Naval Facilities Engineering Systems Command Pacific
Joint Base Pearl Harbor-Hickam, Hawaii

Final

Red Hill Granular Activated Carbon Treatment System Effluent Beneficial Use Interim Report

Joint Base Pearl Harbor-Hickam
Oahu, Hawaii

September 2022

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Prepared for:

Department of the Navy
258 Makalapa Drive, Suite 100
Joint Base Pearl Harbor-Hickam, Hawaii 96860-3134

Prepared by:

CAPE Environmental Management, Inc.
155 Kapalulu Place, Suite 111
Honolulu Hawaii 96819

Jacobs
1132 Bishop Street
Suite 1100
Honolulu, Hawaii 96813

Contract Number: N62742-16-D-1807; Task Order Number: N62742-22-F-0113

Executive Summary

The Department of the Navy (Navy) contracted CAPE Environmental Management, Inc. (CAPE) under Contract N62742-16-D-1807, Contract Task Order (CTO) N62742-22-F-0113 to conduct an evaluation of potential beneficial water use Courses of Action (COAs) for effluent from the Red Hill Shaft Pump and granular activated carbon (GAC) filtration system at Joint Base Pearl Harbor-Hickam (JBPHH) on Oahu, Hawaii. CAPE subcontracted Jacobs to provide subject matter expertise in water reuse, water conveyance, hydrogeology, and regulatory compliance.

The project purpose was to analyze, rank, and propose short- and long-term COAs for implementing beneficial use of groundwater pumped from the Red Hill Shaft and through a GAC filtering system to contain and remove hydrocarbons in part of the aquifer. The GAC filtering system was constructed and began operations in late January 2022. This filtered water is a resource that can be beneficially used and CAPE was directed to evaluate non-potable applications. The filtered water is currently being discharged to Halawa Stream at a rate of approximately 4.2 to 4.6 million gallons per day (mgd) per an approved National Pollutant Discharge Elimination System (NPDES) permit.

The intent of this project was to reduce the discharge flow to Halawa Stream by beneficially using some or all the water by way of the selected COA(s). The project objectives required that, for any COA, at least 10 percent of the filtered water (approximately 420,000 to 460,000 gallons per day) be beneficially used.

Please note that although the CTO and includes the words “drinking water” and “reuse,” this document will use the terms “GAC effluent” instead of drinking water and “use” or “beneficial use,” as applicable, instead of reuse.

Summary of Work Performed

The purpose of this CTO was to evaluate and rank potential COAs. There were three Navy-selected COAs (COA 1 through COA 3) and two COAs to be determined by the CAPE-Jacobs team (COA 4 and COA 5). COA 5, which combined earlier COAs, was later divided into two options, COA 5a and COA 5b, to include different combinations.

- COA 1 – Public/Private Entity and Off-Base DoD Use of Effluent Water
- COA 2 – DoD Entity Use of Effluent Water
- COA 3 – Aquifer Recharge
- COA 4 – Partner with the Honolulu Board of Water Supply (BWS) to Use Existing Non-potable Pipeline
- COA 5a – Aquifer Recharge and Connecting to BWS Non-potable Pipeline
- COA 5b – Aquifer Recharge and New Piping to DoD Users

Initial project deliverables included a 4-week and 8-week brief to Navy personnel. This report is the interim deliverable summarizing findings of all research and analyses.

The 4-week brief of project status was presented to the Navy on 22 February 2022 and included an initial screening of different options within each COA. The screening identified options recommended for elimination, deferment, and further exploration. The COAs recommended for further exploration were carried forward to be analyzed further.

The 8-week brief of project status was presented to the Navy on 17 March 2022. The 8-week brief provided updated analyses and findings; these included a discussion of the estimated amount of effluent identified for beneficial use (in gallons per day), a rough engineering analysis of infrastructure requirements, and Association for the Advancement of Cost Engineering (AACE) Class 5 cost estimates with an accuracy range of plus 100 percent and minus 50 percent.

At the conclusion of the 8-week brief, it was determined that none of the COAs could be feasibly implemented given the uncertainty in the duration of availability of the effluent for beneficial use. The best-case implementation time (that is, planning, design, permitting, and construction) for all of the COAs was estimated to be a little less than 2 years. However, no guarantees on flow availability 2 years in the future can be made because of the unknown duration, pumping on/off patterns, and flow quantities necessary maintain a successful groundwater capture zone to counter the potential for contaminants to migrate away from the Red Hill site. Therefore, the Navy elected to conclude this effort with an interim report.

Courses of Action

Each COA is unique, and a different approach was used to reach each specific, fully defined COA from a host of potential avenues. In general, the process involved the following steps:

1) Looking at options and different types of COAs (that is, private/public, DoD uses, aquifer recharge, and similar)
2) Screening options
3) Developing the COA definition

Table ES-1 summarizes the COAs.

Table ES-1. COA Flow and Pipeline Summary

COA	Name	Estimated Use (mgd)	Exposed Piping (feet)	Buried Piping (feet)
1	Public/Private Entity and Off-Base DoD Use of Effluent Water	1 to 2	[redacted] (b)(3)(A)	[redacted] (b)(3)(A)
2	DoD Entity Use of Effluent Water	1 to 2	[redacted] (b)(3)(A	[redacted] (b)(3)(A
3	Aquifer Recharge	Up to 4.6	[redacted] (b)(3)(A)	[redacted])(3)(A)
4	Partner with BWS to Use Existing Non-potable Pipeline	1 to 2	[redacted] (b)(3)(A)	[redacted] (b)(3)(A
5a	Aquifer Recharge and Connecting to BWS Non-potable Pipeline	Up to 4.6	[redacted] (b)(3)(A)	[redacted] (b)(3)(A)
5b	Aquifer Recharge and New Piping to DoD Users	Up to 4.6	[redacted] (b)(3)(A)	[redacted] (b)(3)(A)

Note: Pipeline distances are approximate

Regulatory and Permitting Considerations

All the COAs reviewed have regulatory and permitting considerations. These regulatory and permitting steps can have long lead times due to the review and approval processes. For example, compliance with National Environmental Policy Act (NEPA) requirements under a categorical exclusion (CATEX) versus an environmental assessment (EA) or an environmental impact statement (EIS) is a significant consideration. Requirements under a CATEX can mean conducting consultations and obtaining concurrence from agencies in an abbreviated and accelerated timeframe (as little as 6 to 9 months). Pre-planning (for example, initial surveys and data evaluation) and the decision to pursue an EA or EIS with associated consultations (such as for cultural, natural resources, water, and similar elements) may require a longer period of time (with various timeframes for pre-planning followed by 1 year for an EA and 2 years for an EIS). The Navy's ability to confirm the appropriateness of a CATEX and obtain appropriate permits and/or data for an EA or EIS would be a critical path activity for the project schedule for any selected COA.

Schedule and Cost Estimate

A preliminary schedule was developed for each COA based on the assumption that the total estimated time considers that the Navy will confirm that these COAs (the undertakings) qualify for a CATEX, which reduces the NEPA requirements. It is also important to note that considerable public interest is expected and, as a result, there is the potential for additional delays that are difficult to predict.

The project team developed a rough order of magnitude (ROM) cost estimate that followed AACE International Class 5 estimate methodologies to achieve an accuracy of minus 50 percent on the low side and of plus 100 percent on the high side. At the time of developing the ROM capital cost estimates, the COA definition was less than 2 percent. This information can be used for strategic planning and conceptual screening. Table ES-2 presents the schedule and cost information.

Table ES-2. COA Schedule and Cost Summary

COA	Name	Total Schedule	Estimated Total Cost
1	Public/Private Entity and Off-Base DoD Use of Effluent Water	23 months	(b)(3)(A)
2	DoD Entity Use of Effluent Water	23 months	(b)(3)(A)
3	Aquifer Recharge	20 months	(b)(3)(A)
4	Partner with BWS to Use Existing Non-potable Pipeline	20 months	(b)(3)(A)
5a	Aquifer Recharge and Connecting to BWS Non-potable Pipeline	23 months	(b)(3)(A)
5b	Aquifer Recharge and New Piping to DoD Users	23 months	(b)(3)(A)

Next Steps for Advancing Conceptual Engineering of COAs

The research efforts into the COAs were halted following the 8-week brief. As such, further evaluations and study are required for a complete COA analysis and definition beyond what is provided herein. Table ES-3 presents a preliminary ranking of the COAs based on such factors as cost, anticipated opposition from private and public entities, permitting challenges, and projected water use; Section 6 of the interim report provides more information on how the rankings were established. The rankings are preliminary and should be revisited after the COAs are better defined and more complete stakeholder engagement is possible. As such, this report should not solely be relied upon for COA selection.

Table ES-3. COA Ranking

Rank	Name
1	COA 4 - Partner with BWS to Use Existing Non-potable Pipeline
2	COA 2 - DoD Entity Use of Effluent Water
3	COA 1 - Public/Private Entity and Off-Base DoD Use of Effluent Water
4	COA 3 - Aquifer Recharge
5	COA 5a - Aquifer Recharge and Connecting to BWS Non-potable Pipeline
6	COA 5b - Aquifer Recharge and New Piping to DoD Users

Some immediate next steps for advancing the conceptual engineering to rank and score the COAs include further interactions with infrastructure owners/local agencies and potential end users, as well as additional engineering and permitting analyses. Although the COAs identified for this project may not be immediately implementable, the research and analyses provide foundational information for further Pearl Harbor area water resource management efforts.

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Appendixes

Tables

Figures

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Acronyms and Abbreviations

µg/L	microgram(s) per liter
AACE	Association for the Advancement of Cost Engineering
AMR	Aliamanu Military Reservation
BWS	Honolulu Board of Water Supply
$CaCO_3$	calcium carbonate
CATEX	categorical exclusion
CCH	City and County of Honolulu
CFR	*Code of Federal Regulations*
COA	course of action
CTO	Contract Task Order
CWA	Clean Water Act
DD	Department of Defense [form]
DoD	Department of Defense
DPP	[City and County of Honolulu] Department of Planning and Permitting
DTS	[City and County of Honolulu] Department of Transportation Services
EA	environmental assessment
EIS	environmental impact statement
FHWA	Federal Highway Administration
FONSI	Finding of No Significant Impact
GAC	granular activated carbon
GIS	geographical information system
H1	Interstate Highway 1
H3	Interstate Highway 3
HAR	Hawaii Administrative Rules
HCO_3	bicarbonate
HDD	horizontal directional drilling
HDOA	State of Hawaii Department of Agriculture
HDOH	State of Hawaii Department of Health
HDOT	State of Hawaii Department of Transportation
HECO	Hawaiian Electric Company
HEPA	Hawaii Environmental Protection Act

HOEQC	Hawaii Office of Environmental Quality
HRS	Hawaii Revised Statutes
ID	identification
JBPHH	Joint Base Pearl Harbor-Hickam
JP-5	jet propulsion fuel, grade 5
M	million(s)
MCC	motor control center
NAVFAC	Naval Facilities Engineering Systems Command
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
PLC	programmable logic controller
POA	Plan of Action
PVC	polyvinyl chloride
PWS	Performance Work Statement
ROD	Record of Decision
ROM	rough order of magnitude
ROH	Revised Ordinances of Honolulu
SDWB	Safe Drinking Water Branch
TO	task order
UIC	Underground Injection Control

1.0 Introduction

The Department of the Navy (Navy) contracted CAPE Environmental Management, Inc. (CAPE) to conduct an evaluation of potential water use Courses of Action (COAs) for effluent from the Red Hill Shaft Pump and Filtration System at Joint Base Pearl Harbor-Hickam (JBPHH) on Oahu, Hawaii. CAPE subcontracted Jacobs to provide subject matter expertise in water reuse, water conveyance, hydrogeology, and regulatory compliance.

Please note that although the CTO includes the word "reuse," this document will use the terms "use" and "beneficial use," as applicable.

1.1 Background and Purpose

The project purpose was to analyze, rank, and propose short- and long-term COAs for implementing beneficial use of groundwater pumped from the Red Hill Shaft and through a granular activated carbon (GAC) filtering system. The purpose of the pumping is to create a groundwater capture zone to counter the potential for contaminant migration away from the Red Hill facility. The GAC filtering system was constructed and began operations in late January 2022. This filtered water is a resource that can be beneficially used, and CAPE was directed to evaluate non-potable applications. The filtered water is currently being discharged to Halawa Stream at a rate of approximately 4.2 to 4.6 million gallons per day (mgd) per an approved National Pollutant Discharge Elimination System (NPDES) permit.

The intent of this project was to reduce the discharge flow to Halawa Stream by beneficially using some or all the water by way of the selected COA(s). The project objectives required that, for any COA, at least 10 percent of the filtered water (approximately 420,000 to 460,000 gallons per day) be beneficially used.

A study of potential alternatives was required to characterize possible mechanism(s) to beneficially use the water. The goal of the project was to assist the Navy in making well-informed, science-based, and risk-based decisions to conserve and maximize the beneficial use of Hawaii's fresh water, decrease the use of potable water resources when non-potable water sources would suffice, and if possible, find opportunities to safely recharge the potable groundwater aquifer.

The COAs were to be screened, defined, and then ranked using a set of criteria weighted by their relative importance. From this ranking, the Navy could review the COAs and, as possible, elect to pursue beneficial use alternative(s) that could be implemented quickly and cost effectively. However, the entirety of the project as originally scoped was truncated; this report summarizes the findings, rankings, and feasibility to date (Section 6.2).

1.1.1 Effluent Filtration System

On 20 November 2021, there was a release of jet propulsion fuel, grade 5 (JP-5) in the Adit 3 Tunnel of the Red Hill facility. The well was turned off and the turbine pumps were secured on 28 November 2021. Hydrocarbon contamination has since been noted in the groundwater monitoring well network of the Red Hill facility.

A hybrid zeolite-GAC treatment system was designed and constructed near Adit 3 of Harbor Tunnel on Red Hill. The purpose of the system is to protect the water quality of the water being discharged to Halawa Stream by removing hydrocarbon contaminants through a process called adsorption. When water containing contaminants such as jet fuel passes through a bed of zeolite or GAC media, the contaminants diffuse into the porous granular particles and attach, or adsorb, themselves onto the walls of the particles' pores.

It is important to note that source water for the system is being drawn from deep in the shaft to lessen the potential for floating contamination to enter the system. The GAC system is not intended to remove floating contamination, which is mainly done via skimmers and absorbents deployed at the Red Hill Shaft water surface.

