations are compatible with nearby homes, commercial areas, resorts and recreational areas. The ranching and rural ambience adds to the value.

<u>The EIS is Adequate</u>

The EIS was prepared in accordance with HRS 343 and HAR §11-200 as described above. Technical analyses on resources relevant to the project and of interest to the public were conducted for the Draft EIS. Probable impacts of both the committed herd size of up to 699 mature dairy cows, and the contemplated herd size of up to 2,000 mature dairy cows, are presented in the EIS.

Comments on the technical reports provided with your letter are summarized in the following section, with the full responses attached to this letter as well as included as appendices A-A through H-H to the Final EIS.

II. Technical Comments

For the most part, the reports attached to your letter contradict findings of HDF's Hawaiʻi-based expert consultants by using assumptions based on poorly-managed conventional feedlot dairy operations on the mainland and, in several cases, incorrect data. Two reports, related to odor and marine biota, were considered by HDF experts to have some validity and additional analysis was conducted. Responses to your comments are summarized in the following section and the complete responses are attached.

Overall, HDF stands by the environmental analyses conducted for the EIS, which uses reasonable and diligent processes to disclose all probable impacts and demonstrates the dairy will not create nuisance impacts down-gradient or beyond surrounding agricultural lands.

A. Economic Impact (Appendix A)

The Draft EIS (DEIS) did not "largely ignore the potential economic impacts of the proposed dairy on tourism on Kauaʻi generally and the impacts to the Grand Hyatt Kauaʻi specifically". The impacts were not omitted, discounted, or assumed away. The finding was no significant adverse economic impacts, a finding based on environmental studies that indicate no significant nuisance impacts affecting resort, commercial, residential or recreational areas.

The discussion of the Kauaʻi economy in the EIS focuses on the island and the regional setting near the HDF site rather on than a single resort. Poʻipū is identified in the EIS as one of two major tourist and luxury home destinations on the island, with the largest inventory of hotel rooms, transient vacation rentals, and luxury vacation homes on the island (Section 4.15.1 *Existing Conditions – Demographic and Economic Conditions*). One of the HDF project objectives is to "Provide local farming employment and build the agricultural economy" (EIS Section 2.3 *Purpose and Need*), which supports a diversified economy that serves to benefit the community, while advancing food self-sufficiency for both the residents and visitors.

The *Assessment of Economic Impacts of the Proposed Hawaiʻi Dairy Farms Facility* by BRG (July 2016) is based on research conducted on impacts from poorly managed mainland conventional feedlot dairy operations. Conventional dairies concentrate their milking cows in feed lots where the cows are fed grains, hay and/or silage. Correspondingly, a large volume of manure is generated in a small area, leading to waste management challenges. These types of operations can generate significant odors and other nuisances, which can extend beyond the property boundaries and affect nearby properties. The sustainable, pastoral rotational-grazing dairy farm proposed by HDF will utilize 100 percent of the manure as nutrients to grow the majority of the herd's feedstock on-site - pasture grass. The environmental studies for HDF indicate no noticeable noise, dust, odors, flies, runoff or other nuisance impacts will extend to resort, commercial, residential or recreational areas.

The EIS notes that despite the changing character of the Poʻipū area towards a resort town, Māhāʻulepū has a long history of agricultural use, as one of the first places in the island chain where sugarcane was commercially grown. In 2011, the State of Hawaiʻi Land Use Commission designated 1,533 acres of land (including 557 acres that make up the Hawaiʻi Dairy Farms project area) as "Important Agricultural Lands" under HRS Chapter 205 – Hawaiʻi's land use law. Per HRS Chapter 205, both State and County governments are responsible for promoting the long-term viability of agricultural use of conserved/protected Important Agricultural Lands. This designation is intended to increase the viability of agriculture through the expansion of the agriculture industry, increase job opportunities, and increase in food security for current and future generations.

The economic consultant for HDF has extensive consulting experience in Hawaiʻi, having started his professional career here in 1967. Dr. Plasch received his Master's and Ph.D. degrees from Stanford University in Engineering-Economic Systems, which gave him a strong background in economics, finance, and quantitative analysis. Additionally, he earned a B.S. degree in engineering from the University of California, Santa Barbara. Dr. Plasch's extensive consulting for State, Federal and county agencies, as well as Hawaiʻi's largest landowners, have covered the topics of economic development (including agriculture and tourism), land and resource economics, market assessments, feasibility studies, valuations, infrastructure financing, public policy analysis, and assessing economic benefits and impacts. Dr. Plash reviewed the comments provided by BRG, Appendix A of your letter, and prepared a response, which is included as Appendix A-A in Volume 5 of the EIS.

B. Odor Impacts

HDF considered comments provided by Exponent to the odor results for the dairy contained in the Draft EIS: *Air Emissions and Odor Evaluation Technical Report* (Arcadis, May 2016). Exponent prepared an odor emission report based on two alternate methods:

1. Exponent used different assumptions on the timing of effluent irrigation and slurry application, as well as different sources for odor emission rates. Exponent assumed both irrigation and slurry would be applied simultaneously, which is incorrect.
2. Odor results were compared against a lower threshold than that used by Arcadis. Exponent argued the threshold "was not considered appropriate for a sensitive population such as hotel guests at a resort area."

Exponent concurred with the emission methods and results presented by Arcadis that quantify odor from the effluent ponds and the dairy facility buildings. The air emission findings in the Arcadis May, 2016 report were not commented on by Exponent.

The HDF air quality and odor technical expert, Arcadis, reviewed Exponent's comments and odor report. To consider the two alternate methods used by Exponent, Arcadis verified operational procedures with HDF: 1) Slurry application will not coincide with effluent application, and 2) slurry will not be applied during days with average wind speeds less than approximately 9 miles per hour (mph) (4 meters per second - m/s) or with winds greater than 20 mph (8.9 m/s). Additionally, HDF confirmed that the dilution of irrigation water with effluent will change based on field conditions. For these reasons, Arcadis recommended refining the odor model to depict both the "typical" irrigation effluent odor and the "wet condition" irrigation effluent odor. Additionally, Arcadis adapted the data used by Exponent for manure (Jacobson et al., 2001) and slurry application (Pain et al. 1988) to account for differences in diet that the cows at HDF will be fed compared to a traditional diet. Data for the manure was adapted to account for the Kikuyu thatch that will receive manure at HDF, as opposed to a conventional compacted dirt feedlot that was assumed by Exponent. The findings of the revised odor technical report are summarized below.

On the second point, Arcadis notes that the odor threshold of 6.5 OU/m³ averaged over one hour and 99.5th percentile was selected based on the specificity of dairy farms. In comparison of odor regulations and guidance from four continents and New Zealand, OU/m³ limits show off-site standard or guidelines in the U.S. to be between 2 and 50 OU/m³ with the majority of values between 5 and 7 OU/m³. Low OU/m³ values are often difficult to observe. For instance, California's South Coast Air Quality Management District states that at 5 D/T (OU/m³) people become consciously aware of the presence of an odor and that at 5 to 10 D/T odors are strong enough to evoke registered complaints. While odors may be perceived over time periods less than one hour, the selected threshold was designed for a one-hour average. If a shorter time period were desired, a higher OU/m³ value (perhaps closer to 10 OU/m³) would have been more appropriate.

For the reasons above, Arcadis prepared a revised odor report that modeled irrigation effluent at two dilutions in for all wind conditions throughout the year, and slurry effluent with wind speeds between 9 and 20 mph, and again used the threshold of the 6.5 OU/m³ annual extent odor level. Modeling was done for both the herd size of 699 mature dairy cows and for the contemplated herd size of up to 2,000 dairy cows. The full results are shown in the Final EIS Sections 4.19.2 and 4.25.2.

The complete Arcadis response to Exponent's comments and the revised odor report are contained in the EIS Volume 5, Appendix B-B.

C. Manure-Related Insects (Appendix C)

The entomological consultant for HDF, Dr. Steven L. Montgomery, has 48 years of field experience in Hawaiʻi environments from mountaintops to lava tubes. He has conducted numerous biological surveys on all islands. Dr. Montgomery has discovered 30+ Hawaiian insects and rediscovered 'lost' species of insects, snails, and plants. The HDF team conducted archival research with resources at Bishop Museum, University of Hawaiʻi, and repositories with applicable collections, and conducted fieldwork on site and in adjacent property in preparation of the January 2016 report included as Volume 2 Appendix B of the EIS. In contrast, the Pacific Analytics report (Appendix C to your letter) was based on general research without a field visit to the HDF site. Following is a synopsis of the responses to the Pacific Analytics report prepared by Dr. Montgomery; the response is included as Volume 5 Appendix C-C to the EIS.

Pest Flies. The range a fly can travel is not the range a fly will travel. More realistic than any theoretical calculations of fly expansion is modern experience in the Islands. Parker Ranch has been upwind of the Mauna Kea Beach Hotel and two other coastal Kohala Resorts sited from Puakō to Waikoloa since they were built decades ago, and the lack of dung fly complaints arising from Parker Ranch is solid evidence that cattle flies overwhelmingly remain close to livestock habitats.

The stable fly was identified as a manure-related insect that currently exists on manure in the immediate vicinity of the HDF site. Natural fly control species such as dung beetles were also identified at the HDF site. Disruption of the dung by birds and dung beetles reduces habitat for breeding flies. The stable fly and other dung-related flies are undoubtedly present nearer to Kōloa and Poʻipū in association with cattle grazing that has been ongoing for generations in the region; beef cattle herds in Kipu and Kipu Kai number over 1,000 and are within 5 miles. If dispersal of manure breeding pests into Poʻipū resorts were to be a public nuisance, such expansion would have already occurred.

Mosquitoes. Mosquitoes have been in the news since publication of the Draft EIS due to outbreaks of mosquito-borne illnesses in semi-tropical climates such as Hawaiʻi. The assertion that HDF could generate large populations of these pests in standing water, ponds, ditches and pasture divots fails to recognize that such conditions are detrimental to dairies and to cows, and also fails to recognize operational controls that would prevent such conditions. The effluent ponds are aerated and mixed, with effluent diluted with wash-water and stormwater runoff moved through the ponds on a regular cycle (EIS Section 3.3.2.4 *Effluent Storage Ponds*). Potable water tanks are covered (EIS Section 3.3.2.2 *Livestock Water Distribution System*). Stormwater runoff from the site overall will be reduced by the thick Kikuyu vegetative thatch to be cultivated in the pastures, as well as increased surface infiltration of rainfall and irrigation due to improved soils from the addition of organic matter in the form of manure (EIS Section 3.3.2.3 *Drainage Improvements*).

Livestock water troughs will contain water for the period of 12 to 24 hours when cows occupy the paddocks. HDF personnel will fill troughs just before the herd enters the paddock(s) for the grazing period; troughs will be emptied after the cows are moved to another paddock. Thus troughs will be managed to prevent mosquito breeding (EIS Section 3.3.2.2).

Dung Beetles. The statement that dung beetles are unlikely to succeed in hastening breakdown of manure and minimizing fly populations is based on incorrect conclusions by the commenter about soil moisture. The citation of several reports attached to your letter use incorrect rainfall data (Exponent 2016; CH2M Hill 2016). Exponent prepared a Stormwater Management Model (SWMM) using rainfall data from a gauge in Līhue rather than the long-standing NOAA rain gauge at Māhāʻulepū (referred to as Māhāʻulepū 941.1), resulting in assumptions of rainfall levels 20 inches above average annual rainfall at the site. Further, the SWMM assumes HDF will add more than 68 inches of irrigation per year, which is a level suitable for dry field conditions. HDF has stated it will monitor field conditions and irrigated as appropriate to the need of the crop; the SWMM asserts HDF would not (G70, EIS Volume 5, Appendix G-G). Further, Appendix C to your letter asserting "excessive moisture, clay soils, and trampling by cows" ignores the EIS analysis of rainfall and soils (EIS Sections 4.1 *Climate* and 4.3 *Soils*).

Several papers are cited throughout EIS Appendix B, relating to dung beetles: Griffith 1997, Markin and Yoshioka 1998, Thomas 2001. The specific research stating that dung beetles, in high populations will bury dung pats four to six inches in one to three days, is included in the Montgomery response to the Pacific Analytics report (Volume 5, Appendix C-C).

Nowhere in the EIS or Appendix B is it stated that HDF will release parasites or predators to control fly populations. HDF would not translocate any species independently. EIS Section 4.11.2 states: HDF and other ranchers on Kauaʻi may choose to engage with the State Department of Agriculture to translocate dung beetle species already present in the State to Māhāʻulepū and other areas if manure-related fly control is needed. DOA has a long record of scrutiny and controls on translocation and introduction of pest control species. All work would be done through and with DOA. Appendix B suggests that "If the HDF cattle began their journey around the HDF paddocks in

the sections near areas where the Māhāʻulepū Cattle Co. herd was recently grazing, the predators and parasites would more readily migrate to the manure being deposited by HDF cattle." This would be a natural process, no releases or transplanting or translocation.

Integrated Pest Management Plan. An Integrated Pest Management Plan is a composite of complementary parts. It is not rational to pull out individual components, suggest failure of one at a time, and then conclude that the whole system will fail. IPM works because each component reduces a part of the problem. They work together, with one unit working to pick up when or where another is not present. Chemical controls affect both beneficial and non-beneficial insects and will be used judiciously. Use of any chemicals will be conducted by a trained applicator, and all labeling requirements will be followed. Management to minimize mosquito breeding habitats is explained in the previous section.

Endangered Arthropods. Review of the area's geology shows the contrast of the karst topography predominant in the Kōloa-Poʻipu area, and the alluvial-filled basin of Māhāʻulepū Valley (EIS Figure 4.16-1 *Geology of Māhāʻulepū and Vicinity*). The alluvium within the valley generally extends about 60 feet under the surface and is underlain by highly weathered lava at a shallow depth by secondary eruptions of the Kōloa series. Neither the botanical and faunal survey nor the invertebrate survey revealed any evidence of lava tubes or caves on the property, and no such features have been reported for the area in the near surrounds of the HDF site. The nearest critical habitat that contains the primary constituent elements required by the Kauaʻi cave wolf spider and the Kauaʻi cave amphipod, consisting of mesocaverns or caves and passages and roots from living plants such as, but not limited to, ʻohaʻi (*Metrosideros polymorpha*), maiʻapilo (*Capparis sandwichiana*), and aʻaliʻi (*Dodonea viscosa*) is 0.75 miles away. Appendix C-C in Volume 5 to the EIS discusses the importance of understanding invertebrate habitats when conducting surveys.

Potential impact to the arthropod population within the cave down gradient will be minimized by the multiple best management practices to be employed in the dairy's design and operations (EIS Section 3.5.1 Paddocks, Fencing and Setbacks). Two types of setbacks will be established to protect water quality of surface water and downstream areas. A physical setback to keep cows and manure from ditches and drainageways will be created with paddock fencing set 35 feet back from the top of bank of drainage ways on site. Vegetation within the setbacks will act as filter strips on both sides of the drainageways to capture and retain nutrients for forage growth on the site. Additional setbacks restrict liquid effluent application within 50 feet of waterways, and other setbacks from water sources are listed in Section 3.5.4.2 Nutrient Balance.

Estimated peak flow of stormwater runoff will be reduced with the improved conditions proposed for the site: 80 acres of maintained drainageways, vegetated setback, and permeable path and roadways. Calculations show reduction in runoff, estimated in Māhāʻulepū Ditch immediately south of the project site where flows combine. Peak flow leaving the project site will be reduced by 257 cubic feet per second (cfs) for the 10-year storm event; for the 25-year storm event, reduced by 283 cfs; and for the 50-year storm event, reduced by nearly 300 cfs (Section 3.3.2.3 *Drainage Improvements*).

Based on hydrological knowledge derived from all drilled wells analyzed by Nance, the downslope movement of ground water from below the pastures toward the habitats of listed arthropods will not reach into the referenced habitats. Recognizing that the food supply of the wholly saprophagic amphipod is organic matter derived from roots and other decaying plant debris, and since nitrogenous and phosphoric nutrients will promote plant growth, their effects, if anything at all, can be expected to expand the food supply in this oligotrophic subterranean ecosystem.

Native Insects. Comparisons to the findings of the HDF manure-related invertebrate assessment with the referenced 1990s study "less than 15 miles away" must, to be appropriate, cite the following major habitat differences: The referenced study covered an area including beach and two natural stream courses, up to 150 m. elevation. Also, study lights drew volant insects from nearby ʻōhiʻa [*Metrosideros*] and a Forest Reserve in Anahola Mountains. The authors note native Hawk moth [sphinx moth] "specimens were collected from light traps set in stream gulches, but it is doubtful that this species breeds in Moloaʻa", or any other pastures.

A full inventory is not typically done when assessing potential impacts of an agricultural use on agriculture zoned land. Dr. Montgomery draws on decades of experience to design each survey to extract germane information under present and projected conditions. Important agricultural lands (IAL) dedicated by owners to long-term food production have a special status supportive of agriculture operations. Having been plowed for sugar cane or heavily grazed by livestock since the 1840s, these lowlands, lacking in even a remnant of the native flora, do not support native invertebrates. Conducting an additional survey using light traps and baits on the pasture would have drawn a few flighted, lowland native insects from the Mt. Hāʻupu foothills, thus would have been inappropriate methodology.

Most of the lowland endemic insects have been exterminated by the alien big-headed ant, Pheidole. [Zimmerman, E. C. (1948). Introduction. *Insects of Hawaii* V.1, p. 65 of 206 pp.] Three insect surveys conducted by Dr. Montgomery on parcels being urbanized along the Poʻipū coast since 1975 found only a very few native arthropods. Those found were usually on native flora, and most were common species occurring widely, some even on all the major islands, like the globe skimmer dragonfly, *Pantala flavescens* and intertidal rock crickets. Though alert for native insects at all times, only a few of the native pantropical dragonfly were seen. Host plants for the Sphinx moth were specifically searched for and NOT found, NOR were evidences of other native rare species [see EIS Appendix B, Invertebrates not present]. Based on Asquith and Messing, it is predicted fungus gnats, stream midges, crane flies, seed bugs and ground earwigs of *Anisolabis* may well be present at HDF, but they are extremely widespread throughout the main Hawaiian islands and are not rare. Please refer to page 20 of the manure-related insect report listed in EIS Volume 2 (Technical Appendices) Appendix B.

D. Pathogen Impacts (Appendix D)

The report by Karen J. Murray for Exponent (July, 2016) ends with a section labeled "Limitations", which states:

> "The information upon which we rely in preparing this report is from the HDF DEIS and from publicly available information. We have generally not verified these data independently and, unless otherwise stated, assume that they are accurate. In addition, some of the data and information generated or reported by the HDF is unclear, and we have interpreted that information to the best of our ability."

So it is clear that the report is not based on any first-hand knowledge of field conditions, but rather is based on site characterizations from another report by Exponent, which incorrectly utilizes rainfall data: *Water and Water Quality Impacts, Hawaii Dairy Farms DEIS, Mahaulepu, Kauai*" (Exponent, 2016). A summary of the inaccuracies of that report is included in section G of this response, following. The full response by HDF's Hawaiʻi-based technical experts accompanies this letter as Appendix G-G.

***Soil Conditions*:** Murray's assertion of "nearly saturated" soil conditions is incorrect, and is based on results of the 2016 Exponent SWMM model. The SWMM model assumes the fields are constantly rained upon and utilized worst-case weather data from a station in Līhue that do not apply to Māhāʻulepū. The rainfall data equivalent used in the SWMM model is equivalent to 72.86 inches per year at the HDF site. However, a NOAA rain gauge "Māhāʻulepū 941.1", located at the makai end of the HDF site, shows that annual rainfall averages just under 50 inches annually, with a single year that reached that extremely high rainfall: 1957, some 59 years ago. The SWMM model assumes not only an unrealistically high rainfall, but also that the fields will be over-irrigated with constant irrigation using irrigation values specifically for dry weather conditions, and concludes that the fields will always be saturated. This is not supported and is in no way how HDF will operate.

***Pathogens from Agriculture*:** The statements made in the pathogen report regarding impacts to human and ecological health from pathogens and fecal indicator bacteria (FIB) from cow manure are both over-simplified and misleading. References throughout the pathogen report by Murray include research on swine operations and conventional cattle feedlot operations, which do not apply to HDF. Common sources of water contamination from manure include runoff and leaching from stockpiled manure or from open lots, neither of which will exist at HDF.

While dairy cows can be a source of fecal pathogens, best management practices described throughout the EIS to protect groundwater are those recommended by NRCS and agricultural extension services such as Cornell University, University of Minnesota, University of Michigan, and Purdue University, to name a few. Pathogen prevention on a dairy begins with healthy animals. Good animal husbandry practices reduce pathogens in manure as healthy, comfortable animals have and shed fewer pathogens that sick, stressed animals. Regular vaccinations, adequate space allowance, and access to feed and water are among the recommendations that are met or exceeded in a pasture-based dairy system. EIS Section 3.4, Herd Management, provides an overview.

***Attenuation*:** As stated in Section 3.5.3, as the cattle excrete on the Kikuyu thatch, nutrients are incorporated into soils through primary decomposers such as earthworms and dung beetles that aerate the soil to make organic materials accessible to secondary microorganism decomposers. The decomposition process breaks down manure into nutrient components that are readily available for uptake by the grass crop. In a healthy system, manure can be cycled through the soil surface in 24 to 36 hours.

Within the ponds, some anaerobic digestion will occur to break down organic component of the manure into soluble forms, typically ammonium, potassium, phosphorus and other soluble nutrients from both feces and urine. The effluent manure is then applied to the pasture and thus is in solution and readily available for absorption by the pasture grass.

With the addition of irrigation water and liquid effluent, the surface soil will be energized microbiologically (EIS, Section 4.11). Stimulated populations of microorganisms are very effective in inactivating pharmaceuticals and additives due to the reduced half-time resulting from enhanced immobilization and degradation by the superactive microbiological community.

***Taro Farm Setbacks*:** GPS technology allows for accurate placement of irrigation. As stated previously, the size of irrigation droplets is large enough to ensure water gets to the ground without evaporating or being carried off, minimizing the risk of overspray. In addition to irrigation technology, 20 foot setbacks on all sides of Hariguchi site are incorporated into the HDF design. In terms of distance, the current loʻi are an additional 500-feet from the northern site boundary, minimizing risk for the taro farm.

Animal Mortality: HDF has adequately planned its cemetery site and has incorporated best management practices to protect water resources surrounding the HDF site. The animal cemetery is specifically located on the north side of the farm, in an area of relatively flat pasture. Site selection criteria for the cemetery paddock included protection from prevailing winds, and distance more than 100 feet away from any drainageway, 200 feet from any natural watercourse, 300 feet from any well, and more than 20 feet from any buildings. Within the cemetery paddock, pits will be sited based on soil suitability and slope. A containment berm will be created around the pit area to prevent both run-off on to, and from, the cemetery site. An area of approximately 5,000 square feet is needed for the animal cemetery at the contemplated herd size of up to 2,000 mature dairy cows, which is a fraction of a 3- to 5-acre paddock. Based on preliminary analysis, HDF does not anticipate encountering groundwater in the cemetery paddock area. Pits will be lined in accordance with NRCS Conservation Practice Standard, Animal Mortality Facility Code 316, to protect groundwater quality.

FIB in the Environment: The baseline conditions found in the agricultural ditch waters from Māhā'ulepū Valley includes pathogens contributed by cattle, dogs, cats, feral pigs, horses and other animals. Each of these animals represents a potential source of pathogens and FIB in the existing baseline condition of ditch waters. The Murray report lists pathogens associated with cattle manure, which are also associated with feral and domesticated animals, decaying organic matter, avian wildlife, vegetation, soils, and even insects.

It is critical to understand that soil conditions in Hawai'i differ greatly from North America. Research in Hawai'i spanning three decades shows that indicator bacteria are widely distributed in a variety of environmental habitats, even when there is little or no input from human and/or animal fecal sources These enteric habitats include soil and sediments, beach sand, aquatic and terrestrial. Some studies have shown the existence of populations of endogenous enterococci in soil, sediment and aquatic vegetation that are not of fecal origin. Over three decades of research investigations and studies regarding soil organisms in Hawai'i have been published by the Water Resources Research Center (WRRC) of the University of Hawai'i at Mānoa, most recently by R. Fujioka and others.

Minimization of Risk: The HDF project is designed to utilize 100 percent of all manure on site for the beneficial nutrients and organic matter that improves soils, including better infiltration and retention of stormwater runoff. The EIS identifies multiple minimization methods that will retain manure and any associated pathogens on-site. The EIS explains the soil cycle as enhanced by manure's organic matter, which increases carbon and the super-energized microbiological community that will utilize all elements within manure and thus minimize pathogens. The EIS explains that the alluvium of Māhā'ulepū Valley has a hydraulic conductivity on the order of 10.5 to 50 feet per day, in comparison to the 201 to 500 feet per day conductivity in the adjacent Kōloa-Po'ipū region with its thousands of on-site sewage disposal systems. The water movement through soils under the proposed dairy site is 10 times slower than the neighboring area, allowing greater time for the remedial properties of soil and associated bacteria to denitrify nitrates and render potential contaminants inert, making this specific site ideal for a pasture-based dairy.

E. Ecological Impacts (Appendix E)

The EIS has adequately evaluated the ecological systems within and surrounding the HDF site as relevant to the proposed project. The statement that the Draft EIS did not address concern previously expressed by the U.S. Fish and Wildlife Service (USFWS) shows a lack of familiarity with the standard response letter provided by the agency to identify many areas of potential concern to any project at the point of an EIS Preparation Notice. The USFWS comment letter to the Draft EIS, with the HDF response can be found in Volume 3, Section A. Complete responses to the Exponent July 2016 report on which your comments for this section are based are in Appendix E-E.

Botanical Survey: The survey design for this project was based on the extensive experience of the botanical consultant, who has 49 years of experience as an ecologist in Hawai'i with the last 20 or so working as a field botanist. Each survey is designed appropriate to the resources to be surveyed and to potential impacts of the proposed project. Botanical surveys conducted for purposes of evaluating impacts from a proposed project in an EIS typically focus on rare native plant species and native ecosystems. The nature of the site and its present and historical uses for intensive agriculture were anticipated to have limited the natural botanical resources anticipated to occur. The results of the survey substantiate this prediction: only four percent of all plants recorded during the survey were native, indicating that only species adapted to constant disturbances can survive. For the HDF project, the botanical survey determined no threatened native plants or native plant habitat occurs on the subject property (or reported from the vicinity).

Concern for the absence of threatened or endangered native Hawaiian plants, very few of which are annuals, in the dry season might be a consideration only in areas with minimal annual rainfall (less than 20 inches annually). Thus, most introduced (exotic) annuals tend to be biennials in our subtropical climate. As a strategy, annuals are typically avoiding winter freezing, a situation not occurring in Hawai'i except at high elevations. The project site is highly disturbed agricultural land and supportive of only a very limited suite of native plants. It could be argued that discovery of native plants is far more likely during the dry season when the growth of dominating weeds (exotics) is more subdued. Potential threats to listed plants on the property do not exist and conducting an additional survey in the "wet" season would not alter the findings.

Avian Survey: In the Rana Biological technical report appended to the EIS, it is clearly stated that the surveys were conducted over the course of two days. Point counts were one component of the avian surveys; they are used to characterize the relative abundance of species present on the property, not to find rare species. The property was searched for habitats and species not detected during the point counts, which is the standard protocol for finding rare avian species in the Pacific. Unlike continental areas, there is not a significant change in the avian makeup of inland areas during migration season, nor are there significant differences in avian species makeup on any given site during a specific fairly narrow breeding window as occurs in the continental United States. The time selected for the avian surveys, late August is a time of the year when migratory shorebirds are present in the Hawaiian Islands thus the surveys were conducted when the greatest diversity of avian species was expected to be present.

The insinuation that cattle usage of the site will likely reduce nesting of protected waterbirds or otherwise harm birds by "breach" of fencing, is misleading. Currently there is very little suitable nesting habitat for stilts, coots or gallinules on the HDF site. None of the protected waterbirds present on the island, with the possible exception of Hawaiian Stilt, are habitat limited. The site has been altered repeatedly as different crops, cattle ranching and farming activity has been conducted on it over the past century. The protected waterbirds on Kaua'i have long adjusted to human activity; coots and gallinules forage in the large number of storm water ditches present along many roads on the island. Any suitable habitat for Nēnē nesting in the greater Kōloa area changes with farming practices. Nēnē, at least on Kaua'i, are relatively plastic in their nest site fidelity.

HDF has and will continue to coordinate with the U.S. Fish and Wildlife Service (USFWS) and the State Division of Forestry and Wildlife (DOFAW) on appropriate minimization and management actions to ensure dairy operations will not result in deleterious impacts to protected wildlife. A draft Endangered Species Awareness and Protection Plan (ESAPP) is appended to the Final EIS, and will be completed through further discussion with the agencies. Fencing, predator control, monitoring for potential outbreaks of avian botulism within the pond areas, and protocols for response to the presence of Nēnē or other protected species on site are further detailed in the ESAPP.

HDF with the agencies have agreed on fencing types, which will vary dependent on the resource to be protected. A perimeter fence around the entire site, as well as surrounding the effluent ponds will be constructed of woven wire fence with approximately five-inch rectangular spacing at the top that diminishes in size towards the ground. This will prevent waterbirds from wandering into the effluent pond area. Barbed wire will not be used in any fencing on site. Electric fence wire will be used within the site to maintain the 35-foot setback from water features and to manage cattle within paddocks and along walkways.

Invasive Avian Species: Alien avian species dominate all lowland areas in the State, and Kaua'i is no exception. These species are not habitat limited. The three species mentioned in particular (Cattle Egret, Barn Owl, and Common Myna) are already present in the greater Kōloa area in large numbers.

Mammalian Survey: The comment that the survey for mammalian species was insufficient to predict potential impacts to the endangered Hoary bat and to predict effects of increased pest mammal species in misleading. In the Hawaiian Islands there are no extant native terrestrial mammalian species with the lone exception of the Hawaiian hoary bat. All of the non-native introduced mammalian species present on the island are ubiquitous and widespread particularly in the lowlands. It is not standard practice for this type of a survey to conduct in-depth mammalian surveys, as is the norm in many locations of continental areas. Nor is it standard practice to attempt to quantify the potential increase in pest mammal species.

For Exponent to suggest that Hawaiian hoary bats may be put at risk by lighting fails to consider that the bats are sighted animals. As such, they are unlikely to collide with a building at any level of illumination. As stated previously, no barbed wire will be used per coordination and agreement with USFWS and DOFAW.

Aquatic Resources Survey: Survey of channelized streams and agricultural ditches on site and down gradient are not needed, as these waterways are intermittent. As stated in the EIS, the stream is clearly intermittent in the upper reaches above the project area. Intermittent streams in Hawai'i flow when there is significant runoff (e.g. from rain storms). Native aquatic fauna are freshwater animals that spend their early larval stage in the ocean and migrate into perennial streams. Migrating into intermittent streams is a death sentence, as such streams do not provide sufficient habitat.

To address comments to the Draft EIS, HDF engaged MRCI to survey the marine biotic community structure and provide baseline documentation of existing conditions. Biotopes – areas of uniform environmental conditions that provide a living place for a specific assemblage of plants and animals - were documented and described for the Māhā'ulepū area. The open coastal exposure to long-period south swells and tradewind-generated seas are reflected in the survey findings. There is essentially no biotic community structure in the areas where the ditch water flow meets the ocean.

Coral community structure throughout the nearshore zone that has a hard bottom is generally restricted to the hardy pioneering coral Pocillopora meandrina. Where substratum is more sheltered from wave effects or has more complexity in the form of undercuts, ridges and knolls, additional common species are seen: Porites lobata and P. compressa, and Montipora patula and M. capitata. Coral cover in such areas was 10 to 20 percent of bottom cover. The exception was a small area approximately 0.3 miles south of the ditch point of discharge, where a well-established coral community was identified. This community likely exists due to a protective lava extrusion that shelters the area from destructive waves. The corals within this area, while not common for the high-energy marine environment, are composed of the most common components of most Hawaiian reefs. Due to the distance from the discharge point (approximately 2,000 feet, or 0.3 mile), nutrient or biological inputs from the ditch would be diluted to background marine levels and have no impact.

So the only benthic communities that could be potentially affected by ditch flow are not in the direct discharge path, but rather in areas where exposure would be only to ditch water that is greatly diluted with ocean water. The effect of elevated nutrients on corals is often cited as a major concern regarding the impact of land-based discharge on reef community structure. However, the observations of MRCI's marine biologist do not support this; the following comes from a review of published scientific research related to potential effect from nutrient subsidies on reef corals. MRCI notes Kinsey (1991) observed that it is incorrect to jump from the observation that coral reefs do well under low nutrient conditions to the conclusion that coral reefs require low nutrient environments. Atkinson and Falter (2003) state: "It is widely believed that any nutrient input to coral reefs is deleterious. This conclusion . . . is simply incorrect." Experiments at Waikīkī Aquarium and at the Great Barrier Reef in Australia show corals flourish in high nutrient environments. An empirical example demonstrating the inaccuracy of the assumption that elevated nutrients always result in negative effects to corals is the coral colonization on the sewage discharge diffusers at outfalls on O'ahu. The outfalls are located in a mixed marine environment similar to that off Māhā'ulepū.

Plankton or benthic algal blooms are also often associated with nutrients. The Great Barrier Reef experiment showed nutrient enrichment is not a sole or major cause of shifts in algal abundance. Benthic algal blooms on Maui that occurred during the 1990's have not returned for the last decade, indicating that nutrient input is not the sole causal factor. See full report and further detail on nutrient impacts to coral reefs in EIS Volume 2, Appendix F addendum.

The EIS does not discuss impacts to marine mammals due to its findings of no impact to downgradient ecosystems from dairy operations. Nowhere does HDF state it will relocate invertebrates such as dung beetles from the Island of Hawai'i. Should HDF determine that feed or equipment is needed from other islands including the Island of Hawai'i, all appropriate and relevant biosecurity control measures used within the agricultural industry will be followed. The unrealistic assumptions and speculation by Exponent and Goodsill regarding HDF operations do not warrant assessment in the EIS. The EIS sufficiently assesses the proposed action as explained in Chapter 3 through its evaluation in Chapters 4, 5 and 6.

F. Impacts from Animals and Manure (Appendix F)

Many of the comments contained in Dr. Meyer's report are predicated on the estimates of manure production and nutrient excretion numbers from Standard D384.2 Manure Production and Characteristics (ASABE, 2005), which HDF does not use. The ASABE standard is outdated while HDF utilized an updated and more accurate Cornell Net Carbohydrate and Protein System (CNCPS) model, rendering the comments invalid.

ASABE is a simplified and general standard last updated in 2005. The ASABE calculations were reasonably correct in year 2000 but have not accounted for changes in genetics, management systems, and nutritional advances over the past 16 years. The ASABE equations, unlike the CNCPS system, does not use farm specific animal, environmental, and dietary inputs to determine its manure production and nutrient excretion estimates, and instead uses "book values".

NRCS Conservation Practice Standard Code 590 – Nutrient Management allows for the use of realistic nutrient inputs when planning for nutrient outputs. The manure production and nutrient excretion estimates from the CNCPS model are more accurate and represent farm specific animal inputs, dietary inputs from available grass trials from the HDF site, and incorporate changes in farm management, genetics, and nutritional advances. Therefore the CNCPS model is more accurate than if manure excretion and nutrient output was based upon "book values".

The commenter's manure production and nutrient excretion estimates table, based upon "book values" of the ASABE Standard, uses the publication Dairy NRC 1988 for diet formulations and input (NRC is the National Research Council that published a handbook, "The Nutrient Requirements of Dairy Cattle"). The 28-year old Dairy NRC 1988 is the predecessor of the most recent NRC publication, last updated in 2001. Because of obsolescence associated with these NRC predictions, the 2015 CNCPS model was used for HDF calculations.

The estimated total number of animals of 892, presented by the commenter, is incorrect. The EIS has included the environmental impacts of the total animal numbers on the farm, based upon the total number of mature dairy cows on the farm, including both lactating and dry animals, and the expected number of calves. It can be conservatively assumed that there will be approximately 85 percent milking and 15 percent dry animals on the farm at any given time. Calculations to determine manure effluent pond capacities, and manure collection volumes per day from the milking facility, are slightly conservative as dry cows will not enter the milking parlor as they will not be milked. However, the total number of animals in terms of manure production and nutrient excretions on the entire farm and pastures are estimated to include both lactating and dry animals.

Replacement animals will be moved off-site and will be replaced at roughly one replacement animal for one mature dairy cow at HDF. The replacement animals will be managed on off-site ranches and will not contribute manure or added nutrients to the HDF project site. The total number of animals allowed on properly zoned and entitled ranch properties is not regulated by the State of Hawai'i and County of Kaua'i, as the manure from grazing animals is not being reused or applied for nutrient and crop fertilization purposes. Therefore, housing of off-site animals will comply with applicable rules and regulations.

The EIS sections labeled "Roadways and Traffic" (Sections 4.18.2, and 4.24.2) identifies the types and number of vehicular trips to and from HDF along county and state roads in the area for both the committed herd size of 699 mature dairy cows, and the contemplated herd size of up to 2,000 mature dairy cows. Vehicles include milk trucks, initially one truck every two days at the committed herd size and increasing to two per day at the contemplated herd size; delivery trucks for sand and feed initially three truck loads per week, increasing to four to five per week at the larger contemplated herd size. A farm truck with stock trailer to move animals to and from off-site ranches is initially anticipated at less than one per day, increasing to two daily trips with the contemplated herd size. Employees, veterinarians, inspectors, and vendors are also included in the daily trip counts.

At the committed herd size of 699 cows, 12 vehicle trips per day would result from HDF operations over the long-term. For HDF operations at the contemplated herd size of up to 2,000 mature dairy cows, the projected trips total 23 vehicles per day. The EIS shows the impact of HDF vehicle trips in the context of projected 2035 traffic for the region, and is less than one-half of one percent for both herd sizes.

