CLOSURE AND POST-CLOSURE PLAN
CENTRAL MAUI LANDFILL
PUUNENE, MAUI, HAWAII

Prepared for

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1. INTRODUCTION

This Closure and Post-Closure Plan (Plan) has been prepared for the Central Maui Landfill (CML) in accordance with the requirements of Hawaii Administrative Rules (HAR) Title 11, Chapter 58, Sections 1-17 and 1-18, and 40 CFR Part 258, Section 258.74(f). This Plan describes the activities that will be taken to close the site at the end of its active life and maintain it for the post-closure care period, in conformance with state and federal requirements including the following:

- Estimate the largest area ever requiring closure at one time during the life of the site.
- Estimate the maximum inventory of wastes ever on site.
- Identify activities necessary to close the site.
- Describe the final closure cover design.
- Provide a schedule for conducting closure activities.
- Describe post-closure care and maintenance activities including a scheduled frequency for them.
- Provide contact information for the person or office responsible for post-closure care.
- Provide an estimate of the costs for a third party to close and provide post-closure care for the facility.
- Describe the funding mechanism to be used to meet the financial assurance requirements for closure and post-closure costs.

This Plan, which replaces the previous version dated February 2017, is the preliminary closure plan for the existing/operational Phases IV, V, and V-B Extension, and the proposed Phase III. The post-closure section documents post-closure activities and costs for Phases I and II, closed in 2007, and for Phases IV, V, V-B Extension, and III.

Sections 2, 3 and 4 of this Plan provide background information on the facility, landfill design, and environmental monitoring systems. Section 5 describes the facilities subject to closure, closure activities and schedule for closure. Section 6 provides the required information on post-closure. Section 7 contains the cost estimates and financial assurance information.

2. SITE DESCRIPTION

2.1 Location

The Central Maui Landfill is located on the eastern side of the isthmus between West Maui and Haleakala, approximately 12,000 feet southeast of the Kahului Airport. Figure 1 is a general vicinity map showing the approximate location of the facility relative to local roads and communities. The Tax Key Map identification for the facility is TMK (2) 3-8-03: 19.

2.2 General Facility Layout

Figure 2 shows the general layout of the CML facility. The CML property is effectively divided into two main parts by Kalialinui Gulch, which trends roughly north south across the center of the property.

Phases I through III are located east of Kalialinui Gulch. Phases I and II were operational land disposal units for approximately 19 years, filled to approved final grades during 2005, subsequently closed and capped during 2006 and 2007, and currently in post-closure.

Phase III, located immediately to the north of Phases I and II, is proposed for development as landfill. Phase III is planned for development in two sub-phases: Phase III-A (approximately 8.5 acres of liner area), and Phase III-B (approximately 8.3 acres of liner area).

Phases IV, V, and V-B Extension comprise the active disposal areas of the facility and have a disposal area footprint of approximately 41 acres on the west side of Kalialinui Gulch. Waste placement in this western portion of the facility began in Phase IV-A during 2005, and has subsequently extended through Phases IV-B, V-A, V-B, and V-B Extension. It is the County's intention to acquire the property for Phase VI and obtain the required permits to develop it as a future landfill phase after development of the Phase III area.

2.3 Topography

The island of Maui is divided into western and eastern portions, generally corresponding to the West Maui and East Maui (Haleakala) volcanoes. The West Maui highlands are older, generally more dissected, and reach a maximum elevation of 5,788 feet above mean sea level (amsl). Haleakala rises to an elevation of 10,025 feet amsl and constitutes the greater bulk of Maui's landmass. Between these two volcanic highlands is an area of relatively subdued topography known as the central isthmus.

The CML facility is located near the eastern edge of Maui's central isthmus. Overall, the land surface in this area slopes to the north and northwest, away from Haleakala and toward the Pacific Ocean shoreline. In a regional sense, the topography near the CML facility is transitional between the more subdued coastal plain topography to the north and northwest, and the more rugged foothills of Haleakala to the southeast. On a more local scale, the CML facility can be seen to occupy a subtle topographic depression, accentuated by quarrying, associated with the north-northwest trending Kalialinui Gulch. At this scale, the topography is somewhat asymmetric, with a fairly substantial north-northwest trending ridgeline located southwest of the facility and a more subdued topography to the northeast. The presence of this ridgeline to the southwest of the facility may be responsible for the slightly more northerly trend of Kalialinui Gulch in the immediate site area, relative to its more northwesterly regional trend.

The natural topography at the CML facility has been substantially altered by pre-landfill quarrying activities and subsequent waste disposal operations. Phases I and II and Phases IV and V disposal areas dominate the current topography at the facility, with elevations of approximately 360 ft-amsl and 330 ft-amsl, respectively. Kalialinui Gulch is locally up to 20 feet deep relative to adjacent portions of the facility, with gulch bottom elevations ranging from 270 ft-amsl at the southern property boundary to about 210 ft-amsl near the northern property boundary. The remainder of the CML facility, although locally irregular, generally slopes to the northwest from the east and south, with elevations ranging from about 220 ft-amsl to 310 ft-amsl.

2.4 Geology and Hydrogeology

Quarrying activities at the CML have provided good exposures of the uppermost 40 feet of lithology at the facility. Additional geologic characterization of site lithology to depths of up to 327 feet below natural grade is obtainable from lithologic logs prepared for the facility's six groundwater monitoring wells. The natural surface of the CML facility is composed predominantly of Kula volcanic rocks that have been weathered to reddish colored silty clay. Where undisturbed, this surficial soil horizon ranges in thickness from about 5 to 15 feet.

This surficial soil horizon is underlain at the CML site by relatively fresh volcanic rocks of the Kula Series. The Kula Series volcanic rocks, which are locally up to 30 feet thick, are in most areas of the site, underlain by an approximately 10 foot thick, reddish brown, silty clay (saprolite) weathering horizon which is, in turn, underlain by a volcanic clinker horizon ranging from less than 5 feet to as much as 20 feet thick. At monitoring wells MW-4 and MW-5 this horizon apparently changes character somewhat, and is characterized as a moderately weathered tuff, ranging in color from gray to dark brown to red brown. Taken as a whole, this saprolite/clinker/tuff horizon appears to be laterally continuous beneath most of the CML facility. It is expected to occur near, or just below the assumed base grades for Phases I and II and the planned base grades of Phase III; and approximately 20 feet below those of Phases IV, V, V-B Extension, and future Phase VI.

Below the saprolite/clinker/tuff horizon, site monitoring wells encountered basaltic volcanic rocks thought to be the upper portions of the Honomanu volcanic series. These materials, which extend to the maximum depth explored in the boreholes (327 feet below natural grade), are primarily hard basaltic flow rocks, with some laterally discontinuous weathered horizon and clinker zones.

The CML facility currently maintains nine groundwater monitoring wells, ranging in depth from 245 to 327 feet below ground surface (see Figure 6). These wells are screened within the basal groundwater zone and provide important information regarding subsurface lithology, groundwater head levels, and groundwater geochemistry for the CML facility. The following description of site hydrogeology is based primarily on site characterization data obtained from these monitoring wells.