This GAC system was started on 29 January 2022 to filter up to 5 mgd of contaminated water extracted from the Red Hill Shaft well before discharging to the Halawa Stream.

The GAC treatment system consists of eight Calgon 20,000-pound units. Each individual unit can flow at 1,200 gallons per minute. There are four sets of vessels in parallel with each set consisting of a lead and lag vessel. When the lead vessel reaches the end of its media life, this allows the second vessel to capture any breakthrough from the first vessel, ensuring removal of contaminates. Three sets of vessels are required to operate concurrently to effectively filter water at the design flow rate. This arrangement allows one set of vessels to have media changed out while the other three sets treat the water. This allows for a very safe treatment process that can be monitored for full treatment capabilities.

Figure 1-1 is an area map showing the location of the Red Hill GAC filtering system at JBPHH. Figure 1-2 shows a system schematic of water pumping, filtering through two of the eight GAC vessels, and discharging to Halawa Stream.

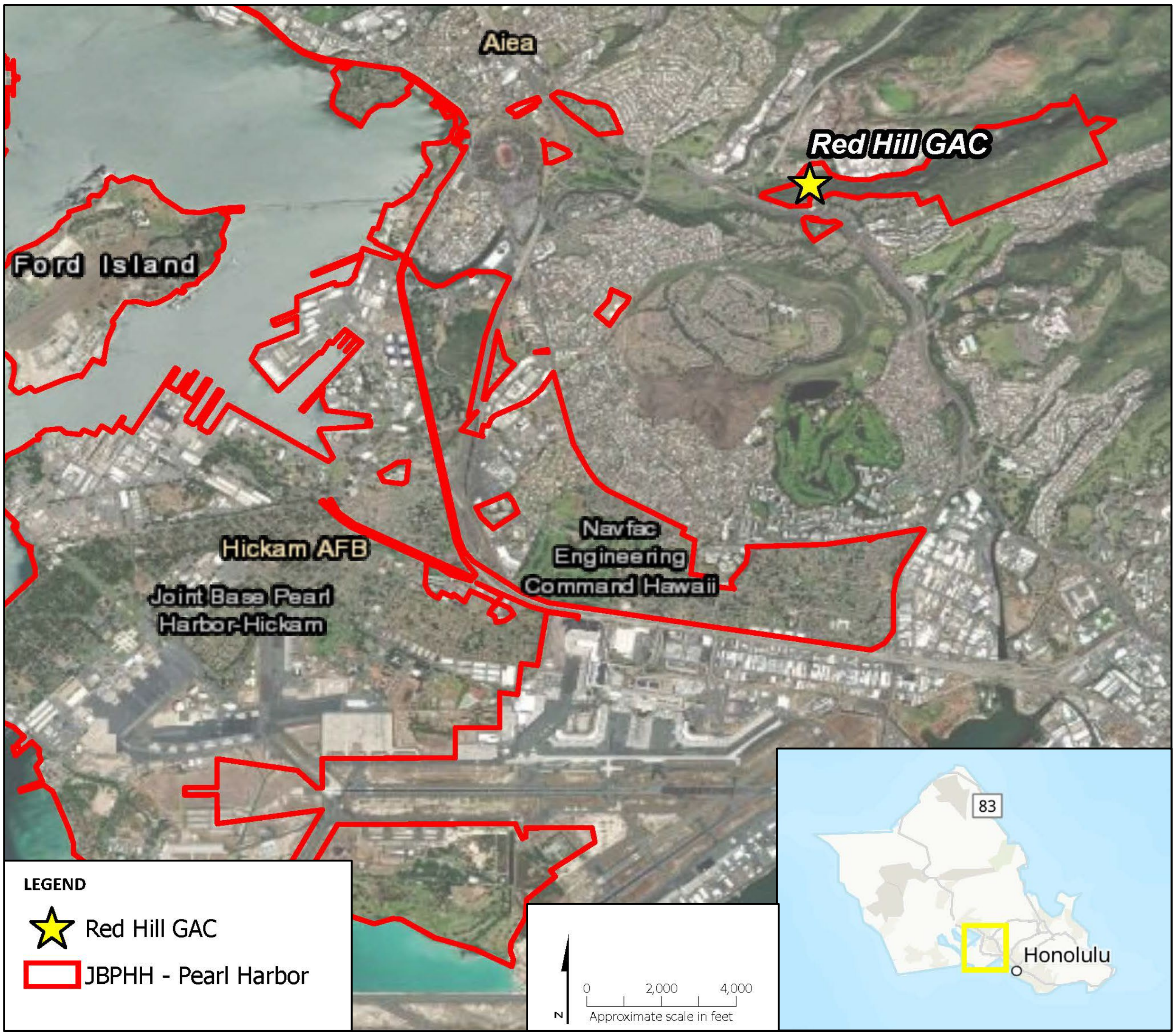

Figure 1-1. Location of Red Hill GAC Filtration System

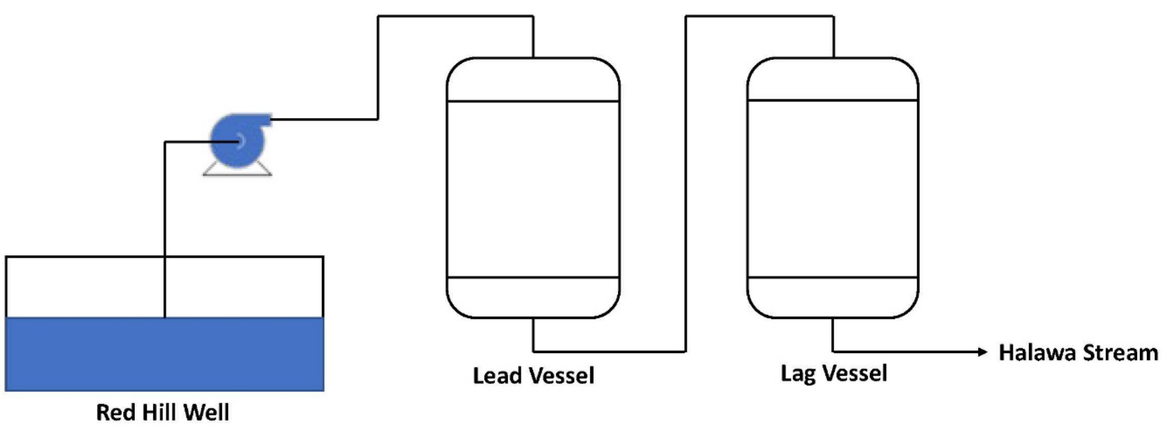

Figure 1-2. Process Schematic of Red Hill GAC Filtration System

1.1.2 Water Quality Sampling and Results

Water sampling of the effluent was conducted to understand the suitability of the water for potential COA applications, including irrigation and other non-potable uses. A series of four water quality sampling events of the system effluent were conducted, and the samples were subsequently analyzed by a laboratory. Table 1-1 summarizes the concentrations of selected cations, anions, and other standard water quality parameters of samples collected on a weekly frequency on 08 February, 15 February, 23 February, and 28 February 2022.

Table 1-1. Water Quality Sampling Results

Sample ID			REDHILL_ 020822	REDHILL_ 021522	REDHILL_ 022322	REDHILL_ 022822
Sample Date			2/8/2022	2/15/2022	2/23/2022	2/28/2022
Method Group	**Analytes**	**Units**	**Result**	**Result**	**Result**	**Result**
300.0-1993 R2.1	Sulfate	mg/L	23	19	18	19
300.0-1993 R2.1	Chloride	mg/L	120	130	120	130
200.7 Rev 4.4	Calcium	mg/L	21	21	21	22
200.7 Rev 4.4	Magnesium	mg/L	20	20	20	21
200.7 Rev 4.4	Sodium	mg/L	49	47	47	48
2320B-2011	Alkalinity	mg/L	67	67	65	65
2320B-2011	Bicarbonate Alkalinity as $CaCO_3$	mg/L	67	67	65	65
2320B-2011	Carbonate Alkalinity as $CaCO_3$	mg/L	5.0 U	5.0 U	5.0 U	5.0 U
2320B-2011	Hydroxide Alkalinity	mg/L	5.0 U	5.0 U	5.0 U	5.0 U
2320B-2011	Carbon Dioxide, Free	mg/L	7.5	5.0 U	5.0 U	5.0 U
2320B-2011	Phenolphthalein Alkalinity	mg/L	5.0 U	5.0 U	5.0 U	5.0 U
2320B-2011	Bicarbonate ion as HCO_3	mg/L	82	81	79	79
2340C-2011	Hardness as $CaCO_3$	mg/L	140	150	140	140
2540C-2011	Total Dissolved Solids	mg/L	330	350	340	330
365.4-1974	Phosphorus	mg/L	0.050 J	0.041 U F1	0.086 J	0.25
9060A	Total Organic Carbon	mg/L	0.50 U	0.50 U	0.50 U	0.50 U
9060A	Total Organic Carbon – Quad	mg/L	0.50 U	0.50 U	0.50 U	0.50 U

Table 1-1. Water Quality Sampling Results

Sample ID			REDHILL_ 020822	REDHILL_ 021522	REDHILL_ 022322	REDHILL_ 022822
Sample Date			**2/8/2022**	**2/15/2022**	**2/23/2022**	**2/28/2022**
Method Group	**Analytes**	**Units**	**Result**	**Result**	**Result**	**Result**
Total Nitrogen	Total Nitrogen	mg/L	0.97	0.72	0.92	0.90

Notes:

$CaCO_3$ = calcium carbonate
F1 = matrix spike and/or matrix spike duplicate recovery exceeds control limits
HCO_3 = bicarbonate
ID = identification
J = Result is less than laboratory reporting limit but greater than or equal to the method detection limit
mg/L = milligram(s) per liter
U = Compound was analyzed for but not detected above laboratory reporting limit

1.2 Summary of Work Performed

For the effluent to be used, potential receivers needed to be identified, routes and mechanisms of water conveyance needed to be evaluated, and potential challenges (such as time, cost, and engineering feasibility) needed to be identified to allow for the ranking of optimal solutions.

The purpose of this CTO was to evaluate and rank potential COAs. There were three Navy-selected COAs (COA 1 through COA 3) and two COAs (COA 4 and COA 5) to be determined by the CAPE-Jacobs team (COA 4 and COA 5). COA 5, which combined elements of the other COAs, was later divided into two options, COA 5a and COA 5b, to include different combinations.

- COA 1 –Public/Private Entity and Off-Base DoD Use of Effluent Water
- COA 2 – Department of Defense (DoD) Users
- COA 3 – Aquifer Recharge
- COA 4 – Partner with Honolulu Board of Water Supply (BWS) to Use Existing Non-potable Pipeline
- COA 5a – Aquifer Recharge and Connecting to BWS Non-potable Pipeline
- COA 5b – Aquifer Recharge and New Piping to DoD Users

Initial deliverables for this project included a 4-week and 8-week brief to Navy personnel. The 4-week brief of project status was presented to the Navy on 22 February 2022 and included preliminary schematics and geographical information system (GIS) maps for the most promising COAs. Limited information was included in the brief for COA 3, Aquifer Recharge, given that location options for an injection well(s) were limited to DoD property and there were ongoing investigations to define the nature and extent of contamination in the vicinity of Red Hill.

The 8-week brief of project status was presented to the Navy on 17 March 2022 and provided updated analyses and findings. These included a discussion of the estimated amount of effluent used (in gallons per day), a rough engineering analysis of infrastructure requirements, and Association for the Advancement of Cost Engineering (AACE) Class 5 cost estimates with an accuracy range of plus 100 percent and minus 50 percent.

1.3 Report Qualifications and Limitations

At the conclusion of the 8-week brief, it was determined that none of the COAs could be feasibly implemented given the uncertainty in the duration of availability of the effluent for beneficial use. The best-case implementation time (that is, planning, design, permitting, and construction) for all of the COAs was estimated to be a little less than 2 years. However, no guarantees on flow availability 2 years in the future can be made because of the unknown duration, pumping on/off patterns, and flow quantities necessary maintain a successful groundwater capture zone to counter the potential for contaminants to migrate away from the Red Hill site. Therefore, the Navy elected to conclude this effort with an interim report.

This decision was based upon several factors. Because of site conditions and distances from the treatment system to probable effluent users, it was not possible to develop COAs that could be implemented immediately (within 6 months) through construction completion. The selection of optimal effluent use COA(s) is also dependent on additional information to be obtained from ongoing efforts to define the nature and extent of groundwater impacts and the predicted results of future hydraulic capture of fuel residuals from ongoing hydraulic modeling efforts. In addition, coordination with and agreement from BWS will be necessary prior to the selection of COAs requiring the use of BWS infrastructure.

This interim report describes only the work completed to date, including all data, findings, analyses, and information gathered over the project duration, from project inception through the 8-week brief (a period of 3 months). Therefore, the final project objectives of quantitatively ranking the COAs and selection of one or more COAs for implementation were found to be unnecessary and are not included in this report, although preliminary rankings are included based on the limited information available at the time of the 8-week brief.

As such, the preliminary nature of the COA analyses performed to date requires that future data collection, stakeholder interactions, and technical evaluation be performed prior to selection of the preferred COA(s) for beneficially using the effluent. Therefore, this interim report should not be relied upon for COA selection.

2.0 Courses of Action

This section presents the process of defining, or developing, a given COA. Three initial general COAs were identified by the Navy: COA 1, public/private use, COA 2, DoD use, and COA 3, aquifer recharge. Two additional specific COAs (COA 4, use of BWS infrastructure, and COA 5, which combined multiple COAs) were identified early on in the project, resulting in a total of five COAs. In general, the process involved the following steps:

1) Investigating options for the different COA types (that is, private/public, DoD uses, aquifer recharge, and similar)
2) Screening the options
3) Developing the COA definition

Note that each COA is unique and not all steps were conducted for each COA. Section 2.2 describes elements common to all COAs, while Sections 2.3 through 2.7 further detail the specific development of each COA considered.

2.1 Potential Users

As a part of this effort, the Navy conducted a desktop review to preliminarily identify potential DoD, public, and private entities in proximity to Red Hill that could potentially benefit from using the filtered groundwater. Potential users identified included the Halawa Correctional Facility, Kaiser Permanente Medical Center, the Veterans Affairs Medical Center, and Waiau Power Plant. The Navy also identified several nearby golf courses for use of the water for irrigation needs, including Moanalua Golf Club, Navy Marine Golf Course, and Pearl Country Club. The CAPE-Jacobs team identified additional potential irrigation and process water users throughout the project.