HDF's operation will generate solid wastes, as any other commercial or agricultural operation would, that must be properly disposed of at appropriate County of Kaua'i trash and solid waste facilities. However, the generated waste will not negatively impact the municipal refuse operations on Kaua'i.

G. Hydrology and Water Quality (Appendix G)

A complete discussion of the multiple incorrect assumptions and assertions in the referenced Exponent July 2016 report is provided in Appendix G-G (EIS Volume 5).

Estimates of runoff and groundwater recharge in the EIS Appendix E relied on prior hydrologic budget analyses by the USGS throughout the state and on the sustainable yields adopted by the State Commission on Water Resources Management (CWRM), which incorporate hydrologic budget analyses. These provide reasonable approximations of annual average conditions at the HDF site. It is of interest to note that the Storm Water Management Model (SWMM) model prepared by Exponent was admittedly not calibrated and had a number of other limitations (page 16 of the Exponent report), all of which resulted in entirely unrealistic results.

The runoff assumptions in Appendix E are based on long-term, average conditions. Application of the NRCS curve method indicates it would take 0.8 inches of rain to create runoff. Based on the 30-year rainfall record for the area, such rainfall events are estimated to occur approximately three percent of days, or an average of 10 days annually. Observations by the groundwater engineer on a date in August of 2016, and those of the HDF onsite manager since his tenure at the farm since 2013, are in accord. The SWMM model assumes 78 percent of total precipitation on the flat areas becomes runoff, which is absurdly unrealistic.

Section D, above, responds to the incorrect rainfall data and inaccurate characterization of "nearly saturated" soil conditions. The 2016 Exponent SWMM model assumes the fields are constantly rained upon and utilizes worst-case weather data from a station in Līhue that do not apply to Māhā'ulepū. Not only does the SWMM model assume unrealistically high rainfall, but also that the fields will be over-irrigated with constant irrigation using irrigation values specifically for dry weather conditions, and concludes that the fields will always be saturated. This is not supported and does not reflect the operational detail provided by HDF in the EIS and the Nutrient Balance Analysis (EIS Volume 2, Appendix D).

The reduction in runoff from various storm events was estimated where flows combine in Māhā'ulepū Ditch immediately south of the project site. For the 10-year storm event, peak flow leaving the project site will be reduced by 257 cubic feet per second (cfs); for the 25-year storm event, reduced by 283 cfs; and for the 50-year storm event, reduced by nearly 300 cfs (Section 3.3.2.3). The 35-foot vegetated buffers will be established in accordance with NRCS Conservation Practice Standard Code 390 and guidance, intended to improve water quality by slowing runoff, filtering pollutants and pathogens (*University of Wisconsin Agricultural Extension- http://www.extension.umn.edu/agriculture/manure-management-and-air-quality/manure-pathogens/best-management-practices/#table*), and reduce runoff flows. On-site retention areas adjacent to raised cow raceways will also hold water on the farm for use by the crop. Erosion downstream will be minimized and water quality is expected to be improved. Assertions regarding downstream impacts via Waiopili Ditch from HDF operations are therefore not supported.

H. Nutrient Mass Balance (Appendix H)

Thus far, HDF has gathered more than two years of trial data for Kikuyu grass with some guinea grass located at the center of Māhā'ulepū Valley on HDF's leased property. While the yield production and nutrient removal rates shown in the EIS would not be the <u>exact</u> nutrient uptake numbers based upon the actual operation of the <u>planned</u> dairy, with the commencement of actual animal grazing, manure production, and effluent application, the trials are representative of and realistic for a rotational-grazing, pasture-based dairy operation. The yield production and nutrient uptake rates are based upon appropriate site-specific inputs and certified laboratory testing for yield results and nutrient content and value to the proposed cows used by HDF. Actual grass is being grown on the farm, which is fertilized and irrigated, cut, and sampled for actual production and nutrient content and uptake data.

Forages were cut, analyzed, and measured for production, nutrient content and quality, and nutrient uptake rates, over this two-year span by HDF's forage expert, Farms n' Forages, a locally-owned business that assists many Hawai'i farmers. The forage was tested and analyzed by Cumberland Valley Analytic Services (CVAS), which is certified by the National Forage Testing Association. CVAS performed wet chemistry analysis for a number of constituents including dry matter, crude and soluble proteins, and minerals, as well as for in vitro non-detergent fiber analysis as a method of assessing the nutritive value of the grass trial samples. The nutrient value of the grasses analyzed was then converted to nutrient uptake rates (in pounds of nitrogen and phosphorus) per ton of dry matter (DM) by Atlantic Dairy Consulting, through the use of the Cornell Net Carbohydrate and Protein System (CNCPS) Model, which uses farm-specific inputs on feed and diets to yield both approximate milk production and manure excretion values and quality.

Farms n' Forages also has experience with non-irrigated pastures in Hawai'i and has previously measured approximately 30 to 40 percent greater yields in irrigated pastures than in non-irrigated pastures. Approximately 74 percent of HDF's pastures are irrigated and 26 percent are non-irrigated, and the effect on yield estimates must be taken into account by HDF for its nutrient management planning, as noted by the CH2M Hill comments. HDF has been conservative in its average annual yield estimate used in the Nutrient Balance Analysis specifically to account for non-irrigated fields and seasonal variability in forage production. HDF will continue to test and analyze, as appropriate, for forage yields and nutrient content, soil nutrient content, manure nutrient content, and water quality and chemical composition for the adjacent drainage ways, to monitor and ensure that nutrients in the farm's system are balanced and kept on the farm to be efficiently utilized by the forage crop. Testing will be done annually at a minimum, per applicable State and Federal law.

The period of daily rainfall of the Māhā'ulepū gauge (No. 941.1), located on the farm site, that was used for the EIS is from January 1, 1984 through December 31, 2013, a period of 10,957 days. The available record is for 10,597 of these days, reflecting only 360 days of truly missing recorded data. Statistics of this rainfall record closely match the Online Rainfall Atlas of Hawai'i (2013) by Giambelluca, T.W., Q. Chen, A.G. Frazier, J.P. Price, Y.L. Chen, P.S. Chu, J.K. Eischeid, and D.M. Delparte. Based on the concurrence of the sources, the available rainfall records of Station 941.1 were taken to be a reasonable representation of the site's actual rainfall. In total, 360 days of truly missing records account for only 3.3 percent of the total length of this time period.

Further, points identified by error codes in the publicly available rainfall data also do not necessarily truly reflect missing data. The Māhā'ulepū gauge records a multi-day precipitation record collecting data over a multiple day period instead of every day. In these instances when a multi-day record is collected, the days over that record are labeled with error codes (-9999). The use of the error code does not actually reflect "missing" data in this scenario. A reasonable and realistic daily rainfall estimate may be determined over that multi-day period. A full accounting of the rainfall data is included in the response to the CH2MHill report contained in EIS Volume 5, Appendix H-H.

Utilizing the last year of grass testing on the HDF site (2015 to 2016), the irrigated fields showed an annual average yield of nearly 19 tons DM per acre per year. Incorporating the non-irrigated fields by applying the reduction percentage to the total non-irrigated areas, the weighted annual average yield still exceeded 17 tons DM per acre per year. HDF is utilizing 16.3 tons DM per acre per year as a conservative estimate for planning purposes to account for the variability in farms, which are biological systems.

HDF utilized comments from the Exponent 2016 odor report (Appendix B of your letter) to adjust the odor model. Odor from slurry was modeled separately from that of effluent irrigation, as only one will occur at a time. To minimize potential odor impacts from slurry used as pasture nutrients, HDF has elected to restrict slurry application to periods when wind speeds are between 9 and 20 mph. With application at the most impactful location, paddocks south of the taro farm, the odor from slurry application barely crosses the southern boundary with the committed herd size of up to 699 mature dairy cows. For the contemplated herd size, the odor from slurry application could extend approximately 1,580 feet, or less than one-third of a mile. As the wind speeds for the application occur, on average, 243 days of the year, the 99.5th percentile is reduced to potentially perceiving the odor just 29 hours per year. The revised odor report is included as an addendum to Appendix I.

Proper operations, maintenance, and repairs of the irrigation system will prevent potential impacts to water quality and prevent direct discharge into the drainage ditches. Stringent preventative maintenance will be in place to make sure all facets of the irrigator operate to the pivot operator's needs. The pivot operator will be responsible to maintain and look after each pivot while in operation. Only one pivot will operate at any given time (though the system is designed and is automated enough such that two pivots may run at the same time), ensuring that the operator is focused and attentive to the one operating pivot. The irrigators are programmed to turn off within 50 feet of water resources. Best management practices for pivot maintenance are included in Appendix H-H.

While the Nutrient Balance Analysis uses an annual, weighted, and realistic yield estimate and nutrient uptake rates, this does not mean that the application of nutrients is uniform based upon the amount, area, schedule, and frequency of nutrient application by type (as-excreted, pivot system, slurry gun, fertilizer). HDF will adaptively manage the timing and placement of applied nutrients on the farm to maximize yield production while also ensuring that there is no over-application of nutrient from applied effluent and as-excreted manure. In planning HDF's initial operation, uniform rates of nutrient application on an annual basis are used for planning purposes, which shows that even with conservative grass production rates, nutrients are not over-applied in the scenario of 699 mature dairy cowherd size while a slight excess of phosphorus can be expected at a herd size of 2,000 mature dairy cows. Should HDF decide to increase the herd size beyond the committed here size, it would incrementally increase the number of animals to ensure phosphorus is properly managed. This is in keeping with the HDF adaptive management approach for the farm. As the farm moves into operations and continues with annual plant, soils, manure, and other required testing, HDF will adaptively manage the placement and timing of nutrients to ensure there is no over-application.

The soils analysis presented in Appendix C of the EIS by Dr. Russell Yost and Nicholas Krueger clearly states that there are two widely differing soil groups on the dairy and that the dynamic management of these two soil types will require specific, unique monitoring and management designed to take advantage of the desirable properties of each and the limitations of each. Two distinct stages of startup and performance of the dairy are anticipated - an initial stage in which soil nutrient levels will be restored to values optimal for pasture productivity and the pasture is being established and the herd developed and the second that represents the finely-tuned dynamic management of the herd size and productivity in relation to the pasture growth and productivity. This would involve "monitoring and adaptive nutrient management" as a second stage of bringing the dairy into an optimal state of productivity and efficiency, which HDF will accomplish and can only accomplish when the farm is in operation. It does not, however, mean that yields or total nutrient application is affected, only that the management and timing of the application may be different to account for chemical and physical properties of the soil, including sodicity, salinity, pH, infiltration and percolation.

III. EIS Procedure is Not Flawed

While an agricultural project on agricultural lands implemented and operated with private funds does not require environmental disclosure, HDF responded to community concerns by agreeing to prepare an EIS. This EIS was prepared in accordance with Hawai'i Administrative Rules Title 11 Chapter 200, implementing Hawai'i Revised Statutes (HRS) Chapter 343. The EIS Preparation Notice was published in January 2015, to notify members of the public that an EIS would be prepared for the project. During the 30-day consultation period, HDF held a public scoping meeting in Kōloa that was open to all. More than 115 people attended, representing the local agricultural community, special interest groups, resort and timeshare properties, and individuals. The purpose of a scoping meeting is to identify issues of concern to be considered and addressed in the EIS. Representatives from HDF and its consultant firm recorded issues and questions posed by the meeting attendees. HDF provided comment sheets so that individuals could submit written comments at that time or could return the sheet by the response deadline. All comments received and responses provides were published in the Draft EIS and the written responses were returned directly to the individual using the address provided. Following the meeting, the lists of issues as recorded were posted on the HDF website.

Following publication of the Draft EIS by the Office of Environmental Quality Control in the Environmental Notice issue of June 8, 2016, the requisite 45-day public review period ensued. Volumes 3 through 9 of the Final EIS contain each comment received, along with a response to substantive comments. The responses have been provided directly to the commenter when an address was provided.

A. Identification of a Trigger for Environmental Review

1. Chapter 343 applies to discretionary approvals of the triggers listed. Wastewater Branch reviewed, but was not called upon to approve, the Waste Management Plan for HDF, which describes the effluent ponds. Effluent ponds are also not considered a wastewater treatment unit because they will be used for livestock, rather than domestic, waste. Therefore, no trigger was activated.
2. Use of Tax Credits. The issuance of tax credits and other tax benefits – such as tax exemptions and deductions – are distinguishable from the use of actual State funds in that these tax benefits act as forbearances or reductions of tax liabilities rather than as direct payment to taxpayers. Thus, taxpayers who receive tax benefits – including tax credits pursuant to Section 235-110.93, Hawai'i Revised Statutes – do not receive State funds, but instead reduce the amount they would otherwise pay to the State.

   The breadth and scope of potential tax credits and other tax benefits further confirms that treating tax credits as a trigger to require environmental assessments is inappropriate. If every tax credit triggered an environmental assessment every resident claiming renewable energy (solar) tax credits would be forced to obtain an environmental assessment, as would investors seeking qualifying high technology business tax credits, producers seeking motion picture tax credits, and developers seeking low income housing tax credits. In addition, treatment of tax benefits as the "use of State of county funds" would potentially implicate tax-exempt organizations and homeowners claiming mortgage interest deductions. For these reasons, the receipt of tax credits and other tax benefits are not the "use of State or county funds" requiring and environmental assessment.

B. Improper Segmentation of Project

HDF has consistently represented the potential maximum herd size as number of cows that reflects the carrying capacity of the land as guided by the results of the nutrient analysis (EISPN Section 2.3 *Proposed Action*; EIS Section 1.2 *Proposed Project*). The committed herd size of up to 699 mature dairy cows will demonstrate the pasture-based system as an economically and environmentally sustainable model for Hawai'i. Precision agricultural technology that monitors cows' health, grass productivity, and effluent management will be used to ensure environmental health and safety, as well as best management practices, and help determine the ultimate carrying capacity of the land.

With proven success at a herd size of 699, HDF will contemplate the possibility of expanding the herd in the future. Agricultural infrastructure for the project is sized for the potential future contemplated herd size of up to 2,000 mature dairy cows, and is described in Chapter 3 of the EIS, *Description of the Proposed Action*. The probable impacts of the potential contemplated herd size are also analyzed and clearly identified in the Draft and Final EIS; a summary table at the end of Chapter 4 identifies the probable impacts at each herd size. Therefore, the potential maximum size of the herd is disclosed, relevant analyses have been conducted, and there has been no improper segmentation of the project.

C. Identification of the Complete Action

Asserting that the EIS fails to describe the proposed action when referencing Section 1.2 of the DEIS ignores the full Chapter 3 which fully describes the Proposed Action. The proposed action is succinctly described in Chapter 3 in a form easy to understand, and includes summary tables and diagrams to convey the information. Additional technical detail is referenced within the chapter and included in the EIS Appendix D, Nutrient Balance Analysis, and Appendix K, Hydrologic Assessment. The following addresses the specific bullets presented in your letter:

- *Wastewater treatment*. The EIS describes the effluent ponds in several sections throughout Chapter 3. The most thorough description is in Section 3.3.2.5 *Effluent Storage Ponds*. The pasture-based dairy relies on 100 percent of the nutrients from manure deposited on the pasture, with application of manure captured in the effluent ponds, to grow the majority of forage for the herd. Collection and storage of effluent provide a tool for the dairy manager to control the schedule, timing, and mix of nutrients to be applied.

  The design, capacity and operations of the effluent storage ponds are described in EIS Section 3.3.2.4 *Effluent Storage Ponds* and Appendix D *Nutrient Balance Analysis* Section 7, Wastewater Management. The sizing and capacity of the ponds is displayed in tables, graphics and text. The pond design is a two-step system consisting of a settling pond and a storage pond. Solids settle out in the settling pond and are also retained through filters. The volume of the settling pond allows space for stirring to re-suspend solids for application to pastures. This mixing space provides an additional 285,241 gallons of pond capacity. Solids will be cycled through the pond onto the paddocks over a maximum period of 45 days.

  Liquid effluent overflows through filtered pipes into the storage pond. The storage pond is sized to hold a volume equivalent to 30 days of effluent from the contemplated herd size of up to 2,000 mature dairy cows, plus normal precipitation and run-off for a 30-day period from the 1.75-acre, uncovered portion of the total facility area to receive manure and wash water, plus the possible rainfall from a 25-year, 24-hour storm event. In the 699-cow scenario, the spare volume is an additional 45 percent of the total volume design. In the 2,000-cow scenario, the spare volume represents an additional buffer of up to 12 percent.

These spare volumes provide even greater buffer above the design capacity. Liquid effluent will be mixed with non-potable water from the Waita Reservoir and applied to pastures through a pivot irrigation system. The typical utilization schedule for the nutrient-laden water from the storage pond for any irrigated pasture area is every four days, depending on field conditions.

In Hawaiʻi, livestock operations follow the *Guidelines for Livestock Management* by the State of Hawaiʻi, Department of Health (DOH), with review by the DOH Wastewater Branch as a part of the process. DOH Wastewater Branch completed its review of HDF's 2014 Waste Management Plan (WMP) for an operation of 699 mature dairy cows, and HDF obtained building permits to construct the dairy facility. On-going technical studies and field trials to determine grass yields and forage data improved the nutrient mass balance analysis. While the pasture-based, rotational-grazing dairy system and its infrastructure is fundamentally the same, the field-tested data based on ground-level trials and studies, improved the WMP. HDF prepared a summary of the changes between the 2014 WMP and the Draft EIS for Wastewater Branch to highlight the refinements and to ease the agency's review of the EIS. The modifications you mention are updates to the relevant nutrient information, which is included in the Nutrient Balance Analysis and incorporated in the EIS. On July 13, 2016, DOW Wastewater Branch acknowledged that its questions on the updates to the WMP had been addressed by HDF, and that WWB had no further comments at that time.

- *New Drains.* Paddocks identified as potentially having drains will be managed so that they are not used during anticipated significant rain events ensuring that there are no cows and therefore no manure that could be collected by runoff and enter into a drain. See complete response to the CH2M Hill (referred to in your letter as "Mark Madison comments") in Appendix H-H.
- *The total number of cows.* The estimated total number of animals presented in Appendix F and referenced in your letter of 892 is incorrect. The numbers provided by HDF in the EIS include both lactating and dry animals, and the expected number of calves. The EIS includes the environmental impacts of the total animal numbers on the farm, based upon the total number of mature dairy cows on the farm, including both lactating and dry animals, and also the expected number of calves. Appendix F-F (Section 4.A) provides additional response to the report by Deanne Meyer.
- *Offsite Locations*. To state that the "Project Summary" section of the EIS does not discuss offsite location and impacts fails to consider the required organization of an EIS under Hawaiʻi Revised Statutes Chapter 343, Environmental Impact Statements. Offsite locations and the impacts from those operations are described in Chapters 3 and 4. Chapter 3 describes the proposed action succinctly related to both on-site and off-site herd management (Section 3.4 and 3.7 respectively); Chapter 4 analyzes relevant environmental resources affected by off-site herd management.
- *Use of public roads and highways*. Use of highways and roads, including Poʻipū Road, is covered in the EIS Sections 4.18 and 4.24 "Roadways and Traffic." The types and number of vehicular trips to and from HDF along county and state roads in the area for both the committed herd size of 699 mature dairy cows, and the contemplated herd size of up to 2,000 mature dairy cows are described. Vehicles include milk trucks, initially one truck every two days at the committed herd size and increasing to two per day at the contemplated herd size; delivery trucks for grain and fertilizer initially one truck load per week, increasing to every three days at the larger contemplated herd size; delivery of sand

for calf bedding twice weekly at the committed herd size and increasing at the larger herd size. A farm truck with stock trailer to move animals to and from off-site ranches is initially anticipated at less than one per day, increasing to two daily trips with the contemplated herd size. Employees, veterinarians, inspectors, and vendors are also included in the daily trip counts.

At the committed herd size of 699 cows, 12 vehicle trips per day would result from HDF operations over the long-term. A summary of all regional traffic with projections to 2035 is shown in Table 4.18-1 of the EIS; HDF trips would increase projected traffic by less than one-twentieth of one percent (0.17 percent).

For HDF operations at the contemplated herd size of up to 2,000 mature dairy cows, additional vehicular trips are projected at 11 more per day than at the committed herd size. The projected trips totaling 23 vehicles per day would include employees and delivery vehicles, and represents an increase in the regional traffic of less than one-third of one percent (approximately 0.30 percent).

There were no omissions of information from the EIS. The relevant details, listed above, were included in the Draft EIS and remain in the Final EIS in the appropriate chapter. Not all details were included in Section 1.2, the section that fulfills the HAR §11-200 requirement of a "brief narrative summary . . . which provides sufficient detail to convey the full impact of the proposed action. . .".

D. Use of Public Funds

Taxpayers who receive tax benefits – including tax credits pursuant to Section 235-110.93, Hawaiʻi Revised Statutes – do not receive State funds, but instead reduce the amount they would otherwise pay to the State. The response in Section III A 2 in this letter discusses the fact that the project does not use State funds and thus disclosure is not relevant.

E. Significant Adverse Impacts

See response under III C, above, which provides direction to the EIS sections where the elements of the action are explained and analyzed. Sections 4.20 and 4.26 provide the cumulative and secondary impacts for both the committed and contemplated herd size, respectively.

The findings of no significant impact are based on analyses of the proposed actions on the existing conditions, and are supported by technical reports conducted by HDF's Hawaiʻi-based expert consultants. By contrast, analyses on the reports prepared by consultants to Kawailoa and Friends of Māhāʻulepū are based on no analyses in the field and use wildly different assumptions and, in several cases, incorrect data. In most cases, the assumptions are based on poorly-managed conventional feedlot dairy operations on the mainland. HDF stands by the environmental analyses conducted for the EIS, which uses reasonable and diligent processes to disclose all probable impacts and demonstrates the dairy will not create nuisance impacts downstream or beyond surrounding agricultural lands.

F. HDF's Alternatives Analysis

Your letter states the EIS alternatives analysis is deficient in four respects:

1. That the no action alternative does not accurately represent land use since the closure of sugarcane cultivation;

2. You assert that the Draft EIS provided inadequate technical studies thus suggestion further study is required, including by the State Historical Preservation Division;
3. Lack of alternate actions to achieve the stated objectives of HDF to produce more than 1 million gallons of fresh, local milk annually for Hawai'i families; and
4. No evaluation of lands other than Grove Farm and on islands other than Kaua'i for the establishment of the pasture-based rotational grazing dairy.

The following provides responses to each of your four points.

1. The No Action Alternative in the Final EIS is described as continuing use for animal grazing, as it was prior to the HDF lease. The site was utilized for beef cattle grazing when HDF was awarded the lease. Also within the valley is a tenant growing taro and utilizes a herd of approximately 80 sheep to control existing grasses and shrubs outside of the taro lo'i to maintain the site through grazing.

   The beef cattle herd size prior to the HDF lease was below the potential stocking rate of two to four animals per acre, and the No Action alternative allows for that probable level of use.

2. HDF has responded to all allegations of incomplete or inaccurate analysis within this letter and its accompanying technical responses to the reports referenced in your letter. HDF initiated the EIS process at the earliest practicable time.

   The majority of technical appendices (A through H) to your letter contradict findings of HDF's Hawai'i-based expert consultants by using wildly different assumptions and, in several cases, incorrect data. In most cases, the assumptions are based on poorly-managed conventional feedlot dairy operations from the U.S. mainland. HDF stands by the environmental analyses conducted for the EIS, which uses reasonable and diligent processes to disclose all probable impacts and demonstrates the dairy will not create nuisance impacts down-gradient or beyond surrounding agricultural lands. All technical responses summarized in this response, and are reproduced in their entirety in FEIS Volume 4 (Appendices 2-A through 5-A, and 27-A) and Volume 5 (Appendices A-A through H-H).

   The State Historic Preservation Division (SHPD) accepted the Archaeological Inventory Survey (AIS) on December 19, 2016. The letter notes that SHPD concurs with the significance assessments and mitigation recommendations in the AIS; both the letter and the AIS are included in Appendix G. No further work is recommended for 14 plantation-era sites (50-30-10-2251 through 2262) within the project area. For two sites found in an area outside the HDF site surveyed at the request of SHPD, the agency stated that the current proposed project will not affect these two sites, an agricultural heiau and petroglyph boulders (50-30-10-2250 and 3094), and no further mitigation is recommended for this project.

3. Alternatives which could attain the same action are discussed in Chapters 2 and 6 of the EIS. A process was undertaken to consider steps to reverse the declining dairy industry in Hawai'i, which in 1984 produced 100 percent of all milk consumed in the state but now imports 90 percent of its milk from the U.S. mainland. With a common interest in agricultural self-sufficiency for Hawai'i, Ulupono Initiative partnered with Finistere Ventures, Grove Farm, Kamehameha Schools, and Maui Land & Pineapple to conduct conducted grass trials on four islands to identify lands capable of producing nutritious forage for dairy cows. Additional operational needs for a pasture-based dairy were identified. Only two sites, both on the island of Kaua'i and both owned by Grove Farm, met most of the site requirements related to forage and operational needs.

The project purpose and need are defined in Section 2.3: The HDF project purpose is to establish a sustainable, pastoral rotational-grazing dairy farm that will increase current local milk production, bolster Hawai'i's declining dairy industry, and reduce reliance on imported milk from the mainland United States. The rotational-grazing dairy system utilizes 100 percent of all manure on-site as natural fertilizer to grow grass. This cost-effective method reduces imported fertilizer and feed, and minimizes potential impacts to the environment. HDF reflects a viable approach to apply use of Important Agricultural Lands to agricultural self-sufficiency and food production. HDF represents a continued commitment by the landowner to support farming and local food production, and to aid in the resurrection of Hawai'i's dairy industry.

Project objectives include "Provide more than 1,000,000 gallons annually of fresh, nutritious milk for Hawai'i families and revitalize the dairy industry in Hawai'i." This is in keeping with the announcement by Hawai'i Governor Ige at the 2016 World Conservation Congress in Honolulu to "Double Local Food Production", thus emphasizing the State's focus on advancing agricultural self-sufficiency in Hawai'i.

4. In response to comments on the Draft EIS, Ulupono Initiative again searched for agriculturally-zoned land with potential long-term availability that may have become available in the past few years. Approximately 1,300 acres of Mahaulepu Farm property on Kaua'i in the Māhā'ulepū area were recently vacated by Pioneer Seed Company. These fields are closer to resorts and residences, and do not provide further benefit to the project or community than the HDF site evaluated in this EIS. Alexander & Baldwin announced in January 2016 that Maui lands in sugarcane will be transitioned to diversified agriculture in the future. However, water rights and access for diversified agriculture must be settled through a forthcoming process, and water availability is currently unknown. Thus, Ulupono Initiative, which conducted the research, is unaware of any new property meeting the requirements for a pasture-based dairy that has become available since its initial evaluation.

G. Mitigation Measures

Throughout the EIS, minimization measures are incorporated into action for both construction and operations of HDF. HDF will comply with all permit requirements, and has designed the dairy to incorporate best management practices (BMPs) of NRCS. HDF developed a Conservation Plan for the project in conjunction with NRCS personnel. The plan was jointly presented to the West Kaua'i Soil and Water Conservation District for its review. In a letter dated December 17, 2013, the WKSWCD "approved" the conservation plan. Pursuant to NRCS guidance, an NRCS Conservation Plan is a confidential document. However, relevant elements of the conservation plan, such as BMPs and protective measures including setbacks from waterways, are described in the EIS. Therefore, the Conservation Plan is not part of the EIS.

As repeated throughout the EIS and this response, the environmental analyses conducted demonstrate that the dairy will not create nuisance impacts down-gradient or beyond surrounding agricultural lands. HDF used reasonable and diligent processes to disclose probable impacts, and will be a responsible steward of the herd, the lands and the waters within and around the dairy site.

H. The DEIS Was Sufficient Pursuant to HAR §11-200-17

As explained previously in this response, the EIS addresses alternatives and minimization measures appropriately. Page 3 of this letter provides the correct and accurate context of the National Park Service reconnaissance study and its conclusion: The reconnaissance study's recommendation for authorization of a Special Resource Study included "so long as it focuses on non-traditional management alternatives that a) involve local partners and b) include options for continued farm and ranch operations on private agricultural lands" (emphasis added). So the outcome of the study was for another study to continue to assess whether the broader ahupua'a of Māhā'ulepū should and could become a National Park. Regardless, as included in EIS Section 4.26.4 *Irreversible and Irretrievable Commitments of Resources*: "Use of the site for dairy operations does not preclude future conservation use of the wider region, such as examined by the U.S. National Park Service (NPS, 2008) reconnaissance study."

Regarding the assertion that the DEIS failed to include "any discussion of indirect environmental consequences" and "irreversible and irretrievable commitments of resources", this is completely false. Sections for each topic were included at both the committed herd size (4.20.2 and 4.20.4) and the contemplated herd size (Sections 4.26.2 and 4.26.4, respectively).

I. HDF Properly Disclosed Required Approvals

All permits and approvals required are listed in Chapter 3 (Section 3.10 with the heading "Implementation and Permit Schedule"), Chapter 5 ("Consistency with Government Plans and Policies"), and are also summarized in Chapter 1 ("Listing of Required Government Permits and Approvals") as required under HAR §11-200-17(h). Note that content requirements for the Draft EIS in the administrative rules is under §11-200-17, rather than the reference to HAR §11-200-16(h) provided in your letter. The status of each identified approval is shown in Tables 1-3 and 3.10-1 under the column heading "Status".

1. Your letter demonstrates you have either mis-understood or are intentional mis-representing the number of animals at the dairy. This has been clarified in the first part of our response, as well as in detail (Appendix F-F) to the incorrect report by Deane Meyer. Regardless, the EIS discusses the distinction between the herd sizes and permit differences in Section 2.4 *Planned Dairy Development on Māhā'ulepū Agricultural Lands*. The tables in the EIS that summarize the permit status clearly distinguish between permits required at different herd sizes.
2. HDF met with DOH in March, 2014 to determine construction activities that would require an NPDES permit, and was advised such a permit was needed for only construction of the dairy facilities themselves. DOH confirmed that construction activities for the sole purpose of growing crops do not require an NPDES permit per HAR §11-55, Water Pollution Control, Appendix C.
3. The permit summary tables referenced above clearly note the U.S. Army Corps of Engineers (USACE) Section 404 agricultural exemption for maintenance of existing drainage ditches on an existing farm at the HDF site. Such activities are not prohibited by or otherwise subject to regulation under Section 404 in accordance with 33 CFR Part 323.4.U.S. Army Corps. This is further discussed in Section 3.2 of the EIS. The USACE letter, dated October 22, 2014, is included in the Final EIS Volume 3 under "Agencies."
4. Characterizing portions of the site as wetlands is unsubstantiated and incorrect. The EIS documents the long agricultural history of the valley noting that it was the first place in the island chain where sugarcane was grown commercially beginning the 1830s. The extensive irrigation systems built to bring water to the leeward (drier) side of the island are evidence that sufficient water was not available for the sugarcane crop in the region. The well-researched compendium, *Sugar Water, Hawaii's Plantation Ditches*, by Carol Wilcox (1996), describes the "Marsh Reservoir" as developed in in the "marshlands outside of Koloa town" in 1906. This wetland was further developed and is now known as the Waita Reservoir, which is east of Māhā'ulepū Valley and not on the HDF site.

Appendix E of the EIS (Volume 2) was prepared by HDF's consulting groundwater engineer with more than 50 years of experience in water quality research and water resource engineering here in Hawai'i. He is considered one of the foremost experts in the field. His report documents the site's ground and surface water resources. The depth to groundwater within the alluvial layer is varied. Final EIS Appendix 2-A (contained in Volume 4) contains a review of the WET report by the HDF groundwater engineer (Appendix 3 to the Friends of Māhā'ulepū comments to the DEIS), which notes that the depth to groundwater in the alluvium that covers the HDF site has been measured several times at all four HDF monitoring wells. Based on the measurements, the actual depths from ground level to the groundwater are between 8 and 24 feet deep.

EIS Section 4.16 *Groundwater Resources* states: "The groundwater and surface water study provides insight to the depth of the groundwater in the alluvial layer. Toward the inland end of the property (wells HDF-1 and 2), groundwater levels are about 80 feet AMSL. The level drops rapidly going makai, to 68 feet AMSL at HDF-4, and to 49 feet at HDF-3. In general, the movement of groundwater in the alluvium is from mauka to makai with ultimate discharge into the marine environment. . ." That the depth to groundwater across the site would not be the same from place to place is axiomatic.

The USACE approval of the agricultural exemption for Section 404 was listed in the DEIS on the page 1-20 of your reference, and is included in the FEIS on page 1-21. Both the DEIS and the FEIS have disclosed all required permits and approvals, along with the status of same.

J. Disclosure and Discussion of State Policy

The discussion of State Water Quality standards and policy is contained in Section 4.17.2 *Surface Water Quality*, Section 4.17.3 *Nearshore Marine Waters*, and Section 5.8 *State of Hawai'i Water Policies.* The Final EIS clearly states that HAR §11-54 does not classify for protection any flowing inland waters within the Māhā'ulepū Watershed, thus the waters fall into Class 2. Per your letter, the State policy to protect Class 2 waters for recreational use and for the protection and propagation of fish and wildlife includes ". . .waters shall not act as receiving waters for any discharge which has not received the best degree of treatment or control compatible with the criteria established for this class" (emphasis added). HDF maintains that the technical analyses conducted for the EIS adequately discloses potential impacts to waters. Setbacks, timing and placement of nutrients, the increased capacity for the effluent ponds and additional safeguards have all been designed into HDF operations as protection for the site and surrounding lands and waters.

K. No Violation of HRS Chapter 343

HDF does not believe there is an applicable trigger for the dairy project, but has addressed the trigger on the OEQC publication form with the following statement:

> Hawai'i Dairy Farms' position is that no applicable HRS Section 343-5 trigger exists; some members of the public have challenged Hawai'i Dairy Farms' position, and have asserted that the use of State funds and approval of a wastewater treatment unit are applicable HRS Section 343-5 triggers.

L. DEIS "Misstatements"

The State Commission on Water Resources (CWRM) report referenced in the EIS provided the information cited. Page 3-70 of the *2013 Update of the Hawaii Water Reuse Survey and Report* states: "The resort's golf course, the Poipu Bay Resort Golf Course, has been irrigated with a blend of R-2 water and stream water since 1991."

Again, the EIS and the economic consultant cite the 2013 CWRM report. Page 3-71 of that report states: "The recycled water has a slight odor when spray-irrigated, and this odor is more noticeable at the first three holes where the higher concentration of recycled water is utilized."

Utilizing reports of agencies is standard practice during research regarding cumulative impacts. The Grand Hyatt Kaua'i property has expressed concern regarding the proposed HDF actions and is the closest resort. For these reasons, the EIS incorporates information from relevant, published references.

The statements regarding nutrients from fertilizers and domestic wastewater in the Po'ipū area do not single out the Po'ipū Bay Golf Course, but rather acknowledge that it is one of two golf courses along with other landscaping and domestic sources in the Po'ipū area that contribute 3.8 times more nitrogen and 1.4 times more phosphorus than the potential discharge from HDF. It is ironic that you claim that the golf course carefully manages fertilizer due to cost and environmental reasons, but charge that a proposed dairy business would not.

IV. Conclusion

The EIS for Hawai'i Dairy Farms was prepared in accordance with both the intent and the spirit of the law. The comments provided in your letter, which are largely based on the reports attached to your letter, contradict findings of HDF's Hawai'i-based expert consultants by using assumptions based on poorly-managed conventional feedlot dairy operations on the mainland and, in several cases, incorrect data. The requirements for an EIS are to disclose probable impacts and to identify minimization measures to reduce impacts. The results of the EIS note that no impacts extend to resort, commercial, residential or recreational areas.

HDF prepared the EIS to share the detailed and thoughtful planning put into designing a world-class, environmentally sound dairy suitable to our island environment. HDF's goal to further food self-sufficiency by reinvigorating the flagging dairy industry in Hawai'i through establishment of a financially and environmentally sustainable, pastoral rotational-grazing dairy will provide more than one-million gallons of fresh milk for Hawai'i's families.

Your comment, along with this response, will become part of the public record and will be published in the Final EIS. A copy of the Final EIS is included on a compact disc with this letter. When published, the Final EIS will be available on the OEQC website which you can access using the following URL, and search "Hawai'i Dairy Farms": http://tinyurl.com/OEQCKAUAI.

Thank you for your participation in the environmental review process.

Sincerely,

GROUP 70 INTERNATIONAL, INC.

Jeffrey H. Overton, AICP, LEED AP
Principal Planner

cc: Hawai'i Dairy Farms
Hawai'i State Department of Health,
Environmental Planning Office

A-A

RESPONSE TO ECONOMIC SECTIONS COMMENTS

Plasch Econ Pacific LLC
Bruce Steven Plasch, Ph.D., President

ECONOMIC CONSULTING: Economic Development • Land Economics • Feasibility & Valuations • Benefits & Impacts

August 24, 2016

Re: Hawai‘i Dairy Farms, Draft Environmental Impact Statement, Economic Sections (**DEIS**),

Response to Comments by:

- Lisa A. Bail, Goodsill Anderson Quinn & Stifel, Letter of July 25, 2016
- Berkeley Research Group (“**BRG”**), “Assessment of Economic Impacts of the Proposed Hawai‘i Dairy Farms Facility,” July 2016.
- Sarah A. Matsumoto and Charles M. Tebbutt, Law Offices of Charles M. Tebbutt, PlC., lettter of July 25, 2016
- John A. Kilpatrick, Ph.D., MAI, FRICS, “Economic and Valuation Impacts of a Proposed Concentrated Animal Operation on Kaua‘i.” July 2016.

1. Economic Impacts of Nuisances

Comments on Economic Impacts

Bail, BRG, Matsumoto and Tebbutt, and Kilpatrick assert that the economic impacts of nuisances from the Dairy were not addressed in the DEIS Appendix J, and/or assert large adverse economic impacts from nuisances.

Responses to Comments

The economic impacts from nuisances were addressed in Appendix J. The impacts were not omitted, discounted, or assumed away. The finding was no significant adverse economic impacts, a finding based on environmental studies that indicate no significant nuisance impacts affecting resort, commercial, residential or recreational areas.