Uppermost Aquifer. HAR 11-58.1-16(b)(1) requires that CML identify and actively monitor the uppermost aquifer beneath the facility. The aquifers underlying the CML are part of the Paia aquifer system, which is in turn part of the larger Central aquifer sector on Maui. Mink and Lau (1990) indicates that both a shallow aquifer, classified as being high-level, unconfined, and perched, and a basal unconfined flank aquifer are potentially present within the aquifer system underlying the area that includes the CML. However, no high-level or perched aquifer has been identified at the CML site during previous investigations. The lack of perched groundwater is indicated by previous site characterization activities at CML, as follows:

- Lithologic logging of borings for site monitoring wells has included descriptions of moisture conditions. No indication of perched groundwater is noted on lithologic logs from any of the site monitoring wells; and,

- Quarrying activities at the site have locally extended completely through the Kula Series Volcanics - the lithologic unit most likely to contain perched groundwater zone - with no evidence of perched groundwater being noted.

The underlying basal aquifer is therefore considered to represent the upper most aquifer beneath the CML facility pursuant to HAR 11-58.1-16(b)(1).

Groundwater Elevations. Depth to groundwater measurements have been conducted in site monitoring wells on at least a quarterly basis in site monitoring wells since 1995, with more frequent measurements (eight per year) being made as part of baseline monitoring activities during 1995-96 and 2002-03. A tidal influence study involving hourly measurements was also conducted in 1996 (Masa Fujioka and Associates, 1997).

The elevation of the basal groundwater zone has typically ranged from 1.5 to 3.5 feet amsl in CML monitoring wells (approximately 220 to 300 feet below ground surface). Groundwater elevations in site monitoring wells show both short-term and long-term variations. The tidal study conducted in 1996 by Masa Fujioka and Associates (1997) indicated minor tidal effects on groundwater levels. Significant seasonal variations in groundwater levels have been noted, with water table elevations being generally higher during and following the winter rainy season than during the dry period. A significant long-term decline of approximately one foot in groundwater elevations is also apparent from monitoring data from 1995 through 2018.

These long-term declining trends in site monitoring wells are consistent with regional trends described by Gingerich (2008).

2.5 Seismic Environment

The CML facility is located within a “seismic impact zone”, defined by Hawaii Administrative Rules (HAR) Section 11-58.1-13(e), as an area with a ten percent or greater probability of experiencing a horizontal acceleration, due to seismic shaking, of more than 0.10 g in a 250-year period. The United States Geological Survey (USGS) has classified the island of Maui in UBC Seismic Zone 2B, defined as having a ten percent probability of exceeding a peak ground acceleration of 0.15 g in 50 years. USGS earthquake hazard maps estimate the peak horizontal ground acceleration in central Maui to be 0.36 g with a 2% probability of occurrence in 50 years. A probability of exceedance of 2% in 50 years is approximately equivalent to a probability of 10% in 250 years, and represents an event expected to occur one time in approximately 2,400 years.

2.5.1 Stability Analysis

The landfill slopes and containment system designs have been analyzed to demonstrate they will resist the maximum horizontal acceleration anticipated at the site. Using the final grades, the stability of the final landfill slopes were evaluated using PCSTABL5M a computer-based analytical program that computes static and pseudo-static factors of safety for the selected critical slope cross-sections. Two analysis were conducted, one for each independent landfill structure on located on each side of the Kalialinui Gulch. One analysis addresses Phases I through III, and the other addresses Phases IV through VI. For each landfill structure, three critical slope cross-sections were selected and analyzed. Both sets of analyses found for all of the cross-sections the static factor of safety exceeds 1.5 and the pseudo-static factor of safety exceeds 1.0, the generally accepted critical value for static and pseudo-static slope stability. Also, there will be no permanent deformation of the liner systems during the design seismic event. Appendix C of the site’s Operations Plan contains the referenced slope stability reports.

Also, the stability of the final cover system was evaluated, and the report is included in Appendix B of this plan. The slope stability for the final cover system utilized an infinite slope model for static, as well as pseudo-static slope stability during a design earthquake event (Matasovic, 1989). The analysis found the static factor of safety exceeds 1.5 under all conditions of cover soil saturation and maximum deformation is estimated to be 0 inches following the design earthquake event.

2.6 Climate

Climatic conditions at the CML facility are characterized by moderate temperatures, limited precipitation, moderate to strong winds, and high evaporation rates. Daily average temperatures at the facility typically range from the low 60's (degrees Fahrenheit) during winter to the high 80's in the summer. Annual precipitation at the CML facility averages about 18 inches. The majority of the rainfall at the CML facility occurs between November and April. Typically, December and January are the wettest months of the year and June is the driest month (Giambelluca et. al. 1986; WRCC 2012).

The site is located windward of the prevailing east to northeasterly trade winds and due to the channeling affect of the central isthmus area, winds speeds at the facility can be substantial. Winds in the area average approximately 13 miles per hour throughout the year, and reach speeds of 25 miles per hour or more with some frequency (WRCC, 2004).

Due to relatively high winds and intense sunlight, evaporation rates are significantly higher than that for the ocean, with summer evaporation often greater than 10 inches per month. The pan evaporation rate in the vicinity of the CML facility averages between 90 and 100 in/yr, the highest averages in Hawaii (Ekern et. al, 1985).

3. FACILITY DESIGN AND OPERATIONS

3.1 General

Figure 2 shows the six phases of development for CML. Phases I and II were closed in 2007. Phase III is planned for construction and use as a future disposal area. Phase III is planned to be constructed over two sub-phases of development, Phase III-A, and Phase III-B. Phase IV-A was placed in service in 2005. Phase IV-B, was placed in service in March 2007. Phase V-A was placed in service in 2009. Phase V-B was placed into service in 2010. Phase V-B Extension was placed into service in 2019. Collectively, Phases IV-A, IV-B, V-A, V-B, and V-B Extension make up the current active areas of the landfill. Phase III-A is the next area to be developed as landfill.

3.2 Liner and Leachate Collection Systems

CML Phases I and II were constructed and placed into service prior to adoption of HAR 11-58.1-14(c) requirements for landfills to be constructed with liners and leachate collection and removal systems. Prior to waste placement in Phases I and II, a system of perforated pipes was placed in direct contact with the previously excavated quarry floor, and landfilled waste was placed directly above these pipes. Five (5) vertical risers ("manholes") were initially installed for monitoring and withdrawing leachate from the pipes at the base of the Phase I and II landfill, but the risers were not extended or maintained as successive lifts of refuse were placed in the landfill, and the risers were eventually buried. According to site personnel, no leachate was detected in the manholes prior to their loss of use. As part of the Phases I and II final closure construction, Manhole 4 was re-established and connected to the exposed pipe from Manhole 5.

The Phase IV-A landfill area was constructed with a composite liner and a leachate collection system. The liner consists of a geosynthetic clay liner (GCL) and a high-density polyethylene (HDPE) geomembrane constructed on a subgrade cushion layer. The leachate collection system is a geocomposite drainage layer above the liner that conducts leachate from the waste to an external concrete wet well equipped with an explosion proof pump and a polyethylene tank. The geocomposite is covered with a 36-inch thick operations layer to protect the liner system.

The liner system of Phase IV-B and Phase V-A are connected to the Phase IV-A liner, but have separate leachate collection systems, and are therefore hydraulically separate from Phase IV-A.