2.2 COA Common Elements

All of the COAs described in this report require construction of some common elements to support their functionality. These common elements are described in this section. Conceptual drawings are included in Appendix D, Engineering Drawings.

2.2.1 Adit 3 Site Improvements

Pumping of filtered effluent water to the COA uses is required. Site improvements at Adit 3 are necessary to support this pumping, such as piping modifications and electrical supply and road improvements. These improvements are common to all COAs described in the subsequent sections of this report. The engineering drawings (Appendix D) present a simple engineering concept of what is required for pumping, piping, and controls, based on delivering flow rates of between 1 and 2 mgd. If COAs were selected that exceeded that flow rate, more pumps or larger pumps with higher flow, pressure, and power requirements would be required. More sophisticated controls and interfaces would be required if a COA was selected that tied into BWS piping systems.

2.2.1.1 Piping

Connection to the effluent piping from the GAC adsorption tanks at Adit 3 is necessary to reroute the water from its current discharge (Halawa Stream) to allow use as described in the COAs. Connection to the piping located downstream of the existing elevated pipe loops is also expected, to ensure that the GAC adsorption tanks remain full of water at all times. Piping from the pump discharge into Adit 3 for eventual routing to COA uses is also required.

2.2.1.2 Pumping

Pumping of the filtered effluent water is necessary to provide adequate pressure at the point of uses identified in each COA. A preliminary hydraulic analysis of the proposed piping system required for the COAs indicated that a boost pressure of 60 pounds per square inch at Adit 3 is required to meet the minimum pressure requirements identified by the Navy's Public Works Department for irrigation use. Two duty pumps and one standby pump, each rated for 1 mgd, were included in the conceptual engineering. The motor size for each pump is estimated at 40 horsepower. Constant speed pumping was selected, with a recirculation loop to allow matching of customer water demand.

2.2.1.3 Pressure Switches

Pressure switches located on the suction side of the pumps would turn off the pumps under low-flow conditions. These switches are necessary to avoid pulling a vacuum on the piping when water supply from the GAC effluent is low or turned off. Because of the criticality of proper functionality, two pressure switches have been included in case one fails. Note that a 75,000-gallon water tank to store GAC effluent prior to pumping was initially identified as being required to avoid vacuum conditions on the pump suction when flows did not match, but was later determined as unnecessary with the use of dual pressure switches for this conceptual model. In addition, limited site space is available near Adit 3 for a 75,000-gallon water storage tank, making use of the dual pressure switches more appropriate for this application. Some schematics shown throughout Section 2 of the report (and included in the 4-week and 8-week briefings) still show the 75,000-gallon storage tank because under certain scenarios it may still be required and the CAPE-Jacobs team wants to depict where it may be required to go.

2.2.1.4 Pressure Relief Valves

Pressure relief valves have been located downstream of the pumps to allow recirculation of flow to the pump suction when use is low by COA users and pressure increases in the piping system. Because of the criticality of proper functionality, two pressure release valves have been included in case one fails.

2.2.1.5 Electrical Supply

Electrical supply is necessary to power the three 40-horsepower pumps. An enclosed electrical room with a motor control center (MCC) is proposed to be located immediately adjacent to the pumps. It is envisioned that the pumps' programmable logic controller (PLC) would also be located within the air-conditioned enclosure.

2.2.1.6 Site Improvements

Various site improvements would be required to support these elements, including site paving to support vehicle movements, concrete pads for the pumps and electrical room, and bollards to protect equipment. More site improvements will likely be identified when the concept is advanced.

2.2.2 Tunnel Routing and Pipe Support

All the COAs require routing of exposed piping within tunnels such as the Adit 3 Tunnel, Harbor Tunnel, and Moanalua Tunnel. Example pipe supports for use in the tunnels are shown in the conceptual engineering drawings included in Appendix D. Selection of the appropriate type of pipe support depends on the obstructions encountered for specific pipe routes. A tour of the Adit 3 Tunnel and Harbor Tunnel was conducted to identify potential obstructions that may need to be avoided when routing the piping. Field notes from the Harbor Tunnel tour that identify the obstruction type and location are included in Appendix B. The tour started at Adit 3 and ended at Adit 2.

2.3 COA 1 – Public/Private Entity and Off-Base DoD Use of Effluent Water

2.3.1 Water Users and Usage

This COA investigated the use of filtered effluent water for private and public uses as well as for DoD uses remotely located from JBPHH. The uses were grouped in the following three geographic areas to maximize the use of conveyance infrastructure to convey water to each area:

- In the immediate vicinity of Red Hill
- Southeast of Red Hill
- West of Red Hill

Large irrigation areas that could potentially use the water were identified by examining aerial photos, and potential industrial and commercial users were identified by reviewing lists of facilities and businesses near Red Hill. Table 2-1 presents a list of potential users identified under COA 1.

A decision was made to defer contact with assessed smaller potential users southeast and west of Red Hill. The rationale was that given the amount and locations of smaller users, the specific feasibility of providing water to these smaller users would remain uncertain until definitive interest in use of filtered effluent water by major users was confirmed and pipeline routing to the major users was more clearly defined. For example, some water conveyance routing to larger users could pass close to or be modified to serve smaller users along the way, which would make the investment more feasible.

Table 2-1. COA 1 Possible Users

Entity Name	Public/Private	Specific Uses	Location Relative to Red Hill	Was Entity Contacted?
Hawaiian Cement	Private	Business operation	Immediate vicinity	Yes
HDOA Animal Quarantine	Public	Facility	Immediate vicinity	Yes
Halawa Correctional Facility	Public	Facility	Immediate vicinity	Yes, but no response
Honolulu Country Club	Private	Irrigation	Southeast	Yes
Moanalua Golf Club	Private	Irrigation	Southeast	Yes

Table 2-1. COA 1 Possible Users

Entity Name	Public/Private	Specific Uses	Location Relative to Red Hill	Was Entity Contacted?
Walter J. Nagorski Golf Course	DoD (non-JBPHH)	Irrigation	Southeast	Yes
Fort Shafter (Palm Circle, baseball field)	DoD (non-JBPHH)	Irrigation	Southeast	No
Tripler Army Medical Center	DoD (non-JBPHH)	Facility	Southeast	No
Tripler Track and surrounding fields	DoD (non-JBPHH)	Irrigation	Southeast	No
AMR Recreation Center	DoD (non-JBPHH)	Irrigation	Southeast	Yes
Moanalua Gardens	Private	Irrigation	Southeast	Yes, but no response
Kaiser Permanente Medical Center	Private	Facility	Southeast	No
Ala Puumalu Community Park	Public	Irrigation	Southeast	No
Keehi Lagoon Beach Park	Public	Irrigation	Southeast	No
Pearl Country Club	Private	Irrigation	West	Yes
Neil S. Blaisdell Park	Public	Irrigation	West	No
Waiau Power Plant	Private	Facility (cooling water)	West	Yes

Note:

AMR = Aliamanu Military Reservation

2.3.1.1 Users Located in the Immediate Vicinity of Red Hill

Three public/private users located in the immediate vicinity of Red Hill were contacted to explore use of effluent water at their sites regardless of potential water use capacity, because of their close proximity and hypothetically simpler/more feasible effluent distribution. These users were Hawaiian Cement, the animal quarantine station operated by the State of Hawaii Department of Agriculture (HDOA), and the Halawa Correctional Facility. Figure 2-1 shows the location of these potential users in relation to Red Hill. Hawaiian Cement and HDOA both indicated that they were not interested in using the water, and the Halawa Correctional Facility did not respond to messages. Because of their lack of interest in participating in the project, it is unknown how much water each entity uses, but the quantities are expected to be relatively small (that is, less than 0.2 mgd based on professional judgement). All three users were eliminated from further consideration based on the lack of response and small potential demand.

The feasibility of constructing a truck fill station located at Red Hill for filling water trucks for remote and temporary water use such as dust suppression was also explored. However, this approach was determined to be impractical because of the large number of water trucks required to use at least 10 percent of the effluent water (for example, approximately 100 trucks per day, each carrying 5,000 gallons of water, would be required for 0.5 mgd of water use).

[redacted] (b)(3)(A)

Figure 2-1. Potential Water Users in the Immediate Vicinity of Red Hill (Red Dots)

2.3.1.2 Users Located Southeast of Red Hill

Numerous potential users of the effluent water located southeast of Red Hill were identified by examining aerial photos for large areas of irrigation (Figure 2-2 and Table 2-1). The estimated water use for each area was developed based on typical summer irrigation rates and is summarized in Table 2-2. The three golf courses in this area were first contacted to explore their interest in using the water because they were assessed to represent the largest potential users of the water, from which a baseline water system could be developed. Two of the three golf courses, Moanalua Golf Club and Walter J. Nagorski Golf Course expressed potential interest in using the water, while the Honolulu Country Club indicated that they were not interested in using the water. An exploratory phone call was held with representatives of the Moanalua Golf Club and the Nagorski Golf Course to further understand their water needs and infrastructure components. A site visit was also made to the Moanalua Golf Club. Appendix A provides a summary of the phone calls and Appendix B provides notes and photographs from the Moanalua Golf Club site visit.

[redacted]

Smaller potential users were not contacted because the plan was to define pipeline routing to the major users first, and then determine the feasibility of providing water to these other users. Water use estimates were not made for building applications (Kaiser Permanente and Tripler Army Medical Center) or small community parks (Ala Puumalu Community Park and Keehi Lagoon Beach Park) because of the expected small demands. For water conveyance, it was determined that the use of the BWS Moanalua Tunnel to the southeast could simplify project implementation and lower costs because of its vicinity to Red Hill, its developed footprint, and the proximity to some users (such as Moanalua Golf Club).

[redacted] (b)(3)(A)

Figure 2-2. Potential Water Users Southeast of Red Hill (Orange Dots)

Table 2-2. COA 1 Calculated Demands Based on Irrigated Area

Entity Name	Public/Private	Irrigation Area (acres)	Estimated Water Demand (mgd)
Honolulu Country Club	Private	120	0.8
Moanalua Golf Club	Private	39	0.3
Walter J. Nagorski Golf Course	DoD	37	0.2
Tripler Track and surrounding fields	DoD	20	0.1
Moanalua Gardens	Private	19	0.1

Table 2-2. COA 1 Calculated Demands Based on Irrigated Area

Entity Name	Public/Private	Irrigation Area (acres)	Estimated Water Demand (mgd)
Fort Shafter (Palm Circle, baseball field)	DoD	11	0.07
AMR Recreation Center	DoD	2	0.01

2.3.1.3 Users Located West of Red Hill

Three potential users of the effluent water were identified west of Red Hill (Figure 2-3), with two representing significant water use: the Hawaiian Electric Company (HECO) Waiau Power Plant and the Pearl Country Club. Although the Waiau Power Plant uses a large amount of water for cooling purposes, they currently source cooling water directly from Pearl Harbor and therefore do not need an alternative water supply. The exact amount of cooling water used by the Waiau Power Plant was not determined because of their lack of interest in the project. Pearl County Club expressed significant interest in using the effluent water because their groundwater withdrawal permit currently limits the amount of water they can extract from their well to 0.3 mgd, which is insufficient for irrigation purposes in the drier months. Appendix A provides a summary of the phone call with Pearl Country Club. Because it represented a much smaller use, contact with representatives of the Neal S. Blaisdell Park was deferred until pipeline routing to the major users was more clearly defined, to determine the feasibility of providing water to the park.

[redacted]

(b)(3)(A)

Figure 2-3. Potential Water Users West of Red Hill (Blue Dots)

2.3.2 Screening Recommendations

The following summarizes the preliminary screening conducted on the potential public/private users of the effluent water:

- The potential users in the immediate vicinity of Red Hill were eliminated from consideration because of the lack of interest.
- The potential users southeast of Red Hill were carried forward for additional exploration because of the interest expressed by some major users in this area, the potential use of existing infrastructure (Moanalua Tunnel) that could reduce project implementation cost, and the potential for a significant amount of water use (greater than 1 mgd).
- The potential users west of Red Hill were eliminated from consideration because of the lack of significant water use in this area (less than 0.5 mgd) and the anticipated high cost and complexity of pipeline routing from Red Hill to Pearl Country Club through a congested urban corridor.

Table 2-3. COA 1 Screening Recommendations
Public/Private Entity and Off-Base DoD Use of Effluent Water

Description	Recommendation
Provide filtered water to the users in the immediate vicinity of Red Hill	***Eliminate*** – lack of interest from users; low water usage
Provide filtered water to users located southeast of Red Hill	***Explore*** – interest from some users; high water usage; Moanalua Tunnel may simplify piping
Provide filtered water to users located west of Red Hill	***Eliminate*** – Highest user, Waiau Power Plant, does not need alternative water source
Truck Filling Station	***Eliminate*** – Limited use potential

Notes:

Eliminate = option not viable
Explore = most promising option

2.3.3 COA Definition

This section presents a detailed description of the COA recommended for further evaluation.

2.3.3.1 COA Overview

Definition of the infrastructure components necessary to support delivery of effluent water to users located southeast of Red Hill was advanced to better understand project feasibility and cost. Figure 2-4 is an overview map of COA 1, and Figure 2-5 is a schematic showing the major infrastructure components required for implementation, which is summarized in the following sections.