The following information was provided in Appendix J:

— HDF vs. Traditional Dairies

The planned Hawai‘i Dairy Farms (“**HDF**” or “**Dairy**”) will be the first in Hawai‘i to employ rotational pasture-grazing. Benefits of pasture grazing includes but are not limited to improved grass growth, even deposits of manure for fertilization, and reduced erosion and runoff. Also, the Dairy will feature

modern facilities and practices, and will comply with all applicable Federal and State environmental standards.

In contrast to the Dairy’s rotational pasture-grazing approach, traditional dairies concentrate their milking cows in feed lots where the cows feed on grains, hay and/or silage. Correspondingly, a large volume of manure is generated in a small area, leading to waste-management challenges. These types of operations can generate significant odors and other nuisance impacts (flies, dust, noise, runoff, etc.) which can extend beyond the property boundaries of a dairy, thereby affecting nearby and downwind properties. In turn, nuisance impacts can have adverse economic impacts on affected neighbors, including but not limited to a loss in property values, reduced tourism, reduced sales and employment, and reduced tax revenues.

— Nuisance Impacts

The environmental studies for the Dairy indicate that no noticeable noise, dust, odors, flies, runoff, or other nuisance impacts will extend to resort, commercial, residential or recreational areas. Noticeable nuisance impacts occurring outside the Dairy property will be limited to the abutting farm and ranch lands which are owned by Māhā‘ulepū Farm, lessor of the Dairy property. These abutting lands are designated Important Agricultural Lands, so they will remain in agriculture for the foreseeable future.

— Economic Impacts of Nuisances

In view of the lack of nuisance impacts on resort, commercial, residential or recreational areas, the Dairy will not adversely affect:

- Guests of resorts in the Kōloa-Po‘ipū region.
- Recreational activities in the region.
- The regional economy (number of visitors, visitor expenditures, retail sales, employment, incomes, etc.)
- Residents when at home in the region.
- Property sales in the region (single-family homes, condominiums, second homes, time-share units, etc.).
- Values of properties in the region.
- County or State taxes derived from residents, resorts, or commercial activities in the region.

The comments by Matsumoto and Tebbutt, and Kilpatrick about the adverse economic impacts of the dairy appear to be based on nuisance parameters and footprints of typical dairies found on the mainland, <u>not</u> on those of the planned Dairy which will be a modern facility that uses rotational pasture-grazing.

2. Size of the Dairy

Comment, Bail, p. 1, §I, ¶1

"This Dairy project is large, and in Hawaiʻi, without precedent. As of January 2015, there were a total of 2,200 milk cows in multiple locations throughout the entire state. … With HDF's planned operation of up to 2,000 cows, the state-wide number will nearly double, …"

Response

Bail's figures are correct but, from a historic perspective, she is incorrect about her assertions that the Dairy would represents a large increase in milk cows and that such a large number of milk cows is without precedent.

As stated, the Dairy will "nearly double" the number of milk cows in Hawaiʻi. But this is only because 20 of 22 dairies closed since 1984 ("Statistics of Hawaiian Agriculture," annual). In 1984, about 12,100 cows produced all of the milk consumed in Hawaiʻi ("Statistics of Hawaiian Agriculture," annual). In that year, Hawaiʻi had about 1.23 million residents and visitors versus a current *de facto* population of about 1.58 million people ("Hawaii Data Book" annual). If Hawaiʻi were still self-sufficient in milk, an additional 2,000 milk cows would amount to a 13% increase in the number of milk cows [2,000 ÷ (12,100 × 1.58/1.23)].

In addition to milk cows, Hawaiʻi has a large number of beef cows: about 80,000 milk and beef cows in 2012 ("Hawaiʻi Farm Facts"). Thus, 2,000 additional cows amounts to an increase of only 2.5% of the inventory.

Also, Hawaiʻi has a precedent of a large concentrations of milk cows. In 1994, Waiʻanae had a cluster of dairies with an estimated 5,400 milk cows (derived from "Decision Analysts Hawaiʻi, inc., "Waiʻanae Planning District, Oʻahu: Agricultural Resources and Activities," November 1997; and "Statistics of Hawaiian Agriculture," annual). Adding beef cattle, pigs, poultry, sheep and goats, the Waiʻanae District had over 670,000 animals—about 17 animals per person. Many residents were unaware of the extent of the livestock activity within their community, even though most livestock operations were within a mile of residential communities along the coast.

3. Odors, Poʻipū Bay Golf Course

Comment, Bail, p. 38, §L, ¶3

"… HDF falsely asserts that there is 'a slight odor when the reclaimed water is sprayed, which is more noticeable at the first three holes because of the higher concentration of reclaimed water. The irrigation of effluent within the recreational area also creates an odor close to the resort.' DEIS at 4-85, Appendix J at III-12. Putting aside the highly subjective nature of the assertion, the assertion is not correct. Kawailoa has not received any complaints from hotel guests or workers related to odors from irrigation. Moreover, there is no reason why the first three holes would smell any differently than the other holes. The underlying premise of the assertion is false since the first ten holes utilize the same water as the first three holes."

Response

The full statement from Appendix J, p. III-12 is as follows:

> "Reclaimed wastewater is used for irrigating farmlands and golf courses throughout Hawaiʻi, including golf courses in Poʻipū. In 2013, the Limticao Consulting Group reported that the Poʻipū Bay Resort Golf Course, which is the golf course for the Grand Hyatt Kauaʻi, uses a mix of 20% to 40% R-2 rated wastewater. However, a mix of up to 60% wastewater is used on the first three holes, resulting in a slight odor during spraying. For the Dairy, the mix will be less than 8%."

The information is from an authoritative report: "2013 Update of the Hawaiʻi Water Reuse Survey and Report," July 2013. It was prepared by The Limtiaco Consulting Group for the State of Hawaiʻi, Department of Land and Natural Resources.

As indicated above, Bail reports that "Kawailoa has not received any complaints from hotel guests or workers related to odors from irrigation." This reinforces the fact that, if properly managed, reclaimed wastewater can be used to irrigate grasses in close proximity to resort areas without adversely affecting tourism or the regional economy. In contrast to the abutting golf course, the Dairy will be much farther away—about 1.5 miles from the Grand Hyatt Kauaʻi to the nearest paddock.

4. Distance of Nuisance Impacts

Comment, BRG, p. 3, ¶4

"The current DEIS fails to address [tourism] impacts adequately even though HDF recognizes that nuisances from the facility might reach properties 3 miles away." (Appendix J of DEIS, at p. III-8.)

Response

This comment has two inaccuracies. First, the adverse economic impacts of nuisances are addressed adequately as explained above.

Second, Appendix J does not contain a statement to the effect that "HDF recognizes that nuisances from the facility [i.e., the proposed Dairy] might reach properties 3 miles away." The relevant Subsection 7.a addresses the impacts on home property values caused by nuisances of some mainland livestock operations, and explicitly states that the findings do not apply to the planned Dairy. Nuisance impacts of the Dairy will not extend to nearby residential (or resort) properties. Relevant portions of this subsection are as follows (Appendix J, pp. III-8 and 9):

7. NUISANCE ISSUES AND IMPACTS

a. Impacts of Concentrated Animal Feeding Operations on

Property Values

A number of mainland studies have addressed the impact of large concentrated animal feeding operations (“**CAFOs**”) on property values of nearby homes (see listing in References). These operations, which are often called feedlots, confine a large number of animals—hogs, chickens, sheep, or cows—in a small area. Correspondingly, a large volume of manure is generated in a small area, leading to waste-management challenges.

Most CAFOs generate significant odors and other nuisance impacts (flies, dust, noise, runoff, etc.) that can extend beyond the CAFO property boundaries, thereby affecting nearby and downwind properties. Usually, but not always, property values of homes near CAFOs are lower than those of similar homes that are not affected by nuisance impacts of CAFOs. Relevant findings of the various studies, some of which are contradictory, include the following:

— Distance

- Significantly lower home values can be limited to less than 1 mile from a CAFO, but some studies have found that lower values can extend beyond 3 miles.

— …

The above findings about the impacts of CAFOs on home values do <u>not</u> apply to the proposed Dairy for the following reasons:

— The HDF pasture system differs from a conventional dairy where cows are confined to barns. Instead of storing manure in lagoons and feeding silage (fomented vegetation) as forage, the Dairy will use rotational pasture-grazing where the animals are dispersed over a large expanse of grassland.

— Home values will not be affected because no noticeable odors, noise, flies, dust, runoff, or other nuisance impacts from the operation will extend to residential areas (see Subsections 7.c and 7.d). Instead, any noticeable nuisance impacts occurring beyond the Dairy property will be limited to the abutting farm and ranch lands which are owned by Māhā‘ulepū Farm, lessor of the Dairy property.

5. Odors, Assumptions for Economic Findings, BRG, p. 8

<u>Comment</u>

“….The DEIS assumes away the potential impacts by claiming that “[c]onsiderable distances will separate the Dairy from the resorts, commercial areas, homes and recreational areas.”

<u>Response</u>

This statement is false. Economic impacts are <u>not</u> assumed away based on distances separating the Dairy from resort, commercial, residential or recreational areas. Instead, economic impacts are based on the environmental studies for the Dairy. These studies indicate that the Dairy will have no noticeable noise, dust, odors, flies, runoff, or other nuisance impacts that extend to resort, commercial, residential or recreational areas. Noticeable nuisance impacts occurring outside the Dairy property will be limited to the abutting farm and ranch lands which are owned by Māhā‘ulepū Farm, lessor of the Dairy property. Consequently, the Dairy will have no adverse economic impacts related to nuisances.

B-B

Response to Technical Memorandum, Hawaii Dairy Farm Odor Impact Assessment

MEMO

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Date:
December 16, 2016

Arcadis Project No.:
HI011182.0000

Subject:
Response to Comments in Exponent Report

Introduction

The Hawai'i Dairy Farm (HDF) submitted a Draft Environmental Impact Statement (DEIS) that included an odor impact analysis that evaluated potential odor impacts from the proposed project. In response to the odor impact analysis, Exponent, Inc. ("Exponent"), retained by Goodsill Anderson Quinn & Stifel LLP on behalf of Kawailoa Development LLP ("Kawailoa") prepared a separate odor analysis (Exponent 2016) and provided comments regarding the odor analysis in the DEIS. This document responds to the main comments made in the Exponent document. Revisions based on these comments are included in the Revised Odor Evaluation Technical Report (December 2016) as presented in Attachment 1.

Odor Thresholds

Exponent Comment

"The odor threshold of 6.5 OU/m^3 averaged over one hour used in the DEIS to evaluate impacts was not considered appropriate for a sensitive population such as hotel guests at a resort area. The DEIS odor threshold being used has not been adopted by any governmental authority or agency. Odors are perceived over much shorter time periods than one hour." (page 2)

Response

The odor threshold of 6.5 OU/m^3 averaged over one hour and 99.5th percentile was selected based on the specificity to dairy farms. In his comparison of odor regulations and guidance from four continents and New Zealand, OU/m^3 limits from Mahin (2001) show off-site standard or guidelines in the U.S. to be between 2 and 50 OU/m^3 with the majority of the values between 5 and 7 OU/m^3. Low OU/m^3 values are often difficult to observe. For instance, California's South Coast Air Quality Management District's states that at 5 D/T (OU/m^3) people become consciously aware of the presence of an odor and that at 5 to 10 D/T odors are strong enough to evoke registered complaints (SCAQMD 1993). While odors may be perceived over time periods less than one hour, the selected threshold was designed for a one hour average. If a shorter time period was desired, a higher value (perhaps closer to 10 OU/m^3) would have been selected. Further, the modeling considers the emission sources at their most impactful locations even though some of the sources are temporary (i.e., irrigation and slurry application). Given the conservative nature of the air dispersion modeling, the threshold used in the DEIS was determined to be appropriate.

Odor Emission Rates

Exponent Comment

"The odor emissions for some sources that were used in the DEIS were considered significantly underestimated. For example, HDF failed to include the odor emissions from fields that had received effluent irrigation or slurry in the hours before the one being modeled and grossly underestimated the odor strengths from several sources." (page 2)

Exponent proposed using odor emission rates from Pain et al. 1988 for irrigation and a separate rate for slurry application and use of the OFFSET model (Jacobson et al. 2001) for emission rates the manure. Exponent concurred with the Arcadis (May 2016) modeling conducted for the DEIS related to emissions from the buildings and effluent ponds.

Response

Irrigation

The longer duration and higher concentrations of odors observed in the Pain et al. 1988 study is likely a result of 1) higher concentration of solids in the effluent; 2) higher application rates; 3) lower absorption rate of the grassland compared to the Kikuyu crop at the project site; and 4) higher silage diet.

For the project site, it is anticipated that the Kikuyu thatch would absorb the liquid and accompanying malodorants from the diluted effluent within a short timeframe, modeled as a one-hour timeframe in this analysis. The effluent to be used at the project will have virtually no dry matter, while the "separate slurry" used in the Pain study reported a value of 5.4%. As it is likely that the solids encompass the majority of the odors, using the separate slurry emission rate is not an appropriate substitute for the effluent. The use of the emission rate for the effluent pond as used in the DEIS is therefore a better option. Although this approach does not account for potential turbulent aeration, it assumes the entire surface of the ground covered within the hour is covered with irrigation water and that the odors from the effluent ponds have not decreased over time due to breakdown of odor related compounds. However, adjustments to the dilution will be made to account for the variable dilutions possible throughout the year as presented in the Attachment 1.

Slurry

Similar to the differences noted above regarding the applicability of the Pain et al.1988 study results of irrigation liquid for this analysis, the slurry in the Pain et al. 1988 study has a higher concentration of solids in the effluent and lower absorption rate of the grassland. The Pain et al. 1998 study used a slurry with 9.2% dry matter while the slurry from HDF is anticipated to be closer to 5% dry matter, thus the value used for the separate slurry would be more appropriate. Additionally, the slurry used at HDF will typically be diluted by 50% or more. The use of revised odor emission rates based on the Pain et al. 1998 study are presented in Attachment 1.

Manure

The results of the Topper data were used in the initial odor model for the DEIS to account for the unique diet of the cows at the project. The use of an open lot value from the OFFSET model does not account for the diet and subsequent feces/urine ratio. Nor does this approach account for the fact that an open lot is a compacted dirt (or concrete) area as opposed to the Kikuyu thatch that where manure is incorporated into what is effectively an organic net. However, the emission rates based on the Jacobson et al. 2001 study for the open lot value used in the OFFSET model can be modified to account for the issues above and are presented in Attachment 1.

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ATTACHMENT 1

Hawaii Dairy Farms Revised Odor Evaluation Technical Report

Group 70 International, Inc.

Kauai Dairy
Maha'ulepu, Hawaii

December 16, 2016

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Figures

1 Introduction

Hawai'i Dairy Farms LLC (HDF) intends to develop a dairy with up to 2,000 cows in the Maha'ulepu Valley on the island of Kaua'i. The project will utilize a pastoral-based rotational grazing system. To demonstrate the sustainability of the dairy, HDF is committed to establishing a herd of 699 cows. HDF will contemplate the possibility of expanding the herd up to 2,000 cows. Both herd sizes are analyzed in this report. This odor evaluation report presents an updated analysis used to determine the potential impacts of odors from both herd sizes for the larger contemplated herd size of the proposed dairy facility at off-site receptors. This report updates the odor section contained in the Air Emissions and Odor Evaluation Technical Report dated May 2016.

2 Project Site

The project area has historically been used for sugar cane production as part of the Koloa Plantation until the late 1990s when the Koloa Mill closed. Since the mill closed, the project area and its surrounding has been leased to various tenants for ranching and diversified agricultural operations. A small plot of land in the lower center of the valley is currently used for taro lo'i and will continue to be leased and farmed after the dairy and related pastures are in full operation. Recreational land use such as golf courses and hotels are located approximately 0.9 miles to the south and residential properties are located more than 1.5 miles to the southwest and west. Figure 1 presents a project location map showing the project site and surrounding land use.

The total dairy farm area inclusive of pasture and dairy facility, but excluding the existing taro farm, was initially calculated as 556.8 acres. For the purposes of this evaluation, the dairy project site was divided into two land use areas: Field 1, 547.1 acres of pasture; and Field 2, 9.7 acres containing the dairy facility. Field 1 is broken up into paddocks of approximately 3 to 5 acres in size.

3 Air Dispersion Modeling Methodology

3.1 Model Selection

Computer-based air dispersion models can be used to determine the concentration and frequency of odors and fugitive dust at specific locations around a source using local weather data. The AERMOD modeling system (AERMOD (version 15181) and its pre-processing programs, AERMAP and AERMET) were used for the analysis. AERMOD is a steady-state Gaussian plume model that requires four general types of input data: emission source information, receptor locations, meteorology, and model specific control options.

3.2 Receptors[1]

Fenceline (boundary) receptors and one Cartesian grid of receptors extending out to 4.5 km from the site were used for the modeling analysis. Fenceline receptor spacing was 25 meters while the Cartesian receptor grid spacing is 100 meters between receptors. All receptors were placed at ground level in the model based on standard modeling protocol.

3.3 Terrain

The project site is situated in the Maha'ulepu Valley on the island of Kaua'i. The valley is on the leeward side of the Ha'upu mountain ridge, which runs in the east-west direction, and the valley is also flanked by ridge lines on both sides. Mt. Ha'upu is the highest point on the ridge line at the back of the valley with an elevation of 2,297 feet. From this point, the ground drops very quickly down to the bottom of the valley to about an elevation of 150 feet. The base of the valley itself is somewhat gradually sloped from an elevation of 150 feet to an elevation of 60 feet along Maha'ulepu Road on the makai side of the project site near the taro farm.

Terrain elevations were obtained from National Elevation Dataset (NED) digitized terrain data from the United States Geological Survey (USGS), and processed using AERMAP.

3.4 Meteorological Data

One year (2014) of AERMET-ready meteorological data for the project site was obtained from Lakes Environmental. The meteorological data were derived from the NCAR MM5 (5th-generation Mesoscale Model) prognostic meteorological model. The data were used to develop the necessary surface and upper air files for the project's location and modeling domain. These files were used as inputs into the AERMET pre-processing software. The final AERMOD-ready meteorological data file was processed using estimated surface characteristics in the project vicinity with AERMET. The surface characteristics were estimated from available aerial photos for the project location. A wind rose plot of meteorological data is presented in Figure 2. This figure shows that the predominant wind direction is towards the southwest.

3.5 Model Control Options

The analysis included the use of selected model control options that allow the model to be made more site and project specific. These model options include land use classification, incorporation of building wake information, averaging time, and regulatory control options. The modeling used the AERMOD regulatory default option. This option includes elevated terrain algorithms, the effects of stack-tip

[1] Receptors are defined as locations at which odor are estimated and do not necessarily denote where a person is located.

downwash, missing data routines, and calm wind processing. In addition, rural boundary layer effects were incorporated into the model.

3.6 Odor Emission Sources

Odor emissions are generated during incomplete anaerobic decomposition of organic matter in manure. Potential sources at the facility would include the effluent ponds, the irrigation system which utilizes effluent, manure from pasture fields, and the dairy buildings. These sources are described in detail in the sections below.

Odor refers to the combined effect of a mixture of gases on the sense of smell. For livestock sources, it may contain hundreds of trace compounds including ammonia (NH_3) and hydrogen sulfide (H_2S). Instead of measuring the individual components of an odor, as is done in standard air concentration modeling, odor concentration is reported in odor units per cubic meter (OU/m^3), and odor emissions are reported in units of odor units per second, OU/s (for point sources) and odor units per second per square meter, $OU/s/m^2$ (for area sources). An odor concentration of 1 OU/m^3 is defined as the threshold where the odor of a sample has a 50 percent probability of being perceived by a trained odor specialist.

3.6.1 Effluent Ponds

The effluent pond design includes two ponds: a settling pond and storage pond. The settling pond allows for the settlement and accumulation of solids with the overflow of liquid effluent entering the storage pond. The effluent ponds are open to the atmosphere. The top of the settling pond is 87 feet by 133 feet with a total depth of 17 feet with side slopes not steeper than 2 horizontal to 1 vertical. Effluent from the settling pond overflows through overflow pipes and into the storage pond. The top of the storage pond is 215 feet by 133 feet with a total depth of 17 feet. However, it is not likely the effluents would reach the top of the ponds as it is designed for a 25-year flood level. Based on a normal 30-day period of rain and effluent storage, the settling pond would be 12 feet deep and the storage pond would be approximately 10.75 deep. The corresponding widths and lengths are 67 feet by 113 feet and 190 feet by 108 feet for the settling pond and storage pond, respectively. The effluent ponds were modeled at ground level.

Each pond was modeled in AERMOD as an area source with dimensions of the anticipated 30-day period of rain and effluent storage effluent surface. Odor emission rates were taken from Feitz 2002 (Dairy Australia, December 2008) which measured 30 ponds over 12 months in Australia. These results were selected over other data presented in Dairy Australia (2008) as it was measured using a wind tunnel apparatus as opposed to isolation flux hoods. According to Dairy Australia, most research shows that isolation flux hoods under-predict odor emissions relative to wind tunnels.

3.6.2 Irrigation

Odors from the irrigation process will be based on the odors volatilizing from effluent water mixed with irrigation water. This water will be applied through two center pivots and released approximately one

meter from the ground surface. Irrigation pivot #1 will be a full circle pivot and irrigation pivot #2 will be a ¾-circle pivot.[2] Before application, the effluent water will be diluted with irrigation water. The effluent concentration will be 4% for the committed herd size and 12% for the contemplated herd size. In typical years, these concentrations will remain relatively consistent throughout the year. However, during years where the winter season is unusually wet, less water will be added to the effluent prior to application and thus the effluent will be in a higher concentration in the irrigation water. For these winter seasons, the effluent concentration could be up to 50% for both the committed and contemplated herd size. Typically, only one pivot will be applying effluent at any given time. The pivots can complete a full rotation every 40 hours.

The odor emissions associated with the effluent ponds were reduced by a factor proportional to dilution of the effluent for irrigation. The diluted effluent will be quickly absorbed into the ground and the odor will be short-lived. Therefore, the area covered in an hour (1/40 of a complete rotation) was modeled as an area emission source. As a conservative scenario, the section closest to the southern boundary was used in this evaluation.

3.6.3 Pasture

The cows will be maintained in six mobs of animals. At the committed herd size of 699 cows, mobs will contain up to 115 animals and for the contemplated herd size of up to 2,000 cows, mobs will contain up to 334 animals. The cows graze for one day per paddock and will produce the majority of the manure in that one paddock as they graze. Each mob will graze in separate paddocks of 27 to 81 acres, and adjacent to paddocks with other mobs. Paddock blocks that would be occupied on a given day were selected based on a typical scenario and were modeled as an area source.

Odor emission rates were based on the Jacobson et al. 2001 study for the open lot value used in the OFFSET model which evaluates odor from feedlot setbacks. However, the use of the open lot value in Jacobson et al. 2001 does not account for the diet and subsequent feces/urine ratio that would be found in cows for this project. Nor does this approach account for the fact that an open lot is a compacted dirt (or concrete) area as opposed to the Kikuyu thatch that where manure is incorporated into what is effectively an organic net. Therefore, the odor emissions in Jacobson et al 2001 was adjusted by the ratio of the estimated odor for a high concentrate (HC) and 20% corn silage diet and low concentrate (LC) and 80% corn silage (typical dairy cows) observed in the Topper et al. (2008) study. Although the HC diet does not necessarily coincide with the project (pasture fed cows were not evaluated in Topper et al., 2008), the HC; 20% silage resulted in the highest percentage of urine in the manure which is consistent with the composition of the anticipated manure. In addition, the impact of the Kikuyu thatch and loose

[2] The ¼ circle not reached by irrigation pivot #2 will receive water through a hard-hose gun irrigation system.

soil is accounted for by using a control efficiency value consistent with an 8" straw or natural crust in the OFFSET model.

3.6.4 Slurry

Solids collected from the settling pond will be applied on designated areas through a "gun type" application system to areas outside the liquid effluent application. The slurry consists of three components; 1) liquid effluent, 2) settled solids from the liquid effluent, and 3) irrigation/collected rain water. The solids will be mixed with irrigation and/or collected rain water at a 1:1 ratio to create the slurry, which can then be pumped to the hydrants resulting in a dry matter percentage of approximately 4%. The slurry will be pumped through underground pipes to hydrants which have a "gun sprinkler". The slurry guns will have an application rate of approximately 158 gallons per minute over a 160 foot spray length at a rate of 0.60 minutes per foot. Approximately 16,000 square feet will be covered with slurry in an hour and application will occur for up to 8 hours a day and will cover approximately 128,000 square feet (2.94 acres) in one day.

The slurry application will not occur in paddocks when occupied by cows. The planned location of the application is anticipated to be on the east portion of the site between the area that is covered by the irrigation two center pivots for the committed herd size of 699 cows. For the contemplated herd size of up to 2,000 cows, slurry will be applied to non-irrigated paddocks and those irrigated without the addition of effluent. Application of the slurry will be periodic (at least every 45 days) and will not occur under the following conditions: 1) Slurry application will not coincide with effluent application via the center pivot; and 2) Slurry will not be applied during days with average wind speeds less than 4 m/s or greater than 8.9 m/s.[3]

The odor emissions associated with the slurry were based on the Pain et al. 1988 study for separated slurry (consistent with the dry matter content). The Pain et al. 1988 study indicated that odors may remain past the first hour after application and vary by time with measurements at application, two hours after application, five hours after application, seven hours after application, and 24 hours after application. The emissions for each hour was extrapolated from these measurements and reduced by a factor of two to account for the dilution of the slurry before application. In addition, an adjustment for the diet, similar to the manure odors, was made. As a conservative estimate, the areas closest to the southern boundary and adjacent to occupied paddocks were used in this evaluation.

3.6.5 Dairy Facility

The dairy facility is contained within an approximately 10-acre area in Field 2. The corresponding building areas are under 0.1% of the total farm area. The dairy buildings include the milking parlor, an implement

[3] Based on the 2014 meteorological data used, the limits of the daily wind speeds will reduce the number of days of potential application to 243 days in a year.

shed, and calf sheds. The milking parlor contains an automated 60-stall rotary which is approximately 256 feet by 88.5 feet by 33 feet tall. Two open bay calf sheds will be constructed to provide safe housing to newly born calves. Each shed will be approximately 81 feet by 26 feet by 15 feet tall. The feeding area will be washed daily and the wastewater transferred to the effluent ponds. Dairy facility odor emissions were modeled as area sources with dimensions of the building footprint. Emission rates consistent with free stall dairy buildings from Jacobson et al. (2001) were used.

Table 1 summarizes the emission fluxes used in the evaluation and the area of the emission source. The emission flux estimates are detailed in Appendix A. As a conservative estimate, the evaluation considers the emission sources at their most impactful locations even though some of the sources are temporary (i.e., irrigation and slurry application).

Table 1. Hawaii Dairy Farms Odor Modeling Parameters

Location	Source	Emission Flux ($OU / s / m^2$)	Area (ft^2)
Effluent Ponds	Settling Pond	8.1	7,571
	Storage Pond	8.1	20,520
Irrigation	Effluent* – wet years, winter	4.05	222,828
	Effluent* Committed	0.32	222,828
	Effluent* Contemplated	0.97	222,828
Pasture	Committed Herd	0.16	1,217,078
	Contemplated Herd	0.45	1,217,078
Slurry Application	Application + 1 hour	6.31	16,000
	Application + 2 hour	7.21	16,000
	Application + 3 hour	7.10	16,000
	Application + 4 hour	7.00	16,000
	Application + 5 hour	6.89	16,000
	Application + 6 hour	5.83	16,000
	Application + 7 hour	4.77	16,000
	Application + 8 hour	4.77	16,000
Dairy Facility	Bay Calf Shed #1	1.84	2,106
	Bay Calf Shed #2	1.84	2,106
	Milking Parlor	1.84	22,656

Notes:
* For typical precipitation conditions, the dilution is anticipated to be 4% for the 699 herd scenario and 12% for the 2,000 herd scenario. During these periods, effluent will only be diluted at approximately 50% at maximum.

3.7 Thresholds

The development of a target odor criteria is complicated by the difficulties in odor sampling and measurement combined with a lack of suitable data on odor levels associated with annoyance and complaint. Mahin (2003) presented regulatory off-site limits based on levels predicted by dispersion modeling in the U.S. range from 1 OU/m^3 to 50 OU/m^3 for a variety of averaging times.

Table 2. Regulatory Odor Thresholds

Location	Off-site standard or guideline	Averaging times
Allegheny County Wastewater Treatment Plant (WWTP)	4 OU/m^3 (design goal)	2-minute
San Francisco Bay Area Air Quality District	5 OU/m^3	Applied after at least 10 complaints within 90-days
State of Colorado	7 OU/m^3 (Scentometer)	
State of Connecticut	7 OU/m^3	
State of Massachusetts	5 OU/m^3*	
State of New Jersey	5 OU/m^3 **	5-minutes or less
State of North Dakota	2 OU/m^3 (Scentometer)	
State of Oregon	1 to 2 OU/m^3	15-minute
City of Oakland, CA	50 OU/m^3	3-minute
City of San Diego WWTP	5 OU/m^3	5-minute
City of Seattle WWTP	5 OU/m^3	5-minute

Notes
* draft policy and guidance for composting facilities
** for biosolids/sludge handling and treatment facilities

Many of these values are for wastewater treatment plant or composting facilities, but none of the regulatory standards are specific to dairy farms. However, an Australian study by Wang and Feitz (2004) suggested 6.5 OU/m^3, 1-hour averaging and 99.5th percentile at receptor as appropriate criteria for the assessment of dairy farm odors. Based on the source of the odor, this odor threshold was selected for this analysis. These criteria represent the extent of the 6.5 OU/m^3 level that has the potential to be reached 0.5% of the time (100% – 99.5%). Using hourly meteorological data, 0.5% would be equivalent to a result exceeding 6.5 OU/m^3 once per 200 hours evaluated. If the emission source could be operated anytime throughout the year, this would equate to 44 hours per year. However, for emission sources such as the slurry application, where application (and therefore odor emissions) would be limited to 243 days of the year (based on daily wind speeds), this would equate to 29 hours per year. In other words, there is a 99.5% chance that the odor threshold of 6.5 OU/m^3 is less than the extent shown, and only 0.5% chance it will be at or beyond the extent shown.

3.8 Results

Odor isopleths were created using the results of AERMOD modeling. The odor modeling analysis and isopleths indicate that the 99.5th percentile of 6.5 OU/m^3 odor threshold extend beyond the dairy farm boundary, however it does not reach recreational nor residential areas. As discussed above, slurry application and effluent application would not occur on the same day. Therefore, separate figures showing the extent of the potential odor impacts were prepared for the slurry application and effluent application in Figures 4 and 5 for the committed herd size and Figures 6 and 7 for the contemplated herd

size, respectively. It should be noted that the parameters used in this analysis were intentionally very conservative and the impacts shown depend on an unlikely confluence of most impactful emission source locations; thus, actual offsite odor impacts are likely to be much lower and/or less frequent than shown.

4 References

Dairy Australia. 2008. Effluent and Manure Management Database for the Australian Dairy Industry. December.

Jacobson, L.D., Schmidt, S. Wood. 2001. OFFSET: Odor from feedlots setback estimation tool. University of Minnesota Publication F0-07680-C.

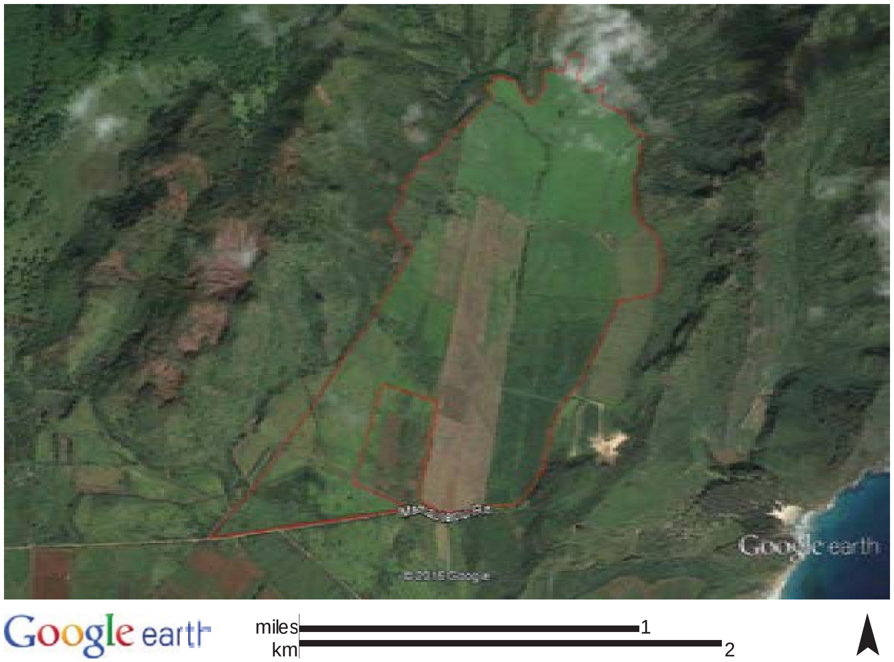
Mahin, T. 2003. Measurement and regulation of odors in the USA. Odor Measurement Review, Japan Ministry of the Environment. Pp. 62-68.

Pain, B.F., Rees, Y.J., Lockyer, D.R., 1998. Odour and Ammonia Emission Following the Application of Pig or Cattle Slurry to Land. Volatile Emissions From Livestock Farming and Sewage Operations. Edited by V.C. Nielsen, J.H. Voorburg, and P.L. L'Hermite. pp. 2-11.

Topper, Patrick A., Robin Brandt, A. Adviento-Borbe, G.J. Lascano, A.J. Heinrichs, E.F. Wheeler. 2008. Odor Evaluation and Gas Emission from Manure of Dairy Heifers Fed High/Low – Forage Quality and High/Low-Concentrate Diets. ASABE Meeting Presentation. June 29-July 2.

Wang, X. and A.J. Feitz 2004. Odor impact criteria for Australian dairy farms, Enviro 04, Sydney NSW, 29-31 March 2004.