Phase IV-B, Phase V-A, and Phase V-B were constructed with prescriptive composite liner systems consisting of two feet of low permeability soil with a maximum permeability of 1.0×10^{-7} cm/sec, overlain by an 80-mil thick HDPE geomembrane. The leachate collection system on the floor is a 12-inch thick layer of gravel with a central gravel-filled trench in which an 8-inch perforated pipe is placed to conduct leachate to a double-lined internal sump. The sump located in Phase IV-B also services Phase V-A and V-B. A

16-ounce per square yard geotextile provides a leachate collection system for the side-slopes. The operations layer over the floor and side slopes in Phases IV-B, V-A and V-B is a 24-inch layer of soil. The leachate collection pipe and sump are sized to serve as the leachate collection system for Phases IV-B, V-A and V-B

The liner system in Phase V-B Extension is identical to that used in Phases IV-B, V-A and V-B. The Phase V-B Extension area is constructed with a double lined leachate collection sump, similar in design as the one servicing Phases IV-B, V-A, and V-B, and is located in the northeast corner of the cell. The Phase V-B Extension leachate sump has been sized to serve the future Phase VI area which will be graded to drain to this sump.

The Phase III disposal area liner system is designed to be identical to the liners in Phase IV-B, V-A, V-B and V-B Extension. Phase III will also be constructed with a double lined sump, located in the northwest corner of Phase III-A, which will be sized to serve the future Phase III-B.

Figure 3 presents the existing liner grades for Phases IV, V, and V-B Extension and the planned liner grades for the proposed Phase III and future Phase VI areas.

3.3 Leachate Management

As noted above, Phases IV-A, IV-B (servicing Phase V-A and V-B areas), and V-B Extension all have separate leachate collection and removal systems. Leachate collected and removed from these existing systems, and the proposed Phase III system, may be managed through the leachate reintroduction system, by spreading at the active disposal working face for litter control and improved waste compaction, or by transporting it off site to a public wastewater treatment facility.

The Phase IV-A external concrete wet well is equipped with a pump that automatically transfers leachate to the leachate storage tank system, which consists of eight (8) 4,000 gallon polyethylene tanks, installed in a concrete secondary containment.

The Phase IV-B sump is equipped with a vertical riser pipe assembly installed at the lowest elevation of the sump, from which leachate is withdrawn using an actively-controlled submersible pump. Similar to the Phase IV-A wetwell, the Phase IV-B sump pumps leachate to to the leachate storage tank system.

The leachate reintroduction system includes pipes to deliver leachate from the leachate tank system to geotextile lined, gravel filled horizontal infiltration trenches in Phases V-A and V-B, and infiltration galleries in Phase IV-B. Additionally, the leachate reintroduction system is equipped with a manual riser connected to the infiltration trenches by which leachate, transported from the leachate storage tanks via tanker trucks, can be gravity fed into the reintroduction system. The leachate reintroduction system will be expanded into Phase V-B Extension as landfilling activities progress and in other future lined areas.

The Phase V-B Extension drains to a leachate collection system sump located in the northeast corner of Phase V-B Extension area. A central northeasterly oriented LCRS trench collects leachate from the 12-inch thick gravel drainage media covering the liner system and conveys it to the sump in perforated 8-inch diameter HDPE pipes. The LCRS drainage layer and LCRS trench/perforated pipes will be extended into the Phase VI area, when constructed, to convey leachate from this area to the Phase V-B Extension sump. The leachate collection sump in Phase V-B Extension is equipped with a vertical riser pipe system similar to that of Phase IV-B.

The proposed Phase III area will drain to a new leachate collection system and sump located in the northwest corner of Phase III-A. A central oriented LCRS trench will collect leachate from the 12-inch thick gravel drainage media covering the liner system and convey it to the sump in perforated 8-inch diameter HDPE pipes. The leachate collection sump in Phase III will be equipped with a vertical riser pipe system similar to that in Phases IV-B and V-B Extension. A leachate reintroduction system, similar to that installed in the Phase IV-B and V areas, will be installed in the Phase III area and will be operated in a manner consistent with the existing system.

3.4 Landfill Gas Management

The present network of perimeter gas monitoring probes at CML consists of 12 probes. Though the landfill gas collection and control system minimizes the chances of gas migration, regulatory agencies require perimeter gas monitoring to verify subsurface gas concentrations do not exceed 5% by volume (50,000 ppm) at the property boundary, and to protect public health and the environment. The existing perimeter gas monitoring system has been incrementally expanded as the landfill footprint has been expanded to maintain compliance with regulatory requirements. The monitoring system is based on probes located at intervals of not more than 1,000 feet around the perimeter of the landfill.

The construction of the Phase III area will impact the existing gas monitoring probes GP-1, GP-2, and GP-10 and these probes will be abandoned and relocated to the perimeter of the Phase III area prior to construction of Phase III-A. Similarly, development of the Phase VI area will necessitate the installation of an additional probe (GP-12).

The locations of existing gas monitoring probes and the proposed new and relocated probes, associated with the construction of Phase III and Phase VI area, are illustrated on Figure 6.

In conformance with state and federal requirements, CML installed a landfill gas collection and control system (GCCS) in 2008. The initial system included a network of vertical gas extraction wells in the closed Phases I and II area and an enclosed flare for LFG destruction. This system was later expanded into the Phase IV and Phase V areas. The collection system in the Phase IV-A and IV-B area consists of vertical extraction wells. Phase V-A, Phase V-B, and Phase V-B Extension were developed with horizontal gas collectors. Leachate collection system cleanouts in Phase IV-A have also been connected to the system.

The LFG collection system will be expanded into the proposed phases of landfill development. Newly developed landfill cells will be constructed with horizontal collectors constructed above the leachate collection system drainage layer. These collectors will be supplemented by additional horizontal collectors installed at higher elevations within the refuse fill. Vertical gas extraction wells will be installed in refuse fill areas as needed to supplement the horizontal collectors and provide additional emissions control as necessary.

All collected LFG is currently combusted in the flare. The LFG flare system consists of a gas handling skid, condensate storage tank, and an enclosed flare with capability of incinerating gas condensate.

Figure 5 presents an overview of the existing landfill gas collection and control system.

3.5 Surface Water Management

Surface water incident on the landfill is directed to perimeter drainage channels by maintaining minimum slopes of 2% to 3% toward roads and benches constructed on side slopes that drain to the perimeter. The existing perimeter channels and those associated with the future Phases are asphalt-paved and are designed to drain to the Phase IV-A basin, where the runoff generally infiltrates into the porous lava rock formation.

3.6 Method of Operation

Disposal operations use the area fill method of disposal, whereby waste is discharged to a limited area each day, and covered at the conclusion of the day's operation. Waste is placed and compacted using dozers and landfill compactors prior to covering. Only select municipal solid waste (MSW) from residential sources is placed in the first five feet above the liner in newly constructed cells to avoid potential damage to the liner.

3.7 Characteristics, Quantity and Source of Waste

CML is permitted to accept solid wastes as defined in HAR 11-58.1-03. Sources generating solid waste received at the CML are residential, commercial, industrial, and construction and demolition (C&D) activities. A list of unacceptable wastes is included in the Solid Waste Management Permit under Special Conditions, Section C.2.(h).

By permit, CML is allowed to accept no more than 1,200 tons of solid waste in one day. CML typically receives and disposes of approximately 770 tons of solid waste each day.