[redacted]

[redacted]

((b)(3)(A)

Figure 2-4. COA 1 System Overview Map

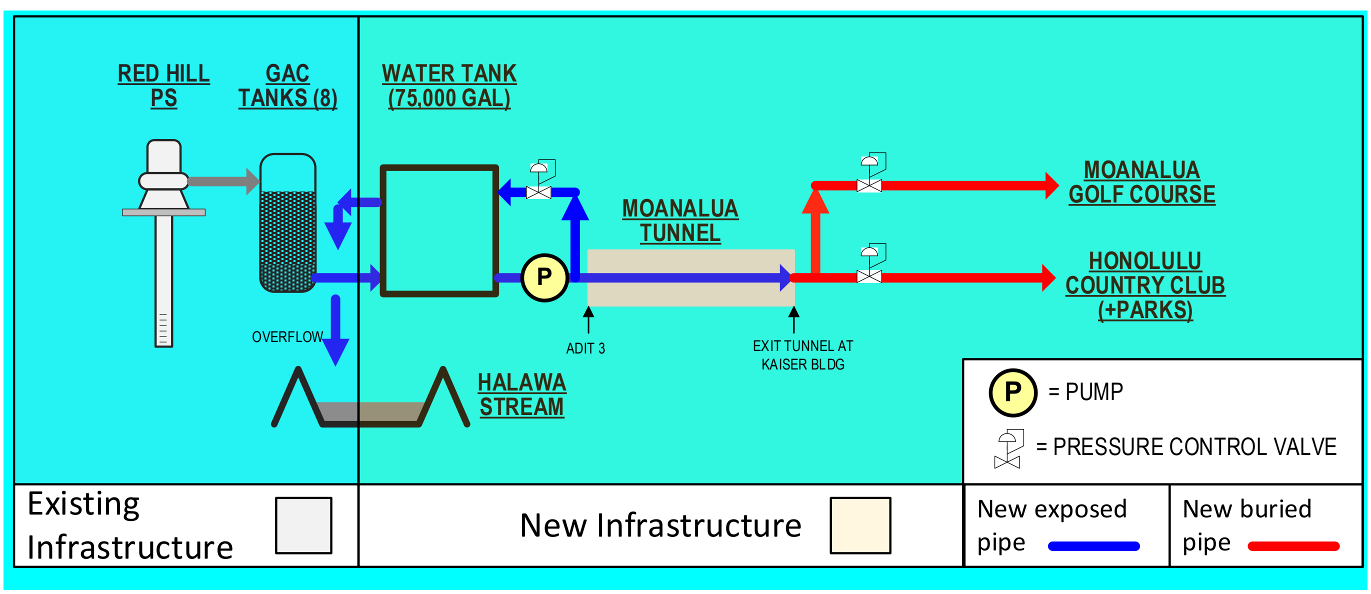

Figure 2-5. COA 1 Preliminary System Schematic

2.3.3.2 Flow Rate

A flow rate of 1 to 2 mgd was identified for this COA, which assumes water use at the Moanalua Golf Club and the Honolulu Country Club. The Honolulu Country Club initially indicated that they were not interested in using the effluent water, so further discussions with them would be necessary to secure their interest and meet the flow rates assumed for this COA. If this COA is implemented, contact with representatives of the Ala Puumalu Community Park should be made to determine their interest in using the water, as the preliminary pipeline route identified for serving the Honolulu Country Club passes through the park.

2.3.3.3 Pipelines

Exposed Pipelines in Moanalua Tunnel

The existing BWS Moanalua Tunnel runs from Red Hill to its exit point adjacent to the Kaiser Permanente building. A 30-inch BWS water pipe is located within the Moanalua Tunnel, but sufficient space exists within the tunnel to route a new 8-inch pipe (Figure 2-6) to convey effluent water to users [redacted] (b)(3)(A) of new 8-inch piping in the tunnel would be needed. Approval from BWS would be required to allow use of the Moanalua Tunnel for pipeline routing.

Figure 2-6. Photo of Moanalua Tunnel

Buried Pipelines

Buried piping would be needed after exiting Moanalua Tunnel to provide effluent water to the Moanalua Golf Club, Ala Puumalu Community Park, and Honolulu Country Club. Figures 2-7, 2-8, and 2-9 show preliminary buried pipeline routes. A combination of open-trench and trenchless construction would be required along the proposed pipeline route. Coordination with private and public landowners would be necessary to secure the necessary easements and approvals. Approximately 6,600 feet of buried piping would be required.

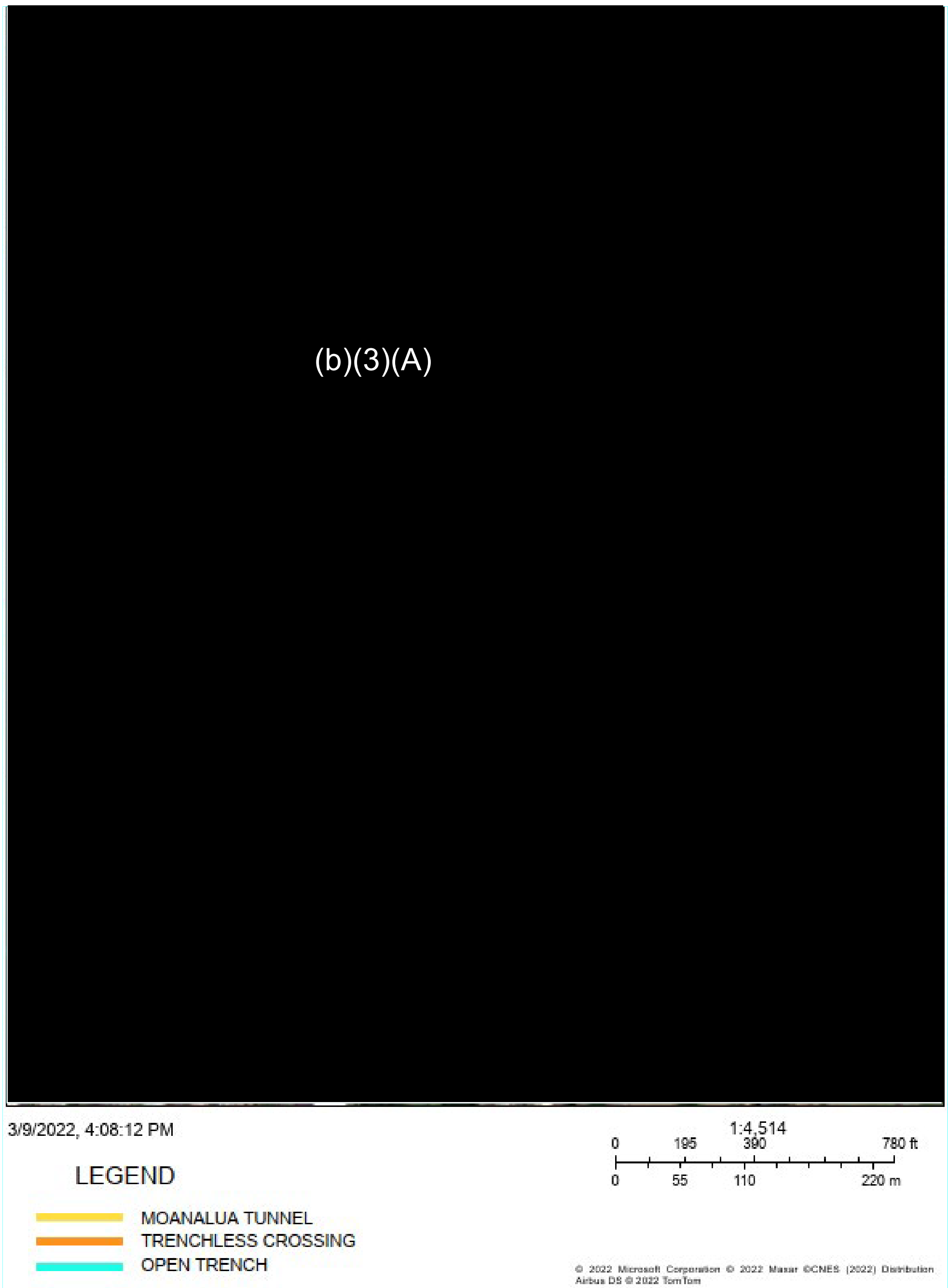

Figure 2-7. Proposed Buried Pipeline Routing for COA 1 after Exiting Moanalua Tunnel (Segment 1)

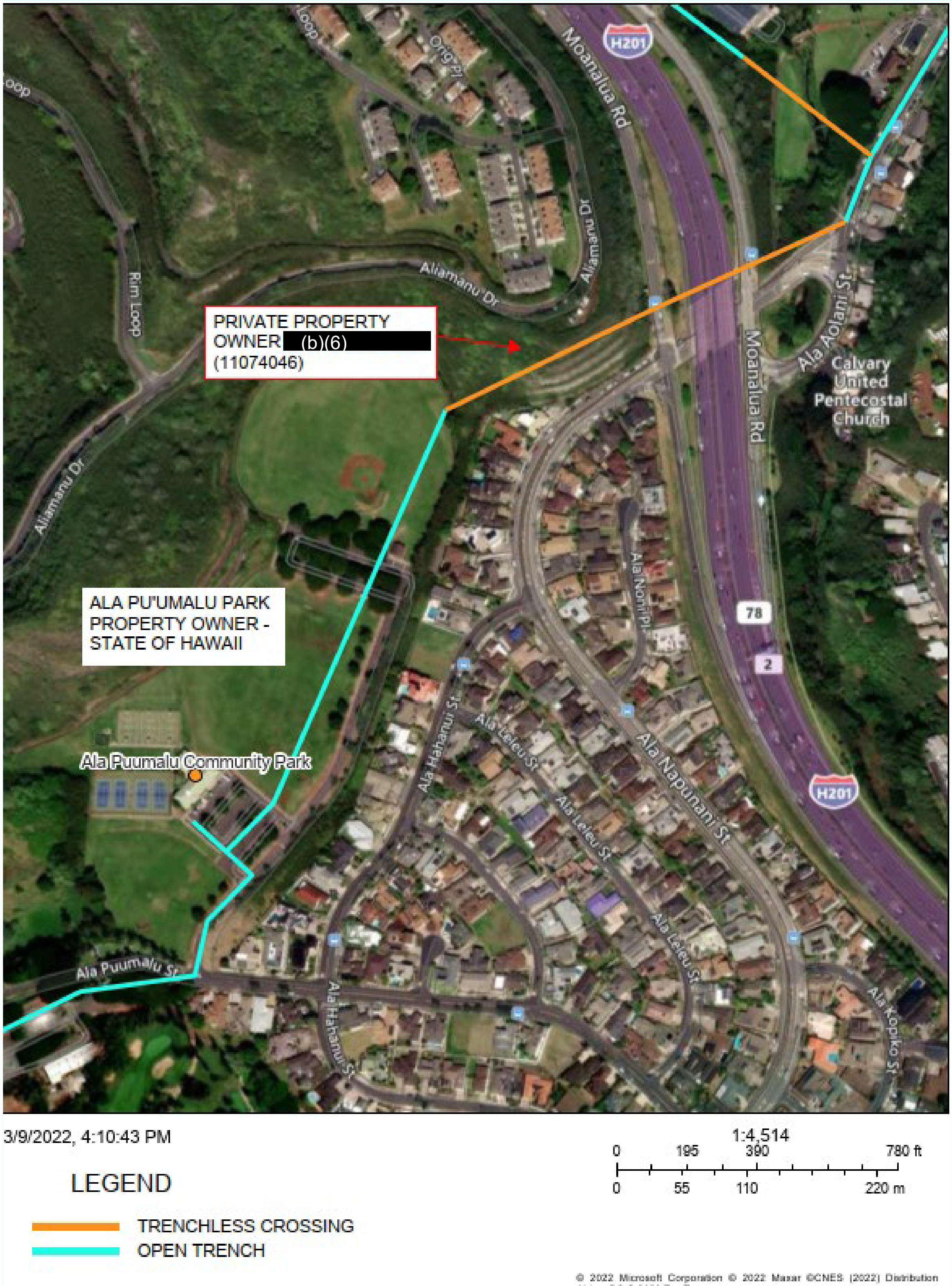

Figure 2-8. Proposed Buried Pipeline Routing for COA 1 to Ala Puumalu Park (Segment 2)

Figure 2-9. Proposed Buried Pipeline Routing for COA 1 to Honolulu Country Club (Segment 3)

2.4 COA 2 – DoD Entity Use of Effluent Water

2.4.1 Water Users and Usage

This COA investigated the use of effluent water within the property boundaries of JBPHH. The COA focused on irrigation applications, because those typically represent the largest water use that can be replaced with a non-potable supply. However, water use data for all applications at JBPHH (for example, indoor, industrial, irrigation, and similar) were not available to confirm this assumption and should be further studied in future phases of this project to determine if other non-irrigation demands that could use non-potable water are significant.

2.4.1.1 JBPHH Water Use for Irrigation

Metered water use data at JBPHH for fiscal years 2021 and 2022 were provided by Navy staff for analysis (Beaudouin, pers. comm. 2021). Current potable water demands are shown on Figure 2-10. Irrigation demands as a percentage of the total potable water use are shown on Figure 2-11 and are, on average, 25 percent of the total potable water use at JBPHH. The four largest irrigation users of water consume about 40 percent of the total irrigation water demand at JBPHH and are summarized in Table 2-4. The combined monthly average water use at the two 18-hole golf courses located at JBPHH is approximately 0.7 mgd, but note that daily demands for each of these golf courses will be significantly higher, especially during periods of drought (interviews of Navy personnel indicated daily peaks of 1 mgd for each golf course during the summer months).

Examination of daily and hourly flow data (if available) should be conducted during the next phase of this project to properly size infrastructure components based on actual peak flow rates. For the purposes of this effort, use of effluent water at Iroquois Point and Ford Island were not explored, given their distance from existing infrastructure and the resultant cost of routing pipelines to these locations.

Other large fields and parks located at JBPHH are also irrigated with potable water, although most are unmetered. Table 2-5 shows fields and parks with an area of 2 acres or more and the estimated peak daily irrigation demands ratioed from the peak daily use of 1 mgd at the Navy Marine Golf Course. A site visit was conducted with Navy personnel to investigate use of filtered effluent water at golf courses, parks, and fields located at JBPHH. A summary of this site visit is included in Appendix B.