Figures



Group 70 International, Inc. (Kauai Dairy)

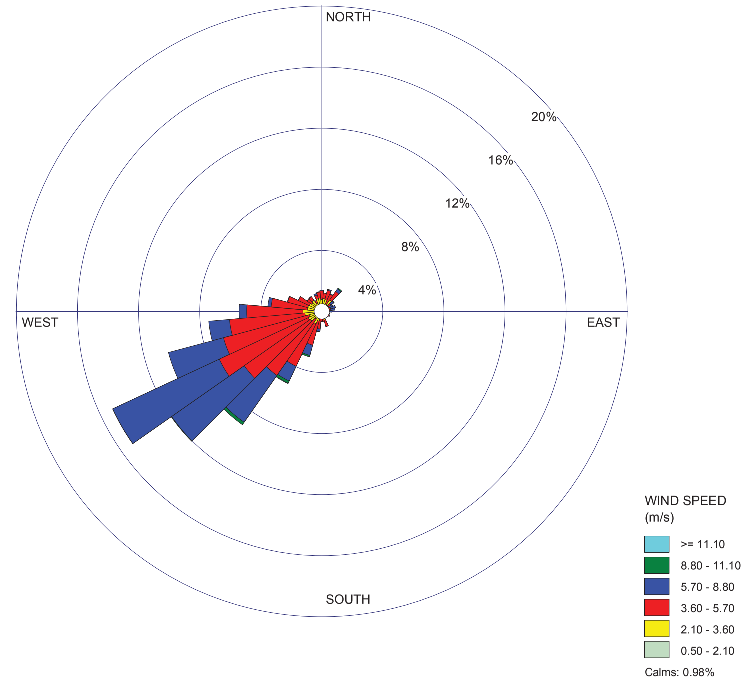
Site Location Map

ARCADIS Design & Consultancy for natural and built assets

FIGURE 1

WIND ROSE PLOT:
MM5 2014 Met data

DISPLAY:
Wind Speed
Flow Vector (blowing to)



COMMENTS:	DATA PERIOD: Start Date: 1/1/2014 - 00:00 End Date: 12/31/2014 - 23:00	COMPANY NAME:	
		MODELER:	
	CALM WINDS: 0.98%	TOTAL COUNT: 8760 hrs.	
	AVG. WIND SPEED: 4.64 m/s	DATE: 5/23/2015	PROJECT NO.:

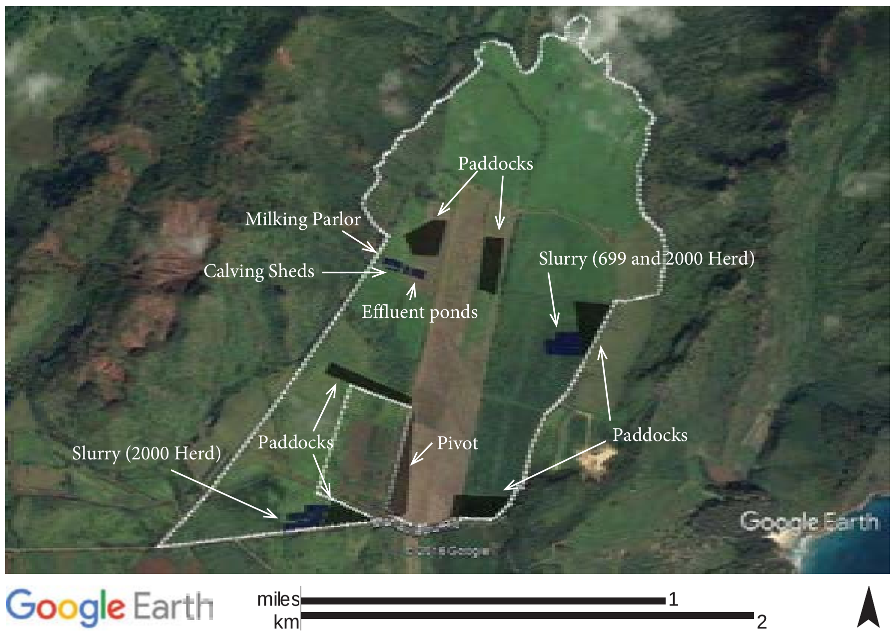
WRPLOT View - Lakes Environmental Software

Group 70 International, Inc. (Kauai Dairy)

AERMOD Wind Input

ARCADIS Design & Consultancy for natural and built assets

FIGURE 2



Group 70 International, Inc. (Kauai Dairy)

Modeled Odor Sources

ARCADIS Design & Consultancy for natural and built assets

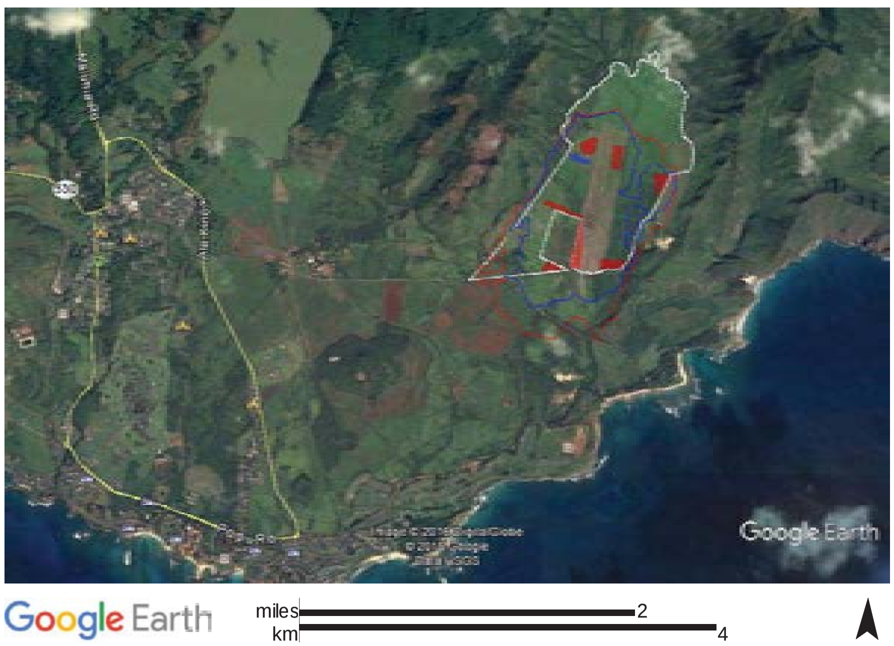
FIGURE 3

Group 70 International, Inc. (Kauai Dairy)

Extent of 6.5 OU/m3 at 99.5th Percentile for Slurry Application– Committed Herd Size

ARCADIS Design & Consultancy for natural and built assets

FIGURE 4



Typical Application

Wet Period Application

Group 70 International, Inc. (Kauai Dairy)

Extent of 6.5 OU/m3 at 99.5th Percentile for Effluent Application– Committed Herd Size

ARCADIS

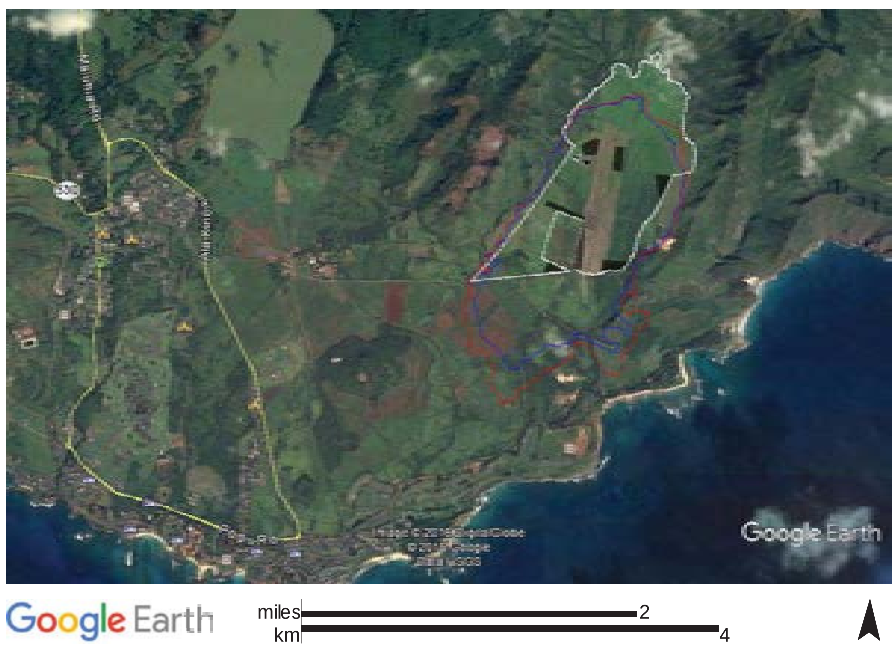
FIGURE 5

Group 70 International, Inc. (Kauai Dairy)

Extent of 6.5 OU/m3 at 99.5th Percentile for Slurry Application– Contemplated Herd Size

ARCADIS

FIGURE 6



Group 70 International, Inc. (Kauai Dairy)

Extent of 6.5 OU/m3 at 99.5th Percentile for Effluent Application– Contemplated Herd Size

ARCADIS Design & Consultancy for natural and built assets

FIGURE 7

Appendix A

TABLE A-2
Emission Fluxes From Sludge Application
Hawaii Dairy Farms

Measurement Hour[1]	Emission Flux[1] OU/m²/hr 10^{-4}	Emission Flux[1] OU/m²/s	Applied Dilution[2]	Diet Adjustment[3]	Adjusted Emission Flux OU/m²/s
0	5.1	14.17	0.5	0.76	5.41
2	6.8	18.89	0.5	0.76	7.21
5	6.5	18.06	0.5	0.76	6.89
7	4.5	12.50	0.5	0.76	4.77

Hour After Application	Emission Flux (OU/s/m²)
1	6.31
2	7.21
3	7.10
4	7.00
5	6.89
6	5.83
7	4.77
8	4.77

Notes
1 Values taken from Pain 1988, Figure 2.
2 Slurry will be diluted prior to application at a 1:1 ratio, at minimum.
3 Adjustment to account the difference in diet for the project cows and typical dairy cows based on the Topper et al 2008 study.

TABLE A-1
Emission Fluxes Used in Odor Evaluation
Hawaii Dairy Farms

Source	Odor Emission Flux (OU/m2/s)	Source
Settling Pond	8.1	Feitz 2002
Storage Pond	8.1	Feitz 2002
Pivot irrigation - winter (wet)	4.05	Storage pond effluent diluted by a factor of 2
Pivot irrigation - Committed	0.32	Storage pond effluent diluted by a factor of 25
Pivot irrigation - Contemplated	0.97	Storage pond effluent diluted by a factor of 8.3
Gun irrigation	0	No effluent water applied to the area
Pasture - Committed	0.16	Derived from Jacobson *et al* 2001
Pasture - Contemplated	0.45	Derived from Jacobson *et al* 2001
Sludge - 1st hour	6.31	Derived from Pain 1998
Sludge - 2nd hour	7.21	Derived from Pain 1998
Sludge - 3rd hour	7.10	Derived from Pain 1998
Sludge - 4th hour	7.00	Derived from Pain 1998
Sludge - 5th hour	6.89	Derived from Pain 1998
Sludge - 6th hour	5.83	Derived from Pain 1998
Sludge - 7th hour	4.77	Derived from Pain 1998
Sludge - 8th hour	4.77	Derived from Pain 1998
Bay Calf Sheds	1.84	Jacobson *et al* 2001
Milking Parlor	1.84	Jacobson *et al* 2001

TABLE A-3
Emission Fluxes From Pasture (Manure)
Hawaii Dairy Farms

Scenario	Reported Emission Flux[1] OU/m^2/s	Herd Size Density (square feet / head) Reported	Project	Herd Size Adjustment[2]	Diet Adjustment[3]	Ground Cover Adjustment [4]	Adjusted Emission Flux OU/m^2/s
Committed Herd Size	4.3	275	1741	0.16	0.76	0.70	0.16
Contemplated Herd Size	4.3	275	609	0.45	0.76	0.70	0.45

Notes
1 Values taken from Jacobson et al 2001 for open lot source.
2 Adjustment for the size of herd. Jacobson et al 2001 reported a herd size density of 275 square feet per head.
3 Adjustment to account the difference in diet for the project cows and typical dairy cows based on the Topper et al 2008 study.
4 An odor reduction of 70% accounts for the loose soil and grass present within the paddocks which is consistent with straw cover (8 inches) in the Jacobson et al 2001 study.

C-C

REVIEW AND RESPONSE TO PACIFIC ANALYTICS JULY 2016 COMMENTS ON THE ARTHROPOD-RELATED SECTION OF THE HAWAII DAIRY FARMS DRAFT ENVIRONMENTAL IMPACT STATEMENT

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Killer Caterpillar (*Eupithecia* new species #8)

November 6, 2016

Mr. Jeffrey H. Overton
925 Bethel Street, Fifth Floor
Honolulu, Hawaii 96813

Subject: Review and response to Pacific Analytics July 2016 comments on the arthropod-related section of the Hawaii Dairy Farms Draft Environmental Impact Statement

Dear Mr. Overton:

Dr. Steven L. Montgomery has 48 years of field experience in Hawai'i environments from mountaintops to lava tubes. He has conducted numerous biological surveys on all islands. Dr. Montgomery has discovered 30+ Hawaiian insects and rediscovered 'lost' species of insects, snails, and plants. He served 8 years as a Natural Area Reserves System Commissioner, 4 years as a Land Use Commissioner, and as a board member on several citizen conservation groups. Ms. Manning served 26 years at Bishop Museum in collections care / documentation and helping to start the trend to share data across repositories.

Pest Flies

Pacific Analytics based their conclusions on theoretical information, rather than an on-site evaluation of the site. Dr. Montgomery conducted fieldwork on site and in adjacent property. Ms. Manning conducted archival research with resources at Bishop Museum, University of Hawai'i, and other repositories with applicable collections.

Dispersal of flies –

The range a fly can travel is not the range a fly will travel. More realistic than any theoretical calculations of fly reproduction are modern animal/fly experiences in the Islands. Parker Ranch has been upwind of the Mauna Kea Beach Hotel and 2 other coastal Kohala Resorts sited from Puakō to Waikoloa since they were built decades ago, and the lack of dung fly complaints arising from Parker Ranch is solid evidence that cattle flies overwhelmingly remain very close to livestock habitats. This is largely because Integrated Pest Management and biological and natural controls have been effective in suppressing fly populations. Here is a prime natural control long in operation: Elmo Hardy in 1981 cited the ubiquitous bigheaded ant's predation on fly eggs and larvae as a major check on numbers.

On South Kaua'i, Māhā'ulepū Cattle Co. herd is an adjacent area where more than 100 cattle are currently present. Other upwind ranches at Kīpū (with more than 1,000 cattle) and Kīpū Kai raise the count of existing beef cattle herds within 5 miles to more than 1,100. If dispersal of

manure breeding pests into Po'ipū resorts and dooryards were to be a public health issue, it would have already occurred.

Mosquitoes

Watering troughs will contain water for the period of 12 to 24 hours when cows occupy the paddocks. HDF personnel will fill troughs just before the herd enters the paddock(s) for the grazing period; troughs will be emptied after the cows are moved to another paddock. Thus, troughs will be managed to prevent mosquito breeding.

Dung Beetles

Several papers are cited throughout EIS Appendix B, relating to dung beetles. Dung beetles are well known biological control agents for horn flies and intestinal parasites. According to Dr. Truman Fincher, Entomologist, Texas A&M University, Horn flies and internal parasites complete their life cycle in dung pats. Dung beetles, in high populations, will bury dung pats four to six inches in one to three days as cited in Appendix B, page 31. www.noble.org/ag/pasture/dungbeetles

The dung does not need to be entirely consumed or buried, but tunneled, dried and variously disrupted as an intact, moist breeding site for the pest species. The beetles are one part of **Integrated** Pest Management, as are the other actors mentioned, such as birds scratching apart the pats and eating the pest larvae. The various species work at different times of day / year, parts of the pest cycle, etc.

Integrated pest management

An Integrated Pest Management Plan is a composite of complementary parts. It is not rational to pull out individual components, suggest failure of one at one time, and then conclude the whole system will fail. IPM works because each component reduces a part of the problem. They work together, with one unit working to pick up when or where another is not present.

New Zealand has a long history of dung beetles usage:

"The rapid removal and processing of dung by dung beetles can result in many benefits including:
Improved soil health and reduced runoff. Beetle tunneling leads to increased aeration of the soil allowing water to penetrate better. Tunneling and dung burial also result in increased grass root growth and biological activity in soils under and adjacent to dung pats. Dung beetle activity therefore leads to reduced run-off of rainfall and better retention of dung and urine in the soil. This in turn results in reduced microbial contamination in run-off, less leachate pollution and reduced eutrophication. " [http://dungbeetle.org.nz/benefits/]

It is important to note that **not all nonnative species are considered invasive**, only those that cause environmental or economic harm, or harm to human health or native species – characterized as harmful and troubling. Dung beetles do not fall into these categories, and with few exceptions were purposefully introduced to benefit public health and the livestock industry by reducing manure-related pests.

Dung beetles ARE non-native but they are NOT INVASIVE. No scholarly discussion of invasive species in Hawaii mentions dung beetles. The beetles reduce manure related pests, and do not prey on or adversely affect any native species of plant or animal. They are not the only control, but part of an integrated system of multiple methods of control. They do not compete with or attack any native species.

The rotational, pasture-based model to be utilized by HDF disperses manure for rapid integration into grass and soils. The manure to be collected from the milking parlor and holding yard will be washed out with water and stored in ponds for use as fertilizer. This differs from conventional feedlot waste management which typically uses heavy equipment to scrape manure from barns and transferring it to lagoons where it is stockpiled.

IPM can also be accomplished by reducing habitat for fly life-cycles as noted on page 10 (Diet of Animals) of Appendix B: . . . the dog dung fly, which is known to breed in cow manure in small numbers, can be reduced by omitting corn from feed (Lee and Toyama, 1991). While dog dung fly was not identified at the HDF site, it is undoubtedly a common pest in areas with high pet populations thriving in yards of dog owners not promptly removing dung.

The comments fail to acknowledge the field work documented as EIS Appendix B, which documents the adjacent cattle operation that moves beef cattle within that property and has a healthy, functioning population of dung beetles in the same soil types as the proposed dairy. Again: flies did not come to food left in the open during the survey or to baited traps above ground, but remained on the manure.

These beetles are adept at flights to rotation pastures using keen olfactory senses to find new dung deposits. Therefore, beetles in the vicinity will move to manure on the HDF site and develop additional populations.

Dung beetles are winter dormant in locations where the **temperate drops dramatically in winter**. Hawaii does not experience that level of temperature change in winter and the **dormancy is NOT triggered**. A review of collecting dates and scholarly publications that show the activity levels of dung beetles in locations such as Louisiana and Florida show year round activity. A table showing collections by month for Florida shows related dung beetle, *Phanaeus* sp., or Rainbow Scarabs, active in Florida year round. [Radtke, Carlton, Williamson, 2008, *Southeastern Naturalist* 7(1):101-110 "A Dung Beetle Assemblage ...Louisiana"; Iowa State University, BugGuide.Net! http://bugguide.net/node/view/3846] A search of a cross-institutional data base of collections *(SCAN)* shows specimens of dung beetles collected in warmer locations in October, November and December.

Practical ground truthing in Hawai'i: February 2011, we assisted with a week of filming in the fields of Hawai'i Island's Kohala Cloverleaf Dairy, where active dung beetles were seen.

Nowhere in the EIS or Appendix B does it state that the HDF will release parasites or predators to control fly populations. HDF would not translocate any species independently. EIS Section 4.11.2 states: HDF and other ranchers on Kaua'i may **choose** to engage with the State Department of Agriculture to translocate dung beetle species already present in the State to Māhā'ulepū and other areas if manure-related fly control is needed. DOA has a long record of scrutiny and controls on translocation and introduction of pest control species. All work would be done through and with DOA. Appendix B suggests that "If

the HDF cattle began their journey around the HDF paddocks in the sections near areas where the Māhā'ulepū Cattle Co. herd was recently grazing, the predators and parasites would more readily migrate to the manure being deposited by HDF cattle." This would be a natural process, no releases or transplanting or translocation.

The EIS proposes reliance on natural controls resulting from dispersal into pastures by already established species now widespread due to many State and Federal successful releases of biocontrol agents over the past century. HDF will cooperate with and support any renewal of dung biocontrol programs by DOA, such as suggested by Markin & Yoshioka 1998 [see Appendix B, Increase Dung Beetle Diversity].

Endangered Arthropods

Based on hydrological knowledge derived from all drilled wells analyzed by Nance, the downslope movement of ground water from below the pastures toward the habitats of listed arthropods will not reach into the referenced habitats. It must be recognized that the food supply of the wholly saprophagic amphipod is organic matter derived from roots and other decaying plant debris, and nitrogenous and phosphoric nutrients will promote plant growth. Thus, their effects, if any occur at all, can be expected to expand the food supply in this oligotrophic subterranean ecosystem.

Native Insects

Surveys are designed appropriate to the habitat, in this case a lowland, alien-dominated pasture with a many decades long history of agriculture where native host plants for native invertebrates were often plowed under to make way for cane. Invertebrates are often the dominant fauna in natural Hawaiian environments. Native Hawaiian plant and invertebrate populations have many interdependencies. Some invertebrates consume and some pollinate native plants. Many native insects are obligatorily attached to specific host plants, using only that plant as their food. These insect - host relationships are ancient and intertwined. Hawaii's native insect fauna was devastated by a combination of processes including deforestation, introduction of vertebrates such as chickens and rats, and introduction of ants and other predatory insects beginning over two centuries ago. It has escalated in the last century with increasing continental insect arrivals. The overall health of native Hawaiian invertebrate populations depends upon habitat quality, sufficient food sources, host plant availability, and the absence or low levels of introduced, continental predators and parasites, which all support classic native ecosystems. The HDF site provides none of these conditions. A full inventory is not typically done when assessing potential impacts of an agricultural use on agriculture zoned land. Montgomery draws on decades of experience to design each survey to extract germane information under present and projected conditions.

Most of the lowland endemic insects have been exterminated by the alien big-headed ant, *Pheidole*. [Zimmerman, E. C. (1948). Introduction. Insects of Hawaii V.1, p. 65 of 206 pp.] Three insect surveys conducted by Dr. Montgomery on parcels being urbanized along the Po'ipū coast since 1975 found only a very few native arthropods. Those found were usually on native flora, and most were common species occurring widely, some even on all the major islands, like the globe skimmer dragonfly, *Pantala flavescens* and intertidal rock crickets. Though alert for native insects at all times, only a few of the native pantropical dragonfly were seen. Please refer to page 20 of the invertebrate report listed as Appendix B of Volume 2 Technical Appendices.

Important agricultural lands (IAL) dedicated by owners to long term food production have a special status supportive of agriculture operations. Having been plowed for sugar cane or heavily grazed by livestock since the 1840s, these lowlands, lacking in even a remnant of the native flora, do not support native invertebrates. Conducting an additional survey using light traps and baits on the pasture would have drawn a few flighted, lowland native insects from the Mt. Hā'upu foothills, thus would have been inappropriate methodology.

Comparisons to the findings of the HDF manure-related invertebrate assessment with the referenced 1990s study "less than 15 miles away" must, to be appropriate, cite the following major habitat differences. The referenced study covered an area including beach and two natural stream courses, up to 150 m. elevation. Also, study lights drew volant insects from nearby ʻōhiʻa [*Metrosideros*] and a Forest Reserve in Anahola Mountains. The authors note native Hawk moth [sphinx moth] "specimens were collected from light traps set in stream gulches, but it is doubtful that this species breeds in Moloa'a", nor any other pastures. Native seed bug individuals were collected from a pasture area, which suggests a breeding population in Moloa'a of *Nysius kinbergi*, a common lygaeid bug. From small trees of *Metrosideros* growing along a road cut, *3* Psocidae bark lice were taken, but, there are no native trees on the HDF site. *Anisolabis eteronoma* earwigs were under cow dung, and it is now considered to be endemic, being well known from every major island, and taken under logs, a niche that is not found anywhere on the HDF site. Based on Asquith and Messing, it is predicted fungus gnats, stream midges, crane flies, seed bugs and ground earwigs of *Anisolabis* may well be present at HDF, but they are extremely widespread throughout the main Hawaiian islands and are not rare. Host plants for the Sphinx moth were specifically searched for and NOT found, NOR were evidences of other native rare species [see EIS Appendix B, <u>Invertebrates not present</u>].

D-D

Response to Technical Memorandum, Expert Report on Pathogens, Hawai‘i Dairy Farms Draft Environmental Impact Statement, May 2016

MEMORANDUM

Group 70 International, Inc. Architecture • Planning & Environment • Civil Engineering • Interior Design • Technology
925 Bethel Street, Fifth Floor • Honolulu, Hawai'i 96813-4398 • PH: (808) 523-5866 • FAX: (808) 523-5874

TO:	HDF Project Team		
ATTENTION:			
DATE:	January 11, 2017		
PROJECT:	Hawaii Dairy Farms EIS	**PROJECT NO:**	212061-04
E-MAIL/ FAX:		**NO. OF PAGES:**	
SUBJECT:	Response to Pathogen Impacts Hawai'i Dairy Farms, Draft Environmental Impact Statement by Karen J. Murray, Ph.D., Exponent prepared July 2016 Attached to comment letter by Goodsill Anderson Quinn & Stifel LLP dated July 25, 2016 as Appendix D		

The following responses incorporate research done by Group 70 and associated technical consultants.

The report by Karen J. Murray for Exponent (July, 2016) ends with a section labeled "Limitations", which states:

> *"The information upon which we rely in preparing this report is from the HDF DEIS and from publicly available information. We have generally not verified these data independently and, unless otherwise stated, assume that they are accurate. In addition, some of the data and information generated or reported by the HDF is unclear, and we have interpreted that information to the best of our ability."*

Thus it is clear the report is not based on any first-hand knowledge of field conditions, and that the author has relied on information prepared by colleagues in the Exponent network that have incorrectly characterized rainfall and soil conditions in the report: *Water and Water Quality Impacts, Hawaii Dairy Farms DEIS, Mahaulepu, Kauai*" (Exponent, 2016). This report was attached at Appendix G of the Goodsill Anderson Quinn & Stifel LLP comment letter to the Draft EIS on behalf of Kawailoa LLP.

The inaccuracies of the water quality report by Exponent are summarized in Appendix G-G of the Final Environmental Impact Statement (Volume 5). Murray's assertion of "nearly saturated" soil conditions is incorrect as it is based on results of the 2016 Exponent Stormwater Management Model (SWMM) that utilizes worst-case weather data from a rain gauge in Līhue that does not apply to Māhā'ulepū. The model also assumes over-irrigation by HDF, portraying unrealistically saturated soils. This fundamental incorrect data is but one of the flaws within the pathogen impacts report prepared by Murray. Responses to additional inaccurate or incorrect assumptions follow.

Hawai'i Dairy Farms (HDF) is a pasture-based rotational grazing dairy specifically designed to utilize 100 percent of the manure as nutrients to grow the majority of the herd's feedstock on-site: pasture grass. This approach differs from the conventional feedlot dairy model that confines dairy cows within barns without access to pasture, and requires transferring, storing or eventually moving 100 percent of the manure offsite.

Statements made in the pathogen report regarding impacts to human and ecological health from pathogens and fecal indicator bacteria (FIB) from cow manure are both over-simplified and misleading. References throughout the pathogen report by Murray include research on swine operations and conventional cattle feedlot operations, which do not apply to HDF. Common sources of water contamination from manure include runoff and leaching from stockpiled manure or from open lots, neither of which will exist at HDF.

Technical reviews and environmental analyses documented in the 2016 Draft Environmental Impact Statement (EIS), and the Final EIS (2017) for the HDF proposed action, conclude that no noticeable nuisance impacts will extend to resort, commercial, residential or recreational areas.

The U.S. Environmental Protection Agency (EPA) recognizes the complexity of manure management and encourages comprehensive nutrient management planning to efficiently use nutrients and protect water quality. HDF has designed a state-of-the-art dairy based on the most successful island models in the world to create a sustainable dairy to reduce Hawai'i's reliance on imported milk.

HDF has utilized technical guidance from the Natural Resources Conservation Service (NRCS) to protect water quality at each step of the dairy design. HDF's Waste Management Plan, prepared following the *Guidelines for Livestock Management* by the State of Hawai'i Department of Health (DOH), was reviewed by the DOH Wastewater Branch (WWB) for an operation of 699 mature dairy cows.

While dairy cows can be a source of fecal pathogens, best management practices described throughout the EIS to protect groundwater are those recommended by NRCS and agricultural extension services such as Cornell University, University of Minnesota, University of Michigan, and Purdue University, to name a few.

Comment: Information provided in the DEIS was incomplete with regard to describing pathogen/FIB baseline conditions and did not show an understanding of pathogen risks in the Hawaii environment

As indicated in the report by Murray, Hawai'i water quality standards are based on the classification of the waterbody under the State's Water Quality Standards and are defined by the Hawai'i Administrative Rule (HAR) §11-54. Waiopili Ditch is more accurately characterized as an agricultural ditch with intermittent flow. Agricultural ditches, for the purpose of water quality standards, are classified as freshwaters/flowing waters. Section 4.17 of the EIS identifies the three primary regulatory definitions for the surface waters of Māhā'ulepū:

1. The Commission on Water Resource Management (CWRM) defines surface water hydrologic units to delineate and codify surface water resources in the State. As described in the EIS, the HDF site is located within the Māhā'ulepū Surface Water Hydrologic Unit, characterized as "relatively high precipitation with relatively low stream discharge". The HDF site is in the bottom-land of the upper Māhā'ulepū Valley, which is fed by several intermittent streams coming off the south slope of the Hā'upu Ridge. Intermittent streams in Hawai'i only flow during periods of significant rainfall that cause runoff. <u>There are no perennial streams</u> in the Māhā'ulepū watershed.
2. On the U.S. Geologic Survey quadrangle map, the main surface water that crosses the HDF site is not named.
3. The USFWS National Wetlands Inventory (NWI) assigned codes that describe the habitat type presumed by the Inventory (most information in the NWI was derived from aerial photographs and maps, not field investigations; USFWS, 2014). All of the water ditches on the property (and the *'auwai* around the margin of the valley floor) are coded "R4SBCx", which represents: intermittent (seasonally flooded) flowing water, in an excavated channel.

The definition of standards for freshwaters in the Murray report is incomplete. The following complete definition has been added to the EIS to round out the reader's understanding: HAR §11-54 does not classify for protection any flowing inland waters within the Māhā'ulepū Watershed, which puts such inland waters into Class 2 [HAR §11-54-5.1(a)(1)(C)]. "The objective of Class 2 waters is to protect their use for recreational purposes, the support and propagation of aquatic life, agricultural and industrial water supplies, shipping, and navigation... These waters shall not act as receiving waters <u>for any discharge which has not received the best degree of treatment or control compatible with the criteria established for this class</u> . . ." The HDF design incorporates the best degree of control to minimize impacts to water quality.

Waiopili Ditch receives runoff from the larger 2,700-acre Māhāʻulepū Valley sub-watershed, including the lands mauka and makai of the proposed dairy. The dairy site represents roughly 20 percent of the sub-watershed, occupying just 557 acres. With rainfall at slightly less than 50 inches annually in Māhāʻulepū Valley, this region is one of the drier areas of the island.

Complaints from the public citing the high levels of enterococcus in Waiopili Ditch and concerns about the proposed dairy prompted the State DOH Clean Water Branch (CWB) to conduct a "Sanitary Survey" of the Māhāʻulepū sub-watershed and the adjacent Waikomo watersheds. The State DOH CWB had not conducted water quality sampling for either nearshore recreation waters at the terminus of Waiopili Ditch, or of surface waters in the Māhāʻulepū Surface Water Hydrologic Unit, as the remote areas are on private lands. Priority for Hawaiʻi's nearshore water quality monitoring goes to public beaches where the general public recreates in numbers; areas accessed across private lands are typically not included due to limited funding.

Comment: FIB baseline studies did not account for seasonal (rainfall, temperature) variability

DOH CWB conducted water sampling within the Waiopili Ditch and areas upstream on five dates from November 2014 through March 2015, and initiated a series of investigations into water quality issues. The Sanitary Survey findings resulted in an expression of concern by DOH CWB that the number of injection wells and cesspools in the adjacent Waikomo watershed, which includes Kōloa and Poʻipū, are impacting the waters of the Waiopili Ditch.

The baseline conditions found in the agricultural ditch waters from Māhāʻulepū Valley includes pathogens contributed by cattle, dogs, cats, feral pigs, horses and other animals. Each of these animals represents a potential source of pathogens and FIB in the existing baseline condition of ditch waters. The Murray report lists pathogens associated with cattle manure, which are also associated with feral and domesticated animals, decaying organic matter, avian wildlife, vegetation, soils, and even insects.

<u>HDF Water Quality Surveys</u>: Marine Research Consultants, Inc. (MRCI) conducted water quality surveys of surface waters and the nearshore marine environment for the EIS and to establish a baseline of existing conditions. Working in conjunction with sampling by Tom Nance Water Resource Engineers (TNWRE) of groundwater in the area, baseline data was recorded on groundwater, surface water, and nearshore marine water quality. The rationale of the water quality assessment was to determine the contribution of groundwater to the marine environment down- gradient of the HDF site, and to provide a baseline of conditions prior to the commencement of any dairy activities. Combining this information with estimates of changes in groundwater and surface water flow rates and chemical composition that could result from the proposed project provided a basis from which to evaluate potential future effects to the marine environment. The technical reports prepared by MRCI and TNWRE are attached to the EIS as appendices E and F, respectively.

The State DOH Water Quality Standards specify "wet season" criteria for streams as November 1 through April 30 [HAR §11-54-5.2(b)]. Sampling was conducted during the wet season. However, during the 9-month period of the baseline data collection, no significant rainfall events occurred that resulted in observable flow to the ocean. This is consistent with research by the groundwater engineer that runoff from the site would be limited to periods of major rainfall events that exceed 0.8 inches. Based on the 30-year rainfall record for the area, such rainfall events are estimated to occur approximately three percent of days, or an average of 10 days annually (EIS Section 4.17.4).

Twelve survey points were established in surface waters: two up-gradient of the HDF site; eight sites in ditches that traverse or bound the HDF site; and two below the site. Six separate sampling sessions were conducted from October 2014 to July 2015. Sampling focused on nutrient and chemical constituents identified in HAR §11-54-06 (b) of the State DOH Water Quality Standards for open coastal waters. Not all sites had water within the channel on

some sampling dates; this is reflected as missing sample sites in data collected by MRCI and displayed in Tables 1 and 2 of the Baseline Conditions report (EIS Volume 2, Appendix F).

At the request of the DOH CWB, MRCI added sampling for bacteriological components on three dates during 2015. DOH CWB also conducted bacteriological testing on two dates sampled by MRCI, and on three additional dates.

Comment: FIB baseline studies did not provide any replication to understand the variability associated with the measured values

DOH CWB conducted sampling in addition to the MRCI sampling. DOH and MRCI followed the CWB Quality Assurance Project Plan. All samples were collected during the "wet" season.

Comment: The presence of FIB in the Waiopili Stream above acceptable levels prior to dairy operation . . . **and *Assertions that concentrations of pathogens will decay rapidly in marine waters receiving input from the Waiopili Stream due to "toxicity" are not supported by data***

MRCI concluded that bacteriological sampling showed indicator bacteria (*Enterococcus, Clostridium*) in surface water samples and nearshore marine samples showed no repetitive pattern: counts were high and variable within surface water sites and between times of sampling. As no dairy cow activities existed during the sampling, the high levels of indicator bacteria are the result of naturally occurring sources (feral animals), as well as other existing land uses.

The CWB results show a clear trend of an increasing enterococci concentration towards the stream mouth. The dense vegetation forms a canopy over the ditch segment where sampling sites 11 and 12 are located, blocking out a large portion of sunlight to the area. There is also a high degree of turbidity in the area. It is believed these serve as a protective barrier to the natural inactivation of the indicator bacteria by sunlight, thereby leading to elevated concentrations.

<u>Impacts Beyond the Shore</u>: MRCI also measured water quality constituents, including nutrients and bacteria, in the nearshore waters off Waiopili Ditch to establish baseline conditions for the EIS. Four ocean transects were established, extending from the shoreline to approximately 200 meters offshore. Transects were clustered near the terminus of the ditch, with transect T-1 to the east intended to serve as a control site, as it is removed from the influence of discharge from Waiopili Ditch. All data collected, along with the location, depth, and physical parameters including turbidity, are shown in Tables 3 and 4 of the Baseline Conditions report referenced above.

Comparing the characterization of nutrients and chemical constituents from surface water samples to those water samples taken in the nearshore marine area reveal that indicator bacteria were substantially lower in the ocean than in the ditch. The rapid decrease is a result of physical mixing of water masses. Water sampling results have shown that elevated levels of the indicator bacteria do not extend beyond the shoreline. Water discharged from the Waiopili Ditch connection to the nearshore ocean encounter a very well mixed coastal regime, driven by nearly constant winds, waves and strong nearshore currents. See EIS Section 4.17.3 *Nearshore Marine Waters*, and Appendix F.

It is critical to understand that soil conditions in Hawaiʻi differ greatly from North America. Research in Hawaiʻi spanning three decades shows that FIB are widely distributed in a variety of environmental habitats, even when there is little or no input from human and/or animal fecal sources. These enteric habitats include soil and sediments, beach sand, aquatic and terrestrial. Some studies have shown the existence of populations of endogenous enterococci in soil, sediment and aquatic vegetation that are not of fecal origin. Over three decades of research investigations and studies regarding soil organisms in Hawaiʻi have been published by the Water Resources Research Center (WRRC) of the University of Hawaiʻi at Mānoa.

Comment: Probable Impacts of FIB/Pathogens were not included in the DEIS despite being a known impact of dairy farming

Pathogen Minimization Measures at HDF: Pathogen prevention on a dairy begins with healthy animals. Good animal husbandry practices reduce pathogens in manure as healthy, comfortable animals have and shed fewer pathogens that sick, stressed animals. Regular vaccinations, adequate space allowance, and access to feed and water are among the recommendations that are met or exceeded in a pasture-based dairy system. EIS Section 3.4 *Herd Management* provides an overview.

Recommended best management practices (BMPs) for reduction of pathogens from manure collection and storage include use of clean-water diversions, vegetated filter strips, and fencing livestock access to waterways. Design and implementation of theses BMPS at HDF is described in Chapter 3, Section 3.3.1.7 *Stormwater Run-Off/Drainage* and Section 3.5.1 *Paddocks, Fencing and Setbacks*. Within the ponds, some anaerobic digestion will occur to break down organic component of the manure into soluble forms, typically ammonium, potassium, phosphorus and other soluble nutrients. Pathogens and bacteria are also reduced in the ponds.

With the addition of irrigation water and liquid effluent, the surface soil will be energized microbiologically (EIS, Section 4.11). Stimulated populations of microorganisms are very effective in inactivating pharmaceuticals and additives due to the reduced half-time resulting from enhanced immobilization and degradation by the superactive microbiological community.

HDF will utilize all recommended animal husbandry and NRCS practices to minimize pathogens on the site, as well as to minimize any transport offsite.

Comment: Dairy wastes are known sources of pathogens with the potential to negatively impact surface and groundwater, especially under conditions found at the proposed HDF

Purported Impacts: The potential impacts mentioned in the pathogen report are speculative and give no credence to the technical reports prepared by HDF and its primarily Hawai'i-based expert consultants. Instead, it relies on reports that use wildly different assumptions and, in several cases, incorrect data. In most cases, the assumptions are based on poorly-managed conventional feedlot dairy operations on the mainland. HDF stands by the environmental analyses conducted for the EIS, which demonstrates the dairy will not create nuisance impacts downstream or beyond surrounding agricultural lands.

One example of incorrect data relied upon in the pathogen report and prepared by another Exponent team relates to rainfall, along with completely erroneous assumptions regarding HDF's irrigation rates, which led to completely saturated soil conditions as explained on page 1 of this response. Another example of incorrect assertions by the Goodsill team is the use of American Society of Agricultural and Biological Engineers (ASABE) "book values" for manure production and nutrient excretion estimates. In the "Comments on Animal and Manure Management in Hawai'i Dairy Farms Draft Environmental Impact Statement" prepared by Deanne Meyer, Ph.D. dated July 2016 and attached to the Goodsill letter as Appendix F, Meyer overstates the amount of manure to be produced. The ASABE calculations were reasonably correct in the year 2000 but have not accounted for changes in genetics, management systems, and nutritional advances over the past 16 years. The Cornell Net Carbohydrate and Protein System (CNCPS) model used by HDF allows inputs on farm specific animal inputs, dietary inputs from available grass trials from the HDF site, and incorporate changes in farm management, genetics, and nutritional advances. So assumptions about the amount of manure output stated in the pathogen report are incorrect. A full review of the Deanne Meyer report is contained in Appendix F-F to this letter, and is included in the Final EIS, Volume 5.

Pathogen Attenuation In a Pasture-based Dairy: The soils at the proposed HDF site are shown to have a hydraulic conductivity (the rate at which groundwater passes through soils) in the range of 10.5 to 50 feet per day, compared

to those of the Kōloa-Poʻipū region that are on the order of 201 to 500 feet per day. The slow time of travel allows pathogens to die-off or degrade to a point of being benign.

This response describes HDF's minimization plan for pathogens related to both herd health and multiple best practices to retain and minimize any pathogens on site. Murray's reliance on incorrect "transport factors" and hydrology provided by another Exponent team is faulty, as previously described. Down-gradient impacts from HDF operations are not anticipated.