The CML accepts solid waste delivered directly by residents, businesses, and commercial collection services within the Island of Maui, except for waste generated in Hana Landfill service area. The cities generating solid waste to be disposed of at CML are Wailuku, Kahului, Waiehu, Paia, Waikapu and Puunene from the central section of Maui (representing 54.6 percent of the total waste stream), Kihei and Wailea from the south section of Maui (16.6 percent of the total waste stream) and Lahaina, Honokowai, Kaanapali and Kapalua from the west section of Maui (20.5 percent of the total waste stream). The remaining waste inflow is received from Makawao, Pukalani and Kula and represents approximately 8.3 percent of the total waste stream.

4. ENVIRONMENTAL MONITORING SYSTEMS

4.1 Groundwater Monitoring

4.1.1 Applicable Monitoring Requirements

CML operates a groundwater monitoring system that complies with the requirements set forth in HAR 11-58.1-16(b)-(e), as described below.

4.1.2 Groundwater Monitoring System

The current groundwater monitoring well network for CML includes nine wells, MW-1 through MW-9 (Figure 6). Monitoring wells MW-1, MW-4, and MW-6 are located upgradient of the CML facility. Monitoring wells MW-2, MW-3, MW-5, MW-7, MW-8, and MW-9 currently comprise the facility's downgradient compliance monitoring well network. The groundwater monitoring wells range in depth from 245 to 327 feet and are screened within the underlying basal groundwater zone. The monitoring well network will be expanded as needed to provide sufficient coverage for groundwater data collection, as additional areas of the site are developed or as the site-specific groundwater monitoring program is modified.

4.1.3 Groundwater Sampling and Analysis Procedures

Groundwater sampling and analysis procedures are described in detail in the most recent update to the site's sampling and analysis plan contained in the Groundwater and Leachate Monitoring Plan, by CH2M Hill (2018). These documents describe detailed procedures for the collection of samples, sample preservation, chain of custody, quality assurance/quality control measures, laboratory analysis and recordkeeping, and reporting. They also describe the statistical methods used for evaluation of groundwater monitoring data.

4.2 Landfill Gas Monitoring and Control

HAR 11-58.1-15(d)(1) requires that concentrations of methane do not exceed 25% of the lower explosive limit in facility structures, or 100% of the lower explosive limits at the property boundary. The lower explosive limit for methane is 5% by volume (50,000 ppm).

Monitoring of the perimeter gas probes is conducted on a quarterly basis and the results placed in the operating record in accordance with HAR 11-58.1-15(d)(2).

5. CLOSURE PLAN

5.1 Estimated Closure Date

Phases I and II were closed and capped in 2006-2007, and are presently in the post-closure maintenance period.

The existing CML Phases IV, V, and V-B Extension and the proposed Phase III have an estimated remaining operational life of approximately 12 years. Operational life would be extended approximately 7 to 8 more years with the development of the future Phase VI area. All active and proposed/future disposal areas will be closed within the required regulatory timeframe after final permitted grades are reached.

5.2 Final Grading Plan

Figure 4 presents the proposed final grades for Phases I, II, III, IV, V, and V-B Extension. The criteria for grading the final grades, and final closure cover include:

- Minimum slopes at 3 percent grades; and
- Steepest slopes at 2.5:1 (horizontal: vertical) grades.

5.3 Final Closure Cover Design

5.3.1 Phases I and II

The final closure cover for CML Phases I and II, approved by Hawaii Department of Health (HDOH) and constructed in 2006-2007 (A-Mehr, Inc. 2007), contains the following prescriptive elements, listed from top to bottom:

- An erosion layer consisting of a minimum of six inches of a mixture of soil and compost, seeded to perennial grasses;

- A minimum of two feet of soil, compacted to achieve a maximum permeability of 1 x 10^{-5} cm/sec; and

- A foundation layer consisting of approximately one foot of previously placed intermediate cover.

The final closure cover was constructed using certified quality assurance procedures. Final grades were established and will be maintained during the post-closure period to support effective surface water management and erosion control.

5.3.2 Phases III, IV, V, and V-B Extension

The proposed final closure cover design consists of the following, listed from top to bottom and illustrated in Figure 7:

- An erosion layer consisting of a minimum of one (1) foot of mixed soil and compost, seeded to perennial grasses;

- An infiltration layer consisting of two (2) feet of soil compacted to achieve a maximum permeability of 5.0×10^{-6} cm/sec; and

- A foundation layer consisting of a minimum of one (1) foot of existing intermediate cover soil, scarified and compacted prior to placement of the infiltration layer.

This proposed design will function as an evapotranspirative (ET) cover. It is an alternative final closure cover meeting the requirement of HAR 11-58.1-17(2) "an infiltration layer that achieves an equivalent reduction in infiltration as the infiltration layer specified in paragraphs (1)(A) and (1)(B)." Paragraph (1)(A) requires the infiltration layer to have "a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present, or a permeability no greater than 10^{-5} cm/sec, whichever is less." Paragraph (1)(B) requires the infiltration layer to contain not less than 18 inches of earthen material.

ET monolithic covers have been developed and are widely used as alternative final closure covers for Subtitle-D compliant landfills. The proven performance of the ET cover system is due to its ability to store infiltrated water within the cover system during wet seasons, and then discharge it during dry periods by processes of evaporation and transpiration by plants in the vegetative cover

The computer program UNSAT-H, which is generally recognized as a preferred method for evaluation of alternative final closure covers, was used to estimate annual percolation rates through the ET cover into the waste mass, using climate data from the on-site CML weather station. The results of the analysis indicate that percolation through the ET cover into the underlying waste mass will be essentially zero, and is therefore equivalent to the permeability of the composite liner systems underlying all existing and proposed lined disposal areas.

Appendix A contains the details of the alternative cover analysis.

Detailed specific closure plans will be submitted to HDOH a minimum of 6 months before closure of future areas.

5.4 Surface Water Management

Existing temporary and interim drainage systems in areas to be closed will be enhanced by construction of paved roads and channels to convey runoff efficiently to the perimeter drainage system.

5.5 Landfill Gas and Leachate

5.5.1 Leachate Management Facilities

Although the Phase I and II area is not lined, a leachate collection and removal system, as described in Section 3.2, was constructed with a manhole riser (Manhole No. 4) as a monitoring and removal point if leachate is generated. To date, no leachate has been detected in Phases I and II. If leachate is detected, it will be withdrawn and transported to a publicly owned wastewater treatment facility for disposal.

Leachate from the closed landfill areas will be managed by recirculation through the current and future expanded leachate reintroduction systems. Operation of leachate reintroduction systems in the post-closure period will be consistent with the operational plans and any permit-specific requirements or limitations. As needed, leachate may also be managed through off-site disposal at a publicly owned wastewater treatment facility. The ultimate disposition of leachate collected during the post-closure period will be determined in the future based on the volume of leachate produced and the operational performance of the leachate reintroduction systems.

5.5.2 Landfill Gas Management Facilities

As described in Section 3.4 above, the existing landfill gas collection and control system will be expanded throughout the active life of the landfill, and prior to final closure of Phases III, IV, V, and V-B Extension areas.

5.6 Schedule

Phased or final closure activities for the currently active areas and proposed/future areas, or portions thereof, will be implemented according to the following schedule, which will be refined as final closure plans are developed.