[redacted]

[redacted]
(b)(3)(A)

Figure 2-10. JBPHH Potable Water Use per Water Shaft

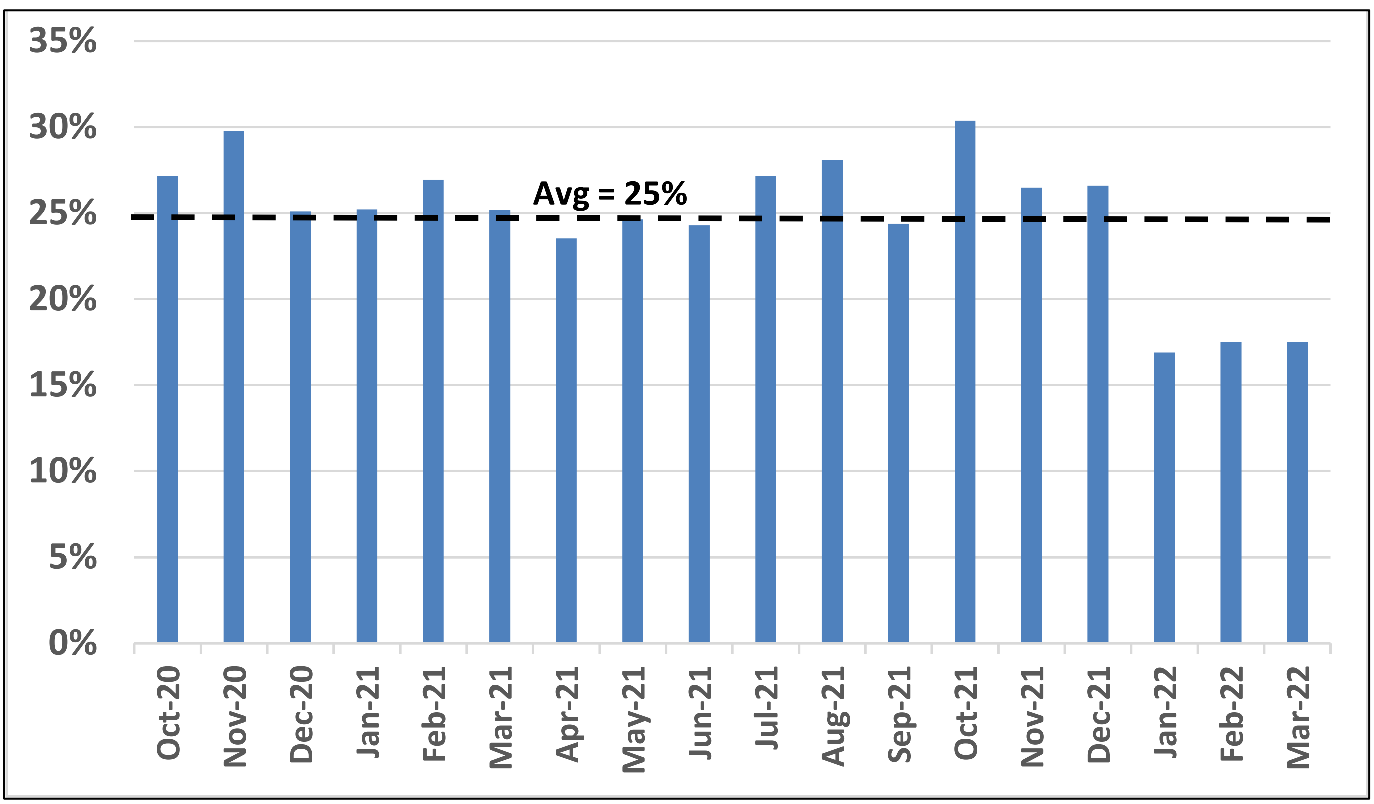

Figure 2-11. Irrigation Use as a Percentage of Total Potable Water Use

Table 2-4. Four Largest Irrigation Users at JBPHH

User/Location	Metered?	Monthly Demand: Minimum/Average/Maximum (mgd)	Specific Uses
Navy Marine Golf Course	Yes	0.1/0.4/0.6	Irrigation of 18-hole golf course
Mamala Bay Golf Course	No	Avg = 0.3 (estimated)	Irrigation of 18-hole golf course
Iroquois Point	Yes	0.3/0.6/0.7	Irrigation of Kapilina Housing area
Ford Island	Yes	0.2/0.4/0.6	Approximately 65% to 70% of Ford Island irrigation is for Public-Private Venture housing; the remainder is for Region-billed common areas

Table 2-5. Estimated Peak Daily Irrigation Demands for Irrigated JBPHH Golf Courses, Parks, and Fields

Golf Course/Park/Field	Irrigated Area[a] (acres)	Estimated Peak Daily Demand[b, c] (mgd)
Mamala Bay Golf Course	169	1.1
Navy Marine Golf Course	154	1.0
Hickam Par 3 Golf Course (Kealohi Golf Course)	27	0.2
Quick Field	7	0.05
Richardson Fields 1-3, 6-8	5	0.03
Hickam Softball Fields	5	0.03
Ward Field	5	0.03
Gazebos 1, 2, and 3	3	0.02
Makalapa Pavilion	3	0.02
Vandenburg Field	2	0.01
Millican Field	2	0.01

[a] Irrigated areas are estimated using GIS.

[b] Peak daily demands are calculated by extrapolating irrigation data from Navy Marine Golf Course (that is, 1 mgd for 154 acres).

[c] Examination of daily and hourly flow data (if available) should be conducted during the next phase of this project to properly size infrastructure components based on actual peak flow rates.

2.4.1.2 Conveyance of Effluent Water from Red Hill to JBPHH

Effluent water must be conveyed from Red Hill to JBPHH to allow use within JBPHH property boundaries. The following main conveyance options were considered that would allow the transfer of up to 5 mgd of flow:

- New pipe(s) installed within Harbor Tunnel
- (b)(3)(A) [redacted]
- Discharge and extraction from Halawa Stream
- New pipe installed within Halawa Stream

2.4.2 Screening Recommendations

Table 2-6 provides major considerations associated with these COA 2 conveyance options. Option 1 is recommended for further consideration because of the significant challenges associated with the other options (for example, agency coordination and easements). The other options should only be explored if significant challenges arise with implementation of Option 1 during conceptual engineering.

Table 2-6. COA 2 Screening Recommendations
DoD Entity Use of Effluent Water

Option	Considerations	Recommendation
1. Install new pipe(s) in Harbor Tunnel	• Flows up to 2.3 mgd could be conveyed in one 8-inch pipe; flows up to 4.6 mgd could be conveyed in two 8-inch pipes. • Insufficient space is available in Harbor Tunnel for routing of pipes larger than 8 inch in diameter. • Approval from Navy Supply Systems Command required for use of Harbor Tunnel.	***Explore***
2. Use existing 30-inch water pipeline in Harbor Tunnel	• The 30-inch water line in Harbor Tunnel has historically been used for delivery of potable water from the Red Hill Shaft to JBPHH and for supplying water to the Army housing at Red Hill. • The potable water supply to Army housing at Red Hill would be severed and a connection to the BWS system would be required. • If the Red Hill Shaft is used again in the future as a potable supply, conversion of this pipe from non-potable service to potable service or new piping would be required.	***Defer***

Table 2-6. COA 2 Screening Recommendations
DoD Entity Use of Effluent Water

Option	Considerations	Recommendation
3. Discharge and extraction from Halawa Stream	• Continue discharging filtered effluent water to Halawa Stream. Extract water from the concrete-lined portion of Halawa Stream near Aloha Stadium using a new below-grade submersible pump station. Convey water from new pump station to JBPHH property via new buried pipeline. • Approval from the HDOT and DLNR CWRM would be required to allow use of Halawa Stream. • Public and/or private easements would be required for buried piping. • Water quality degradation may occur from vegetation and debris present in Halawa Stream.	***Eliminate***
4. Install new pipe in Halawa Stream	• Anchor pipe to sides or trench/bore and install underneath concrete-lined portion of Halawa Stream. Exit stream near Aloha Stadium and convey water to JBPHH property via new buried pipeline. • Routine maintenance required. • Approval from HDOT and DLNR CWRM would be required to allow use of Halawa Stream. • Public and/or private easements would be required for buried piping. • There are vandalism concerns with the exposed pipeline.	***Eliminate***

Notes:

CWRM = Commission on Water Resource Management
Defer = less promising option that could be revisited
DLNR = Department of Land and Natural Resources
Explore = most promising option
Eliminate = not an option
HDOT = State of Hawaii Department of Transportation

2.4.3 COA Definition

This section presents a detailed description of the COA recommended for further evaluation.

2.4.3.1 COA Overview

Definition of the infrastructure components necessary to support delivery of effluent water to JBPHH was advanced to better understand project feasibility and cost. Figure 2-12 is an overview map of COA 2, and Figure 2-13 is a schematic showing the major infrastructure components required for implementation, which is summarized in the following section. Pipelines are shown to most of the potential users identified in Table 2-5, with the exception of Richardson Fields, the gazebos, and Makalapa Pavilion, all of which are not in close proximity to the primary or secondary conveyance routes or have significant obstructions (for example, Halawa Stream), making pipeline routing to these small demands difficult and costly.

[redacted]

[redacted]
(b)(3)(A)

Figure 2-12. COA 2 System Overview Map

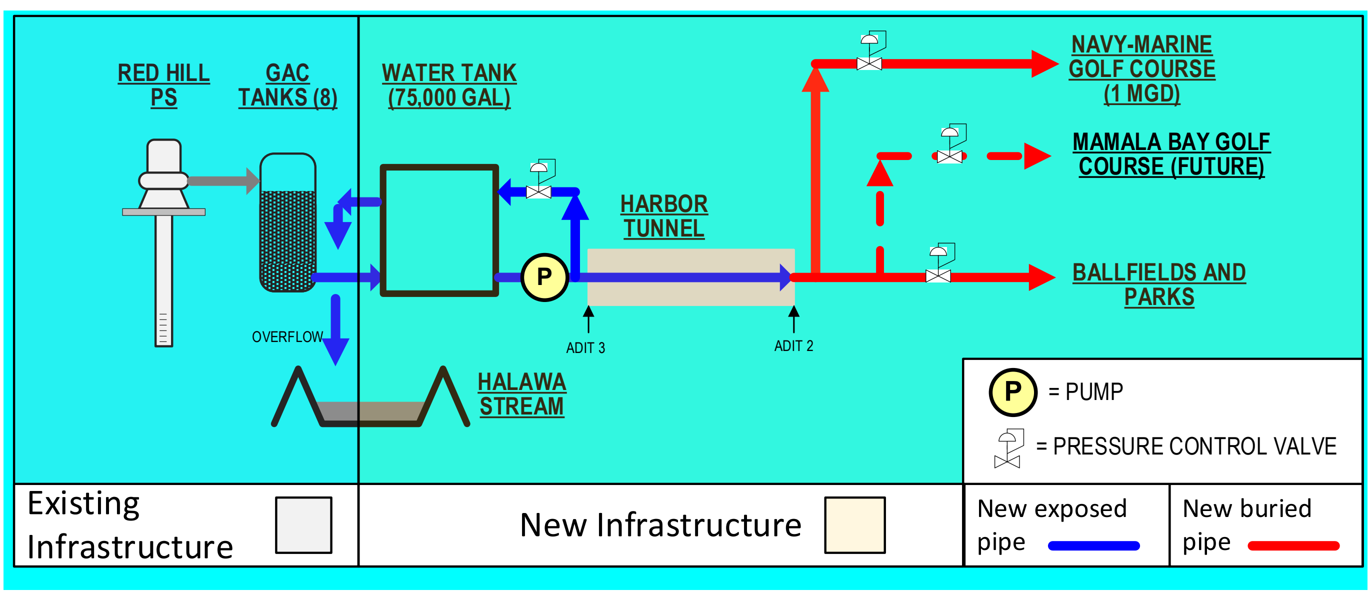

Figure 2-13. Preliminary COA 2 System Schematic

2.4.3.2 Flow Rate

A flow rate of 1 to 2 mgd was identified for this COA, which assumes water use at the Navy Marine Golf Course and parks and fields located along the pipeline route to the golf course (green pipeline on Figure 2-12). Water use could be expanded to 2 to 3 mgd if the water was also supplied to the Mamala Bay Golf Course and parks and fields located along this pipeline route, but this would require much more piping (yellow pipeline on Figure 2-12). Expanding pipeline lengths as necessary to support expansion to 2 to 3 mgd is considered a future activity and this additional piping is not included in the buried pipeline lengths listed in the following section.

2.4.3.3 Pipelines

Exposed Pipelines in Harbor Tunnel

Space within Harbor Tunnel would be used to route effluent water from Red Hill to JBPHH. Water would be conveyed in an 8-inch pipe mounted to the wall of the tunnel and located above the existing 30-inch water line. The new pipe would exit the tunnel at Adit 2, at which point buried piping would be provided to route water to the Navy Marine Golf Course and other users. Exiting the new pipe at Adit 1 was also explored but determined infeasible due to significant space constraints at this adit. Approximately [redacted] in Harbor Tunnel would be required from Red Hill to Adit 2. An inspection of Harbor Tunnel was conducted to evaluate obstructions that would be encountered when routing the new 8-inch pipe. A summary of this inspection is provided in Appendix B. Schedule 80 polyvinyl chloride (PVC) is recommended for use to better accommodate pipe installation challenges within the tight space constraints of the tunnel, but final material selection depends on ultimate pressure requirements and material handling considerations. Navy staff indicated that pipe penetrations through bulkheads would likely need to be oil tight.

Buried Pipelines

Buried piping would be needed after exiting Harbor Tunnel to provide effluent water to the Navy Marine Golf Course and parks and fields located along the pipeline route. Figure 2-14 and Figure 2-15 show preliminary buried pipeline routes to Millican Field, Ward Field, the Hickam softball fields, and the Navy Marine Golf Course. A combination of open-trench and trenchless construction would be required along the proposed pipeline route. The pipeline route was reviewed by the Navy Public Works Department and comments were incorporated into the proposed routing. [redacted] of buried piping would be required. Appendix C shows preliminary pipeline routes to Mamala Bay Golf Course and parks and fields along the way, if these additional users were included.

[redacted]

(b)(3)(A)

Figure 2-14. Proposed Buried Pipeline Routing for COA 2 after Exiting Harbor Tunnel (Segment 1)

[redacted]

(b)(3)(A)

Figure 2-15. Proposed Buried Pipeline Routing for COA 2 after Exiting Harbor Tunnel (Segment 2)

2.5 COA 3 - Aquifer Recharge

This COA investigated the potential beneficial use of the filtered effluent water from Red Hill Shaft to recharge the basalt aquifer in the vicinity of JBPHH. The basalt aquifer is the primary drinking water aquifer in the area and is the main source of water for domestic, municipal, and industrial supply in the Honolulu area. Two technologies were evaluated to recharge the aquifer system: surface percolation in spreading ponds and direct injection into the aquifer system using injection wells.

2.5.1 Approach and Potential Benefits of Groundwater Recharge

To evaluate the potential viability of each of the recharge technologies under consideration, a review of available geologic and hydrogeologic information on the area was performed. The following three key documents provided a large portion of the information used to evaluate the feasibility of aquifer recharge under COA 3:

- *Conceptual Site Model, Investigation and Remediation of Releases and Groundwater Protection and Evaluation, Red Hill Bulk Fuel Storage Facility* (NAVFAC 2019)
- *Groundwater Flow Model Report, Red Hill Bulk Fuel Storage Facility* (NAVFAC 2020)
- *Red Hill Shaft Recovery and Monitoring Plan* (Department of the Navy et al. 2022)

The locations considered for potential recharge operations were constrained by Navy direction that limited recharge options to government-owned property in the JBPHH area to streamline permitting and other logistical challenges with project implementation. Further, the percolation or injection of significant quantities of effluent into the aquifer beneath the Red Hill Facility was considered too risky from the perspective of compromising the efficacy of the hydraulic capture zone created by Red Hill Shaft pumping, potentially resulting in the spread of contamination into downgradient areas. Therefore, implementation of recharge operations on Red Hill Property was also eliminated from consideration. These constraints greatly reduced the locations for potential recharge operations.