Comment: Pathogens are able to survive days to months within cow patties and in effluent ponds which will allow time for transport offsite

Murray cites research by Sinton et al. (2007) in association with the assertion that concentrations of *Enterococcus* in cattle manure ". . . survive up to 60 days or longer under appropriate conditions . . ." It is important to note key methods utilized in the controlled research study: half of the samples analyzed were inoculated with the pathogens; and the inoculated and field-collected samples were placed in a controlled pasture area after being formed in a molded shape to replicate a cow patty, and were protected from disruption by cattle. A conclusion of the study is that sunlight contributes to bacterial inactivation through dehydration of the patty.

The study cited (Sinton et al. 2007) begins to attempt to quantify conditions in which pathogens may survive in cow manure on pasture, however, it is hardly a definitive statement as to what will occur within the HDF pastures. Within the rotational grazing system at HDF, patties will be disrupted by cows and birds. Primary and secondary decomposers will also work to break down and incorporate manure into soils. The site is also exposed to constant sunlight, which can inactivate bacteria on the patty surface and contribute to patty dehydration. While the role of sunlight is complex, both these factors contribute to bacterial inactivation.

Comment: Pathogens related to livestock manure have been implicated in multiple outbreaks of human illness

Murray has carefully selected the livestock-related bacteria studies to support her assertion that cow manure poses a higher risk to human health impacts than that of swine or other livestock. She does not acknowledge that human-related sewage poses the highest human health risk, and does not identify the limitations and issues surrounding use of FIB to determine human health risks to bathers. Correlations have not been established between FIB concentrations and gastro-intestinal (GI) illnesses at beaches characterized by non-point sources of FIB[i]. Extra-enteric sources of FIB have been reported to multiply in environmental habitats (soil, sediments, sand, plants, algae) in tropical as well as temperate climates. It should be noted that since extra-enteric FIB multiplied in environmental habitats, such as soil rather than intestinal habitats of humans or animals, these bacteria are not indicators of fecal contamination. As a result, the numbers of extra-enteric FIB in environmental water samples are not related to degree of sewage contamination or degree of animal fecal contamination[ii].

The U.S. Environmental Protection Agency (EPA) recommends the use of enterococci as FIB. However, because the State DOH is aware of the shortcomings of enterococci as a fecal indicator, the DOH uses a secondary tracer bacterium *Clostridium perfringens* for routine monitoring of ambient surface waters. *C. perfiringens* was selected as a secondary tracer because of an observed correlation between this human-specific bacterium and human health risk. *C. perfiringens* appears to track with other human-specific pathogens which appear to originate from septic tanks[iii].

The explanation for why human fecal discharges, represented by sewage sources of FIB, are reliable predictors of GI illness rate and non-point sources of FIB are unreliable predictors of GI illness rate is based on the principle of the species barrier, which is demonstrated by susceptibility of humans to one set of disease causing pathogens and various other animals being susceptible to their own set of disease causing pathogens. Based on this principle, the

World Health Organization concluded that water, which has been contaminated by human feces or sewage effluent, has the greatest potential for transmitting diseases to humans. In contrast, water contaminated by various animal feces represents variable and generally lower risks to bathers[iv].

Studies by the EPA on health effects of recreation in waters impacted by agricultural animal fecal contamination concluded that:

- The predicted median risk of illness from recreational exposure to the cattle-impacted waterbody is 25- to 150-times lower than the risk of illness associated with human sources of contamination;
- The predicted median risk of illness from recreational exposure to the pig-impacted waterbody is approximately 30-times lower than the risk of illness associated with human sources of contamination; and
- The predicted median risk of illness from recreational exposure to the chicken-impacted waterbody is approximately 20- to 5000-times lower than the risk of illness associated with human sources of contamination.

In instances where further information is needed, the DOH uses a "toolbox" approach in which additional EPA-recommended tests are used to help determine human health risks. Because enterococci may be found in many extra-enteric secondary habitats, it is very important to understand the phylogeny of enterococci and the ecology of the group. Not understanding this and acting on enterococci concentration alone may often lead to erroneous decisions and unnecessary expenditures of limited resources that could be better utilized elsewhere. This is particularly relevant to the tropical environment of Hawai'i, where favorable growth conditions persist year-round[v].

Murray's repetitive citations of poorly managed livestock operations have nothing to do with the conditions at HDF or its impacts.

Comment: Much of the soil at the HDF is described as "anaerobic" and poorly drained, which may affect the potential for pathogens to survive and be transported offsite.

The EIS clearly explains the benefits of the soil type to the pasture-based dairy location. Soils in the Māhā'ulepū sub-watershed are formed by the poorly permeable alluvium that covers the valley floor. The alluvium is highly weathered lava that forms silty clay layer, which is described as "poorly drained". The classification of soils as poorly drained indicates a relatively slow rate water movement within soil and to surrounding areas. Poorly drained is not an indication of low or poor infiltration. Infiltration refers to the ability of water to enter the soil surface, whereas "drainage" refers to the movement of water within or from the soil profile. This slow movement allows for attenuation (reduction) of bacteria, pathogens, and nutrients from manure (EIS Section 4.3 *Soils*).

The HDF groundwater engineer demonstrated that there are two groundwater bodies within the valley that are completely hydrologically separated: shallow groundwater in valley's alluvial material, from confined groundwater in the underlying volcanics, which is the source of public drinking water. EIS Section 4.16.2 *Potable Water* identifies the flow paths identified in the source water assessment program conducted by the DOH Safe Driving Water Branch for the public drinking water wells closest to HDF. The pathlines depict the water capture is from the west- north-west; HDF lies due east (Figure 4.16-3).

In summary, Murray again relied upon faulty characterization of "saturated soils" and fails to understand the benefits of attenuation provided by the HDF site's soils.

Comment: Unlike nutrients, which the DEIS asserts will remain constant with the proposed change from a 699-head up to a 2,000-head farming operation . . . pathogens would be expected to scale proportionally . . .

<u>Pathogen Scale Change between 699 and 2,000 Herd Size</u>: A premise of the Murray report is that pathogens continue at full strength ad infinitum. This is simply untrue. Pathogens require specific conditions to survive, much less to multiply. It is incorrect to assume that there will be increased runoff with an increase in herd size. Increases in components associated with integrated pest management (IPM) such as dung beetles, and the soil microbial community, will also increase proportionally. HDF will continue to follow the same NRCS practice standards regardless of herd size.

Chapter 3 of Final EIS includes additional information on herd management and the grazing cycle. Paddocks will not be "more frequently" grazed should the herd size increase; the number of cows in each paddock will increase for the short duration within the paddock. Her statements regarding compaction do not acknowledge a basic premise of the short-duration rotational grazing method, or the properties of the thick Kikuyu grass thatch.

Should HDF decide to expand the herd to more than 699 mature dairy cows at some time in the future, additional nutrients from manure will be available to supplant that need for chemical fertilizers to meet the agronomic need of the grass crop. Setbacks from water resources identified in EIS Section 3.5.4.2 *Nutrient Balance* will be maintained regardless of the herd size.

Comment: The taro farm which is nearly enclosed by the HDF property has fields with standing water and represents another potential source and/or receptor for pathogens which was not considered by the HDF in the EIS

The pivot system is designed to effectively utilize water to irrigate the crops. GPS technology allows for accurate placement of irrigation, turning the spray off where programmed to avoid water resources. The irrigation nozzles are sized to deliver a droplet large enough to ensure water gets to the ground without evaporating or being blown away. The overhead pivot will not be operated when wind speeds exceed the system specifications.

In addition to precision irrigation technology, 20-foot setbacks on all sides of the Hariguchi site are incorporated into the HDF design. Currently, the existing lo'i are located approximately 500-feet from its northern site boundary, so setbacks are much greater.

Per the 2016 Department of Health Clean Water Branch Māhā'ulepū Sanitary Survey (DOH, 2016), the Haraguchi taro farm poses no significant risks to Waiopili Ditch as a potential contamination source.

Comment: The use of burial pits for deceased cattle described in the . . . HDF Waste Management Plan . . . presents an additional risk for pathogen transport to ground or surface waters.

HDF has adequately planned its cemetery site and incorporated Best Management Practices required to protect water resources surrounding the HDF site. The anticipated animal mortality rate for HDF is typically less than two percent for productive cows, with higher rates in young and stillborn calves, for a total of less than five percent of the herd. The animal cemetery is specifically located on the uphill side of the farm, in an area of relatively flat pasture. Site selection criteria for the cemetery paddock included protection from prevailing winds, and distance of greater than 100 feet away from any drainageway, 200 feet from any natural watercourse, 300 feet from any well, and more than 20 feet from any buildings. Within the cemetery paddock, pits will be sited based on soil suitability and slope. An area of approximately 5,000 square feet is needed for the animal cemetery at the contemplated herd size of up to 2,000 mature dairy cows, which is a fraction of a 3- to 5-acre paddock. Pits will be lined in accordance with NRCS Conservation Practice Standard, Animal Mortality Facility Code 316.

Comment: Mitigation Measures to control the risks of pathogen transport to surface and ground waters were not included in the DEIS, as no impact of the dairy farm was considered

The comment by Murray, again, ignores the best practices designed into the farm. As stated in EIS Section 4.17.4, HDF operations will follow the practice standards of the NRCS to minimize FIB/pathogen impacts. These practices include setbacks to minimize impacts to waterways. Physical setbacks will be created with fences installed 35-feet from drainageway (totaling 70-feet in width) to keep cows away from surface waters. Within the 35-foot setback, vegetation will be established to create filter strips to capture particulates during stormwater runoff. Another setback restricts application of effluent within 50 feet of the drainageways; only irrigation water will be used as needed to maintain the vegetated buffer and pasture grass, keeping nutrient applications away from waterways. Also see Section 3.5.1 *Paddocks, Fencing and Setbacks* in the EIS.

A pathogen control report prepared by scientists at the University of Minnesota (Spiehs and Goyal, 2007) notes that best management practices such as those to be used at HDF can aid dairies in reducing pathogen transfer from their operations. The setbacks will minimize stormwater runoff, and thereby pathogen transport from any fresh manure that may not yet be broken down and incorporated into soil. Mitigation measures to control risks of pathogen transport include vegetative filter strips and circulated storage ponds, such as the effluent ponds provided in the HDF project scope. Within the ponds, some anaerobic digestion will occur to break down organic component of the manure into soluble forms, typically ammonium, potassium, and phosphorus and other soluble nutrients from both feces and urine. The effluent manure is then applied to the pasture and thus is in solution and readily available for absorption by the pasture grass.

The statement regarding Figure 3.5-1 "shows a surface water ditch running through the middle of the paddocks" again points to the lack of field work conducted by Murray. From all descriptions throughout the EIS, it is clear that the old ditch is outside the HDF site. The mapping variation on the USGS quadrangle map used as the EIS base map is most likely due to survey data processing and computer-aided design (CAD) conversion factors. A perimeter fence will be erected along the HDF site that will exclude the out-of-use ditch.

Comment: . . . HDF should have a monitoring program to determine the extent of any impact . . .

HDF has documented the design and operational actions it will take to comply with NRCS practices and BMPs. Nutrient balance monitoring minimizes the agricultural impacts to surface water and groundwater by properly utilizing manure and commercial fertilizers in balance with plant nutrient requirements. By following the NRCS Nutrient Management Standard (590), HDF will optimize nutrient applications through proper timing, placement, utilization, and monitoring of nutrients. Shallow groundwater wells have been developed by HDF to provide for baseline and future monitoring.

The State Department of Health Clean Water Branch (Sanitary Survey Branch) has stated that the FIB identified in Waiopili Ditch is not attributable to the dairy. According to the DOH, the source of FIB is likely from onsite disposal systems located in the Kōloa-Poʻipu region. Further testing is ongoing to determine the source of the FIB.

HDF has collected initial baseline data on surface waters, nearshore marine waters, and shallow groundwater within the alluvium. The monitoring is focused on nutrient and chemical constituents, however, bacteriological data was collected at the request of DOH in the surface and nearshore marine waters. Periodic sampling will be ongoing. These monitoring programs will provide feedback to the dairy management team regarding changes in water quality. Increases in nutrients as a result of dairy establishment or operations can inform modification of the operation's nutrient management. Modifications to the timing and placement of effluent can be made; the rate of application can be changed; different crops can be utilized to increase uptake by plants; and the number of cows can be changed. Nutrient management is a dynamic process that is informed by monitoring a number of parameters; the ability to monitor nearby water bodies for changes in nutrients is an additional check that provides data that can be made available to the public.

Overall, the HDF EIS has demonstrated that setbacks will minimize impacts from effluent, a potential source of pathogens, from drainageways and other water resources. HDF has been designed to incorporate NRCS and other best practices for protection of water resources. Physical setbacks will be created with fences installed 35-feet from drainageway (totaling 70-feet in width) to keep cows away from surface waters. Within the physical setbacks, vegetation will be established to create filter strips to capture particulates during stormwater runoff. Another setback restricts application of effluent within 50 feet of the drainageways; only irrigation water will be used as needed to maintain the vegetated buffer.

Drainage improvements and future pasture conditions will reduce stormwater runoff through the establishment of the thick Kikuyu grass thatch, vegetated filter strips along drainageways, and maintenance of ditches. Over the long-term, the surface water quality in the agricultural ditches and Waiopili Ditch will be improved by active management of the dairy site.

References

[i] Roger S. Fujioka, Helena M. Solo-Gabriele, Muruleedhara N. Byappanahalli, and Marek Kirs. 2015. Conference Report: U.S. Recreational Water Quality Criteria: A Vision for the Future, in: *International Journal of Environmental Research and Public Health* 12(7): 7752-7776. July. doi:10.3390/ijerph120707752. Accessed at: http://www.mdpi.com/journal/ijerph.

[ii] *ibid*

[iii] *ibid*

[iv] *ibid*

[v] State of Hawaiʻi, Department of Health, Clean Water Branch (CWB). 2016. Waiopili Ditch Sanitary Survey, Kauai, Part I. Available at: http://health.hawaii.gov/cwb/files/2016/03/160328-DOH-CWB-Water-Monitoring-Mahaulepu-Sanitary-Survey.pdf

E-E

Response to Exponent Comments on Ecological Assessment In Hawai‘i Dairy Farms Draft Environmental Impact Statement, May, 2016

MEMORANDUM

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TO:	HDF Project Team		
ATTENTION:			
DATE:	December 15, 2016		
PROJECT:	Hawaii Dairy Farms EIS	PROJECT NO:	212061-04
E-MAIL/ FAX:		NO. OF PAGES:	
SUBJECT:	**Response to Exponent Comments on Ecological Assessment in Hawai'i Dairy Farms Draft Environmental Impact Statement, May, 2016.** Hawai'i Dairy Farms Draft Environmental Impact Statement		

This response and the attached responses from HDF expert consultants show that the biological surveys conducted for the dairy project are appropriate and complete. Survey methods used were designed and undertaken by biologists with more than 3 decades of experience in Hawaii, using survey protocols widely accepted for impact analyses. HDF stands by the environmental analyses conducted for this EIS, which uses reasonable and diligent processes to disclose all probable impacts and demonstrates the dairy will operate in a way that minimizes potential impact to threatened or endangered species.

Section 2.1 – Botanical Survey. <u>The botanical survey assessing the proposed project area is insufficient to predict the potential impacts to both exotic plants and threatened native plants.</u>

The complete response to this section is addressed in Appendix E-E document *"AECOS Consultants response to Exponent (2016) "Comments on Ecological assessment in Hawaii Dairy Farms Draft Environmental Impact Statement, May 2016, Botanical Survey Section 2.1"*.

The botanical survey design for HDF was based on the extensive experience of the botanical consultant, who has 49 years of experience as an ecologist in Hawai'i with the last 20 or so working as a field botanist. Each survey is designed appropriate to the resources to be surveyed and to potential impacts of the proposed project. Botanical surveys conducted for purposes of evaluating impacts from a proposed project in an EIS typically focus on rare native plant species and native ecosystems.

The nature of the site and its present and historical uses for intensive agriculture were anticipated to have limited the natural botanical resources anticipated to occur. The results of the survey substantiate this prediction: only four percent of all plants recorded during the survey were native, indicating that only species adapted to constant disturbances can survive. For the HDF project, the botanical survey determined no threatened native plants or native plant habitat occurs on the subject property (or reported from the vicinity).

Concern for the absence of threatened or endangered native Hawaiian plants, very few of which are annuals, in the dry season might be a consideration only in areas with minimal annual rainfall (less than 20 inches annually). Thus, most introduced (exotic) annuals tend to be biennials in our subtropical climate. As a strategy, annuals are typically avoiding winter freezing, a situation not occurring in Hawai'i except at high elevations. The project site is highly disturbed agricultural land and supportive of only a very limited suite of native plants. It could be argued that discovery of native plants is far more likely during the dry season when the growth of dominating weeds (exotics) is more subdued. Potential threats to listed plants on the property do not exist and conducting an additional survey in the "wet" season would not alter the findings.

Section 2.2 – Avian Survey. <u>The avian surveys assessing the bird populations and long-term planned habitat changes were insufficient to predict the potential impacts to threatened and endangered endemic birds and to predict whether exotic bird populations would increase.</u>

The response to this section is addressed in Appendix E-E document *"Rana Biological Consulting response to Exponent (2016) "Comments on Ecological assessment in Hawaii Dairy Farms Draft Environmental Impact Statement, May 2016, Avian Survey Section 2.2 and Mammalian Survey Section 2.3"*.

The Rana Biological technical report appended to the EIS clearly states that the surveys were conducted over the course of two days. Point counts were one component of the avian surveys; they are used to characterize the relative abundance of species present on the property, not to find rare species. The property was searched for habitats and species not detected during the point counts, which is the standard protocol for finding rare avian species in the Pacific.

Unlike continental areas, there is not a significant change in the avian makeup of inland areas during migration season, nor are there significant differences in avian species makeup on any given site during a specific fairly narrow breeding window as occurs in the continental United States. The time selected for the avian surveys, late August is a time of the year when migratory shorebirds are present in the Hawaiian Islands thus the surveys were conducted when the greatest diversity of avian species was expected to be present.

HDF has and will continue to coordinate with the U.S. Fish and Wildlife Service (USFWS) and the State Division of Forestry and Wildlife (DOFAW) on appropriate minimization and management actions to ensure dairy operations will not result in deleterious impacts to protected wildlife. A draft Endangered Species Awareness and Protection Plan (ESAPP) is appended to the Final EIS (Appendix L), and will be completed through further discussion with the agencies. Fencing, predator control, monitoring for potential outbreaks of avian botulism within the pond areas, and protocols for response to the presence of Nēnē or other protected species on site are further detailed in the ESAPP.

Section 2.3 – Mammalian Survey. <u>The mammalian survey assessing the mammal populations and long-term planned habitat changes was insufficient to predict the potential impacts to the endangered Hoary bat and to predict the effects of increased pest mammal species.</u>

The response to this section is addressed in Appendix E-E document *"Rana Biological Consulting response to Exponent (2016) "Comments on Ecological assessment in Hawaii Dairy Farms Draft Environmental Impact Statement, May 2016, Avian Survey Section 2.2 and Mammalian Survey Section 2.3"*.

The comment that the survey for mammalian species was insufficient to predict potential impacts to the endangered Hoary bat and to predict effects of increased pest mammal species in misleading. In the Hawaiian Islands there are no extant native terrestrial mammalian species with the lone exception of the Hawaiian hoary bat. All of the non-native introduced mammalian species present on the island are ubiquitous and widespread particularly in the lowlands. It is not standard practice for this type of a survey to conduct in-depth mammalian surveys, as is the norm in many locations of continental areas. Nor is it standard practice to attempt to quantify the potential increase in pest mammal species.

For Exponent to suggest that Hawaiian hoary bats may be put at risk by lighting fails to consider that the bats are sighted animals. As such, they are unlikely to collide with a building at any level of illumination. As stated previously, no barbed wire will be used per coordination and agreement with USFWS and DOFAW.

Section 2.4 – Other Terrestrial Fauna. <u>Other important terrestrial fauna, such as invertebrate, amphibian, and reptiles were not assessed as part of the DEIS for the proposed project area, and thus the DEIS is insufficient to predict the potential impacts to the fauna community from HDF activities.</u>

Hawai'i has no native amphibians or reptiles. The two amphibians noted during the invertebrate survey represent introduced species that are widespread throughout the lowlands will neither pose an impact to, nor will be impacted by, HDF operations. EIS Volume 2, Appendix B contains a list of invertebrates and other wildlife noted at HDF during the survey.

Section 2.5 – Aquatic Resource Surveys. <u>The aquatic resources were not surveyed, and thus the assessment of the proposed project area was insufficient to predict the potential impacts to the freshwater and marine communities from HDF activities.</u>

The response to this section is addressed in Appendix E-E document *"AECOS Consultants response to Exponent (2016) "Comments on Ecological assessment in Hawaii Dairy Farms Draft Environmental Impact Statement, May 2016, Aquatic Resources Survey Section 2.5"* and the paragraphs below.

To address comments to the Draft EIS, HDF engaged MRCI to survey the marine biotic community structure and provide baseline documentation of existing conditions. Biotopes – areas of uniform environmental conditions that provide a living place for a specific assemblage of plants and animals - were documented and described for the Māhā'ulepū area. The open coastal exposure to long-period south swells and tradewind-generated seas are reflected in the survey findings. There is essentially no biotic community structure in the areas where the ditch water flow meets the ocean.

Coral community structure throughout the nearshore zone that has a hard bottom is generally restricted to the hardy pioneering coral *Pocillopora meandrina*. Where substratum is more sheltered from wave effects or has more complexity in the form of undercuts, ridges and knolls, additional common species are seen: *Porites lobata* and *P. compressa*, and *Montipora patula* and *M. capitata*. Coral cover in such areas was 10 to 20 percent of bottom cover. The exception was a small area approximately 0.3 miles south of the ditch point of discharge, where a well-established coral community was identified. This community likely exists due to a protective lava extrusion that shelters the area from destructive waves. The corals within this area, while not common for the high-energy marine environment, are composed of the most common components of most Hawaiian reefs. Due to the distance from the discharge point (approximately 2,000 feet, or 0.3 mile), nutrient or biological inputs from the ditch would be diluted to background marine levels and have no impact.

So the only benthic communities that could be potentially affected by ditch flow are not in the direct discharge path, but rather in areas where exposure would be only to ditch water that is greatly diluted with ocean water. The effect of elevated nutrients on corals is often cited as a major concern regarding the impact of land-based discharge on reef community structure. However, the observations of MRCI's marine biologist do not support this; the following comes from a review of published scientific research related to potential effect from nutrient subsidies

on reef corals. MRCI notes Kinsey (1991) observed that it is incorrect to jump from the observation that coral reefs do well under low nutrient conditions to the conclusion that coral reefs require low nutrient environments. Atkinson and Falter (2003) state: "It is widely believed that any nutrient input to coral reefs is deleterious. This conclusion . . . is simply incorrect." Experiments at Waikīkī Aquarium and at the Great Barrier Reef in Australia show corals flourish in high nutrient environments. An empirical example demonstrating the inaccuracy of the assumption that elevated nutrients always result in negative effects to corals is the coral colonization on the sewage discharge diffusers at outfalls on O'ahu. The outfalls are located in a mixed marine environment similar to that off Māhā'ulepū.

The assumptions and speculation by Exponent and Goodsill regarding HDF operations do not warrant assessment in the EIS. The EIS sufficiently assesses the proposed action as explained in Chapter 3 through its evaluation in Chapters 4, 5 and 6. Additional information regarding the MRCI Resource Surveys can be found in the addendum to EIS Volume 2, Appendix F, *A Baseline Assessment of Marine Biotic Community Structure of Mahaulepu, Kauai, Hawaii* (MRCI, 2016).

Section 2.6 – Harmful Algae Blooms. <u>The DEIS did not address the potential for harmful algal blooms in water features on the property that could spread into the nearby marine system.</u>

Plankton or benthic algal blooms are also often associated with nutrients. The Great Barrier Reef experiment showed nutrient enrichment is not a sole or major cause of shifts in algal abundance. Benthic algal blooms on Maui that occurred during the 1990's have not returned for the last decade, indicating that nutrient input is not the sole causal factor.

The assertion that "algae blooms" will occur due to elevated nutrients from stormwater has not borne out in the nearshore marine environment off Waiopili Ditch. Even during the typical low rainfall conditions, there is always a discharge from Waiopili Ditch to the ocean, and water quality sampling has documented that the ditch water is elevated in nutrients. Therefore, it would be expected that algae blooms would be occurring under current conditions, but inspection of the nearshore mixing zone indicates that such blooms are not occurring.

A large body of scientific literature documents that, contrary to popular belief, reef corals do not necessarily require low nutrient water. In Hawai'i, Atkinson et al. 1994 showed that a multitude of corals from around the Pacific Basin growing at the Waikiki Aquarium in high nutrient marine groundwater have higher linear growth rates than corals in the wild. There is no reason to expect that a short-term exposure of a very limited community to elevated nutrients will result in any negative impacts to corals in the mixing zone of Waiopili Ditch and the ocean.

Section 2.7 – Introduction of Exotic Species. <u>The DEIS does not address the controls necessary to stop further invasive species from arriving to Kaua'i during transportation of equipment and feed, relocation of invertebrates such as dung beetles, and attraction of exotic species due to habitat changes (e.g., settling or storage ponds); thus the analysis of the DEIS is insufficient in its assessment of the impacts from the proposed project.</u>

The response to this section is addressed in EIS Volume 5, Appendix C-C. Nowhere in the EIS or Appendix B is it stated that HDF will release parasites or predators to control fly populations. HDF would not translocate any species independently. EIS Section 4.11.2 states: HDF and other ranchers on Kaua'i may choose to engage with the State Department of Agriculture to translocate dung beetle species already present in the State to Māhā'ulepū and other areas if manure-related fly control is needed. DOA has a long record of scrutiny and controls on translocation and introduction of pest control species. All work would be done through and with DOA.

Section 3.0 – US Fish and Wildlife Service Recommendation letter and Response to Recommendations. In a six-page letter from Aaron Nadig, USFW Island Team Manager, to Jeffrey Overton, USFW listed concerns and recommendations for the proposed HDF project.

HDF has and will continue to coordinate with the USFWS and State DOFAW on appropriate minimization and management actions to ensure dairy operations will not result in deleterious impacts to protected wildlife as previously explained in the response to Section 2.2. HDF is committed to operations that pose no adverse impacts to endangered species and has prepared the initial draft ESAPP with input from the agencies. In the meetings, HDF and USFWS discussed facility design and operations as well as minimization measures for the eight endangered species that may occur on or overfly the site (four waterbirds, the Hawaiian goose, two seabirds that overfly the greater Kōloa/Po'ipū area seasonally, and the Hawaiian hoary bat).

The Final EIS Section 4.10, Fauna, has been refined to clarify elements of the ESAPP as well as to incorporate USFWS comments. A draft ESAPP is appended to Volume 2 of the Final EIS as Appendix L, and will be completed through further discussion with the agencies.

E-E

AECOS CONSULTANTS RESPONSE TO EXPONENT (2016) "COMMENTS ON ECOLOGICAL ASSESSMENT IN HAWAII DAIRY FARMS DRAFT ENVIRONMENTAL IMPACT STATEMENT, MAY 2016" BOTANICAL SURVEY, SECTION 2.1

AECOS Consultants response to Exponent (2016)
"Comments on Ecological assessment in Hawaii Dairy Farms Draft Environmental Impact Statement, may 2016"
Botanical Survey, Section 2.1

The comments provided by Exponent (2016) to support their contention that the "botanical survey assessing the proposed project area is insufficient to predict the potential impacts to both exotic plants and threatened native plants" are the result of a lack of understanding of the methodologies used, the results obtained, or the significance of the results. However, all such criticisms merit serious consideration and are rebutted here.

1) *"Sampling was only conducted in the dry season, so wet season annual plants were likely missed or under represented"*

Botanical surveys conducted for purposes of evaluating impacts from a proposed project in an environmental impact statement (EIS) typically focus on rare native plant species and native ecosystems. Very few listed natives are annuals and concern for their absence in the dry season might be a consideration only in areas with minimal annual rainfall (less than ~20 inches annually). Thus, most introduced (exotic) annuals tend to be biennials in our subtropical climate. As a strategy, annuals are typically avoiding winter freezing, a situation not occurring in Hawaiʻi except at high elevations.

Seasonality, especially as it pertains to vegetation, is generally not significant in the wet subtropics. Drought years versus years of extended wet months have significance with respect to plant abundance, most particularly for exotics and survival of native plant seedlings. Wet (windward) vs. dry (leeward) areas have significance with respect to the composition of the extant flora. Dry versus wet season—not so much. The native flora is well-adapted to wet vs. dry seasonality; discovery and identification of natives is in almost no case determined by the time of year that a survey is conducted.

The project site is highly disturbed agricultural land and supportive of only a very limited suite of native plants. It could be argued that discovery of native plants is far more likely during the dry season when the growth of dominating weeds (exotics) is more subdued. The abundance of many non-native herbaceous plants would be expected to vary with the amount and distribution of prior rainfall, but discovering this sort of pattern of weedy growth is not a purpose of the botanical survey.

2) *"Plants flowering or seeding in the wet season were also likely missed or under-represented"*

To cite a beginning student book on "How to identify plants" to support a contention that the botanist might miss native plants not observed in flower or fruit is patently ridiculous. A small percentage of <u>non-native</u> plants can be difficult to identify in the absence of flowering (see "A Key to the Grasses of the Hawaiian Islands" by E. B. Guinther at http://www.aecos.com/CPIE/Grass_Intro.html), but these plants certainly would not be passed over for this reason if they in any way resembled a native species. Like all field botanists, the author encounters plants that are not immediately recognized and must be photographed or collected to identify correctly. In some cases these cannot be identified to species, and may be listed as uncertain identity in the flora list.

3) *"The methodology…used a 'wandering pedestrian transect method'…not quantitative population measures"*

Correct, there is no representation that the methodology produces a quantitative measure of the extant populations of plant species present on the site. Nor would anyone want to invest the time to produce such a result for an EIS, unless there were ecologic or economic reasons for so doing. For example, we have done quantitative surveys on native trees where a project proposed to remove some number of the trees and the total and their distribution are both important to assessing impacts. Obviously, quantitative methodologies have their purpose in certain studies of vegetation patterns, or in looking at native vs. non-native populations in semi-intact or invaded native ecosystems. Exponent's (2016) point is not a criticism of the botanical survey undertaken for this project at a location where quantitative methods could not be more inappropriate. The survey design for this project was selected based on 49 years of experience as an ecologist in Hawaiʻi, the last 20 or so working as a field botanist. Each survey I conduct is designed appropriate to the resources to be surveyed and to the project that is proposed.

4) *"The wandering pedestrian transect method would miss very small plants as the assessor is walking around"*

This statement implies the assessor just walks around without particularly looking for plants. The wandering pedestrian transect method is used precisely to prevent missing rare species, which most natives could be expected to be in the lowlands. Missing rare species would be an expected result of applying a quantitative transect method, fixing the survey area to a pre-established point or line. Using both methodologies would improve only the quantitative aspects of the result, something of very little interest in assemblages that are almost entirely non-native. And does Exponent actually believe kneeling is a part of quantitative but not part of qualitative methodologies? This point is such a complete stretch as to be bereft of validity. The conclusion that "[a]dequate assessment" requires some combination of "both methods" is unsupportable. Rebuttal points 1) and 3) address the "important seasons" and need for better quantification, respectively. Selection of survey methodology must always be based upon the need for the survey and not on unfounded generalizations as presented by Exponent (2016).

5) *"It is unclear how much of the area was sampled…a map showing recorded transects would be necessary…"*

The field botanist must make decisions while surveying as to exactly what areas are likely to enhance the species list being developed. Constantly reviewing the GNSS record of his/her track as the survey unfolds is an aid to establishing completeness in real time. The only deficiency likely revealed by routinely providing the recorded track is if the botanist missed an area that, from aerial photographs, is clearly different or unique (in terms of physiography or vegetation) from areas that were surveyed. Without combining knowledge of local physiography and vegetation, one cannot accurately assess completeness of a pedestrian survey, the primary advantage of which is the ability to explore the mosaic of habitats that can make up a survey area. The question of completeness comes down to this: were all the various habitats present explored by the botanist?

The record of the botanical "transect" is available. Typically, this map is not presented in either the technical report or the DEIS, absent a compelling reason to do so. In surveying lands with some presence of natives or other features of concern, a map is produced that shows the distribution of such features, their location being a primary reason for using a field GNSS. The route(s) travelled in such a case can have a bearing on the depiction of the distribution and perhaps the species counts. The biggest problem with displaying the route on a map as a matter of routine is that many factors important to assessing completeness are just not evident from such a map. For example, how far to each side of a track can species of interest reasonably be detected? In a pasture, this distance is far greater than in a forest or in shrub land, Mature, monotypic stands of, for example Guinea grass (*Megathyrsus maximus*), are not going to be traversed as completely as more open areas; and, since the yield of species other than the grass is generally few or none, need not be.

6) *"…The high number of invasive species highlights that Hawaii is already highly invaded. It is critical to develop sound management strategies to ensure that the proposed project does not increase the introductions or populations of invasive species."*

The Hawaii Dairy Farms project area was historically used for sugar cane production as part of the Kōloa Plantation, beginning in the 1830s until the late 1990s, when the Kōloa Mill closed. Management strategies for enhancing native plants on any developed parcel in lowland Hawaiʻi are rather limited. This subject appears to have been addressed in the DEIS in mitigation proposals.

Finally, the summary statement provided by Exponent speaks directly to the quality of the effort those authors made. To wit, "*The botanical survey assessing the proposed project area is insufficient to predict the potential impacts to both exotic plants and threatened native plants.*" First, predicting the actual or potential impact of a project to exotic species is seldom a requirement of such a survey/report, an exception being the presence of exotic specimen trees such as those listed by the City & County of Honolulu Exceptional Tree Program or perhaps others of significant resource or recreational value. Because no such specimens are extant on the subject property, the failure of the botanical survey or the DEIS to address this non-issue cannot be considered a deficiency. The second point summarized by Exponent is the insufficiency to predict potential impacts on threatened native plants. The primary purpose of the botanical survey was quite specifically to address this issue. The finding that no "threatened native plants" or native plant habitat occurs on the subject property (or reported from the vicinity) addresses this issue directly as intended. Potential threats to listed plants on the property do not exist and conducting an additional survey in the "wet" season would not alter the findings.

Submitted by:

Eric Guinther
September 26, 2016

E-E

Rana Biological Consulting Response to Exponent (2016) "Comments on Ecological assessment in Hawaii Dairy Farms Draft Environmental Impact Statement, May 2016" Avian Survey, Section 2.2 and Mammalian Survey Section 2.3

Rana Biological Consulting response to Exponent (2016): "Comments on Ecological Assessment In Hawaii Dairy Farms Draft Environmental Impact Statement, May 2016" Avian Survey (Section 2.2) and Mammalian Survey (Section 2.3)

The comments provided by Exponent (2016) to support their contention that the "*The avian surveys assessing the bird populations and long-term planned habitat changes were insufficient to predict the potential impacts to threatened and endangered endemic birds and to predict whether exotic-bird populations would increase"* demonstrate a lack of understanding of the methodologies used, standard methodologies used in Hawai'i and the Tropical Pacific, the results reported, and the significance of those results. However, all such criticisms merit serious consideration and are addressed here.

1) Exponent's comments in the first, second and third bullet points state that; sampling consisted of "*only"* 168 minutes, surveys were only conducted once, thus fail to address temporal, breeding season and migration season patterns etc.

In the Rana Biological technical report appended to the DEIS it was clearly stated that the surveys were conducted over the course of two days. Point counts were one component of the avian surveys; they are used to characterize the relative abundance of species present on the property, not to find rare species. The property was searched for habitats and species not detected during the point counts, which is the standard protocol for finding rare avian species in the Pacific. Unlike continental areas, there is not a significant change in the avian makeup of inland areas during migration season, nor are there significant differences in avian species makeup on any given site during a specific fairly narrow breeding window as occurs in the continental United States. The time selected for the avian surveys, late August is a time of the year when migratory shorebirds are present in the Hawaiian Islands thus the surveys were conducted when the greatest diversity of avian species was expected to be present.

The survey site is highly disturbed pasturage, which was formerly in sugar cane cultivation for over a century – the avian and mammalian makeup to be expected on the site is well known to anyone who has worked in the Hawaiian Islands for any period of time.

2) The Exponent comments in the fourth and fifth bullets state that the DEIS failed to provide reference regarding comparison of survey data, and state that the point count station interval was larger than the USDA recommends.

The technical report and thus the DEIS did not provide a reference to the comparison data, it should have said that the comment was based on the results of over 30 years of avian surveys conducted by the lead author on the Island of Kaua'i (David, 2016). In Hawai'i and the Tropical Pacific avian survey protocols are based on those developed by the former National Biological Survey (NBS), and further refined by the United State Geological Survey (USGS) during the Hawaii Forest Bird Surveys and subsequent iterations of said same – the lead author was one of the lead counters on many of those surveys on all islands in Hawai'i and many in the Tropical Pacific. The 300-meter spacing used on this survey is a version of those protocols developed for open habitats used originally for surveying Palila (*Loxioides bailleui*) a critically endangered finch-billed honeycreeper. A closer spacing of the point count stations in a pasture would have resulted in a significant over count of species as many of the birds in that habitat can be heard at distances greater than 300 meters – the cutoff used in this survey technique.

3) The second bullet comment under "2.2.2. Endemic endangered waterbirds" suggesting that cattle usage of the site will likely reduce nesting habitat and nesting success of protected waterbirds, and may cause mortality on young prior to fledging, is misleading. Currently there is very little suitable nesting habitat for stilts, coots or gallinules on the Dairy site. None of the protected waterbirds present on the island, with the possible exception of Hawaiian Stilt, are habitat limited. The site has been altered repeatedly as different crops, cattle ranching and farming activity has been conducted on it over the past century. The protected waterbirds on Kaua'i have long adjusted to human activity and ephemeral availability of nesting habitat, one does not have to even get out of a speeding car to see coots, and gallinules foraging in the large number of storm water ditches present along many of the roads on the Island. Any suitable habitat for Nēnē nesting in the greater Koloa area changes with farming practices. Nēnē, at least on Kaua'i, are relatively plastic in their nest site fidelity.