- Six months prior to when final waste will be received - Begin preparation of detailed plans and specifications.
- Six months following receipt of final waste – Complete all closure construction activities including removal of structures.
- Nine months following receipt of final waste – Complete documentation and notification requirements.

5.7 Largest Area Requiring Closure

Final closure cover was installed over the entire 42-acre waste footprint of Phases I and II in 2006-2007.

The anticipated maximum area of CML that will require placement of final cover upon closure of the remainder of the site will be approximately 69 acres (approximately 18 acres in Phase IV, approximately 23 acres in Phase V, including Phase V-B Extension, and approximately 28 acres in Phase III). The final grades of Phase III will blend into adjacent Phase II area, and will overlay a portion of the closed Phase II area.

Currently, the developed, and active disposal areas of Phases IV-A, IV-B, V-A, V-B, and V-B Extension represent the largest area requiring closure, and is approximately 41 acres.

5.8 Maximum Waste Inventory

Approximately 3,100,000 tons of solid waste were landfilled in CML Phases I and II at the time of its closure.

The disposal capacity in the currently active portions of Phases IV, V, and V-B Extension, is approximately 4,600,000 cubic yards, or about 2,760,000 tons at an average in-place airspace utilization factor (AUF) of 1,200 pounds of solid waste per cubic yard of airspace (inclusive of cover soil). Proposed Phase III is estimated to have a disposal capacity of approximately 3,000,000 cubic yards.

5.9 Closure Activities

Closure of CML, after all remaining permitted disposal areas are filled to capacity, will be implemented by the following sequence of activities:

- <u>Final design and construction procurement.</u> Detailed plans and specifications will be prepared by a Hawaii Registered Civil Engineer (RCE). Plans will include the final closure cover, storm water management system, demolition or removal of structures, any necessary revisions to site security or related systems, and modifications to environmental controls or monitoring systems.

- <u>Final closure cover construction.</u> The plans and specifications developed in the prior activity will be used to secure one or more construction contracts to implement the final closure. Construction of the final closure cover over the landfill surface will involve placing and grading soil, installation or modification as necessary to the leachate management system, the surface water management system, and the landfill gas control system. Final closure grades will be established to maintain effective surface water management, erosion control, and revegetation throughout the post-closure period. Construction activities will be carried out by one or more qualified contractors, under the supervision of an RCE and qualified construction quality assurance personnel to ensure conformance to project plans and specifications.

- Revegetation. Revegetation will be accomplished through hydro-mulch seeding the final vegetative cover layer. Seed will be a mix of perennial grasses and not more than 25 percent annual grasses, as approved by the Hawaii Department of Agriculture for planting in agricultural areas on the Island of Maui. Mulch will be a specially processed fiber containing no growth or germination inhibiting components. Areas found to be inaccessible by a hydro-mulch seeder, will be seeded by hand as needed.

- Removal of structures. At this time, it is not anticipated that any structures will be removed after site closure. The County is currently in the process of permitting an adjacent property to host a variety of recycling facilities and County hauling operations, and it is expected that the existing CML buildings will continue to be used in association with these planned activities after the final closure of the landfill. .

- Closure documentation. Following completion of all closure construction activities, the RCE will prepare a final construction quality assurance report certifying that closure has been completed in accordance with the approved Closure Plan and applicable plans and specifications. The County will submit the report to the HDOH in accordance with HAR 11-58.1-17(a)(8). In addition, the County of Maui, owner of the property, will record on the deed to the landfill property a notation that the site has been used as a landfill facility and that its use is restricted, as required under HAR 11.58.1-17(a)(9).

6. POST-CLOSURE CARE PLAN

6.1 Post-Closure Responsibility

The County of Maui will provide 30 years of post-closure care and maintenance, unless, at an earlier time, it is demonstrated to the satisfaction of HDOH that the site poses no further risk to the public or the environment. During the post-closure period, the County will inspect, maintain and monitor the site in conformance with HAR 11-58.1-17(b) by implementing the activities described in the following sections.

6.2 Monitoring and Maintenance Activities

This section describes the specific activities to be conducted during the post-closure period in conformance with HAR 11-58.1-17(b)(1), including:

- Maintenance of the final closure cover
- Operation and maintenance of leachate collection and removal systems
- Operation and maintenance of the LFG management system
- Groundwater monitoring
- Landfill gas monitoring

6.2.1 Final Closure Cover Maintenance

The following scheduled activities will be conducted throughout the post-closure period to ensure the integrity of final closure cover systems.

- Semi-annual inspection and maintenance. Inspections during fall (September-October) and spring (March-April) will identify any areas of eroded cover or other damage, and repairs will be made by adding soil or rock, grading or other activities as required. All storm water conveyances and structures will be inspected, cleaned of sediment and repaired as needed. Areas of cover with vegetation will be inspected to ensure that any plants with rooting systems deeper than the top vegetative cover are removed.

- As-needed inspections and repairs. Additional inspections will be made following any unusual events with potential to cause excessive erosion or damage to the environmental control systems. Such events would include severe rainstorms or earthquakes. Damage discovered during inspections will be repaired on a timely basis.

6.2.2 Leachate Collection and Removal System

Leachate collection and removal system (LCRS) sumps will be monitored on a regularly scheduled basis, at a frequency determined by the rate of leachate production at each sump during the post-closure period. Leachate will be removed as needed to prevent a depth of leachate above the liner (outside the limits of the concentrating sump area), in excess of 30 centimeters (12 inches) as required by HAR 11-58.1-14(b).

Leachate will be managed as described in Section 5.5.1 above. The volume of leachate generated is projected to decrease significantly after construction of the final closure cover. It will continue to decrease during the post-closure period as organic matter in the waste degrades and is converted to carbon dioxide and methane.

6.2.3 Landfill Gas Management System

The landfill gas system requires regular operational and maintenance attention. The following activities and frequency are typically required:

Daily to weekly frequency:

- Monitor, via personal inspection or by remote monitoring systems, the performance of the flare or other final control device; maintain or repair as needed.

Weekly to monthly frequency:

- Visual inspection of aboveground pipe and fittings to detect and repair any significant settlement, leaks, or damage.

- Check liquid levels in condensate sumps, pump and dispose of condensate by thermal destruction in the flare, or off-site disposal at a publicly owned wastewater treatment facility.

- Check gas quality at each active wellhead and adjust vacuum and flow as needed to maintain optimum gas quality in each well (approximately 50% methane, with minimal oxygen content).

Semi-annual or annual frequency:

- Schedule preventive maintenance of flare and other final control device utilized in the future, such as gas-to-energy equipment, according to manufacturer's recommendations.

Condensate management will be an ongoing activity throughout the post-closure period or as long as the gas control system is operated. Condensate will be pumped or drained by gravity to a storage tank, and will be disposed of by one or a combination of thermal destruction in the flare, reintroduction to the landfill via the leachate reintroduction system, or off-site disposal at a publicly owned wastewater treatment facility. Detailed procedures for condensate management during post-closure will be developed based on long-term determination of gas and condensate production volumes from the LFG collection and control system.

6.2.4 Ground Water and Landfill Gas Monitoring

Current programs for monitoring of groundwater and landfill gas migration, as described in Section 4 above, or approved modifications to those programs, will be continued throughout the post-closure period. Perimeter gas probes and facility structures will be monitored on a quarterly basis during the post-closure period. Groundwater will be monitored on a semi-annual basis during the post-closure period.