The potential benefits of aquifer recharge include the following:

- Replacing groundwater pumped from Red Hill Shaft to reduce net withdrawals from the aquifer
- Creating a hydraulic barrier downgradient of the Red Hill Shaft to reduce the potential for migration of contaminated groundwater associated with the Red Hill Shaft from migrating downgradient toward JBPHH and regional drinking water shafts in the area
- Reducing the potential for seawater intrusion into the basalt aquifer beneath JBPHH

2.5.2 Infiltration and Injection

Aquifer recharge of filtered effluent water within the JBPHH area using surface percolation ponds was determined to be technically infeasible for the following reasons:

- Surface spreading basins require large areas of relatively flat-lying ground to support pond construction. Given the density of development in the area and relatively steep topography, few to no optimal locations are present in the immediate vicinity of JBPHH. The Makalapa

Crater area was considered as a potential surface recharge location but was eliminated due to its previous use as a waste disposal area.

- The subsurface geology in the area is comprised of river valleys underlain by thick sequences of saprolite, or weathered basalt, which exhibits low vertical permeability and therefore represents poor conditions for successful operation of surface spreading basins.
- Construction of percolation ponds would disturb relatively large areas of land that would be difficult to permit and may generate opposition from public stakeholders.

Aquifer recharge using injection wells appears to be a viable technology to deliver up to 4.6 mgd of filtered effluent water into the basalt aquifer system using a two injection well system with the wells spaced approximately 1,000 feet apart. Consideration of potential injection locations was restricted to areas near JBPHH. Upon careful review of available areas to site injection wells, the Makalapa Park area (Figure 2-17) was selected as the optimal location for the following reasons:

- Subsurface hydrogeologic conditions were compatible with injection operations as the cap rock overlying the basalt aquifer was only 320 feet thick (Figure 2-16), and the basalt aquifer hydraulic conductivity was high enough to accept the target injection quantities (4.6 mgd).
- Makalapa Park has sufficient available space to construct the injection wells and associated infrastructure to support the injection well system.
- Makalapa Park is near Adit 2 of Harbor Tunnel (approximately 1,200 feet away), which will minimize the cost of filtered effluent water conveyance to the injection sites.

An additional consideration that influences location of injection wells into the basalt aquifer is the Underground Injection Control (UIC) line established by the State of Hawaii Department of Health (HDOH) and the No-Pass Zone established by the BWS (Figure 2-17). The recommended injection locations are mountainward (*mauka*) of the UIC line and oceanward (*makai*) of the No-Pass Zone. Therefore, a UIC permit for injection would be required by the HDOH, but no permit would be required from the BWS. Additional information on required permitting is provided in Section 3.

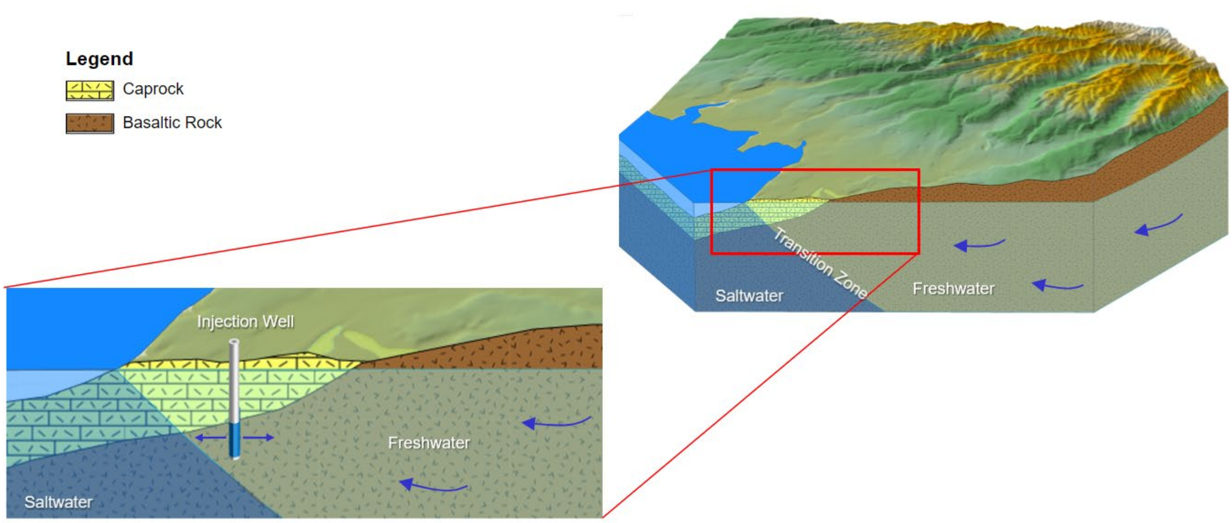

Figure 2-16. Conceptual Diagram of Injection Well Option

2.5.3 Screening Recommendations

The following summarizes the screening conducted on the aquifer recharge option for beneficial use of the filtered effluent water:

- The use of surface spreading basins to recharge the aquifer was eliminated because of the lack of suitable construction sites, poor subsurface conditions for percolation of applied water, and potential permitting challenges.
- The use of injection wells to recharge the basalt aquifer is technically feasible and could likely recharge up to the full 4.6 mgd of filtered effluent water available for recharge using two injection wells spaced approximately 1,000 feet apart.
- Because of concerns regarding disturbance of the hydraulic capture zone created by Red Hill Shaft pumping, injection was not considered for areas on Red Hill property.
- A suitable location for injection was selected on JBPHH property near Makalapa Park, where space exists for the construction of the two injection wells along with the necessary related infrastructure.

Table 2-7 presents screening recommendations for COA 3.

Table 2-7. COA 3 Screening Recommendations
Aquifer Recharge

Description	Recommendation
Reinjection at base of Harbor Tunnel	***Explore*** – potential to use up to 4.6 mgd, conveyance via Harbor Tunnel; permitting may be challenging
Reinjection near Red Hill	***Eliminate*** – Injection may adversely impact capture zone created by Red Hill Shaft pumping
Infiltration Basin	***Eliminate*** – soil characteristics and hydrogeologic setting in available Navy parcels not likely suitable; challenges to successful permitting and implementation

Notes:
Eliminate = option not viable
Explore = most promising option

2.5.4 COA Definition

Following evaluation of site conditions and technical feasibility, COA 3 was refined to only include recharge through injection wells located on JBPHH property. This section presents a detailed description of the COA recommended for further evaluation.

2.5.4.1 COA 3 Overview

The injection well system necessary to inject up to 4.6 mgd of effluent would consist of two injection wells drilled into the basalt aquifer to a depth of 500 feet each. Each well would be capable of injecting a minimum of 1,750 gallons per minute, and the wells would be spaced approximately 1,000 feet apart. The proposed locations of the injection wells at Makalapa Park are shown on Figure 2-17, with additional detail provided on Figure 2-18.

[redacted]

[redacted]

(b)(3)(A)

Figure 2-17. COA 3 Schematic and Map Overview

[redacted] (b)(3)(A)

Figure 2-18. Makalapa Park Well Locations and Pipeline Routing

2.5.4.2 Injection Well Sizing and Considerations

The conceptual engineering of the extraction well system (Figure 2-19 and Appendix D) assumed the following:

- Depth to top of basalt aquifer = 320 feet below ground surface
- Depth to bottom of injection well = 500 feet below ground surface
- Hydraulic conductivity of basalt aquifer = 1,500 feet per day
- Injection well diameter = 24 inches
- Number of injection wells = 2
- Injection well capacity = 1,750 gallons per minute per well
- Water table head ≈ 5 feet above mean sea level
- Basalt aquifer head ≈ 15 feet above mean sea level
- 12-inch injection and backflushing pipeline; 5 feet per second velocity
- Wellhead equipped with flow meter, pressure gauge, level transducer

- Motor operated butterfly valves to control injection to the well or backflushing to waste
- 20 by 40 foot building to house each well (2 total buildings)
- Vertical line shaft turbine pump and motor to provide backflushing capabilities and equipped with variable frequency drives

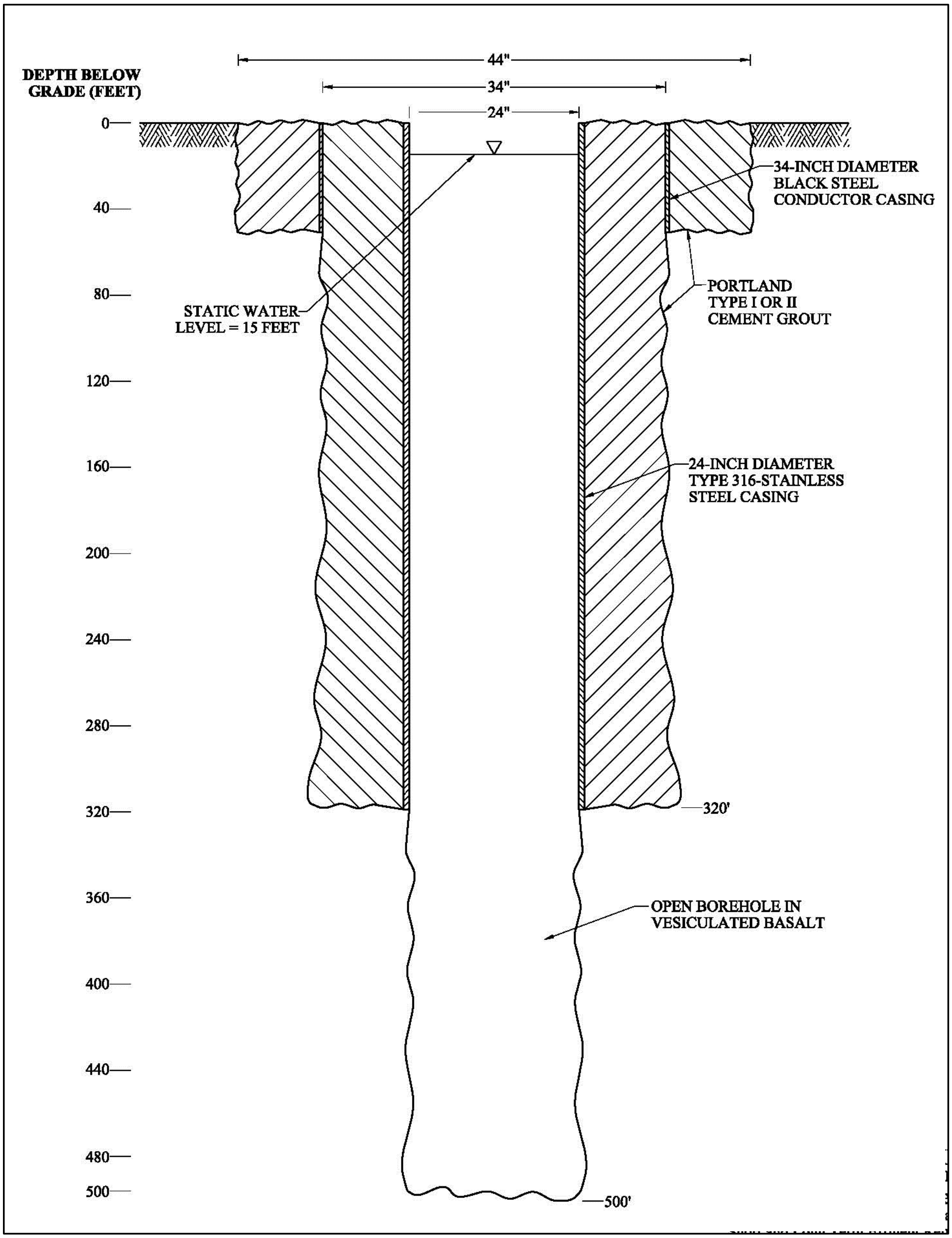

Figure 2-19. COA 3 Injection Well Conceptual Model

2.5.4.3 Pipelines

Exposed Pipelines

Similar to COA 2, space within Harbor Tunnel would be used to route filtered effluent water from the Red Hill treatment facility to JBPHH. Water would be conveyed in two 8-inch pipes mounted to the wall of the tunnel and located above the existing 30-inch water line. The new pipe would exit the tunnel at Adit 2, at which point buried piping would be provided to route water to Makalapa Park, where it will be injected into the bedrock aquifer through two injection wells. Schedule 80 PVC is recommended for use to better accommodate pipe installation challenges within the tight space constraints of the tunnel, but final material selection depends on ultimate pressure requirements and material handling considerations. Navy staff indicated that pipe penetrations through bulkheads would likely need to be oil tight.

Buried Pipelines

Buried piping would be needed after exiting Harbor Tunnel to conduct filtered effluent water to the injection wells constructed at Makalapa Park. Figure 2-18 shows the preliminary buried pipeline routes to Makalapa Park. Because of the steep embankment located adjacent to Adit 2, the 1,200-foot-long buried pipeline to Makalapa Park would likely be constructed using horizontal directional drilling (HDD) technology.

2.5.4.4 Potential Implementation at Makalapa Park

The implementation of the injection well facilities at Makalapa Park proposed two locations with an approximate 1,000-foot distance between each injection well. As described in Section 2.4.4.3, a trenchless construction method (such as HDD) would be used to install an 18-inch pipe between Adit 2 and the Makalapa Pavilion parking lot. The 18-inch line would reduce to a 12-inch pipe and split at a 12-inch by 12-inch tee to connect injection wells 1 and 2 as shown on Figure 2-20. The 12-inch pipe connecting to injection well 2 would parallel the existing gravel path that borders the fence line. In addition, both injection wells would connect to a below-grade storage tank that would be used to retain backwash water prior to discharge. Backwash water would then discharge to vegetation located to the east of injection well 1.

[redacted]

(b)(3)(A)

Figure 2-20. COA 3 Proposed Injection Areas

2.6 COA 4 – Partner with BWS to Use Existing Non-potable Pipeline

2.6.1 Water Users and Usage

Water users and usage for COA 4 will be the Navy Marine Golf Course (as described for COA 2 in Section 2.3.1) and at the Daniel K. Inouye International Airport (as described in Section 2.6.3).

2.6.2 Screening Recommendations

No preliminary screening (such as coordination with BWS or airport authorities) was conducted. COA 4 should continue to be explored.