Minimization measures designed to avoid impacts to protected avian and bat species will be addressed in the Avian Species Protection Plan discussed in Section 4.10.2 in the EIS. Avian Species Protection Plans are frequently used to define and implement minimization and best management practices on private lands and by many utility companies. There are multiple such plans in affect on the Island of Kaua'i.

4) Comments under Exponent 2.2.4 "Effect of increasing populations of invasive species" regarding "exotic" birds are misleading. Alien avian species dominate all lowland areas in the State, Kaua'i is no exception. These species are not habitat limited. The three species mentioned in particular (Cattle Egret, Barn Owl, and Common Myna) are already present in the greater Koloa area in large numbers. State and federal wildlife agencies are aware of that reality, and are working to reduce the number of Cattle Egrets and Barn Owls on the Island. HDF has expressed willingness to support the work of these agencies on HDF lands, as well as to develop an integrated pest management program that will be included in the Avian Species Protection Plan discussed in Section 4.10.2 in the EIS.

5) Exponent comments that the assessment of alien mammalian species is insufficient to predict potential risk to the endangered Hoary bat (Exponent Section

2.3, Mammalian Survey) and to predict the effects of increased pest mammal species is misleading. In the Hawaiian Islands there are no extant native terrestrial mammalian species with the lone exception of the Hawaiian hoary bat. All of the non-native introduced mammalian species present on the Island are ubiquitous and widespread, particularly in the lowlands. It is not standard practice for this type of a survey to conduct in-depth mammalian surveys, as is the norm in many locations in continental areas. Nor is standard practice to attempt to quantify the potential increase in pest mammal species.

6) Exponent comment that "there was great concern as presented in the USFW recommendation letter". The referenced letter contained the standard list of concerns typically provided to a project prior to preparation of an environmental assessment or EIS. The USFWS dated July 25, 2016 acknowledges that barbed wire will be at ground level. HDF is following standard fencing protocol used throughout the island of Kaua'i. Concerns raised over the potential use of barbed wire on fencing will be addressed in the Avian Species Protection Plan discussed in Section 4.10.2 in the EIS.

For Exponent to suggest that Hawaiian hoary bats may be put at risk by lighting, fails to consider that Hawaiian hoary bats are sighted animals. As such, they are unlikely to collide with a building at any level of illumination.

The *Flora and Fauna Surveys Conducted for the Kauai Dairy Farms Project, Māhā'ulepū, Island of Kaua'i, Hawai'i* (Rana Biological, 2015), includes both construction and operational recommendations to minimize impacts to protected species, including shielding lights at night to reduce the potential for interaction with nocturnally flying seabirds. These recommendations will be further specified in an Avian Species Protection Plan. The lead author has developed APPs and provides biological monitoring support for private resort and golf course projects across the island of Kaua'i where Nēnē and endangered waterbirds utilize landscapes created by resorts and golf courses.

Submitted by Reginald David
August 30, 2016

E-E

AECOS CONSULTANTS RESPONSE TO EXPONENT (2016) "COMMENTS ON ECOLOGICAL ASSESSMENT IN HAWAII DAIRY FARMS DRAFT ENVIRONMENTAL IMPACT STATEMENT, MAY 2016" AQUATIC RESOURCES SURVEY, SECTION 2.5

AECOS Consultants response to Exponent (2016)
"Comments on Ecological assessment in Hawaii Dairy Farms Draft Environmental Impact Statement, may 2016"
Aquatic Resources Survey, Section 2.5

The comments provided by Exponent (2016) to support their contention that "[t]he aquatic resources were not surveyed, and thus the assessment of the proposed project area was insufficient to predict potential impacts to the freshwater… communities from HDF activities" can be addressed to some extent by the myself as an ecologist, although addressing this issue was not part of my scope of work.

1) *"No survey of the aquatic plants or biota in the freshwater features of the property was made because it was the dry season." "The water features should be surveyed for native organisms during the wet season when filled with water."*

The "season" when surveys were conducted has no bearing on the observations made with respect to the channelized streams and agricultural ditches located on the subject property. The stream is clearly intermittent in the upper part of the project and upslope from the project. Intermittent streams in Hawai'i flow when there is significant runoff (rain storms), not when it is the "wet" season. Any aquatic plants present were included in the botanical survey.

2) *"This connection [to the ocean at Gillins Beach] may allow native aquatic organisms seasonal access to the proposed HDF property"*

The connection of local agricultural ditches to the ocean may well "provide" access for some native amphidromous fauna to the intermittent stream system. This native aquatic fauna is NOT entering streams on a seasonal basis as temporary habitat of value to the species population. These organisms are freshwater animals that spend their early larval stage in the ocean and migrate into <u>perennial streams</u> as their juvenile and adult stage habitat. Migrating into an intermittent stream is a death sentence, since the species cannot find suitable habitat to establish a breeding population. In essence, suitable habitat for native, freshwater fishes, mollusks, and crustaceans is not present at the project site, nor upstream of the project site, and bears no relationship to the season for conducting surveys.

Submitted by:

Eric Guinther
September 27, 2016

F-F

Response to Deanne Meyer "Comments on Animal and Manure Management In Hawai'i Dairy Farms Draft Environmental Impact Statement", July 2016

MEMORANDUM

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TO:	HDF Project Team		
ATTENTION:			
DATE:	December 21, 2016		
PROJECT:	Hawaii Dairy Farms EIS	PROJECT NO:	212061-04
E-MAIL/ FAX:		NO. OF PAGES:	
SUBJECT:	**Response to Deanne Meyer "Comments on Animal and Manure Management in Hawai'i Dairy Farms Draft Environmental Impact Statement", July 2016** Hawai'i Dairy Farms Draft Environmental Impact Statement		

The following responses incorporate research done by Group 70 and our associated technical consultants.

Section 2. By proposing this project in Hawai'i, HDF avoids more stringent requirements applied by other jurisdictions.

Hawai'i Dairy Farms is committed to providing fresh, nutritious milk that's affordable for local families – produced in Hawai'i for Hawai'i. HDF is a positive step toward Hawai'i's food security, economic diversity, and sustainability. At steady-state, the farm will more than double existing local milk production, significantly reducing Hawai'i's reliance on imported milk from the mainland United States, which currently accounts for roughly 90 percent of our statewide supply. HDF's operations are based on the most successful island models in the world and will utilize a sustainable, pasture-based rotational grazing system and 21st century technology. Dairies in Hawai'i have been in operation for many years and are not new to the islands. HDF intends to revitalize the struggling dairy industry in Hawai'i.

HDF is dedicated and required to meet all applicable regulations and requirements for dairy operations in the State of Hawai'i and County of Kaua'i, as well as national guidelines and standards set by the USDA, NRCS, and EPA. HDF is not located in the State of California and is not subject to California regulations.

Section 3. HDF has failed to properly quantify manure production and nutrient excretion.

Many of the comments contained in Dr. Meyer's report are predicated on the estimates of manure production and nutrient excretion numbers from Standard D384.2 Manure Production and Characteristics (ASABE, 2005) which HDF does not use. The ASABE standard is outdated while HDF utilized an updated and more accurate Cornell Net Carbohydrate and Protein System (CNCPS) model, rendering the comments invalid. The ASABE standard is less accurate for the following reasons below:

HDF's Nutrient Balance Analysis is predicated on farm specific inputs and calculated outputs using the Cornell Net Carbohydrate and Protein System (CNCPS) model. While the Standard D384.2 Manure Production and Characteristics (ASABE, 2005) can still be used today to estimate manure production and nutrient excretion, the

CNCPS model uses more realistic nutrient inputs. ASABE is a simplified and general standard last updated in 2005. The ASABE calculations were reasonably correct in year 2000 but have not accounted for changes in genetics, management systems, and nutritional advances over the past 16 years. The ASABE equations, unlike the CNCPS system, does not use farm specific animal, environmental, and dietary inputs to determine its manure production and nutrient excretion estimates, and instead uses "book values".

NRCS Conservation Practice Standard Code 590 – Nutrient Management allows for the use of realistic nutrient inputs when planning for nutrient outputs. The manure production and nutrient excretion estimates from the CNCPS model are more accurate and represent farm specific animal inputs, dietary inputs from available grass trials from the HDF site, and incorporate changes in farm management, genetics, and nutritional advances. Therefore the CNCPS model is more accurate than if manure excretion and nutrient output was based upon "book values".

The commenter's manure production and nutrient excretion estimates table, based upon "book values" of the ASABE Standard, uses the publication Dairy NRC 1988 for diet formulations and input (NRC is the National Research Council that published a handbook, "The Nutrient Requirements of Dairy Cattle"). The 28 year old Dairy NRC 1988 is the predecessor of the most recent NRC publication, last updated in 2001. Because of obsolescence associated with these NRC predictions, the 2015 CNCPS model was used for HDF calculations.

References to the CNCPS model calculations can also be found in peer review scientific literature, namely, in the Journal of Dairy Science 98:6361–6380 The Cornell Net Carbohydrate and Protein System: Updates to the model and evaluation of version 6.5 M. E. Van Amburgh, et. al. and also in the JDS 95 :2004–2014 Development and evaluation of equations in the Cornell Net Carbohydrate and Protein System to predict nitrogen excretion in lactating dairy cows R. J. Higgs, et. al. and JDS 81: 2029 - 2039 Evaluation and Application of the Cornell Net Carbohydrate and Protein System for Dairy Cows Fed Diets Based on Pasture Kolver, E.S. et al.

Section 4A: HDF does not quantify the total number of dairy animals associated with the project.

At any given time, HDF will have a total of up to 699 mature dairy cows, including both lactating and dry cows in the proposed project or up to 2,000 mature dairy cows in the contemplated project. Non-milking or dry cows will be managed off-site. It can be conservatively assumed that there will be approximately 85 percent milking and 15 percent dry animals on the farm at any given time. Therefore, calculations to determine manure effluent pond capacities and manure collection volumes per day, at the milking facility, are slightly conservative as dry cows will not enter the milking parlor as they will not be milked. However, the total number of animals in terms of manure production and nutrient excretions on the entire farm and pastures are estimated to include both lactating and dry animals.

Therefore, the estimated total number of animals of 892, presented by the commenter, is incorrect, as the numbers provided by HDF in the EIS include both lactating and dry animals, and the expected number of calves. The EIS will include the environmental impacts of the total animal numbers on the farm, based upon the total number of mature dairy cows on the farm, including both lactating and dry animals, and the expected number of calves.

Mortality rates on the farm are projected to be less than 5 percent annually. These rates apply to producing cows, baby calves (less than 60 days old), as well as stillborn animals. Producing cows will have lower mortality rates than newborn or young stock.

Replacement animals will be moved off-site and will be replaced at roughly one replacement animal for one mature dairy cow at HDF. The replacement animals will be managed on off-site ranches and will not contribute manure or added nutrients to the HDF project site. Cows in various stages of lactation and rest will be transferred between HDF and other ranches as needed for animal health and dairy productivity. The availability of calves from a dairy such as HDF provides new animals to maintain or expand a beef herd. Each ranch will determine its capacity based on business and operational goals. Two ranches on Kaua'i have initially expressed an interest in taking HDF calves and cows. Manure from these off-site animals grazing is not being reused or applied to crops for fertilization purposes, so the State and County do not regulate the total number of animals on these sites. Therefore, housing of off-site animals will comply with applicable rules and regulations.

Section 4B. HDF's Waste Management Plan Underestimates the number of calves.

Review of a Waste Management Plan (WMP) is a function of the Wastewater Branch of the Department of Health (DOH) in accordance with the DOH Guidelines for Livestock Management (2010). The WMP review process is not part of an Environmental Impact Statement, or subject to public review and comment.

However, as noted above, the number of mature dairy cows on the farm will not exceed 699 in the proposed project or up to 2,000 in the contemplated action. Therefore, this comment is incorrect as it does not account for the proper number of animals. HDF estimates 150 calves to be on-site for the 699 mature dairy cowherd size and not 205 calves that is incorrectly estimated by the commenter. HDF's estimate is based upon the advice and expertise of HDF's dairy manager, as well as national dairy consultants, and aligns with the planned management of the farm.

As mentioned and acknowledged in the comment, the calves moved off-site will need to be raised by growers and off-site ranchers. The total number of animals allowed upon these off-site ranches is not regulated by the State of Hawai'i and County of Kaua'i on properly zoned and entitled ranch properties, because manure from these off-site animals is not being reused or applied for nutrient and crop fertilization purposes, and the animals will only be grazing.

Section 4C. HDF does not provide sufficient information to precisely quantify manure production.

HDF has provided manure production quantities in Appendix D, Nutrient Balance Analysis to the EIS. HDF estimates that each mature dairy cow will produce 90.8 lbs. of manure per day. To obtain this quantification, HDF and its consultants utilized the Cornell Net Carbohydrate and Protein System (CNCPS) model. Within this model, farm specific animal types, dietary inputs, forage inputs, and other environmental considerations are used to estimate manure production as well as milk production numbers on a per cow per day basis.

As the commenter states, milk production numbers are taken into account into the manure production estimates, but are not required to be provided as part of a nutrient balance calculation such that the proper feed inputs and manure outputs are utilized in the calculations. The potential environmental impact is from the manure production and not specifically the milk production numbers. While manure production is dependent on the milk production – the environmental impacts can be measured by manure production numbers only. Other factors related to milk production, such as traffic (truck loads), etc., are described in the EIS.

The DEIS has also been revised to eliminate the inconsistency in the overall milk production estimated for the entire year. The correct annual milk production estimate for HDF is nearly 1.5 million gallons at the committed herd size of 699 mature dairy cows.

Section 4D. HDF calculates manure production incorrectly.

As previously stated, HDF has utilized the Cornell Net Carbohydrate and Protein System (CNCPS) model to estimate and calculate its manure production from the committed and contemplated herd sizes of 699 and up to 2,000 respectively. The results of that model show that the cow will produce 90.8 lbs of manure per day, which is reasonable and realistic for a pasture-based, rotational-grazing dairy system and not underestimated, and is sufficient for planning for nutrient management of a new dairy operation.

While the comments utilize the ASABE equations and standard to estimate manure production and nutrients excreted, the CNCPS provides a much more accurate accounting of manure and nutrients on the farm, and for a pasture-based, rotational-grazing dairy system. It is true that the Standard D384.2 Manure Production and Characteristics (ASABE, 2005) can be and is still used today to estimate manure production and nutrient excretion.

However, ASABE is a simplified and general standard last updated in 2005. The ASABE calculations were reasonably correct in year 2000 but have not accounted for changes in genetics, management systems, and nutritional advances over the past 16 years. The ASABE calculator, unlike the CNCPS system, does not use farm specific animal, environmental, and dietary inputs (i.e. grass quality and nutrient content) to reach its manure production and nutrient excretion estimates. Refer to the previous comment responses as well.

Additionally, the calculations within the comments are misrepresented, erroneous, and not based upon the farm-specific and field-tested values provided in the Nutrient Balance Analysis:

Manure produced per day per mature dairy cow = 90.8 lbs. per day = 10.9 gallons per day. This value is for the entire 24-hour day, and includes periods when the cow is awake, resting, milking, or walking. Therefore, on a true 24-hour cycle, the cow produces only 0.45 gallons per hour. However, HDF has conservatively estimated that the cow manure amounts used in the effluent pond sizing would be based upon the assumption that the majority of manure will be produced while awake (16 hours total, 14 hours in the pasture or walking, 2 hours in the parlor). Therefore, in a 16-hour period, the cow produces 0.68 gallons per hour using the same overall manure production of 10.9 gallons per day. This results in a larger capacity effluent pond system, designed to store more manure captured within the 2 hour milking time at the parlor, and is reflected in the DEIS and the Nutrient Balance Analysis. Based upon the reasoning in the comment, HDF could have elected to size the ponds for 0.45 gallons per cow per hour, resulting in a smaller capacity pond system, but did not.

Additionally, the total manure excretion over a 24-hour period is misrepresented as 16.32 gallons per cow, when the NBA clearly states that the total cow manure produced per day is 10.9 gallons per cow, determined by the more accurate CNCPS model. The comment intentionally uses the conservative hourly estimate of manure production described (for 16 hours), that it believes is incorrect, and then applies it over the entire 24-hour day in a fashion to exaggerate results. The overall manure production per cow per day is 90.8 lbs. or 10.9 gallons, regardless of if the production is uniform or not, throughout the day. This is the basis of all calculations.

While the commenter mentions the Updated Waste Management Plan submitted to the DOH in May 2016 as well, that document is not part of the EIS. Review of a Waste Management Plan (WMP) is a function of the Wastewater Branch of the Department of Health in accordance with the DOH Guidelines for Livestock Management (2010). The WMP review process is not part of an Environmental Impact Statement, or subject to public review and comment.

HDF updated its 2014 WMP for up to 699 mature dairy cows to reflect refinements identified during the planning process and field-tested data. HDF operations, as documented in the original and updated WMP, are reflected in the EIS, and are consistent with Appendix D, Nutrient Balance Analysis for Hawai'i Dairy Farm. DOH has reviewed the updates and its comments have been sufficiently addressed (no further comments).

Section 4E. HDF underestimates nutrient output from the proposed dairy project.

As previously mentioned, the total number of animals on the farm will include 699 mature dairy cows, including both lactating and dry animals, as well as 150 calves, or up to 2,000 mature dairy cows including both lactating and dry animals, as well as 500 calves. All manure and nutrient excretions from the total number of animals are provided in Section 8 of the Nutrient Balance Analysis. Refer to the previous responses regarding discussion on the quantity of manure or nutrients, based upon the CNCPS model versus ASABE "book values" which do not take into account farm specific and field-tested data from HDF's site, or account for 16 years of changes to management systems, genetics, or nutrient and diet advances.

Excretions regarding off-site animals were not ignored. Based upon arrangements with off-site ranchers and managers for the replacement herds, the animals held off-site for HDF will either replace existing animals at a 1:1 ratio, or will be added to these off-site locations. The total number of animals allowed upon these off-site ranches is not regulated by the State of Hawai'i and County of Kaua'i on properly zoned and entitled ranch properties, because manure from these off-site animals is not being reused or applied for nutrient and crop fertilization purposes, and the animals will only be grazing.

<u>Section 4F. HDF has not provided sufficient information to assess nutrient mass balance at paddock scale.</u>

Hawai'i Dairy Farms will comply with the conditions and requirements as set forth by:

- State of Hawai'i Department of Health (DOH). January 19 2010. *Guidelines for Livestock Management*. Prepared in collaboration with the University of Hawai'i at Manōa, Cooperative Extension Service, College of Tropical Agriculture and Human Resources, West Maui Soil & Water Conservation District, USDA – Natural Resource Conservation Service, U.S. Environmental Protection Agency – Region 9.
- Natural Resources Conservation Service (NRCS) Pacific Islands Area. November 2012. *Conservation Practice Standard - Nutrient Management* Code 590. Field Office Technical Guide (FOTG) Section IV.

HDF will follow an adaptive nutrient management process, as prescribed in the Guidelines and Conservation Practice Standards, which will be adjusted and monitored as the farm is established and grass nutrient content, manure testing, and milk production numbers are confirmed. In planning for the establishment of the pasture-based dairy, HDF is using realistic grass yield values and nutrient content projected from site-specific field trials, climatic conditions, soil nutrient sampling data, and other environmental conditions to consider nutrient management and appropriate application rates. Nutrient timing and application will not exceed the agronomic need of the kikuyu crop.

HDF's Nutrient Balance Analysis meets both standards listed above in terms of assessing nutrient mass balance.

Additionally, for the committed herd size of 699 mature dairy cows, HDF's Waste Management Plan (July 2014, Updated May 2016) identified Conservation Management Units (CMU), which typically consisted of around 5 paddocks, grouped based upon proximity and underlying soil types. The purpose of the CMU's was to identify where potentially different nutrient management techniques could be used amongst the different CMU's, based upon soil types (i.e. the timing, placement, and specific amounts of nutrients applied would be adaptively managed as much as practical to meet the agronomic need of the crop). While the Waste Management Plan identified these management units, the overall nutrient application recommendations (nutrients per month or per year) for each CMU were consistent among each other based upon soils testing data from Spectrum Analytics. Each CMU is anticipated to be able to produce the anticipated grass yields, based upon field trials. HDF would prepare a similar plan for a herd size that would exceed 699 mature dairy cows on the farm, as required by applicable State and Federal laws.

As confirmed by the "Hawai'i Dairy Farms Baseline Nutrient Status: Implications for Long-Term Sustainability, Productivity, and Soil Health" soils report by Dr. Russell Yost, Nicholas Krueger, at the University of Hawai'i at Mānoa, there are two main groupings of soils on the HDF site, of which both are suitable for kikuyu grass growth. While each grouping may require separate management techniques in terms of its physical, chemical, and nutrient properties, including pH, salinity, percolation and infiltration, nitrogen and phosphorus concentrations, etc., yield goals exceeding 20 tons of DM per acre per year are achievable, are not expected to vary by soil type or soil management measures, and are supported by two years of grass trials. Therefore, for the purposes of the Nutrient Balance Analysis, and in accordance with NRCS and DOH guidance, nutrient mass balance assessments were considered for the pasture areas using uniform grass yields and nutrient uptake numbers, as part of planning for the farm's operation.

Additionally, because the soils are so deficient in nutrients, there is no impact from uniform application. As the farm is in operation, an adaptive nutrient management process will commence to identify specific Conservation Management Units, scheduled for different management techniques. Soil, forage, and manure testing and analysis will inform any adjustments needed for the different management zones to efficiently and properly apply nutrients to maximize nutrient uptake.

As mentioned, a supplemental Waste Management Plan will be prepared if HDF anticipates moving past the committed herd size of 699 mature dairy cows, and will continue to be amended should HDF approach the upper limit of up to 2,000 cows (HDF will likely add additional livestock incrementally and to the carrying capacity of the farm). This plan is not required at this time as the committed herd size is 699 mature dairy cows. However, it is mentioned because the plan must be submitted and reviewed by DOH, similar to HDF's currently reviewed plan for operations of up to 699 mature dairy cows.

Many of the additionally requested items from the comments are provided:

1. Irrigated areas and irrigation types by area. See Section 6 of the NBA.
2. Nutrient application rates (in lbs. per month by nutrient type). See Section 8.4 of the NBA.
3. Nutrient application rates by application type. See Section 8.4.4 of the NBA.
4. Productivity (in tons DM per acre per year). See Section 8.3.5 of the NBA.
5. Nutrient Uptake (in lbs. per ton DM). See Section 8.3.5 of the NBA.

Regarding the yields for non-irrigated pasture, HDF has conducted more than 2 years of grass yield trials on HDF sites, and has engaged Farms n' Forages to complete these trials. Farms n' Forages has extensive experience in grass and forage production on each of the major islands in the Hawai'i. Based upon the field trials, utilizing primarily Kikuyu grass mixed with some guinea grass, and interspersed with diversified forages from November to March, average annual yields on the HDF site can be estimated and range from 17 tons DM per acre per year to over 20 tons DM per acre per year, with appropriate fertilizer as recommended by the HDF's grass & forage expert and irrigation applications that do not exceed the agronomic need of the crop. Monthly yield values often exceeded 20 tons DM per acre per year in the summer months and lowered to between 15 and 18 tons DM per acre per year in the winter months (with diversified forage). This was verified by forage testing and on-site soil sampling performed by Farms n' Forages (grass yields), Spectrum Analytics (soils and fertility recommendations), Cumberland Valley Analytic Services (grass nutrient) as well as Dr. Yost (soils and fertility recommendations).

Farms n' Forages also has experience with non-irrigated pastures in Hawai'i and have previously measured approximately 30 to 40 percent greater yields in irrigated pastures than in non-irrigated pastures. Approximately 74% of HDF's pastures are irrigated and 26 percent are non-irrigated, and must be taken into account in the yield estimates, as noted by the comments.

Incorporating these factors into the grass yield estimates, HDF believes that 16.3 tons of DM per acre per year is a conservative, reasonable, and realistic weighted annual yield goal which meets NRCS Conservation Practice Standard - Nutrient Management Code 590 requirements for both irrigated and non-irrigated fields combined and accounts for seasonal variability. Code 590 requires that a realistic yield goal be used in the planning of a new dairy operation. The 16.3 tons of DM per acre per year is a conservative production estimate, considering the irrigated fields can yield over 20 tons of DM per acre per year in the summer and between 15-18 tons DM per acre per year in the winter. It also takes into account the reduction in yields from non-irrigated fields. Once the farm is in operation, HDF will adaptively manage the timing and placement of nutrient, in conjunction with the expected and realized yields of the paddocks, to ensure that there is no over-application of nutrient and that the timing of application is as close as practical to meet the agronomic need of the crop.

HDF will also manage the application of nutrients from each application type (as-excreted, liquid effluent, slurry) based upon if the field is irrigated or non-irrigated. Irrigated fields with higher yields may be utilized more in the 18-day rotation cycle, while non-irrigated fields with lower yields will be utilized less as part of the 18-day rotation depending on the yields obtained, to ensure that nutrients are not over applied.

From a nutrient balance and nutrient accounting standpoint, the annual weighted yield average accounts for the lower yields expected from non-irrigated portions of the pasture and during the winter months, and incorporates that into the nutrient uptake (an overall lower yield average means less overall nutrient uptake). Proper management of the farm's operation, by season, is critical to ensure that the non-irrigated areas are utilized properly, especially in the winter months.

HDF also plans to utilize reserve forage to reduce the amount of commercial feed it needs to bring in as the amount of grass forage does not provide for all of the nutrients the cow requires. Excess forage, which may be gathered in higher yielding months, would allow for supplementing with reserve forage in lieu of commercial feed during lower yielding months. Paddocks not utilized may be harvested via the swathing and baling of the grass. These bales will be stored for use in the winter months or used to supplement feed.

Many of the remaining questions are answered in various sections of the DEIS. The commenter is requested to review the other sections with respect to the amount of commercial feed required and milk production. While related to nutrient balance, they are not the end results. The end results are specified in the Nutrient Balance Analysis showing that the animal sources of nutrient are not enough to support the grass growth required within the committed herd size of 699 mature dairy cows. At 16.3 tons of DM per acre per year of production, a weighted average amongst irrigated and non-irrigated fields at HDF's site and accounting for seasonal variability, additional commercial nitrogen and fertilizer will be required. The amount of grass produced will satisfy a majority of the cow's diet.

At the 2,000 contemplated herd size and 16.3 tons of DM per acre per year, phosphorus applications per month are projected to exceed the demand of the crop at 16.3 tons DM per acre per year. HDF will adaptively manage the nutrients in this scenario and either manage a herd size less than 2,000 (HDF will incrementally increase animals such that there is no actual over application), or could realistically see yields greater than 16.3 tons of DM per acre per year over the entire farm, even with irrigated and non-irrigated areas or seasonal variability taken into account, which would mean that all sources of manure would not meet the plant requirement at a higher yield.

Section 4G. Animal Cemetery.

HDF has adequately planned its cemetery site and incorporated Best Management Practices required to protect water resources surrounding the HDF site. The anticipated animal mortality rate for HDF is typically less than 2 percent for productive cows. Greater numbers of animal mortality are expected for the young and stillborn calves, consisting of between 4 percent and 5 percent of the herd size. The animal cemetery is specifically located on the north side of the farm, in an area of relatively flat pasture.

Site selection criteria for the cemetery paddock included protection from prevailing winds, and distance more than 100 feet away from any drainageway, 200 feet from any natural watercourse, 300 feet from any well, and more than 20 feet from any buildings. Within the cemetery paddock, pits will be sited based on soil suitability and slope. An area of approximately 5,000 square feet is needed for the animal cemetery at the contemplated herd size of up to 2,000 mature dairy cows, which is a fraction of a 3- to 5-acre paddock.

A containment berm will be created around the pit area to prevent both run-off on to, and from, the cemetery site. Six (6) pits, approximately 20' x 40' overall and 8 to 10' deep, are designed to accommodate carcasses of up to 150 cows and 360 calves or stillborn animals at any given time, sized to accommodate anticipated mortality numbers for the contemplated herd size of up to 2,000 mature dairy cows. The design is provides approximately 2 years of cemetery capacity. Individual pits within the area will be a minimum of 2-feet wide with a length appropriate to bury the carcass. Pits will be lined in accordance with NRCS Conservation Practice Standard, Animal Mortality Facility Code 316, to protect groundwater quality. Each animal carcass will be dusted on all sides with ground limestone. The bottom of each pit will be also dusted. Pits can be reused every 18 to 24 months, which is the typical time for a carcass to decompose.

Pit bottoms will be level, and carcasses will be placed in a single layer and covered with at least 2 feet of organic material. Multiple layers may be created, if needed, with subsequent burials, or additional area within the cemetery paddock may be used as needed. Based on preliminary analysis, HDF does not anticipate encountering groundwater in the cemetery paddock area when excavating the pits. The cemetery area will not be grazed and will be fenced.

HDF may also consider procuring and installing an incinerator to use for managing mortality on the farm. The incinerator would meet the appropriate guidance from NRCS Conservation Practice Standard – Animal Mortality Code 316 as well as State and EPA emissions regulations, to ensure no adverse air quality impact from the incinerator operations.

Section 4H. HDF has failed to describe or quantify offsite impacts.

Refer to comment response to comment 4E.

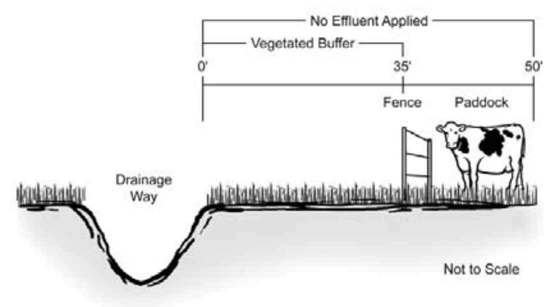
Section 4I. HDF failed to establish management measures for stream buffers.

The main drainageways within the HDF property have two setbacks:

1. A physical setback of 35'. No dairy animal is physically allowed within 35' of the drainageways on the HDF site (fenced off). In addition, these 35' areas will be vegetated to protect water quality within the drainageways, in accordance with NRCS Conservation Practice Standards and guidance.

2. An irrigation setback of 50'. No irrigation with effluent is allowed within 50' of the drainageways on the HDF site. Irrigation with non-effluent water (i.e. water from Waita Reservoir only) would occur to ensure proper vegetation growth of the remaining paddock area outside of the 35' fenced setback or of the 35' vegetated buffers themselves.

The 35' vegetated buffers will not be regularly mowed but will be maintained to protect water quality and reduce overgrowth to maintain flow capacities of the drainageways. Plant matter removed from the buffers will not be discharged directly into the water resource.



Section 4J. HDF has inconsistencies in representing and underestimates vehicle trips that will enter or leave the dairy daily.

The EIS sections labeled "Roadways and Traffic" (Sections 4.18.2, and 4.24.2) identifies the types and number of vehicular trips to and from HDF along county and state roads in the area for both the committed herd size of 699 mature dairy cows, and the contemplated herd size of up to 2,000 mature dairy cows. Vehicles include milk trucks, initially one truck every two days at the committed herd size and increasing to two per day at the contemplated herd size; delivery trucks for sand and feed initially three truck loads per week, increasing to four to five per week at the larger contemplated herd size. A farm truck with stock trailer to move animals to and from off-site ranches is initially anticipated at less than one per day, increasing to two daily trips with the contemplated herd size. Employees, veterinarians, inspectors, and vendors are also included in the daily trip counts.

At the committed herd size of 699 cows, 12 vehicle trips per day would result from HDF operations over the long-term. A summary of all regional traffic with projections to 2035 is shown in Table 4.18-1 of the EIS; HDF trips would increase projected traffic by less than one-twentieth of one percent (0.17 percent).

For HDF operations at the contemplated herd size of up to 2,000 mature dairy cows, additional vehicular trips are projected at 11 more per day than at the committed herd size. The projected trips totaling 23 vehicles per day would include employees and delivery vehicles, and represents an increase in the regional traffic of less than one-third of one percent (approximately 0.30 percent).

Section 4K. HDF has failed to quantify solid waste impacts.

HDF's operation will generate solid wastes, as any other commercial or agricultural operation would, that must be properly disposed of at appropriate County of Kaua'i trash and solid waste facilities. However, the generated waste will not negatively impact the municipal refuse operations on Kaua'i.

HDF anticipates that only one small trash dumpster will be required to handle solid wastes from the facility and farm per week. No feed bags will be used as trucks will bring feed in to a storage silo, and wastes will typically consist of containers and bags for items such as herbicides, pesticides, and sanitizers, as well as paper towels and other waste typical of agricultural and dairy operations. Pharmaceuticals will be disposed of properly in biohazard bags but are not anticipated in large quantities.

Section 4L. HDF Failed to Consider Reasonable Alternatives.

Determination of the project purpose and need is explained in Chapter 2 of the EIS. Alternative locations were evaluated early on in the formation of the HDF project. With a common interest in agricultural self-sufficiency for Hawai'i, Ulupono Initiative partnered with Finistere Ventures, Grove Farm, Kamehameha Schools, and Maui Land & Pineapple to conduct conducted grass trials on four islands to identify lands capable of producing nutritious forage for dairy cows. Additional operational needs for a pasture-based dairy were identified. Only two sites, both on the island of Kaua'i and both owned by Grove Farm, met most of the site requirements related to forage and operational needs. A successful dairy venture requires a long-term lease, ample water source, and relatively flat land to avoid stress on cows. Māhā'ulepū Valley was the only site that met all requirements.

G-G

RESPONSE TO EXPONENT, "WATER AND WATER QUALITY IMPACTS, HAWAI'I DAIRY FARM DEIS, MĀHĀ'ULEPŪ, KAUA'I", JULY 2016

MEMORANDUM

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TO:	HDF Project Team		
ATTENTION:			
DATE:	December 21, 2016		
PROJECT:	Hawaii Dairy Farms EIS	PROJECT NO:	212061-04
E-MAIL/ FAX:		NO. OF PAGES:	
SUBJECT:	**Response to Exponent, "Water and Water Quality Impacts, Hawai'i Dairy Farm DEIS, Māhā'ulepū, Kaua'i", July 2016** Hawai'i Dairy Farms Draft Environmental Impact Statement		

The following responses incorporate research done by Group 70 and our associated technical consultants.

Footnote Page 4: The Hawai'i Department of Health (HDOH) sent a letter to Mr. Paul T. Matsuda at Group 70 International on 15 June 2016 (HDOH, 2016) stating that wastewater effluent from the proposed storage pond should not be distributed via irrigation gun. Presumably, HDOH would also object to distributing manure slurry from the settling pond via irrigation. Thus, it is not clear that the proposed slurry distribution methodology is feasible from a regulatory perspective

To put the question into context, DOH requested a single clarification to the Waste Management Plan Updates submitted to DOH in May 2016. Review of a Waste Management Plan (WMP) is a function of the Wastewater Branch of the Department of Health (DOH) in accordance with the DOH Guidelines for Livestock Management (2010). The WMP review process is not part of an Environmental Impact Statement, or subject to public review and comment.

HDF updated its 2014 WMP for up to 699 mature dairy cows to reflect refinements identified during the planning process and field-tested data. HDF operations, as documented in the original and updated WMP, are reflected in the EIS, primarily in Appendix D, Nutrient Balance Analysis for Hawai'i Dairy Farm.

In a June 15, 2016 letter, DOH asked for confirmation that the areas previously designated for drip irrigation using only irrigation water, now planned for gun-irrigation (61.4 acres outside of the pivot extent in the southwest portion of the farm), would use irrigation water from Waita Reservoir and liquid effluent from the storage ponds would not be applied by the gun irrigators. Group 70 responded in a July 6, 2016 letter that this particular area will not receive effluent water from the storage ponds via the gun system and will utilize irrigation water only from Waita Reservoir. In a final July 13, 2016 letter response, DOH indicated there were no further comments.

The "inference" that DOH would not approve of any manure slurry application via the gun system is erroneous:

1. Application of manure slurry is recommended by the DOH, "Slurries may be distributed through an irrigation system equipped with nozzles that have a large opening." Refer to: State of Hawai'i Department of Health (DOH). January 19 2010. Guidelines for Livestock Management. Prepared in collaboration with the University of Hawai'i at Mānoa, Cooperative Extension Service, College of Tropical Agriculture and Human Resources, West Maui Soil & Water Conservation District, USDA – Natural Resource Conservation Service, U.S. Environmental Protection Agency – Region 9. Appendix Page B.13, #6 - Utilization.

2. DOH has reviewed HDF's Waste Management Plan (WMP) for the 699 cow scenario, dated July 23, 2014, which indicated gun-applied slurry in certain other areas, and had no comment.

3. The comment from DOH regarding the WMP Update submitted in May 2016 purely focused on the gun-irrigation of liquid effluent from the storage ponds and not a slurry mixture. No gun-irrigation of liquid effluent is proposed anywhere on the farm. All liquid effluent is applied via the center pivot system.

8. Appendix K provides insufficient details on hydrologic drainage design calculations.

1. Design calculations for runoff from the 9.7 acre HDF headquarters area specifically are not required at this time, as the majority of runoff from impervious surfaces at the facility drain into the effluent ponds and are accounted for in the design of the effluent ponds. The 9.7 acre headquarters area site piping design and sizing to ensure adequate conveyance, based upon applicable codes and standards, and will be completed following acceptance of the EIS. The runoff from the remaining area around the facility flows overland towards the pasture, and the increase in runoff from existing conditions from these remaining areas is negligible compared to overall sources of contributions of runoff within the valley.

2. Inputs into the TR-55 model are provided in Tables 3 and 5. Outputs are provided in Tables 3 and 5 and the appendix.

3. The data used included the project site's topographic survey and publicly available elevation models provided by USGS (see Figure 3 in the report). Refer to Figures 8 and 9 for ditch location and flow patterns on the site. Refer to Tables 3 and 5 for time of concentration inputs into the TR-55 model, including lengths of flow, slopes, and surface conditions.