6.3 Contact Personnel

The title, address and telephone number of the person responsible for CML post-closure activities is:

> Chief, Solid Waste Division
> Department of Environmental Management
> County of Maui
> 2200 Main Street, Suite 225
> Wailuku, Hawaii 96793
> Telephone (808) 270-7875

6.4 Post-Closure Land Uses

The closed landfill portions of the CML property will be maintained as open space or for non-disposal solid waste management activities during the post-closure period. Portions of the closed landfill areas may be developed for permissible activities associated with the County's solid waste management program, including equipment storage, or use as a maintenance and vehicle storage yard for refuse collection vehicles.

The County may also consider the installation and operation of a photovoltaic system over a portion of the closed landfill, should it be shown to the satisfaction of HDOH that installation and operation of such a system would not disturb the integrity of the final closure cover, the liners, or any other component of the containment, and monitoring systems over the post-closure care period.

Existing structures in the administrative area may be maintained as a business center for County solid waste operations. Other activities related to County solid waste operations may also be conducted on the site, provided they are compatible with safe and effective management of all post-closure care operations at the closed landfill.

Prior to establishment of any occupied structures or intensive use activities in closed areas, appropriate amendments will be made to this Post-Closure Plan and submitted to HDOH for approval. Amendments will describe precautions and programs to prevent damage to the final cover, ensure protection of the environment and public health and safety.

7. FINANCIAL ASSURANCE

7.1 Applicable Requirements

The cost of final closure and post-closure care for the largest area of the site ever requiring closure, and establishing financial assurance funding are in accordance with the requirements of 40 CFR Part 258, Section 258.74(f).

7.2 Closure Cost Estimate

The current largest area requiring closure is approximately 41 acres, the existing developed landfill footprint that has yet to be closed; Phases IV-A, IV-B, V-A, V-B, and V-B Extension.

Development and landfilling in Phase III will increase the largest site area ever requiring final closure to approximately 69 acres.

The estimated total cost for closure of the Phases IV, V, and V-B Extension, including a 20% contingency factor, is $7,787,303. The closure cost estimate for the current landfill footprint is summarized in Table 7-1.

Closure costs, including a 20% contingency, are estimated to be $5,501,027 for the Phase III area. The amount of financial assurance for final closure provided by the County of Maui will be increased by this amount upon initiation of landfilling activities in the Phase III area.

Appendix B contains the detailed assumptions and computations. The estimated costs are in 2019 dollars, and will be adjusted annually for inflation as provided in HAR 11-58.1-18(c)(1)(B).

7.3 Post-Closure Care Cost Estimate

The estimated annual cost for post-closure care and maintenance is $230,849 per year for 42 acres in Phases I and II, and $534,752 per year for 69 acres in Phase IV, Phase V, Phase V-B Extension, and Phase III areas. Table 7-1 presents a summary of post-closure costs for the closed landfill area and for the planned landfill footprint.

Appendix B contains the detailed assumptions and computations. The estimated costs are in
2019? ~~2017~~ dollars, and will be adjusted annually for inflation as provided in HAR 11-58.1-18(c)(1)(B).

7.4 Financial Assurance Mechanism

As a local government, the County provides financial assurance based on the local government financial test mechanism of federal 40 CFR Part 258, Section 258.74(f). The amount of financial assurance to be provided is based on the area of landfill constructed and closed, and will be adjusted annually as discussed below.

Based on Sections 7.1 through 7.3 above, the total estimated costs for final closure of Phases IV, V, (including Phase V-B Extension), and III is $13,288,331. The remaining post-closure care for Phases I and II, and post-closure care for Phases IV, V (including Phase V-B Extension), and III are $4,155,282 and $16,042,546 respectively. As such, the estimated total financial assurance required under the current condition will be $33,486,159. Estimated costs are in 2019 dollars, and will be adjusted annually for inflation as provided in HAR 11-58.1-18(c)(1)(B).

Financial assurance amounts will be adjusted after development of Phase VI to account for the additional landfill area that will require final closure construction. Phase VI?

The County completed closure of Phases I and II in 2007. Therefore, no financial assurance for closure of Phases I and II is required. Financial assurance is required for the remaining 18 years of post-closure care in Phases I and II as of 2019.

Amendments to this Plan and financial assurance documentation will be made whenever existing portions of the site are closed or new areas are developed and used for disposal operations.

TABLE 7-1

CENTRAL MAUI LANDFILL
CLOSURE / POST-CLOSURE COSTS
IN 2019 DOLLARS

Closure	**Phase IV, V, V-B Ext & III**	**Total**
Final Closure Cover	$7,849,940	$7,849,940
Revegetation	$787,774	$787,774
Leachate Management	-	-
Landfill Gas Monitoring and Control	$1,258,357	$1,258,357
Groundwater Monitoring Installation	-	-
Drainage Installation	$1,177,538	$1,177,538
Security Installation	-	-
Removal of Structures	-	-
Subtotal Closure	$11,073,609	$11,073,609
Contingency	$2,214,722	$2,214,722
Total Closure Cost (2019 Dollars)	**$13,288,331**	**$13,288,331**

Post-Closure Monitoring and Maintenance - Annual Cost

	Phases I and II (Closed 2007)	**Phase IV, V, V-B Ext & III (Future Closure)**	**Total**
Final Closure Cover Maintenance	$66,304	$116,031	$182,335
Leachate Management	$10,083	$51,036	$61,119
Gas Management	$82,224	$223,985	$306,208
Monitoring	$41,699	$124,243	$165,942
Drainage	$23,792	$12,408	$35,900
Security	$1,175	$1,175	$2,349
Inspection	$5,873	$5,873	$11,746
Subtotal - Annual Cost (2017 Dollars)	$230,849	$534,752	$765,601
No. of Years Required / Remaining Responsibility	18	30	
Subtotal x years	**$4,155,282**	**$16,042,546**	**$20,197,829**
Total Closure and Post-Closure Cost	**$4,155,282**	**$29,330,877**	**$33,486,159**

8. REFERENCES

A-Mehr, Inc. 2007. Final Report of Construction Quality Assurance, Phases I and II Closure, Final Cover and Drainage Improvements, Central Maui Landfill, Puunene, Hawaii. September.

CH2M, Inc. 2018. Groundwater and Leachate Monitoring Plan, Central Maui Landfill, Puunene, Maui. Revised March 2019.

Ekern, Paul C. and Jen-Hu Chang. 1985. Pan Evaporation: State of Hawai'i, 1894-1983. State of Hawaii Department of Land and Natural Resources, Division of Water and Land Development, Honolulu, Hawaii, Report R74.

Giambelluca, Thomas W., Michael A. Nuller, and Thomas A. Schroeder, 1986. Rainfall Atlas of Hawai'i. State of Hawaii Department of Land and Natural Resources, Division of Water and Land Development, Honolulu, Hawaii, Report R76, 1986.

Gingerich, S.B., 2008, "Ground-Water Availability in the Waiuku Area, Maui, Hawai'i", U.S. Geological Survey Scientific Investigations Report 2008-5236.