2.6.3 COA Definition

This section presents a detailed description of the COA recommended for further evaluation.

2.6.3.1 Approach for Use of Existing BWS Non-potable Infrastructure

This COA investigated connecting filtered effluent water to the pipeline system operated by BWS that supplies non-potable water to the Daniel K. Inouye International Airport. The existing non-potable pipeline system pumps water from Kalauao Spring located near Sumida Farms to the BWS Halawa Reservoir for subsequent gravity flow to the airport (Figure 2-21). The pipeline from Halawa Reservoir to the airport is located along Interstate Highway 1 (H1) and runs directly past the Navy Marine Golf Course, providing a convenient means of supplying filtered effluent water to the golf course using existing infrastructure. Use of 1 mgd at the Navy Marine Golf Course, coupled with current airport uses that are estimated at 0.3 mgd, would allow 1 to 2 mgd of demand for the effluent water.

[redacted] (b)(3)(A) The diameter of the existing non-potable pipeline is suspected to be 20 inches, which should provide ample capacity for 1 to 2 mgd of flow. However, a detailed hydraulic evaluation should be conducted after more information is collected from BWS on the exact location, size, and operational characteristics of the non-potable pipeline system.

Filtered effluent water from Red Hill would replace water from Kalauao Spring, which is suspected to have elevated salt concentration, potentially improving the quality of the water used within the airport. Kalauao Spring water quality should be confirmed with BWS. It is expected that the existing BWS pump station at Kalauao Spring would be maintained as an emergency backup to the non-potable pipeline system.

[redacted] (b)(3)(A)

Figure 2-21. COA 4 System Overview Map

2.6.3.2 Pipelines

Connection to BWS

Two alternatives were identified for connecting to the existing non-potable pipeline: [redacted] (b)(3)(A). Final selection of the preferred approach should consider cost and non-monetary factors such as environmental impacts and traffic interruptions, which were not evaluated as part of this work. Note that the exact location and size of the existing non-potable pipeline is unknown because construction drawings of the system were unavailable at the time of writing this report. Further data collection should be conducted in coordination with BWS if this COA is advanced.

Alternative 1

Connection to the non-potable pipeline system near Halawa Reservoir would require [redacted] (b)(3)(A) The buried pipeline for this alternative is presented on Figure 2-22 as a green line connecting Adit 3 to the BWS line. Public and private easements would likely be required for this alternative depending on the exact alignment that is ultimately selected.

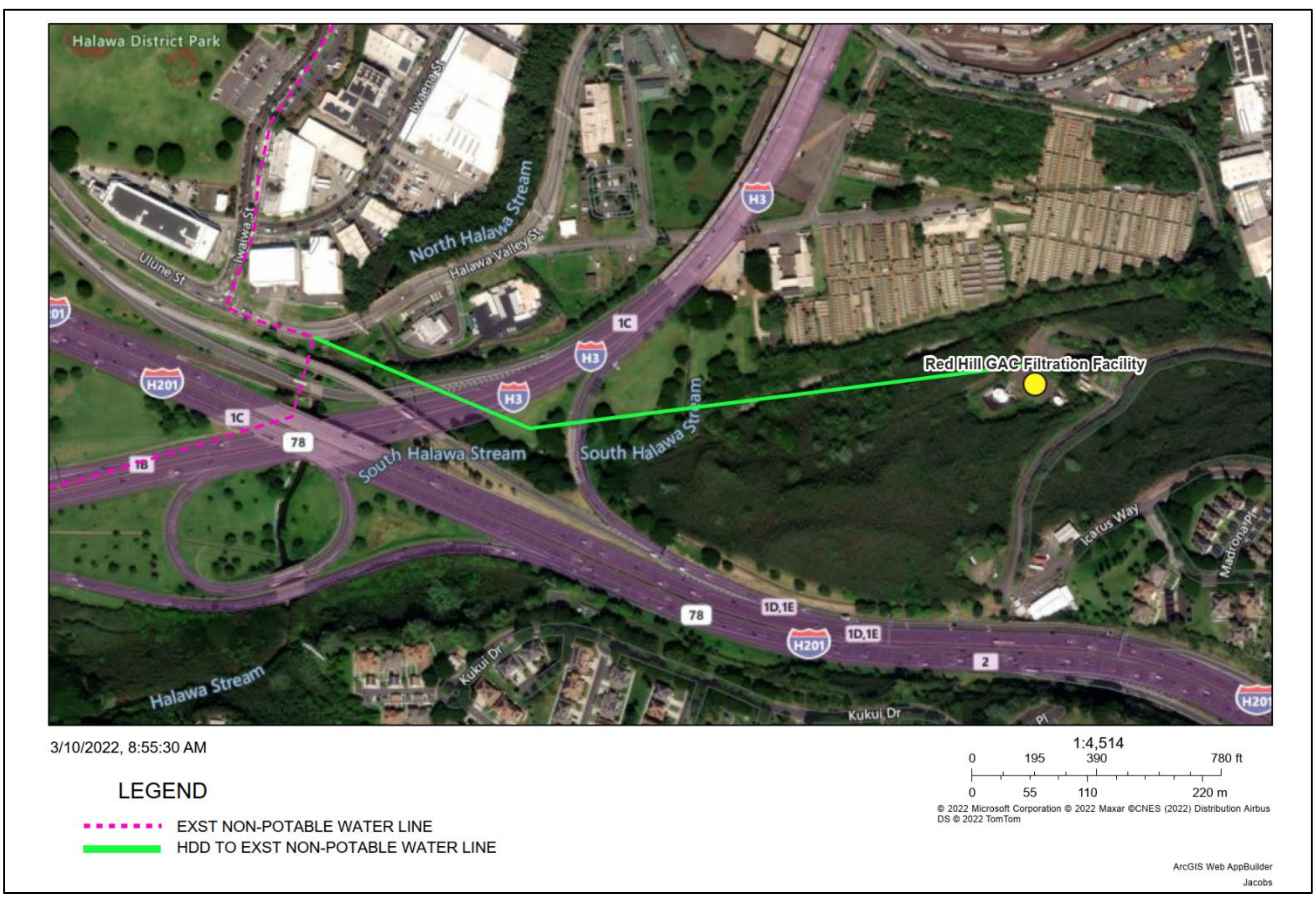

Figure 2-22. COA 4 Alternative 1 Buried Pipelines Map

Alternative 2

[redacted] (b)(3)(A). Trenchless pipeline construction under H1 may be required depending on the exact location of the existing pipeline. Public easements would likely be required for this alternative.

[redacted] (b)(3)(A)

Figure 2-23. COA 4 Alternative 2 Buried Pipelines Map

Connection to the Navy Marine Golf Course

Providing water to the Navy Marine Golf Course would be accomplished by connecting to an existing water pipe that fills the golf course's main irrigation pond (Figure 2-24). Connection to the existing water pipe would be downstream of the reduced pressure backflow preventer that prevents backflow from the golf course to the BWS potable water system. A combination of open-cut and trenchless pipeline construction would likely be required. The existing connection to the BWS potable water supply would be maintained as an emergency backup. Public easements would likely be required for this alternative.

Figure 2-24. COA 4 Main Pond Buried Pipelines Map

2.7 COA 5 – Combination of Aquifer Recharge and Other COAs

2.7.1 Water Users and Usage

Water users for COA 5 will be DoD irrigation users, and the total usage for the irrigation portion of the COA will match that of COA 2 and COA 4. COA 5 is unique because the water not used for irrigation would be used for aquifer recharge, resulting in a total usage of up to 4.6 mgd of filtered effluent water.

2.7.2 Screening Recommendations

No preliminary screening was conducted and this COA should continue to be explored.

2.7.3 COA Definition

This COA would include reinjection near Adit 2 for the Harbor Tunnel (COA 3) and provide water to DoD and/or public users via one of two options (Figure 2-25):

- Option 1 (COA 5a): Connecting to existing BWS pipeline (incorporating COA 4)
- Option 2 (COA 5b): Pipeline routed through Harbor Tunnel and new irrigation line (incorporating COA 2)

[redacted]

Regardless of the option selected, this COA would use the full amount of water discharged from the filtration facility, up to 4.6 mgd.

[redacted] (b)(3)(A)

Figure 2-25. COA 5 System Overview Map Showing All Options

2.7.3.1 Option 1 (COA 5a) – Combination of Aquifer Recharge (COA 3) and Connecting to BWS Non-potable Pipeline (COA 4)

Under this combination, only one injection well would be constructed near Adit 2 of the Harbor Tunnel. Approximately 12,600 feet of exposed piping would be routed through Harbor Tunnel, to Adit 2. At Adit 2, an additional 500 feet of buried piping would be required to reach a suitable location for the injection well. In addition, approximately 10,500 feet of exposed piping would be routed from Adit 3 through Harbor Tunnel to reach the location where the pipeline would exit the tunnel (the location where BWS pipeline crosses Harbor Tunnel). An additional 1,000 feet of buried piping would be needed to connect to the BWS pipeline and to connect the BWS pipeline to the Navy Marine Golf Course.

2.7.3.2 Option 2 (COA 5b) – Combination of Aquifer Recharge (COA 3) and New Piping to DoD Users (COA 2)

Under this combination, only one injection well would be constructed near Adit 2 of the Harbor Tunnel. Two approximately 12,600-foot lengths of exposed 8-inch piping would be routed through Harbor Tunnel to Adit 2. At Adit 2, an additional 500 feet of 10-inch buried piping would be required to reach a suitable location for the injection well. In addition, an additional 15,000 feet of 12-inch and 8-inch buried piping would be required to reach DoD users. Additional pipeline will be required to extend the service to include Mamala Bay Golf Course or other irrigated areas (see the notation for Conveyance Line – Secondary Alignment on Figure 2-25).

2.7.3.3 Screening Recommendations

Table 2-8 presents COA 5 screening recommendations.

Table 2-8. COA 5 Screening Recommendations
Combination of Aquifer Recharge and Public/DoD Uses

Description	Recommendation
Reinject and connect to BWS non-potable system to convey water to Navy Marine Golf Course and HNL Airport	***Explore*** – shortest construction implementation time; high use (4.6 mgd)
Reinject and new pipe routed in Harbor Tunnel, exit Adit 1, convey water to Navy Marine Golf Course and Injection well	***Explore*** – high use (4.6 mgd); all piping on DoD property reduces risk

Notes:

Defer = less promising option that could be revisited
Explore = most promising option

2.8 COA Summary

Table 2-9 summarizes the estimated flow diversion and pipeline lengths for each COA recommended for further exploration.

Table 2-9. COA Flow and Pipeline Summary

COA	Name	Estimated Flow (mgd)	Exposed Piping (feet)	Buried Piping (feet)
1	Public/Private Entity and Off-Base DoD Use of Effluent Water	1 to 2	[redacted] (b)(3)(A)	[redacted] (b)(3)(A)
2	DoD Use of Effluent Water	1 to 2	[redacted] (b)(3)(A)	[redacted] (b)(3)(A)
3	Aquifer Recharge	Up to 4.6	[redacted] b)(3)(A)	[redacted] (b)(3)(A)
4	Partner with BWS to Use Existing Non-potable Pipeline	1 to 2	[redacted] (b)(3)(A)	[redacted] (b)(3)(A)
5a	Aquifer Recharge and Connecting to BWS Non-potable Pipeline	Up to 4.6	[redacted] (b)(3)(A)	[redacted] (b)(3)(A)
5b	Aquifer Recharge and New Piping to DoD Users	Up to 4.6	[redacted] (b)(3)(A)	[redacted] (b)(3)(A)

Note:

Piping distances are approximate

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3.0 Regulatory and Permitting Considerations

This section identifies the significant regulatory and permitting considerations for the COAs, which are summarized in Table 3-1. They do not identify all permits that will be required, but instead focus on those that typically have long lead times and extensive review and approval processes. For example, compliance with National Environmental Policy Act (NEPA) requirements under a categorical exclusion (CATEX) versus an environmental assessment (EA) or an environmental impact statement (EIS) is a significant consideration. Requirements under a CATEX can mean conducting consultations and obtaining concurrence from agencies in an abbreviated and accelerated timeframe (as little as 6 to 9 months). Pre-planning (for example, initial surveys and data evaluation) and the decision to pursue an EA or EIS with associated consultations (such as cultural, natural resources, water, and similar elements) may require a longer period of time (with various timeframes for pre-planning followed by 1 year for an EA and 2 years for an EIS). Less significant requirements or permits, such as obtaining a Navy Department of Public Works Excavation Permit or notifying the Hawaii Utility Notification Center (that is, One Call), are not included in this section because they are not anticipated to require extensive lead time, reviews, and approvals. It cannot be emphasized enough that the Navy's ability to obtain the listed permits is a critical path for this project; this is further discussed in Section 4.

3.1 NEPA Department of Navy Categorical Exclusions

Regulations for implementing NEPA are included in 40 *Code of Federal Regulations* [CFR] Parts 1500-1508. NEPA requires federal agencies to assess the environmental impacts of proposed actions prior to making decisions. A federal action or undertaking may be "categorically excluded" from a detailed environmental analysis (such as an EA or EIS) when the federal action normally does not have a significant effect on the human environment (40 CFR 1508.4). Federal agencies, in consultation with the Council on Environmental Quality (CEQ), develop agency-specific CATEXs. There are 49 Navy-specific CATEXs (32 CFR 775.6(f)); 5 of those 49 Navy-specific CATEXs—32 CFR 775.6(f)(14, 27, 32, 33, and 35)—appear to be applicable to the COAs.

3.1.1 Requirement

The Navy would need to determine and document the basis for the CATEX(s). The potentially applicable CATEXs include the following:

- *32 CFR 775.6(f)(14) Alterations of and additions to existing buildings, facilities, and systems (for example, structures, roads runways vessels, aircraft, or equipment) when the environmental effects will remain substantially the same and the use is consistent with applicable regulations.*
- *32 CFR 775.6(f)(27) Minor land acquisitions or disposals where anticipated or proposed land use is similar to existing land use and zoning, both in type and intensity.*
- *32 CFR 775.6(f)(32) Grants of license, easement, or similar arrangements for the use of existing rights-of-way or incidental easements complementing the use of existing rights-of-way for use by vehicles (not to include significant increases in vehicle loading); electrical, telephone, and other transmission and communication lines; water, wastewater, storm water,*

and irrigation pipelines, pumping stations, and facilities; and for similar utility and transportation uses.