9. Appendix K seems to employ an incorrect SCS curve number for areas draining to "Mahaulepu Ditch East."

Table 3 of the report contains a typographic error, only, in the SCS curve number (CN) identified. The CN for Mahaulepu Ditch East should read 69 and has been updated in the report. The related calculations utilize a CN = 69 and the results reflect the correct value of CN = 69.

10. It does not appear that calculated peak design flow rates were used to evaluate existing drainage structures at the HDF site.

The purpose of the analysis was to determine if there were any negative impacts from the proposed project compared to existing conditions, from the development of the site into a dairy farm. Because HDF will improve pasture conditions and incorporate kikuyu grasses with a thick thatch, peak runoffs will be attenuated and reduced. There is no negative impact to existing infrastructure from a project that reduces peak runoff and peak flows.

Specific hydraulic analysis of existing drainage structures will be done when the farm construction plans are prepared and if existing structures must be upgraded to adequately convey run-on and off-site flows, those structures will be identified and improved to ensure proper conveyance, according to applicable codes and standards.

Peak flow rates from the SWMM model presented in the comments are not representative of the project site, and simply unrealistic. *Rainfall data used in the SWMM model was from a gauge in Lihue, not Mahaulepu. The 1,102 million gallons (MG) per year of precipitation is equivalent to 72.86 inches per year over the HDF's site of 557 acres. Rain gage 941.1 is located at the makai end of the HDF site. The last time the annual rainfall was that high was in 1957, some 59 years ago. The modeled rainfall rate is unrealistically high (Nance).*

The problem with the commenter's approach is the assumption that HDF will be irrigating at rates for average and somewhat dry conditions during periods of what the commenter assumes will be exceedingly wet conditions based on the use of unrealistically high modeled rainfall rates, which it will not. HDF will irrigate to meet the agronomic needs of the Kikuyu grass crop. *This erroneous assumption is apparent in the SWMM model of the HDF site under "project" conditions (Figure 8 on page 19 of the Exponent report). The most glaring of these is the input of rainfall at 1,102 MG/year (72.86 inches/year) and irrigation at 1,034 MG/year (68.37 inches/year). That total of 141.23 inches per year would have the site as a perpetual mud bog and the total is 3.3 times the Kikuyu grass ET. Obviously, there is no way the HDF project would be operated in this manner. This result bears no resemblance to reality. It is a completely unrealistic misrepresentation of how conditions will be when the HDF site is in operation (Nance).*

11. <u>It appears that important watershed features were not considered in the evaluations contained in DEIS Appendix K</u>

Runoff was conservatively estimated as though the older and previously not-maintained, off-site cutoff ditches on the uphill side of the HDF site were unable to divert any flow from running onto the site from the steep slopes. In the proposed condition, again, it was conservatively estimated that run-on to the site would occur if by chance the cutoff ditches were blocked. This conservative estimation allows HDF to plan for worst-case scenarios in terms of the amount of run-on into the HDF site from upslope areas.

If the cutoff ditches are maintained as planned (and as agreed by the landowner), run-on towards the site will be significantly reduced (as it will be diverted along the valley walls and downstream of the HDF site), and therefore the potential for surface runoff through and from the paddocks is significantly reduced. This will reduce the amount of potential nutrient discharge through surface runoff, which is why the estimation of nutrient loss through surface runoff, utilized in the water quality assessments in the DEIS, is minimal from the farm site. Most of the rainfall will remain on-site and be absorbed by the soil for use by the crop.

Additionally, the comment compares two completely different ways of calculating runoff (Exponent Model and HDF Hydrology Assessment). The storm events presented by the Exponent comments are for events of varying durations and intensities that are not specified for use by the NRCS in calculating runoff. The TR-55 model used by HDF, follows the NRCS Conservation Practice Standards for use to calculate runoff from agricultural project sites. The TR-55 model calculates runoff from 24-hour events at multiple recurrence intervals (2-year, 10-year, 25-year, 50-year).

Ultimately, the SWMM model used by Exponent claims there is a relative increase in runoff from existing conditions to proposed conditions. This claim is erroneous because the Exponent comments are based on unrealistically high rainfall rates, combined with constantly saturated ground conditions due to constant irrigation at rates planned for average conditions. This is unrealistic and in no way how HDF will operate. The model's water balance assumes 141.23 inches of irrigation and rainfall per year which is clearly not the case. It assumes the worst rainfall year within the last nearly 60 years, along with maximum irrigation at all times. The NBA and irrigation section clearly states that HDF will not irrigate more than the grass crop demands. Additionally, a 2-year, 24-hour event with 4.78 inches of rainfall contributing 1,896.9 cubic feet per second (cfs) of peak flow (HDF-

Calculated) compared to a 12-hour event with 6.01 inches of rainfall contributing 363 cfs or 490 cfs of peak flow (Exponent-Calculated) would appear to show less total runoff from a nearly 1,800 acre contributing watershed and development of the project.

12. <u>It appears that the hydrologic modeling in DEIS Appendix K failed to consider the impact of irrigation practices on soil moisture, and thus may not have represented design peak flow rates downstream of the HDF site accurately.</u>

See previous response to comment #11. Exponent's model assumes the fields are constantly rained upon based on worst-case Lihue weather data that does not even apply to Mahaulepu. It assumes the fields are over-irrigated with constant irrigation using irrigation values that are noted for dry weather conditions, and therefore the fields are always saturated. This is not supported and is in no way how HDF will operate.

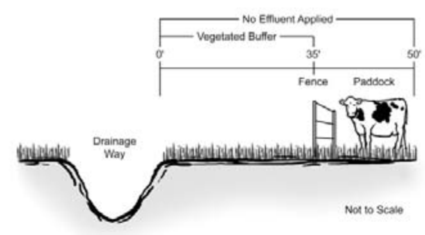
13. <u>Appendix K hydrologic modeling fails to evaluate potential erosion impacts in the Waiopili Stream downstream of the project site.</u>

See previous response to comment #11.

No increases in flow as part of the HDF project are anticipated due to the cultivation and establishment of good condition pasture. The TR-55 model, expectedly, reduces the CN for "good", well-maintained pasture versus "fair" or "poor" pasture and is not subjected to unrealistically high irrigation amounts such as in the SWMM model provided by the comments. It is odd that the comment would say the increase in the pasture condition would reduce the CN number within the TR-55 model, but also states there will be an increase in the peak flow rates. This is only because the commenter assumes that HDF will be irrigating its pasture non-stop and the pastures will always be saturated.

The reduction in runoff from various storm events was estimated where flows combine in Māhāʻulepū Ditch immediately south of the project site. For the 10-year storm event, peak flow leaving the project site will be reduced by 257 cubic feet per second (cfs); for the 25-year storm event, reduced by 283 cfs; and for the 50-year storm event, reduced by nearly 300 cfs (Section 3.3.2.3).

With no increase in peak flow, there is no negative downstream impact to Waiopili Ditch. In fact, peak flows would be attenuated by the pasture conditions. The 35-foot vegetated buffers will be established in accordance with NRCS Conservation Practice Standard Code 390 and guidance, intended to improve water quality by slowing runoff, filtering pollutants and pathogens (*University of Wisconsin Agricultural Extension-http://www.extension.umn.edu/agriculture/manure-management-and-air-quality/manure-pathogens/best-management-practices/#table*), and reduce runoff flows. On-site retention areas adjacent to raised cow raceways will also hold water on the farm for use by the crop. Erosion downstream will be minimized and water quality is expected to improve.



H-H

(Nutrient Mass Balance – G70 Re CH2M)

Response to CH2M Hill Engineers, Inc. “Comments on Dairy Management, Dairy Waste Management, Cropping, and Soils Conditions Relative to Dairy Waste Management in Draft Environmental Impact Statement for Hawai‘i Dairy Farms, Māhā‘ulepū, Kauai, May 2016”

MEMORANDUM

Group 70 International, Inc. Architecture • Planning & Environment • Civil Engineering • Interior Design • Technology
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TO:	HDF Project Team		
ATTENTION:			
DATE:	December 21, 2016		
PROJECT:	Hawaii Dairy Farms EIS	PROJECT NO:	212061-04
E-MAIL/ FAX:		NO. OF PAGES:	
SUBJECT:	**Response to CH2M Hill Engineers, Inc. "Comments on Dairy Management, Dairy Waste Management, Cropping, and Soils Conditions Relative to Dairy Waste Management in Draft Environmental Impact Statement for Hawai'i Dairy Farms, Māhā'ulepū, Kauai, May 2016"** Hawai'i Dairy Farms Draft Environmental Impact Statement		

The following responses incorporate research done by Group 70 and our associated technical consultants.

Footnote Page 11: The Hawai'i Department of Health (HDOH) sent a letter to Mr. Paul T. Matsuda at Group 70 International on 15 June 2016 stating that wastewater effluent from the proposed storage pond should not be distributed via irrigation gun. Presumably, HDOH would also object to distributing manure slurry from the settling pond via irrigation gun. Thus, it is not clear that the proposed slurry distribution methodology is feasible from a regulatory perspective

To put the question into context, DOH requested a single clarification to the Waste Management Plan Updates submitted to DOH in May 2016. Review of a Waste Management Plan (WMP) is a function of the Wastewater Branch of the Department of Health (DOH) in accordance with the DOH Guidelines for Livestock Management (2010). The WMP review process is not part of an Environmental Impact Statement, or subject to public review and comment.

HDF updated its 2014 WMP for up to 699 mature dairy cows to reflect refinements identified during the planning process and field-tested data. HDF operations, as documented in the original and updated WMP, are reflected in the EIS, primarily in Appendix D, Nutrient Balance Analysis for Hawai'i Dairy Farm.

In a June 15, 2016 letter, DOH asked for confirmation that the areas previously designated for drip irrigation using only irrigation water, now planned for gun-irrigation (61.4 acres <u>outside of the pivot extent</u> in the southwest portion of the farm), would use irrigation water from Waita Reservoir and liquid effluent from the storage ponds would not be applied by the gun irrigators. Group 70 responded in a July 6, 2016 letter that this particular area will not receive effluent water from the storage ponds via the gun system and will utilize irrigation water only from Waita Reservoir. In a final July 13, 2016 letter response, DOH indicated there were no further comments.

The "inference" that DOH would not approve of any manure slurry application via the gun system is erroneous and refuted on several fronts:

1. Application of manure slurry is recommended by the DOH, "Slurries may be distributed through an irrigation system equipped with nozzles that have a large opening." **Refer to:** State of Hawai'i Department of Health (DOH). January 19 2010. *Guidelines for Livestock Management.* Prepared in collaboration with the University of Hawai'i at Mānoa, Cooperative Extension Service, College of Tropical Agriculture and Human Resources, West Maui Soil & Water Conservation District, USDA – Natural Resource Conservation Service, U.S. Environmental Protection Agency – Region 9. **Appendix Page B.13, #6 - Utilization.**

2. DOH has reviewed HDF's Waste Management Plan (WMP) for the scenario of up to 699 cows, dated July 23, 2014, which indicated gun-applied slurry in certain other areas, and had no comment.

3. The comment from DOH regarding the WMP Update submitted in May 2016 purely focused on the gun-irrigation of liquid effluent from the storage ponds and not a slurry mixture. No gun-irrigation of liquid effluent is proposed anywhere on the farm. All liquid effluent is applied via the center pivot system.

<u>**1. The DEIS claims to have nearly the best yield in the world for Kikuyu grass based upon a farm trial but does not present any scientific design for the trial or any raw data or statistical analysis of data to support the claim. The high yield that is the basis of the nutrient balance is unfounded.**</u>

Thus far, HDF has gathered more than 2 years of trial data for Kikuyu grass located at the center of Māhā'ulepū Valley on HDF's leased property. The Kikuyu grass measured consists primarily of Kikuyu with some guinea grass mixed in. Cover crops (diversified forage) were also inserted into the Kikuyu grass during the winter months to provide the additional forage needed when the primarily Kikuyu grass mix may not be as productive. The use of diversified forage is recommended by the National Resource Conservation Service (NRCS) Conservation Practice Standard – Nutrient Management Code 590.

Forages were cut, analyzed, and measured for production, nutrient content and quality, and nutrient uptake rates, over this 2 year span by HDF's forage expert, Farms n' Forages, a locally-owned business that assists many Hawai'i farmers. The forage was tested and analyzed by Cumberland Valley Analytic Services (CVAS), which is certified by the National Forage Testing Association. CVAS performed wet chemistry analysis for Dry Matter (DM), Crude Protein, Soluble Protein, Acid Detergent Fiber (ADF), Neutral Detergent Fiber (NDF), Ash, Calcium (CA), Phosphorus (P), Magnesium (Mg), Potassium (K), Sodium (Na), Iron (Fe), Manganese (Mn), Zinc (Zn), Copper (Cu), and in vitro NDF analysis as a method of assessing the nutritive value of the grass trial samples. The nutrient value of the grasses analyzed was then converted to nutrient uptake rates (in lbs. of nitrogen and phosphorus per ton of DM by Atlantic Dairy Consulting, through the use of the Cornell Net Carbohydrate and Protein System (CNCPS) Model, which uses farm-specific inputs on feed and diets to yield both approximate milk production and manure excretion values and quality.

HDF coordinated the collection of grass samples beginning September 2, 2014 and repeated sampling every fourth harvest after an 18-day rest period. The intent was to simulate the harvest of grass by cows grazing a paddock every 18 days. Even with the frequent cutting (every 2.5 weeks), forage yields exceeding 16.3 tons of DM per acre per year (incorrectly noted as 16.4 in the CH2M Hill comments) were realized and measured by Farms n' Forages, and is a conservative annual yield target taking into account lower production the winter months, boosted by the inclusion of diversified forages. Nutrient uptake, content, and the chemical composition of the grass samples are based upon this cutting schedule, without over-fertilization based upon HDF's grass & forage expert's recommended fertilizer application rates, or over-irrigation based upon visual observation beyond the agronomic need of the crop.

HDF believes the grass yield rate of 16.3 tons of DM per acre per year and the nutrient uptake rates of 64 pounds of nitrogen removed per ton of DM and 11.4 lbs. of phosphorus removed per ton of DM, as shown in the Nutrient Balance Analysis of the DEIS, are reasonable and realistic rates based upon the work and analytics performed by Farms n' Forages, CVAS, and Atlantic Dairy Consulting. *Other data from Hawaii also with the highly productive C4 grasses document world class, indicate high levels of productivity are realistic (Valencia-Gica et al. 2012 data from Hawai`i) (Yost).* The yield rates and nutrient uptake/removal rates provided are in accordance with NRCS guidance and provide a realistic projection of the yield production and nutrient uptake for a planned dairy operation. It is consistent with the requirements and processes of the NRCS – Nutrient Management Code 590.

While the yield production and nutrient removal rates shown in the DEIS would not be the exact nutrient uptake numbers based upon the actual operation of the planned dairy, with the commencement of actual animal grazing, manure production, and effluent application, the trials are representative of and realistic for a rotational-grazing, pasture-based dairy operation. The yield production and nutrient uptake rates are based upon appropriate site-specific inputs and certified laboratory testing for yield results and nutrient content and value to the proposed cows used by HDF. Actual grass is being grown on the farm, which is fertilized and irrigated, cut, and sampled for actual production and nutrient content and uptake data.

2. The DEIS uses rainfall data from the local Māhāʻulepū 941.1 rain gauge which has hundreds of missing data points in 30 years of record and is not suitable for irrigation scheduling or manure management.

The period of daily rainfall of the Māhāʻulepū gage (No. 941.1), located on the farm site, that was used for the DEIS is from January 1, 1984 through December 31, 2013, a period of 10,957 days. The available record is for 10,597 of these days, of which only 360 days is truly missing recorded data. Moreover, statistics of this available record closely match the Online Rainfall Atlas of Hawaii (2013) by Giambelluca, T.W., Q. Chen, A.G. Frazier, J.P. Price, Y.L. Chen, P.S. Chu, J.K. Eischeid, and D.M. Delparte. Based on this, the available rainfall records of Station 941.1 were taken to be a reasonable representation of this site's actual rainfall (Nance). In total, 360 days of truly missing records account for only 3.3 percent of the total length of this time period.

Additionally, points identified by error codes in the publicly available rainfall data also do not necessarily truly reflect missing data. The Māhāʻulepū gauge does not record data every day and in many instances, records a multi-day precipitation record collecting data over a multiple day period instead. In these instances when a multi-day record is collected, the days over that record are labeled with error codes (-9999). The use of the error code does not actually reflect "missing" data in this scenario. A reasonable and realistic daily rainfall estimate may be determined over that multi-day period (e.g. by averaging or by comparison to other available rain gauge data in the area such as HDF's Ag Hub system).

As shown in the following table for the month of September 1992, which the CH2M Hill comments specifically point out as a month with significant "missing" data, there are three (3) sets of multi-day precipitation records (MDPR), as well as eight (8) sets of daily records (PRCP). CH2M Hill has identified 19 days of missing data in this month. In fact, there are no days with actual missing data when taking into the account the MDPR readings. The table below reflects the publicly available data in the format received from the National Oceanic and Atmospheric Administration (NOAA) for the Māhāʻulepū 941.1 rain gauge, with the "Notes" column added for discussion:

DATE	MDPR, (0.1mm)	MDPR, (in)	DAPR	PRCP (0.1 mm)	PRCP (in)	Notes:
19920930	-9999		-9999	0	0	PRCP Recording Taken = 0"
19920929	-9999		-9999	0	0	PRCP Recording Taken = 0"
19920928	5	0.0	6	-9999		MDPR Recording Taken over 6 Days = 0"
19920927	-9999		-9999	-9999		If MDPR = 0", then Daily PRCP = 0"
19920926	-9999		-9999	-9999		If MDPR = 0", then Daily PRCP = 0"
19920925	-9999		-9999	-9999		If MDPR = 0", then Daily PRCP = 0"
19920924	-9999		-9999	-9999		If MDPR = 0", then Daily PRCP = 0"
19920923	-9999		-9999	-9999		If MDPR = 0", then Daily PRCP = 0"
19920922	660	2.6	12	-9999		MDPR Recording Taken over 12 Days = 2.6"
19920921	-9999		-9999	-9999		If MDPR = 2.6", then Daily PRCP = +/-0.22"
19920920	-9999		-9999	-9999		If MDPR = 2.6", then Daily PRCP = +/-0.22"
19920919	-9999		-9999	-9999		If MDPR = 2.6", then Daily PRCP = +/-0.22"
19920918	-9999		-9999	-9999		If MDPR = 2.6", then Daily PRCP = +/-0.22"
19920917	-9999		-9999	-9999		If MDPR = 2.6", then Daily PRCP = +/-0.22"
19920916	-9999		-9999	-9999		If MDPR = 2.6", then Daily PRCP = +/-0.22"
19920915	-9999		-9999	-9999		If MDPR = 2.6", then Daily PRCP = +/-0.22"
19920914	-9999		-9999	-9999		If MDPR = 2.6", then Daily PRCP = +/-0.22"
19920913	-9999		-9999	-9999		If MDPR = 2.6", then Daily PRCP = +/-0.22"
19920912	-9999		-9999	-9999		If MDPR = 2.6", then Daily PRCP = +/-0.22"
19920911	-9999		-9999	-9999		If MDPR = 2.6", then Daily PRCP = +/-0.22"
19920910	-9999		-9999	0	0	PRCP Recording Taken = 0"
19920909	-9999		-9999	0	0	PRCP Recording Taken = 0"
19920908	13	0.1	4	-9999		MDPR Recording Taken over 4 Days = 0.1"
19920907	-9999		-9999	-9999		If MDPR = 0.1", then Daily PRCP = +/-0.03"
19920906	-9999		-9999	-9999		If MDPR = 0.1", then Daily PRCP = +/-0.03"
19920905	-9999		-9999	-9999		If MDPR = 0.1", then Daily PRCP = +/-0.03"
19920904	-9999		-9999	114	0.45	PRCP Recording Taken = 0.45"
19920903	-9999		-9999	229	0.90	PRCP Recording Taken = 0.90"
19920902	-9999		-9999	41	0.16	PRCP Recording Taken = 0.16"
19920901	-9999		-9999	41	0.16	PRCP Recording Taken = 0.16"

As noted in the table, the multi-day precipitation total from September 23 to September 28 shows a MDPR of 0 inches. Total rainfall for each day can be assumed to be 0 inches. From September 5 to September 8, another MDPR was recorded of 0.1 inches, also negligible (if averaged, the daily rainfall would equal 0.03", quite insignificant to any agricultural operation). Even within the twelve (12) day MDPR recording of rainfall from September 11 to September 22, a total of 2.6 inches of rainfall was recorded. While the daily totals are not provided, the data is sufficient to characterize rainfall and for use within HDF's Nutrient Balance Analysis and its irrigation management plan, which is based upon monthly rainfall totals. CH2M Hill's comment that the month of September 1992 contains excessive "missing" data is therefore not supported.

Referring to **Table 4 – NOAA – Average Monthly Precipitation Data**, and **Table 12 – Monthly Irrigation Demand** within the Nutrient Balance Analysis, based on the available historical data, NOAA data from the Māhāʻulepū 941.1 rain gauge shows an average rainfall in the month of September of 2.73 inches. Based upon the September 1992 total rainfall for the month at 2.7 inches from the NOAA Māhāʻulepū 941.1 rain gauge, the month appears consistent compared to the historical average. The multi-day precipitation data totals do not have any effect on the irrigation demand analysis, as the total rainfall each month is used in irrigation planning. An irrigation water management plan will be developed by the farm in accordance with NRCS Conservation Practice Standards Rainfall and applied irrigation will be monitored and controlled on a daily basis during farm operations.

The Līhuʻe rain gauge, utilized in the CH2M Hill comments, is also not representative of the Māhāʻulepū site. It is located on the windward side of the Haʻupu mountain range, some six miles from the project site. The CH2M Hill modeled rainfall used is 70.14 inches per year from the Līhuʻe station. The modeled rainfall rate is unrealistically high as compared to the average 44.26 inches per year from the Māhāʻulepū rain gauge 941.1. The Māhāʻulepū gauge, in turn, is located on the project site and provides site specific data. *Statistics of this available record closely match the Online Rainfall Atlas of Hawaiʻi (2013) by Giambelluca, T.W., Q. Chen, A.G. Frazier, J.P. Price, Y.L. Chen, P.S. Chu, J.K. Eischeid, and D.M. Delparte. Based on this, the available rainfall records of Station 941.1 were taken to be a reasonable representation of this site's actual rainfall (Nance).* In total, 360 days of truly missing records account for only 3.3% of the total length of this time period.

3. The use of annual average manure application and annual average yield estimates grossly underestimates the nitrogen discharge from the slurry application paddocks.

HDF understands the concerns regarding non-irrigated areas and their lower potential yields. HDF has conducted more than 2 years of grass yield trials on HDF sites, and has engaged Farms n' Forages to complete these trials. Farms n' Forages has extensive experience in grass and forage production on each of the major islands in the State of Hawaiʻi. Based upon the field trials, utilizing primarily Kikuyu grass mixed with some guinea grass, and interspersed with diversified forages from November to March, average annual yields on the HDF site range from 17 tons DM per acre per year to over 20 tons DM per acre per year, with appropriate fertilizer and irrigation applications that do not exceed the agronomic need of the crop. These monthly yields often exceeded 20 tons DM per acre per year in the summer months and lowered to between 15 and 18 tons DM per acre per year in the winter months (with diversified forage). This was verified by forage testing and on-site soil sampling performed by Farms n' Forages (grass yields), Spectrum Analytics (soils and fertility recommendations), Cumberland Valley Analytic Services (grass nutrient) as well as Dr. Yost (soils and fertility recommendations in Appendix C of the EIS).

Farms n' Forages also has experience with non-irrigated pastures in Hawaii and has previously measured approximately 30 to 40 percent greater yields in irrigated pastures than in non-irrigated pastures. Approximately 74 percent of HDF's pastures are irrigated and 26 percent are non-irrigated, and the effect on yield estimates must be taken into account by HDF for its nutrient management planning, as noted by the CH2M Hill comments. HDF has been conservative in its average annual yield estimate used in the Nutrient Balance Analysis specifically to account for non-irrigated fields and seasonal variability in forage production.

HDF believes that 16.3 tons of DM per acre per year is a conservative and realistic weighted yield goal which meets NRCS Conservation Practice Standard - Nutrient Management Code 590 requirements for both irrigated and non-irrigated fields combined and accounts for seasonal variability. Code 590 requires that a realistic yield goal be used in the planning of a new dairy operation. Taking the reduction in grass yields in non-irrigated fields, based upon the percentages provided by Farms n' Forage, the 16.3 tons of DM per acre per year is a conservative production estimate, considering that irrigated fields can yield over 20 tons of DM per acre per year in the summer and between 15-18 tons DM per acre per year in the winter.

Utilizing the last year of grass testing (2015 to 2016), the irrigated fields showed an annual average yield of nearly 19 tons DM per acre per year. Incorporating the non-irrigated fields by applying the reduction percentage to the total non-irrigated areas, the weighted annual average yield still exceeded 17 tons DM per acre per year. HDF is utilizing 16.3 tons DM per acre per year as a conservative estimate for planning purposes to account for the variability in farms, which are biological systems. HDF will continue to test and analyze, as appropriate, for forage yields and nutrient content, soil nutrient content, manure nutrient content, and water quality and chemical composition for the adjacent drainage ways, to monitor and ensure that nutrients in the farm's system are balanced and kept on the farm to be efficiently utilized by the forage crop. Testing will be done annually at a minimum, per applicable State and Federal law.

HDF will also manage the application of nutrients, from <u>each</u> application type (as-excreted, liquid effluent, slurry, fertilizer) based upon whether the field is irrigated or non-irrigated. Irrigated fields with higher yields will be grazed more often, while non-irrigated fields with lower yields will be grazed less, for the 18-day rotation depending on the yields obtained, to ensure that nutrients are not over applied (lower yielding paddocks may be utilized in spans beyond 18-days). Because the slurry application is expected to occur very infrequently (typically spaced between 3-6 weeks apart), application of slurry nutrients to non-irrigated fields will still not exceed the agronomic need of nutrients for the crop. Even if the application is more frequent (closer to every 3 weeks), less nutrients will be applied per slurry application as less solids have built up in the settling ponds at the dairy facility.

From a nutrient balance and nutrient accounting standpoint, the annual weighted yield average accounts for the lower yields expected from non-irrigated portions of the pasture and seasonal variability during the winter months. It incorporates these factors into the nutrient uptake (an overall lower annual yield average means less overall nutrient uptake). Proper management of the farm's operation, by season and by adaptively managing the timing of the application of nutrients or timing of the use of each paddock, is critical to ensure that the non-irrigated areas are utilized without over-application of nutrients, especially in the winter months. HDF is committed and required to adaptively manage its operations per NRCS standards and also to ensure nutrients are not wasted.

HDF also plans to utilize reserve forage to reduce the amount of commercial feed it needs to bring in as the amount of grass forage does not provide for all of the nutrients the cow requires. Excess forage, which may be gathered in higher yielding months, would allow for supplementing with reserve feed in lieu of commercial feed during lower yielding months. Paddocks not utilized may be harvested via the swathing and baling of the grass. These bales will be stored for use in the winter months or used to supplement feed.

HDF's Nutrient Balance Analysis separates out nutrients by application type, and has identified the total amount of nutrients (by each application type and area) applied by month. Refer to **Table 26C: Estimated Monthly Nutrient Application on Slurry Areas for 699 Mature Dairy Cows and 50 Calves in Pen.** It identifies 42 acres of area for the slurry application for the 699 mature dairy cowherd size, and shows that the nitrogen applied in lbs. per month (from both slurry and as-excreted sources) is less than half of the expected uptake of nitrogen by the forage. The phosphorus applied is a little more than half of the expected uptake of phosphorus by the forage. Therefore, even with seasonal variations in yield plus non-irrigated fields producing 70 percent of the yield (per Farms n' Forages as noted above), there would be no over application of nutrients.

The commenter only discusses the scenario of 699 mature dairy cows, but similarly, referring to Table 28C of the Nutrient Balance Analysis, monthly nutrient applications are shown for the scenario of up to 2,000 mature dairy cows. There would be no over application of nitrogen but a slight excess of phosphorus, exactly at 2,000 mature dairy cows and a grass yield of 16.3 tons DM per acre per year. As explained previously, HDF does not intend to over apply phosphorus but will manage the herd size to meet the nutrient needs of the grass crop based on yields.

HDF will address the management concerns regarding splitting irrigated and non-irrigated areas of the pastures. HDF will adaptively manage the irrigation systems when the farm is in operation, and can temporarily add irrigation systems to non-irrigated fields to improve forage yields and nutrient uptakes of specific paddocks, as needed, once the farm is in operation. From a use and management perspective, this allows HDF the flexibility to efficiently run its operation.

4. HDF proposes the unprecedented use of manure effluent application pivots across a stream and depends upon complex failure prone smart valve center pivots to stop flow and not drip while the pivots are on bridges over the stream.

The pivots cross portions of the Waiopili drainage ditch and another separate agricultural drainage ditch which ultimately discharge to the ocean. The pivot systems are equipped with a drop hose valve that will be composed of a composite material, with small sensors that are low maintenance and resistant to salty weather conditions.

Proper operations, maintenance, and repairs of the irrigation system will prevent potential impacts to water quality and prevent direct discharge into the drainage ditches. Stringent preventative maintenance will be in place to make sure all facets of the irrigator operate to the pivot operator's needs. The pivot operator will be responsible to maintain and look after each pivot while in operation. Only one pivot will operate at any given time (though the system is designed and is automated enough such that two pivots may run at the same time), ensuring that the operator is focused and attentive to the one operating pivot. The irrigators are programmed to turn off within 50 feet of water resources.

Best management practices for operations and maintenance will include daily, monthly, and semi-annual tasks.

Operations Best Practices:
1. View the system and make sure all towers are in alignment.
2. Check out each drop hose to see if all are hanging properly and operating properly.
3. Check each tower to make sure both tires are inflated and secure to tower stand
4. Re-evaluate all operations and check control panel as to current pressure.
5. Perform visual inspection of the systems at least every two hours during the day (pivots move slowly and are designed to apply irrigation and effluent over a 48-hour cycle). Watch areas of non-application to assure system is working properly.
6. Respond to pivot notifications and automatic shutoffs for improper operation, especially during nighttime hours.

Daily Maintenance Best Practices:
1. Repair or replace any nozzle ends not working properly.
2. Examine all wheel hubs and grease where needed. Inspect for flat tires and repair as needed.
3. Observe wheel tract towers controls. If any rust or any other material is present clean up and apply WD40 to extended control bolt.
4. Adjust control bolt on any tower that is out of line.

Monthly Maintenance Best Practices:
1. Check air pressure on tires.
2. Check levels of gear lube in each gear box.
3. Grease each wheel hub.
4. Remove and examine each drop hose solenoid attachment to make sure no rust has built up inside the connections. If so, clean and put back together and make sure it moves in both directions.

Semi-Annual Maintenance Best Practices:
1. Change gear lube in each gear box. Remove gear lube and replace with new gear lube. Place old gear lube in used oil container in shop. Re-check levels after one hour of operation.
2. Examine each power shaft coupling to determine excessive wear or broken parts. Replace any coupling with a new one.
3. Clean out control boxes. Turn all power off and remove panels from each unit and clean any dirt or mud in the box. Make sure fuse box has spare fuses for all operations.
4. Spray area around Pivot Head to eliminate weeds or grass from Control Box area.
5. Spray around the west side water control valve.

5. The DEIS underestimates the discharge of nutrients to the stream and groundwater by an order of magnitude.

Two percent (2%) of nitrogen and one percent (1%) of phosphorus nutrients excreted as manure, applied as effluent or slurry, or applied as commercial fertilizer are conservatively estimated to be potentially lost to the environment as a result of dairy operations on the site. HDF has developed and plans to incorporate several best management practices to ensure that this nutrient loss is minimized, if not removed, on a more typical basis. 35-foot vegetation setbacks from drainage ditches on site, retention areas adjacent to the raised cow raceways, and irrigation of effluent matching the crop demand and ensuring no over-application of effluent are Best Management Practices and are ways that HDF intends to contain all nutrients on site during typical dairy operations and under typical weather conditions.

The model presented by CH2M Hill is based upon the Līhuʻe rain gauge as well as an unrealistic amount of rainfall, both of which are not representative of the Māhāʻulepū site. **See previous responses above as to why the Māhāʻulepū rain gauge is more appropriate for the project site than the Līhuʻe rain gauge.** Comparing the 12 month period of rainfall noted in the comments with the rainfall in Māhāʻulepū based off of the Māhāʻulepū rain gauge, rainfall between June 1996 and May 1997 was recorded at 55.93 inches in Māhāʻulepū, while rainfall in Līhuʻe was noted at 70.14 inches in CH2M Hill's comments, significantly different. While this year period shows higher than average annual rainfall, it does not show such a high value as Līhuʻe at 70.14 inches.

Therefore, the CH2M Hill model assumption - that the fields are constantly rained upon based on worst-case Līhuʻe weather data that does not even apply to Māhāʻulepū, and therefore assumes the fields are constantly saturated - is erroneous. This is also not supported by field observations. As a result, the CH2M Hill model's results showing a nutrient loss rate of 57 percent is erroneous, unrealistic, and highly exaggerated. Such a loss rate would not support any grass growth in the valley, which is clearly not the case based upon grass testing done thus far on the project site.

The comment also unrealistically represents all discharge occurring directly to a stream. Daily nutrients are contained on the farm and reutilized by the pastoral-based, rotational grazing system and the thick Kikuyu grass thatch. Nutrients potentially carried in runoff will be contained by vegetated buffers and retention areas adjacent to the raised cow raceways, and will not discharge nutrient directly to any on-site ditch in typical rain events. Thus, the representation that over 300,000 lbs. of nitrogen per year is discharged is grossly exaggerated.

6. The DEIS states that the dairy will be operated in accordance with NRCS code 590 but disregards the code guidance by not considering wetter than average conditions

NRCS code 590 does not require that nutrient management and dairy operations be based on wetter than average conditions. The code rather specifies that consideration be given for "weather conditions" in general.

The comment also inaccurately describes the top two inches of the soil as saturated during the entire month and year. Simple field observation indicates that this is rarely the case.

HDF's Nutrient Balance Analysis (NBA) meets NRCS Conservation Practice Standard – Nutrient Management Code 590. HDF's NBA states that HDF will not apply nutrients via liquid effluent or slurry two days prior to and two days following a significant rain event, in which surface runoff could be anticipated and expected. In two days, it can reasonably be expected that regardless of soil type, the top two inches of soil will not be saturated as described in the comment.

Additionally, as stated in the Nutrient Balance Analysis in the EIS, irrigation (including liquid effluent) will not be applied should it exceed the irrigation demand of the crop. Therefore, applied irrigation will not exceed the soil water holding capacity and crop demand. The Kikuyu mix of grasses will form a thick thatch which will essentially limit and contain surface runoff. *Kikuyu grass ... forms an exceedingly thick thatch that [is] certain to attenuate, if not completely block, surface runoff (Yost).* Even in the winter months, where diversified forages will be used, the Kikuyu thatch will be maintained by using no-till planting methods when diversified forages must be planted in November and December to boost forage yields. Vegetated 35-foot buffers and retention areas adjacent to the raised cow raceways will prevent other runoff from reaching surface water ways.

As recommended by the NRCS in planning of new operations involving re-use of livestock manure as a nutrient source, HDF initially plans to apply effluent in uniform rates if the irrigation demand of the crop and the yield of the crop are able to be sustained. The biological system of the farm will vary and irrigation applications and effluent/nutrient applications will be adjusted as required, once the farm is in operation. As the Nutrient Balance Analysis states, the irrigation demand of the crop, as realized in Hawaii, cannot be provided solely by rainfall, even in the winter months. Irrigation can be limited to ensure there is no over-application of irrigation and effluent by reducing the amount of irrigation (which **Table 12 – Irrigation Demand Summary** shows). The storage pond allows for flexibility in adjusting irrigation amounts.

Also, the effluent and as-excreted manure does not provide the full balance of nutrients that the grass needs to grow at the expected 16.3 tons DM per acre per year. Commercial fertilizer will be needed to supplement the agronomic requirements of the forage. In a typical application, equal amounts of effluent will be provided throughout the year as the effluent simply does not provide enough nutrients to the grass. As the nutrient mass balance shows in the Nutrient Balance Analysis, even in the winter months, there is no over-application of nutrient in the scenario of 699 mature dairy cows and a slight potential excess application of phosphorus that must be accounted for in the scenario of up to 2,000 mature dairy cows. Should HDF contemplate expanding the herd size, it would do so incrementally until phosphorus becomes the limiting factor so that no over-application occurs.

7. The DEIS uses erroneous weather data to size the manure lagoon and proposes intentionally discharging manure from the storage lagoon before cataclysmic storms resulting in most of the manure running off directly to surface water.

Refer to the previous response regarding purported "erroneous" weather data.

The United States Department of Agriculture (USDA), NRCS, State of Hawaii Department of Health, and other published guidelines for agricultural practices within the United States agree that the 25-year, 24-hour event is the design standard for waste storage systems. Planning and designing for events greater than this is simply not required by regulators and unreasonable.

HDF has provided additional storage capacity beyond the 25-year, 24-hour storm event in the form of extra storage within the effluent ponds, as well as a secondary containment berm, which exceeds regulatory guidelines. The secondary containment area and berm essentially provides an additional 30 days of effluent storage, or nearly 50% more volume than the storage pond provides in the scenario of up to 2,000 mature dairy cows, enough to hold another two – 25-year, 24 hour storms.