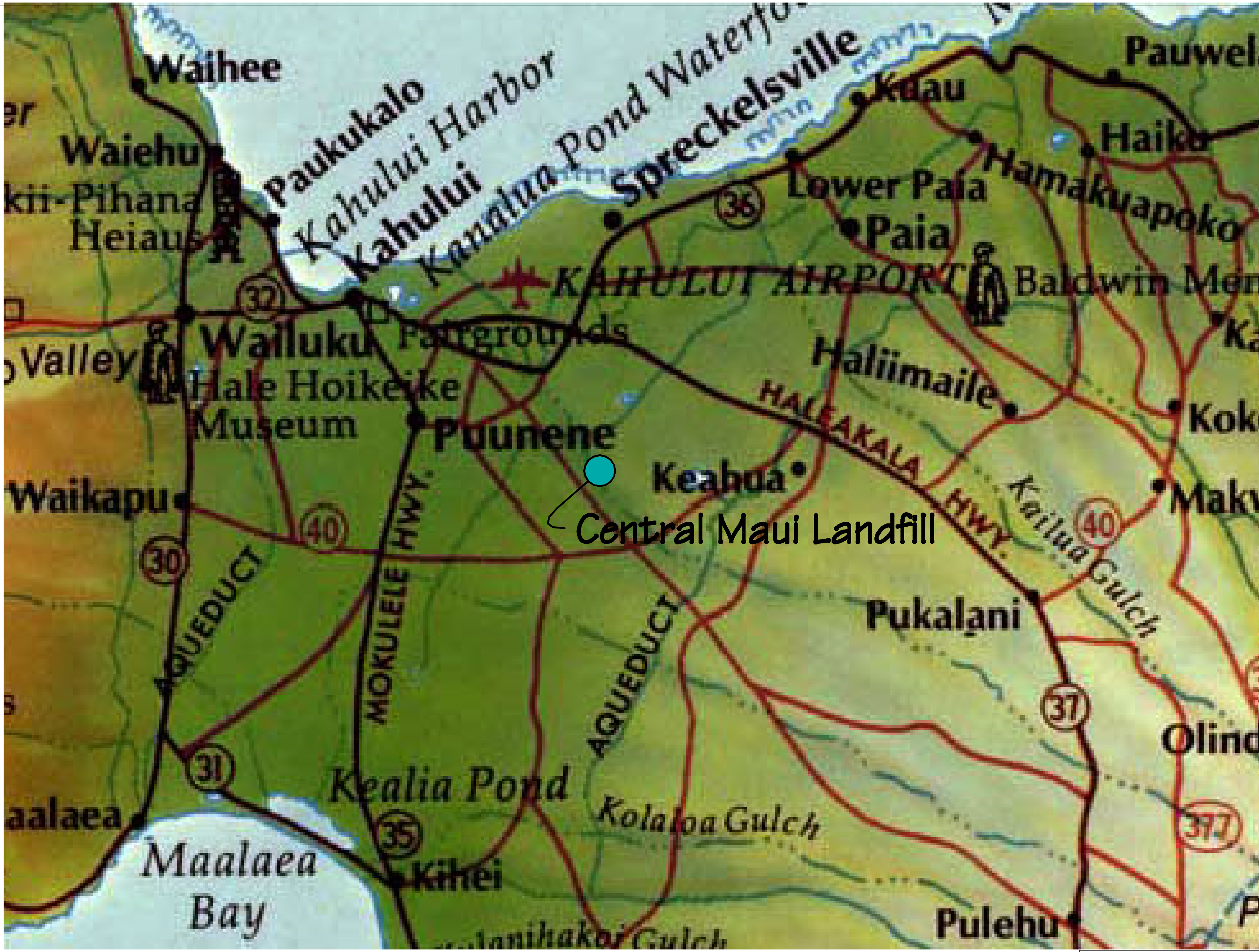
Hawaii Water Resources Regional Study (HWRRS), January 1979, "Hawaii Water Resources Plan".

Masa Fujioka and Associates, 1997. Hydrogeological Characterization Report, Central Maui Sanitary Landfill, Puunene, Maui, Hawaii. January 31.

Mink, J.F. and L.S. Lau, February 1990, "Aquifer Identification and Classification for Maui, Groundwater Protection Strategy for Hawaii", Water Resources Research Center, Technical Report No. 185.

Western Regional Climate Center (http://www.wrcc.dri.edu).

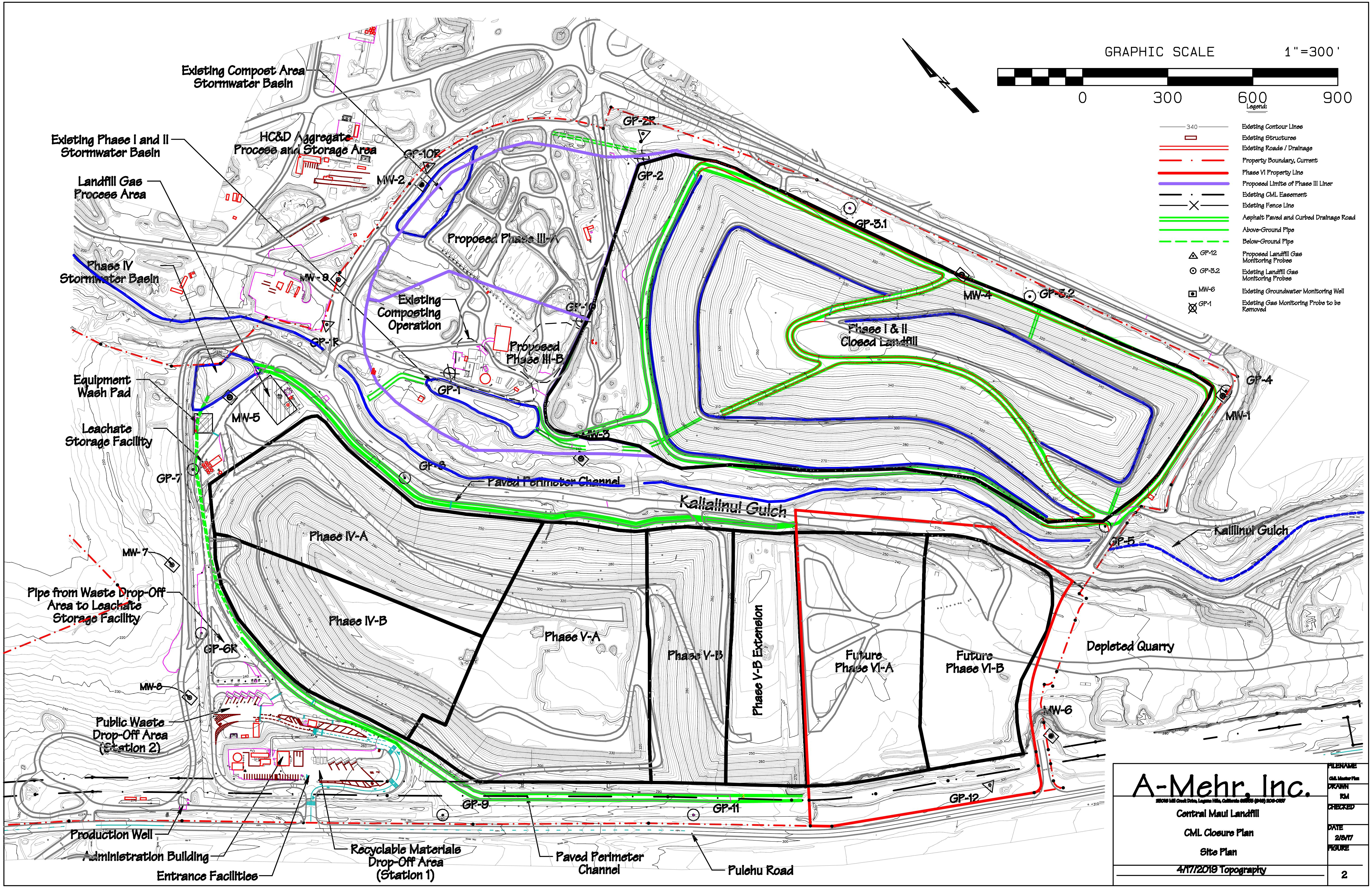
Figures



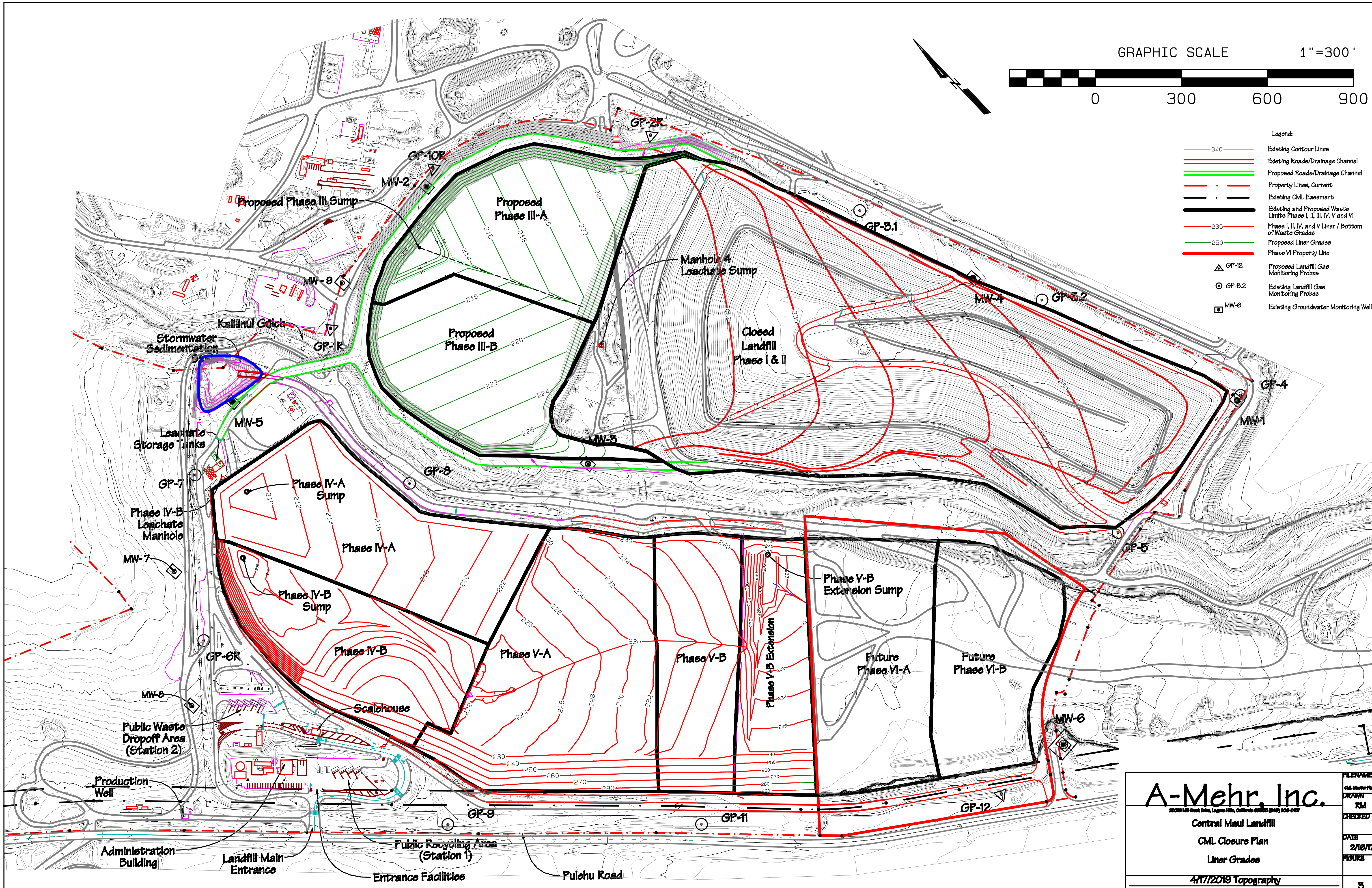
Vicinity Map

A-MEHR, INC
23016 Mill Creek Drive, Laguna Hills, CA 92653
(949) 206-0157 (949) 206-9157 FAX
Central Maui Landfill
Closure Plan
Vicinity Map

FILE Closure Plan
DRAFT RM
CHECK
DATE 10/19/16
FIGURE 1



GRAPHIC SCALE
1"=300'
0
300
600
900
Legend:
Existing Contour Lines
Existing Structures
Existing Roads / Drainage
Property Boundary, Current
Phase VI Property Line
Proposed Limits of Phase III Liner
Existing CML Easement
Existing Fence Line
Asphalt Paved and Curbed Drainage Road
Above-Ground Pipe
Below-Ground Pipe
GP-12 Proposed Landfill Gas Monitoring Probes
GP-3.2 Existing Landfill Gas Monitoring Probes
MW-6 Existing Groundwater Monitoring Well
GP-1 Existing Gas Monitoring Probe to be Removed
Existing Compost Area Stormwater Basin
Existing Phase I and II Stormwater Basin
HC&D Aggregate Process and Storage Area
Landfill Gas Process Area
Phase IV Stormwater Basin
Proposed Phase III-A
Existing Composting Operation
Proposed Phase III-B
Phase I & II Closed Landfill
Equipment Wash Pad
Leachate Storage Facility
Paved Perimeter Channel
Kailalinui Gulch
Phase IV-A
Phase IV-B
Phase V-A
Phase V-B
Phase V-B Extension
Future Phase VI-A
Future Phase VI-B
Depleted Quarry
Pipe from Waste Drop-Off Area to Leachate Storage Facility
Public Waste Drop-Off Area (Station 2)
Production Well
Administration Building
Entrance Facilities
Recyclable Materials Drop-Off Area (Station 1)
Paved Perimeter Channel
Pulehu Road
GP-2R
GP-2
GP-10R
MW-2
GP-3.1
MW-4
GP-3.2
GP-4
MW-1
MW-9
GP-10
GP-1R
GP-1
MW-5
MW-3
GP-8
GP-7
GP-5
MW-7
GP-6R
MW-8
MW-6
GP-9
GP-11
GP-12
A-Mehr, Inc.
Central Maui Landfill
CML Closure Plan
Site Plan
4/17/2019 Topography
FILENAME
DRAWN
RM
CHECKED
DATE
2/8/17
FIGURE
2



A-Mehr, Inc.

Central Maui Landfill

CML Closure Plan

Liner Grades

4/17/2019 Topography

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DRAWN	RM
CHECKED	
DATE	2/16/17
FIGURE	3