In the event of a cataclysmic event, discharge to the drainage ways can be expected, as allowed under typical guidance of the NRCS, EPA (NPDES AFO/CAFO Permitting), and Department of Health. HDF will work with all regulators and in the best interest of the community when planning for and addressing potential cataclysmic events, when able to be forecasted. In the example of the Kaloko Dam breach, while such a scenario is unlikely in Māhā'ulepū and the example references a different drainage system and location on Kauai, water levels built up in the reservoir over 40+ days. Such a scenario is unrealistic and unrelated to the dairy's systems and waste storage ponds. Though such an event is not supported by the rain gauge data at Māhā'ulepū, HDF would have the opportunity to prevent discharge and cumulatively reduce the effluent levels in the pond, over a 40 day period, through applicable management techniques and dewatering. The extra spare volume in the pond and secondary containment berm provide additional protections.

8. Dung beetles are misrepresented as being capable of consuming manure year round even though they are not active in the winter.

Dung Beetles aren't winter dormant in Hawaii. Dung beetles are winter dormant in locations where the temperate drops dramatically in winter. Hawaii does not experience that level of temperature change in winter and the dormancy is NOT triggered. A review of collecting dates and scholarly publications that show the activity levels of dung beetles in locations such as Louisiana and Florida show year round activity. Practical ground truthing in Hawai'i: February 2011, the entomological team assisted with a week of filming in the fields of Hawai'i Island's Kohala Cloverleaf Dairy, where active dung beetles were seen.

Refer to Volume 5, Appendix C – C for additional responses to comments regarding manure related insects.

9. No documentation is presented for 16.4 tons per acre of Kikuyu grass yield with grazing and no documentation is presented to support even higher proposed yields of 20 tons per acre.

Refer to the previous response about grass yields used in the report based upon field trials, sampling data, data analytics, and supported academic research.

The comment misrepresents and misunderstands the 16.3 tons DM per acre per year. Under such a yield, nearly 1,875 mature dairy cows can be supported on the farm. There would be an excess of grass forage in the scenario of 699 mature dairy cows. If yields were to increase to 17.3 tons DM per acre per year, up to 2,000 mature dairy cows can be supported without over-application of nitrogen and phosphorus nutrients. At 20 tons DM per acre per year, or more, which can be expected and supported by field trials and academic research, even more cows could be supported on the pasture without over-application on nutrients from cow manure and effluent. However, HDF has identified the maximum contemplated herd size as 2,000 mature dairy cows.

The 16.3 tons DM per acre per year is not limited to the 699 cow scenario. With the grass trials and nearly 470 acres of pasture, the conservative estimate of 16.3 tons DM per acre per year can support nearly the entire project. The 20 percent increase will cover the increase from 1,875 mature dairy animals (supported at 16.3 tons DM per acre per year without nutrient over-application) to 2,000, a modest 7% increase in the herd size and forage production.

With respect to irrigation, as noted in previous responses, HDF believes that 16.3 tons of DM per acre per year is a conservative and realistic weighted yield goal which meets NRCS Conservation Practice Standard - Nutrient Management Code 590 requirements for both irrigated and non-irrigated fields combined and accounts for seasonal variability. Code 590 requires that a realistic yield goal be used in the planning of a new dairy operation. The 16.3 tons of DM per acre per year is a conservative production estimate, considering the irrigated fields can yield over 20 tons of DM per acre per year in the summer and between 15-18 tons DM per acre per year in the winter. It also takes into account the reduction in yields from non-irrigated fields.

10. The milk production predicted by the HDF is presented without scientific references or any data to show actual milk production on Kaua'i with Kikuyu grass rotational grazing.

The milk production, and therefore nutrient production, numbers used for nutrient balance and accounting for HDF's Nutrient Balance Analysis were calculated using the Cornell Net Carbohydrate Protein System (CNCPS) model, prepared by Robert C. Fry, DVM, Atlantic Dairy Consulting. The appropriate environmental inputs into and outputs from the model are based upon field trials or site specific data as available. The nutrient mass balance and accounting on the farm is provided in the Appendix D – Nutrient Balance Analysis (NBA), based upon the CNCPS model, which is sufficient for evaluating environmental impacts from a pasture-based rotational grazing dairy operation.

Please see previous responses to nutrient uptake numbers supported by the grass farm trials.

The 18-day rotation is the basis of the field trials – which is typically producing yields greater than 16.3 tons DM per acre per year to support nearly 2,000 mature dairy cows. The 18-day rotation allows for six mobs of cows to be utilized on the farm, based upon the number of paddocks designed. Grass yields, protein content, and nutrient uptake numbers are all predicated on the 18-day rotation / cutting and are supported by field tested data and laboratory analytics. While the CH2M Hill report provides its own inputs, not based upon field-specific data, to estimate milk production from Kikuyu-based pastures, it does not take into account actual forages proposed by HDF and actual forage nutrient content field tested and analyzed in a laboratory for this specific project.

11. The HDF prediction of nitrogen removal with Kikuyu grass grazing is overstated and not documented.

The CTAHR grass analytics provided in the comment are from a fully mature kikuyu grass crop at 84 days (12 weeks) of growth compared to HDF grass harvested in a vegetative state at 18 day intervals. The comment suggests that plant nitrogen uptake for the proposed Kikuyu grass is assumed to be no greater than 545 lb/ac/year based upon the 84-day growth. This is a wrong assumption based on the antiquated plant bioassay results completed by CTAHR on mature 84 day (12 weeks) grass vs. vegetative grass used for pasture (Atlantic Dairy Consulting, Robert Fry, DVM). Nutrient uptake from a mature grass sample will be significantly less than a younger grass sample, and is not representative of the rotational-grazing proposed by HDF.

12. Kikuyu grass in the nutrient balance analysis is presented incorrectly as having a uniform nutrient uptake every day of the year.

As far as kikuyu production and quality, HDF understands that it is not uniform throughout the year, like any forage. HDF's grazing operation plans for filling in seasonal slumps with other forages (diversified forages and cover crops) with a primary Kikuyu grass base. HDF understands that any grazing operation is not designed based solely around one forage due to seasonal production changes... A diversified stand of the forages that have the best production and survivability in the region is provided and planned for by HDF (Farms n' Forages, Kristin Mack).

Based upon using diversified forages, consistent yields exceeding 16.3 tons DM per acre per year are realistic, as indicated by the grass trials. As such, HDF believes that 16.3 tons DM per acre per year and the resulting nutrient uptake numbers are conservative and can be applied to the farm nutrient mass balance calculations. Kikuyu fields with diversified forage in the winter months yield between 15 and 18 tons of DM per acre per year, while summer months of Kikuyu grass (without cover crops) exceed 20 tons of DM per acre per year in production estimates.

Under guidance from the NRCS, an annual average yield estimate is allowed for nutrient mass balance planning for a new dairy operation, and nutrient management based upon daily nutrient uptake as suggested by the commenter is simply not realistic in a biological system. However, for the purposes of the EIS, a monthly yield estimate was reviewed based upon results from the grass trials, indicating that a projected yield of 16.3 tons of DM per acre per year is on the lower end of projected monthly production, even considering possible seasonal slumps in the winter

months. This type of analysis is very conservative and not required. Nutrient management planning for the planning of new dairy operations is based upon realistic annual yield estimates and nutrient uptake.

Even analyzed monthly, HDF is confident that with diversified forages, yields of 16.3 tons per acre per year are expected amongst the entire farm (also weighted for irrigated / non-irrigated areas as previously discussed). In fact, trials show yields between 15 and 18 tons DM per acre per year in the winter months and exceeding 20 tons DM per acre per year in the summer months. Therefore, the NBA mass balance is being conservative as it is using a lower monthly yield projection over the entire year for its forage nutrient uptake and milk production numbers. In essence, HDF pastures would be able to uptake even more total amounts of nutrients at the average annual yields realized in the grass trials (meaning more cows than 2,000 could be supported).

Additionally, and as responded to previously, the nutrients provided by the manure and effluent simply do not meet the grass nutrient requirements at 16.3 tons DM per acre per year, a lower projected yield result, that is also weighted for irrigated and non-irrigated areas, which is then projected over the entire year. Variability in the grass yield is taken into account in the 16.3 tons DM per acre per year, and yet additional nutrients beyond that provided by the manure of the cows, will be required for adequate grass growth.

HDF plans to utilize reserve forage to reduce the amount of commercial feed it needs to bring in as the amount of grass forage does not provide for all of the nutrients the cow requires. Excess forage, which may be gathered in higher yielding months, would allow for supplementing with reserve feed in lieu of commercial feed during lower yielding months. Paddocks not utilized may be harvested via the swathing and baling of the grass. These bales will be stored for use in the winter months or used to supplement feed.

13. The nutrient balance incorrectly applies the same amount of nutrients uniformly to all soil types in all paddocks under each irrigation method.

Individual application of nutrients per irrigation method will not be uniform as the NBA describes three (3) different scenario types of nutrient application (non-irrigated and as-excreted, pivot irrigated and as-excreted, and slurry application and as-excreted), all with differing total amounts of nutrients. **Refer to Tables 25-28.**

The total nutrients applied are also based upon total area and the capacity of the infrastructure (pivots and slurry system). Finally, it is also based upon the irrigation demand in terms of how much manure nutrient is applied at any given time from the pivot system.

While the Nutrient Balance Analysis uses an annual, weighted, and realistic yield estimate and nutrient uptake rates, this does not mean that the application of nutrients is uniform based upon the amount, area, schedule, and frequency of nutrient application by type (as-excreted, pivot system, slurry gun, fertilizer). HDF will adaptively manage the timing and placement of applied nutrients on the farm to maximize yield production while also ensuring that there is no over-application of nutrient from applied effluent and as-excreted manure. In planning HDF's initial operation, uniform rates of nutrient application on an annual basis are used for planning purposes, which shows that even with conservative grass production rates, nutrients are not over-applied in the scenario of 699 mature dairy cowherd size while a slight excess of phosphorus can be expected at a herd size of 2,000 mature dairy cows. As previously mentioned, HDF will likely incrementally increase the herd size to ensure phosphorus is properly managed, as part of its adaptive management of the farm. As the farm moves into operations and continues with annual plant, soils, manure, and other required testing, HDF will adaptively manage the placement and timing of nutrients to ensure there is no over-application. With a conservative yield rate of 16.3 tons DM per acre per year, there is still a deficit of nutrient available for the crop and more commercial fertilizer will be required to supplement nutrients. This deficit will only grow if and when yields improve on the farm. As previously mentioned, including adjustment for irrigated and non-irrigated areas and accounting for seasonal variability, average annual yields of over 17 tons DM per acre per year are realized on the HDF project's site.

The soils analysis presented in Appendix C of the EIS by Dr. Russell Yost and Nicholas Krueger also clearly states that there are two widely differing soil groups on the dairy and that the dynamic management of these two soil types will require specific, unique monitoring and management designed to take advantage of the desirable properties of each and the limitations of each. The statement also indicates that there two distinct stages of startup and performance of the dairy - an initial stage in which soil nutrient levels will be restored to values optimal for pasture productivity and the pasture is being established and the herd developed and the second that represents the finely-tuned dynamic management of the herd size and productivity in relation to the pasture growth and productivity. This would involve "monitoring and adaptive nutrient management" as a second stage of bringing the dairy into an optimal state of productivity and efficiency, which HDF will accomplish and can only accomplish when the farm is in operation. It does not, however, mean that yields or total nutrient application is affected, only that the management and timing of the application may be different to account for chemical and physical properties of the soil, including sodicity, salinity, pH, infiltration and percolation, etc.

14. Appendix D incorrectly dismisses the importance of protecting Waiopili Stream and the coastal waters and beach.

Flowing inland waters within the Māhāulepū Watershed fall into Class 2, not otherwise classified for protection [HAR §11-54-5.1(a)(1)(C)]. "The objective of Class 2 waters is to protect their use for recreational purposes, the support and propagation of aquatic life, agricultural and industrial water supplies, shipping, and navigation . . . These waters shall not act as receiving waters for any discharge which has not received the best degree of treatment or control compatible with the criteria established for this class. . . ." (DOH, 2014).

The stretch of open coastal waters at the terminus of Waiopili Ditch is classified as Class A under State Water Quality Standards, as no embayments, marine waters, or open coastal waters in the vicinity are listed in HAR §11-54 for special protection. Use of Class A waters in the standards state: "the objective of Class A [marine] waters that their use for recreational purposes and aesthetic enjoyment be protected. Any other use shall be permitted as long as it is compatible with the protection and propagation of fish, shellfish, and wildlife, and with the recreation in and on these waters. These waters shall not act as receiving waters for any discharge which has not received the best degree of treatment or control compatible with the criteria established for this class" (DOH, 2014).

HDF intends to include best management practices to protect water quality within the man-made and natural portions of Waiopili Ditch, as well as the coastal waters and beach. Such practices included installation of 35-foot wide vegetated buffers and filter strips, 50-foot setbacks with effluent irrigation, on-site retention areas adjacent to the raised raceways, and development of the Kikuyu thatch which will attenuate surface runoff and prevent pollutants from reaching the on-site water ways. Even in the winter months, where diversified forages will be used, the Kikuyu thatch will be maintained by using no-till planting methods when diversified forages must be planted in November and December to boost forage yields.

15. HDF used faulty climatic data as the basis of the water balance and nutrient balance analysis.

Refer to previous response to comment #2.

16. HDF used faulty climatic data for the irrigation water balance.

Refer to previous response to comment #2.

Pan evaporation data and evapotranspiration data are both from publicly available, regularly utilized and accepted, data sources and both are site-specific to Māhāʻulepū and not used for rainfall estimates. Both sources are acceptable and site specific, and measure different criteria (rainfall, pan evaporation, and evapotranspiration). Comment states that "HDF obtained pan evaporation data from State of Hawaiʻi DLNR Pan Evaporation Report R74 dated August 1985 for station Māhāʻulepū 940.00. HDF obtained evapotranspiration data from UH Mānoa

Department of Geography, 2014 Evapotranspiration Maps (Lat 21.907N, 159.422W)". The data is not selective and are referenced to their most appropriate source.

17. HDF is setting a new precedent for unacceptable risk of spraying manure effluent directly into a stream by use of smart valve pivots that cross the stream on bridges

The smart valve pivot systems do not present an unacceptable risk. It is a precisely controlled, computer driven machine that allows for specific and exacting application of effluent and irrigation, thereby reducing risk or mistakes in application of effluent. This technology, while relatively new, is not unprecedented in the United States and is in fact state-of-the-art for agricultural practices, allowing for variable effluent application amounts to suit the specific site's and crop need.

While maintenance of a complicated machine is a potential concern due to its complex nature, use of the pivot systems should not be shied away from. HDF will perform all recommended and required maintenance on the pivot systems as previously noted, and will intensively and rigorously inspect the operations of the pivots.

The application rate of 0.39 inches is what the pivot will typically be spraying but the application rate must vary based on the irrigation demands of the crop and weather conditions. The application rate is also distributed over a 48 hour time period as one cycle takes approximately 48 hours to complete. The irrigation demand noted in **Table 12** of the NBA indicates that in the summer months, 0.18 inches of irrigation is needed daily, or 0.36 inches over a 48 hour period, on average. Irrigation from the pivot is also lost to evaporation, and actual irrigation volumes to meet the actual crop demand will likely be approximately 10 - 20 percent higher than the estimated demands, depending on irrigation equipment efficiency (lost to evaporation) and current conditions. This means the pivot must spray typically around 0.39 inches per 48 hours (10 percent loss) and even greater amounts if more irrigation is lost to evaporation. What is noted is a "typical" application.

With the thick Kikuyu thatch previous discussed, and at an irrigation rate that meets crop demand, ponding and runoff is not expected to occur.

18. HDF has selected big gun spray irrigators to apply manure slurry even though this is the application method most commonly associated with odor complaints.

The slurry gun systems and its application were extensively modeled for odor impacts. Please refer to the technical study regarding odor. Its expected impacts are generally localized around the dairy farm itself. The slurry gun system will be installed under the recommendations and guidance of the *Guidelines for Livestock Waste Management* which recommends using large nozzle applicators for slurry. Refer to the State of Hawaiʻi Department of Health (DOH). January 19 2010. Guidelines for Livestock Management. Prepared in collaboration with the University of Hawaiʻi at Mānoa, Cooperative Extension Service, College of Tropical Agriculture and Human Resources, West Maui Soil & Water Conservation District, USDA – Natural Resource Conservation Service, U.S. Environmental Protection Agency – Region 9. **Appendix Page B.13, #6 - Utilization.**

DOH also has reviewed HDF's Waste Management Plan (WMP) for the scenario of 699 mature dairy cows, dated July 23, 2014, which indicated gun-applied slurry, and had no comment.

Slurry application is infrequent and will be timed to apply when there are no anticipated rain events and sufficient wind speeds to disperse and prevent odor issues. It will not be run simultaneously with the pivot irrigation system and the volume of nutrients will not exceed the agronomic demand of the crop. Refer to the previous discussion on the kikuyu thatch regarding no expected ponding or runoff from slurry application.

19. HDF does not account for the reduction of yields from non-irrigated pasture which is documented in Hawai'i to be approximately ½ of the irrigated yield.

HDF understands the concerns regarding non-irrigated areas and their lower potential yields. HDF has conducted over 2 years of grass yield trials on HDF sites, and has engaged Farms n' Forages to complete these trials. Farms n' Forages has extensive experience in grass and forage production on each of the major islands in the State of Hawaii. Based upon the field trials, utilizing primarily kikuyu grass mixed with some guinea grass, and interspersed with diversified forages from November to March, yields on the HDF site range from 17 tons DM per acre per year to over 20 tons DM per acre per year, with appropriate fertilizer and irrigation applications that do not exceed the agronomic need of the crop. These yields often exceeded 20 tons DM per acre per year in the summer months and lowered to between 15 and 18 tons DM per acre per year in the winter months (with diversified forage). This was verified by forage testing and on-site soil sampling performed by Farms n' Forages (grass yields), Spectrum Analytics (soils and fertility recommendations), Cumberland Valley Analytic Services (grass nutrient) as well as Dr. Yost (soils and fertility recommendations).

Farms n' Forages also has experience with non-irrigated pastures in Hawaii and have previously measured approximately 30 to 40 percent greater yields in irrigated pastures than in non-irrigated pastures. Approximately 74 percent of HDF's pastures are irrigated and 26 percent are non-irrigated, and must be taken into account in the yield estimates, as noted by the comments.

Incorporating these factors into the grass yield estimates, HDF believes that 16.3 tons of DM per acre per year is a conservative and realistic weighted yield goal which meets NRCS Conservation Practice Standard - Nutrient Management Code 590 requirements for both irrigated and non-irrigated fields combined and accounts for seasonal variability. Code 590 requires that a realistic yield goal be used in the planning of a new dairy operation. The 16.3 tons of DM per acre per year is a conservative production estimate, considering the irrigated fields can yield over 20 tons of DM per acre per year in the summer and between 15-18 tons DM per acre per year in the winter. It also takes into account the reduction in yields from non-irrigated fields.

HDF will manage the application of nutrients, from each application type (as-excreted, liquid effluent, slurry) based upon if the field is irrigated or non-irrigated. Irrigated fields with higher yields will be utilized more in the 18-day rotation cycle, while non-irrigated fields with lower yields will be utilized less as part of the 18-day rotation depending on the yields obtained, to ensure that nutrients are not over applied. Because the slurry application is expected to occur infrequently (typically spaced between 3-6 weeks apart), application of slurry nutrients to non-irrigated fields will still not exceed the agronomic need of nutrients for the crop. Even if the application is more frequent (every 3 weeks), less nutrients will be applied per slurry application as less solids have built up in the settling ponds at the dairy facility.

From a nutrient balance and nutrient accounting standpoint, the annual weighted yield average accounts for the lower yields expected from non-irrigated portions of the pasture and during the winter months, and incorporates that into the nutrient uptake (an overall lower yield average means less overall nutrient uptake). Proper management of the farm's operation, by season, is critical to ensure that the non-irrigated areas are utilized properly, especially in the winter months.

20. HDF presents multiple irrigation application rates and most of them are in excess of soil infiltration rates on at least part of the soil under each irrigation method.

As previously mentioned in the responses and in the NBA, irrigation amounts will vary based upon the actual irrigation demand. While a typical application may be close to 0.39 inches per 48-hour cycle in the summer months, in standard engineering design, one does not plan for exactly 0.39 inches of irrigation per 48 hour cycle. Assuming loss to equipment efficiencies (20%) and no inclusion of liquid effluent, as well as drier than average conditions meaning increased irrigation demand, it stands to reason that irrigation demands exceeding 0.43 inches

per 48-hour cycle, may be required at some point. Thus, the infrastructure system, including the pivots, as well as the irrigation water source, Waita Reservoir, should be sized and able to supply for a possible "upper-end" application rate. The rate of 0.48 inches per 48 hour cycle, or 0.24 inches per day was chosen. This is used to size the system and not indicative of the everyday application of irrigation. However, in a standard engineering design, infrastructure is oversized to allow for losses to inefficiencies and allows some buffer, and in this case, the upper end rate is no different.

21. The significant variability of rainfall across the farm is not considered in HDF's yield estimates, irrigation and manure application rates, and nutrient balance.

The latitude and longitude used for determining the evapotranspiration rates and references for the crop were taken from the center of the farm and not in the low end of the valley. The center of the farm is most representative and directly applicable to sizing of the dairy facilities.

22. HDF fails to discuss mitigation for livestock water troughs which will provide ideal habitat for mosquito breeding.

Watering troughs will contain water for the period of 12 to 24 hours when cows are utilizing the troughs in the occupied paddocks. HDF personnel will fill troughs just before the cow "mobs" enter the paddock(s) for the grazing period; troughs will be emptied after the cows are moved to another paddock. Troughs will be managed to prevent mosquito breeding.

Refer to Volume 5, Appendix C – C for additional responses to comments regarding manure related insects.

23. The grass yield and nutrient uptake are from a farm trial that is not supported by any raw data, data analysis, or discussion of the scientific analysis and scientific design of the trial to validate the results.

See previous responses. Cutting grass at frequent intervals simulates grazing. The thatch of the kikuyu minimizes compaction and reduced yields commented upon. HDF did not over-fertilize the grass trial areas beyond the HDF's grass & forage expert's recommended fertilizer application rates, or over-irrigate based upon visual observation.

24. The DEIS fails to address the negative impacts of intentional over application of phosphorus.

Please refer to the NBA, Page 73:

"As previously mentioned, nutrient management and mass balance analyses are dynamic and are influenced by the many different environmental variables that enter into nutrient cycle planning from grass yields, stocking density, manure nutrient content, soil nutrient content, and crop nutrient content.

Soils analyses currently indicate that the farm soils are extremely deficient in phosphorus. In the initial phases of the farm, HDF anticipates that larger amounts of phosphorus beyond the crop need will improve soil conditions, as the binding of phosphorus to the soil ensures that it stays in the soil profile and is available for continued use by the grass during the paddock's 18 day rest period and during the summer months of high productivity. Ultimately, when the farm is established after a few years, HDF intends to provide only the nutrient the grass crop needs, once the soil conditions improve and the farm nutrient balance and management becomes a "maintenance" operation. Until then, additional phosphorus, beyond the crop demand, is allowable in soils with low phosphorus leaching properties, per the NRCS Risk Analyses.

Based upon the soils health report by Dr. Russell Yost and Nicholas Krueger, University of Hawai'i at Mānoa, College of Tropical Agriculture and Human Resources (CTAHR), an initial (one-time or cumulative over the first few years) application of up to 230,000 lbs. of phosphorus over 469.9 acres of pasture will be beneficial to the current soil nutrient content to maximize productivity for the grass crop during the establishment phase of the pasture. The planned application of phosphorus, even for the 2,000 mature dairy cow herd is approximately 91,000 lbs. annually, of which around 87,300 lbs. will be taken up by the forage. Stated differently, the 91,000 lbs. of phosphorus per year exceeds the crop uptake demand at a grass yield of 16.3 tons of DM per acre per year by about 3,700 lbs. of phosphorus. The planned amount of 91,000 lbs. per year of applied phosphorus in this scenario, however, is only a fraction of what could be initially applied to improve soil conditions as recommended by Dr. Russell Yost when soil nutrient content was measured. At 699 mature dairy cows and 150 calves, there is simply a deficit of nutrient to meet crop demand, regardless of the soil nutrient conditions."

HDF would also not increase the herd size immediately to 2,000 cows if the phosphorus application exceeded the agronomic need of the crop and the optimum soil phosphorus content. The 3,700 lbs. of excess phosphorus per year is only estimated at exactly 2,000 cows, and does not take into account how HDF's operations could grow through a reasonable incremental increase in animals on the farm. The excess phosphorus also does not reflect points in time when the farm is operating somewhere in between 699 mature dairy cows and up to 2,000 mature dairy cows. Once the farm is established, HDF may elect to mitigate phosphorus by reducing the herd size to less than 2,000 cows, or by increasing the grass yield beyond 16.3 tons DM per acre per year which is highly likely. Increased yields result in increased overall nutrient uptake and removal from the soil profile.

Refer to G70's responses to the Deanne Meyer report regarding manure production. Manure production estimates are more realistic and specific at 90.8 lbs. per day per mature dairy cow.

Refer to previous responses regarding the grass trials regarding phosphorus uptake in Kikuyu.

25. The HDF has erroneously used average soil conditions, average manure applications, average weather, average irrigation, and average yields to present a flawed nutrient balance.

Refer to the previous responses regarding the use of two management styles for soils, analysis by manure application types, the monthly and annual bases for weather and precipitation, conservatively analyzed and realistic grass yields, and varied irrigation to meet the agronomic need of the crop.

26. HDF plans to empty the manure storage ponds onto paddocks prior to cataclysmic storms but fails to provide analysis of environmental impacts or mitigation.

The USDA, NRCS, EPA, and standard industry practices ensure that the effluent pond systems are designed to withstand major storm events. However, regulations also allow for potential effluent discharges for extreme storm events or cataclysmic events. While scenarios such as this are unfortunate, they cannot be completely prevented.

HDF has taken appropriate steps and acted in good faith to expand the available storage capacity of the ponds and includes extra storage capacity within a downstream berm, designed to hold an additional 30 days of effluent storage at 2,000 mature dairy cows or over 1 million gallons of liquid. The additional capacity is well beyond what is required by the State of Hawaii and by NRCS Conservation Practice Standards and technical guidance. Such a berm and other retention areas adjacent to raised raceways on-site would assist with keeping as much effluent on the fields instead of in the waterways if the pond were emptied.

27. HDF's nutrient balance calculations fail to consider using reduced land areas for manure application even though the report identifies the limitations of many paddocks and presents addition of drains that are not well defined.

As indicated, some paddocks may not receive nutrients if the paddock cannot be managed at that time. As noted, "less than two days after heavy rain and with management of surface water after a significant rain event (diversion to a retention area, etc.), the soils are observed to be dry enough to graze, even without a Kikuyu thatch."

All paddocks and pasture will receive nutrients, but their conditions will dictate whether a given paddock will receive nutrients at a particular point in time. However, available storage in the ponds should attenuate for situations where additional effluent must be stored since it cannot be applied to certain paddocks at a particular point in time. Additionally, as yields increase, more nutrients may be utilized on site.

Proper management of the rotation of mobs will ensure that certain operationally challenging areas be utilized only when there are no anticipated significant rain events and not utilized when significant rain is forecast. Paddocks identified as potentially having drains will be managed so that they are not used during anticipated significant rain events ensuring that there are no cows and therefore no manure that could be collected by runoff and enter into a drain.

28. Potential increases of nitrogen and phosphorus leaving the proposed HDF site are underestimated by use of the flawed nutrient balance analysis as the basis of nutrient availability.

Refer to previous responses as to the accuracy and the preparation of the Nutrient Balance Analysis report, which the comments mischaracterize as "errors and omissions".

29. The DEIS underestimates potential impacts of rain plus irrigation and disregards the variation of rainfall across the farm.

The rain gauge used for the NBA is located near the taro farm, and not in the very low end or the upper end of the entire valley. The rain gauge used is appropriate for sizing of the effluent ponds. The majority of the farm is on the lower gentle slopes of the valley, away from the adjacent valley walls, and the NOAA rain gauge is representative of a relatively consistent site.

The Rainfall Atlas of Hawaii rainfall information is provided in Table 1 of the Nutrient Balance Analysis (pg. 10). These average rainfall totals are used to size the waste management systems, as required by the DOH Guidelines for Livestock Management. It shows a total annual precipitation of 49.95 inches, and a rainfall from the month of November (6-inches) is used for sizing of the effluent ponds.

Irrigation demand and scheduling is based upon the Māhāʻulepū Rain Station 941.1, which shows a total average annual precipitation rate of 44.26 inches. The rain gauge data provides real time data that can be used to accurately size monthly irrigation demands shown in Table 12 of the NBA, on page 37.

30. Appendix E underestimates the total nitrogen associated with manure from 2000 cows by 100,000 pounds per year.

Refer to the responses above and Group 70's responses to the Deanne Meyer Report (2016) in Appendix F – F, with respect to the total nitrogen associated with manure from up to 2,000 mature dairy cows from HDF. The model prepared by the commenters, yielding 592,029 lbs. of nitrogen applied and 335,934 lbs. of nitrogen loss is based upon standards last updated in 2005 that do not represent HDF's pastoral-based, rotational grazing system and ignore field-gathered, laboratory-tested data including grass yields and nutrient uptake analyses. Their models do not use farm-specific animals, dietary inputs, and have not accounted for changes in genetics, management systems, and nutritional advances over the past 16 years. *(1) Journal of Dairy Science 98:6361–6380 The Cornell Net Carbohydrate and Protein System: Updates to the model and evaluation of version 6.5 M. E. Van Amburgh, et. al. (2) JDS 95 :2004–2014 Development and evaluation of equations in the Cornell Net Carbohydrate and Protein System to predict nitrogen excretion in lactating dairy cows R. J. Higgs, et. al. (3) JDS 81: 2029 - 2039 Evaluation and Application of the Cornell Net Carbohydrate and Protein System for Dairy Cows Fed Diets Based on Pasture Kolver, E.S. et al.*

The model presented by CH2M Hill is based upon the Līhuʻe rain gauge as well as an unrealistic amount of rainfall, both of which are not representative of the Māhāʻulepū site. **See previous responses above as to why the Māhāʻulepū rain gauge is more appropriate for the project site than the Līhuʻe rain gauge.** It assumes the fields are constantly rained upon based on worst-case Līhuʻe weather data that does not even apply to Māhāʻulepū, and therefore assumes the fields are constantly saturated. This is not supported by visual observations and is in no way how HDF will operate. As a result, such a loss rate of nutrient (57 percent) is unrealistic and highly exaggerated and would not support any grass growth in the valley.

31. The use of a first order approximation underestimates the loss of nitrogen to the environment by a quarter of a million pounds per year for 2000 cows.

Refer to the previous response to the total nutrient mass balance for HDF, and its calibration to a current manure modeling system (Cornell Net Carbohydrate Protein System- CNCPS) and based on actual field trials for nutrient uptake by the forage. The characterization that the NBA is a first order approximation is incorrect as it is based upon detailed milk production and manure production modeling based upon field gathered, laboratory-tested grass trials. *The model used by the commenters and nutrient numbers from Deanne Meyer are based upon "book values" from nearly 20 years ago from an industrial-type dairy which is not characteristic of HDF (Atlantic Dairy Consulting, Robert Fry, DVM).*

32. HDF uses first order approximations to erroneously predict the impact to the local environment as only 26 percent of the existing nitrogen discharges but CH2M's modeling calculates the nitrogen discharge from 2000 cows at 870 percent of existing nitrogen discharges.

Refer to the responses above and Group 70's responses to the Deanne Meyer Report (2016) in Volume 5, Appendix F – F, with respect to the potential contribution of nutrients to the environment from HDF at up to 2,000 mature dairy animals. The model prepared by the commenters, yielding 592,029 lbs. of nitrogen applied and 335,934 lbs. of nitrogen loss is based upon standards last updated in 2005 that do not represent HDF's pastoral-based, rotational grazing system and ignore field-gathered, laboratory-tested data including grass yields and nutrient uptake analyses. Their models do not use farm-specific animals, dietary inputs, and have not accounted for changes in genetics, management systems, and nutritional advances over the past 16 years. *(1) Journal of Dairy Science 98:6361–6380 The Cornell Net Carbohydrate and Protein System: Updates to the model and evaluation of version 6.5 M. E. Van Amburgh, et. al. (2) JDS 95 :2004–2014 Development and evaluation of equations in the Cornell Net Carbohydrate and Protein System to predict nitrogen excretion in lactating dairy cows R. J. Higgs, et. al. (3) JDS 81: 2029 - 2039 Evaluation and Application of the Cornell Net Carbohydrate and Protein System for Dairy Cows Fed Diets Based on Pasture Kolver, E.S. et al.*

The model presented by CH2M Hill is based upon the Līhuʻe rain gauge as well as an unrealistic amount of rainfall, both of which are not representative of the Māhāʻulepū site. It assumes the fields are constantly rained upon based on worst-case Līhuʻe weather data that does not even apply to Māhāʻulepū, and therefore assumes the fields are constantly saturated. This is not supported by visual observations and is in no way how HDF will operate. As a result, such a loss rate of nutrient (57%) is unrealistic and highly exaggerated and would not support any grass growth in the valley.

HDF's nutrient balance for the farm with 2000 cows indicates that on an annual basis, 490,200 pounds of nitrogen will be needed to grow the grass (Table 7 of Appendix E). 432,664 pounds (88 percent) would be from the manure produced by the cows and 57,536 pounds (12 percent) would be applied in fertilizer. The CH2M Hill model computes the nitrogen discharge from the farm with 2000 cows would be 335,934 pounds in a year or 69 percent of the nitrogen required to grow the grass. If CH2M Hill's model result is even remotely correct, the grass could not be grown and the farm could not exist. CH2M Hill's model result is completely unrealistic (Nance).

33. It is unfortunate that the scientists that prepared each appendix have used the erroneous data from the Group 70 and Red Barn DEIS as the base assumption for nutrient balances and water balances. Most of the same comments made previously apply to this report where the previously discussed incorrect data is used.

Refer to the responses above and Group 70's responses to the Deanne Meyer Report (2016) in Volume 5, Appendix F – F, with respect to the potential contribution of nutrients to the environment from HDF at up to 2,000 mature dairy animals. The model prepared by the commenters, yielding 592,029 lbs. of nitrogen applied and 335,934 lbs. of nitrogen loss is based upon standards last updated in 2005 that do not represent HDF's pastoral-based, rotational grazing system and ignore field-gathered, laboratory-tested data including grass yields and nutrient uptake analyses. Their models do not use farm-specific animals, dietary inputs, and have not accounted for changes in genetics, management systems, and nutritional advances over the past 16 years. *(1) Journal of Dairy Science 98:6361–6380 The Cornell Net Carbohydrate and Protein System: Updates to the model and evaluation of version 6.5 M. E. Van Amburgh, et. al. (2) JDS 95 :2004–2014 Development and evaluation of equations in the Cornell Net Carbohydrate and Protein System to predict nitrogen excretion in lactating dairy cows R. J. Higgs, et. al. (3) JDS 81: 2029 - 2039 Evaluation and Application of the Cornell Net Carbohydrate and Protein System for Dairy Cows Fed Diets Based on Pasture Kolver, E.S. et al.*

The model presented by CH2M Hill is based upon the Līhuʻe rain gauge as well as an unrealistic amount of rainfall, both of which are not representative of the Māhāʻulepū site. It assumes the fields are constantly rained upon based on worst-case Līhuʻe weather data that does not even apply to Māhāʻulepū, and therefore assumes the fields are constantly saturated. This is not supported by visual observations and is in no way how HDF will operate. As a result, such a loss rate of nutrient (57%) is unrealistic and highly exaggerated and would not support any grass growth in the valley.

34. The assessment of impacts to the shoreline were made with consideration of low levels of nitrogen and phosphorus which are not correct.

Refer to the responses above and Group 70's responses to the Deanne Meyer Report (2016) in Volume 5, Appendix F – F, with respect to the potential contribution of nutrients to the environment from HDF at up to 2,000 mature dairy animals. The model prepared by the commenters, yielding 592,029 lbs. of nitrogen applied and 335,934 lbs. of nitrogen loss is based upon standards last updated in 2005 that do not represent HDF's pastoral-based, rotational grazing system and ignore field-gathered, laboratory-tested data including grass yields and nutrient uptake analyses. Their models do not use farm-specific animals, dietary inputs, and have not accounted for changes in genetics, management systems, and nutritional advances over the past 16 years. *(1) Journal of Dairy Science 98:6361–6380 The Cornell Net Carbohydrate and Protein System: Updates to the model and evaluation of version 6.5 M. E. Van Amburgh, et. al. (2) JDS 95 :2004–2014 Development and evaluation of equations in the Cornell Net Carbohydrate and Protein System to predict nitrogen excretion in lactating dairy cows R. J. Higgs, et. al. (3) JDS 81: 2029 - 2039 Evaluation and Application of the Cornell Net Carbohydrate and Protein System for Dairy Cows Fed Diets Based on Pasture Kolver, E.S. et al.*

The model presented by CH2M Hill is based upon the Līhuʻe rain gauge as well as an unrealistic amount of rainfall, both of which are not representative of the Māhāʻulepū site. It assumes the fields are constantly rained upon based on worst-case Līhuʻe weather data that does not even apply to Māhāʻulepū, and therefore assumes the fields are constantly saturated. This is not supported by visual observations and is in no way how HDF will operate. As a result, such a loss rate of nutrient (57%) is unrealistic and highly exaggerated and would not support any grass growth in the valley.

35. Appendix K of the DEIS erroneously states that the proposed dairy is not expected to significantly impact drainage conditions and peak flow patterns on the farm.

Kikuyu forms a thick thatch that essentially reduces compaction and absorbs and can even block runoff. Even in the winter months, where diversified forages will be used, the Kikuyu thatch will be maintained by using no-till planting methods when diversified forages must be planted in November and December to boost forage yields. Conditions under good pasture management with a thick Kikuyu thatch are expected to improve runoff retention, increase time of concentrations, and reduce peak flows from rainfall that lands on the pasture. Irrigation is not considered a factor in peak runoff calculations, especially if HDF has agreed to not irrigate the fields with effluent within 2 days of forecasted heavy rain and 2 days following.

HDF will not be altering any of the major drainage ways within the valley.