- *32 CFR 775.6(f)(33) New construction that is similar to or compatible with existing land use (that is, site and scale of construction are consistent with those of existing adjacent or nearby facilities) and, when completed, the use or operation of which complies with existing regulatory requirements (for example, a building within a cantonment area with associated discharges and runoff within existing handling capacities). The test for whether this CATEX can be applied should focus on whether the proposed action generally fits within the designated land use of the proposed site.*
- *32 CFR 775.6(f)(35) Acquisition, installation, modernization, repair, or operation of utility (including, but not limited to, water, sewer, and electrical) and communication systems (including, but not limited to, data processing cable and similar electronic equipment) that use existing rights of way, easements, distribution systems, and facilities.*

3.1.2 Analysis

CATEXs may be applicable because all COAs would do the following:

- Require easements or arrangements for the use of existing rights-of-way, such as Moanalua Tunnel, Red Hill Tunnel, or existing rights-of way along H1, Kamehameha Highway, or City and County owned streets and would complement the utilities that currently exist within the right-of-way (40 CFR 1508.4(f)(32))
- Result in new construction similar to and compatible with existing land use as a utility corridor (40 CFR 1508.4(f)(33))
- Require acquisition, installation, and operation of utility systems (for example, water conveyance piping) that use existing rights-of-way, distribution systems, and/or facilities (40 CFR 1508.4(f)(35))

If a CATEX is not applied, then an EA/Finding of No Significant Impact (FONSI) or EIS/Record of Decision (ROD) would be needed, which would require additional time to plan for and subsequently prepare, review, and approve.

3.2 Hawaii Environmental Protection Act

The Hawaii Environmental Protection Act (HEPA) (Hawaii Revised Statutes [HRS] 343) is similar to NEPA and requires agencies to prepare an EA/FONSI or EIS/ROD for actions that may adversely impact the environment. Hawaii Administrative Rules (HAR) 11-200.1 further describes the requirements to implement HRS 343.

3.2.1 Requirement

An EA is required for actions that propose the use of state or county lands or the use of state of county funds (HRS 343-5).

Construction within the existing right-of-way and interconnections with State and City infrastructure that is limited to the installation and improvement, renovation, construction, or development of infrastructure within an existing right-of-way or highway is potentially exempt from HRS 343 (HAR 200.1-14 through 17 and HAR 200.1-31).

3.2.2 Analysis

Although the Navy will be undertaking the action, COA 1, COA 3, COA 4, COA 5a, and COA 5b will require coordination with State and County agencies for permits and/or the use of State and City and County of Honolulu right-of-way and utility interconnections and improvements to existing infrastructure that would result in some expenditure of State or City funds that typically trigger HEPA requirements. However, HEPA does appear to provide some flexibility, similar to the NEPA CATEXs (HRS 343-5).

When a federal agency (such as the Navy) determines that a proposed action is exempt from NEPA, the state or county agency may consider the federal exemption in making its determination on whether the proposed action is also exempt from HEPA (HAR 11-200.1-31(2)).

Some permits (such as the UIC permit required for COA 3, COA 5a, and COA 5b) are subject to public hearing, which may trigger more extensive requirements as part of the permit review and approval process but may also trigger additional requirements to satisfy HEPA. The Navy would need to determine and document the applicability of the NEPA CATEX and HEPA applicability. It is also strongly advised that the Navy consult with the Hawaii Office of Environmental Quality (HOEQC) on the applicability and opportunities to synchronize NEPA and HEPA requirements.

3.3 Federal Highway Administration and State of Hawaii Department of Transportation

The Federal Highway Administration (FHWA) and HDOT review and permit work that will impact state highways.

3.3.1 Requirement

HDOT review, approval, and issuance of a permit is required for work that will disturb state highways (HAR 15-264-6). The permit required for construction is referred to as an HDOT Permit to Perform Work Upon State Highways.

3.3.2 Analysis

COA 1, COA 4, and COA 5a cross State-owned highways and interstate freeways that require an HDOT Permit to Perform Work Upon State Highways. During preliminary discussions, HDOT mentioned that any work within the interstate freeways (for example, Moanalua Freeway and H1) would also require consultation with the FHWA and that consultation could extend the time required to process and issue the permit. It is assumed that the Navy would be able to help facilitate expedited reviews from FHWA because of the highly publicized and politicized nature of any project associated with Red Hill.

3.4 City and County of Honolulu Permits

3.4.1 Requirement

COA 1, COA 4, and COA 5a will require several City and County of Honolulu permits as described in the Revised Ordinances of Honolulu (ROH).

3.4.2 Analysis

The following permits are anticipated to be required from the City and County of Honolulu Department of Planning and Permitting (DPP):

- Trenching Permit: Required for intrusive work in City streets unless covered by a building permit.
- Grading Permit: Required if more than 50 cubic yards are excavated or filled.
- Stockpiling Permit: Required for stockpiling more than 100 cubic yards unless covered by a grading permit and considered incidental to grading.
- Building Permit: Required for pipeline construction and interconnections.

On other high-profile public projects, the DPP has required engineering to be 100 percent complete prior to submittal. If DPP requires 100 percent engineering for any of the COAs, the overall schedule would extend out another 8 to 11 months, and the review and approval process would not begin until engineering is completed.

3.5 State of Hawaii Department of Health Permits

The following HDOH permits may be required:

- NPDES Individual Permit Authorizing Discharges of Storm Water Associated with Construction Activities
- Underground Injection Control (UIC) Permit

3.5.1 Requirement

Coverage under the NPDES General Permit Authorizing Discharges of Stormwater Associated with Construction Activities is required for activities that disturb 1 acre or more of total land area. NPDES permit coverage is also required for activities that disturb less than 1 acre of total land area that are part of a larger common plan of development or sale if the larger common plan will ultimately disturb 1 acre or more of total land area [40 CFR 122.26(b)(15) and HAR 11-55-34.02(b)(2) and Appendix C].

A UIC permit is required for construction (HAR 11-23-07) and operation (HAR 11-23-11) of injection wells.

3.5.2 Analysis

NPDES Permit: Coverage under the NPDES construction stormwater general permit is required for all COAs with the exception of COA 4, because these options will cumulatively disturb more than 1 acre across contiguous and non-contiguous areas. Coverage can be obtained by submitting a HDOH Clean Water Branch Notice of Intent form and complying with permit conditions.

UIC Permit: For COA 3, COA 5a, and COA 5b, a permit is required to install the injection well and a separate permit is needed to operate and use the well. A public hearing may be required if there is significant public interest. Injection wells will be permitted to be constructed, modified, and operated. Injection well(s) would be classified as Class V Subclass B salt water intrusion barrier injection wells, which inject non-polluting fluids into any geohydrologic formation, including underground sources of drinking water to prevent the intrusion of salt water into fresh water, if they inject water of equal or lesser chloride concentration as that portion of the aquifer into which injected (HAR 11-23-06(b)(3)(D)).

The 9- to 12-month timeline includes submittal of the general application 6 months before the anticipated date of injection well construction and 3 to 6 months to accommodate evaluation, corrections, public notice, and inspection. An approval to construct and test the injection well is issued by departmental letter after the application is satisfactorily processed.

Construction of an injection well is followed by injection testing. Injection test results, geologic logs, and other information as requested must be submitted collectively as a final engineer/geologist report. A UIC permit to operate the injection well is issued after the final report is satisfactorily completed. (The UIC permit contains monitoring and reporting requirements and permit conditions.)

During preliminary discussions, the HDOH Safe Drinking Water Branch (SDWB) UIC Section said that they anticipated there would be significant public interest and, as a result, a public hearing would be required. They also mentioned that if the injection wells were going to be classified as Class V Subclass B salt water intrusion barrier wells, they may request extensive data to verify that salt water intrusion is a problem in the area that the wells would be installed. If the data does not exist, preliminary borings, wells, and groundwater data may need to be collected and included to support the permit application.

3.6 Property Acquisitions/Approval

Depending on which COA is selected, property acquisitions including easements would need to be negotiated and recorded. The 6- to 12-month timeline provided in Table 3-1 assumes that separate rights-of-entry for pre-construction and construction could be prepared and executed to facilitate access concurrent with formal property acquisitions for easements. Because of the potential multiple stakeholders, including other government agencies, the time needed for property acquisition could easily extend beyond 12 months.

3.7 Board of Water Supply Rules and Regulations

3.7.1 Requirement

Connections to the BWS system piping will require BWS review and approval according to the Rules and Regulations Chapter I, Section 1. BWS restricts waste disposal facilities within the No-Pass Zone per Rules and Regulations, Chapter III, Section 3-301. The No-Pass Zone is the area *makai* of the No-Pass line; waste disposal areas are allowed *makai* of the No-Pass line.

3.7.2 Analysis

COA 1 and COA 4 will require connections to BWS piping, which will require BWS review and approval of the engineering, construction, and operation. However, during preliminary discussions, the BWS told the Navy to prioritize and exhaust all options related to COA 2 prior to further evaluating COA 1 and COA 4.

For COA 3, because the injection wells are not associated with a waste disposal facility, the wells would not be restricted. However, BWS should be consulted to verify the interpretation and in case of concerns related to the injection wells.

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[redacted]

Table 3-1. Regulatory and Permitting Considerations for the COAs

COA	Name	NEPA CATEX[a] and EA/EIS[b]	HEPA CATEX and EA/EIS	FHWA Approvals	HDOT State Highway Permit	CCH-DPP Building and Civil Engineering Permits	CCH DTS Street Usage	HDOH CWA NPDES Form C	HDOH SDWB UIC	Property Acquisition/ Agreements	BWS Approval	Total Estimated Time Required (months)[c]
	Time Required (months)	**6 to 9[a] 12 to 24[b]**	**6 to 9[a] 12 to 24[b]**	**6 to 12**	**6**	**9**	**3**	**1 to 3**	**9 to 12**	**6 to 12**	**6 to 1**	
1	Public/Private Entity and Off-Base DoD Use of Effluent Water	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	12
2	DoD Entity Use of Effluent Water	Yes	No	No	No	No	No	No	No	No	No	12
3	Aquifer Recharge	Yes	Yes	No	No	No	No	Yes	Yes	No	No	12
4	Partner with BWS to Use Existing Non-potable Pipeline	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	12
5	Combination of Aquifer Recharge and Other COAs (Option 1/ Option 2)	Yes/Yes	Yes/Yes	Yes/No	Yes/No	Yes/No	Yes/ No	Yes/Yes	Yes/Yes	Yes/No	Yes/No	12

Table 3-1. Regulatory and Permitting Considerations for the COAs

[a] CATEX with some Section 7 Endangered Species Act (ESA) consults

[b] No CATEX assumes an EA/FONSI timeline of 12 months and an EIS/ROD timeline of 24 months. These efforts do not include pre-planning that may be associated for these actions and involve Section 106 National Historic Preservation Act and/or some ESA consults (CEQ 2020).

[c] Assumes a CATEX will be applied and that permits will occur concurrently. The total time is the estimated time for the longest duration permit or requirement.

Notes:

CCH = City and County of Honolulu
CWA = Clean Water Act
DTS = Department of Transportation Services
No = not applicable to COA
Yes = applicable to COA

4.0 COA Schedule and Cost

4.1 Schedule

Table 4-1 presents the preliminary schedule. The total estimated time assumes that these COAs (the undertakings) qualify for a CATEX (to be confirmed by the Navy), which will reduce the NEPA requirements. Confirming that the COAs qualify for a CATEX would potentially reduce the timeframes for obtaining NEPA concurrence to approximately 6 to 9 months versus 12 to 24 months if a full NEPA evaluation is required. If a full NEPA evaluation is required, the timelines may also include pre-planning, which can take an additional 12 to 36 months. It cannot be emphasized enough that the Navy's ability to confirm the appropriateness of the CATEX and obtain the listed permits would be a critical path for the project schedule.

It is also important to note that considerable public interest is expected because of the very public-facing Red Hill situation. As a result, there is the potential for additional delays that are difficult to predict.

Lastly, the schedule assumes that permit applications can be submitted with preliminary engineering plans without fully defining the work. Preliminary engineering activities (up to 30 percent engineering) are anticipated to require about 3 months. There is a risk that agencies will require the engineering piece to be fully completed prior to submittal of the application. For example, the City and County of Honolulu DPP recently required engineering to be 100 percent complete prior to submittal on other public projects. Having to wait to submit the permit application until engineering is 100 percent complete would push back the schedule for obtaining the permit and the overall schedule for completion of the selected COA.

The estimate timeline for engineering is dependent on the COA because some are more complex than others. Final engineering activities (30 percent to 100 percent engineering) are expected to require 8 months for COA 3 and COA 4 and 10 to 11 months for COA 1, COA 2, and COA 5. Navy review is assumed to occur at the 30 percent and 90 percent engineering milestones and is scheduled to last 1 month.

4.2 Cost Estimate

A rough order of magnitude (ROM) capital cost estimate is presented in Table 4-2 for various project components, including Adit 3 site improvements, tunnel piping, buried piping, and injection wells. The project team followed AACE International Level V estimate methodologies to achieve an accuracy of -50 percent on the low side and +100 percent on the high side. At the time of developing this ROM capital cost estimate, the COA definition was less than 2 percent. This information can be used for strategic planning and conceptual screening. Appendix E presents the assumptions and limitations of this cost estimate.

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Table 4-1. Preliminary Project Schedule

COA	Description	Activity	Year 1												Year 2											
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	Public/Private Entity and Off-Base DoD Use of Effluent Water	Permitting																								
		Engineering																								
		Construction																								
2	DoD Entity Use of Effluent Water	Permitting																								
		Engineering																								
		Construction																								
3	Aquifer Recharge	Permitting																								
		Engineering																								
		Construction																								
4	Partner with BWS to use Existing Non-potable Pipelines	Permitting																								
		Engineering																								
		Construction																								
5	Combination of Aquifer Recharge and Other COAs	Permitting																								
		Engineering																								
		Construction																								

Note:

Assumes a CATEX will be applied and that permits will occur concurrently with engineering. The total time is the estimated time for the longest duration permit or requirement. Having to wait to submit the permit applications until engineering is 100 percent complete would push back the schedule for obtaining the permit and the overall schedule for completion of the selected COA.

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Table 4-2. Rough Order of Magnitude Capital Cost Estimate

Project Component	COA 1	COA 2	COA 3	COA 4	COA 5A	COA 5B
Adit 3 Site Improvements	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Tunnel Piping	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Buried Piping	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Injection Wells	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Total	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Notes:

This represents an AACE Level V Cost Estimate accuracy of -50% on the low side and +100% on the high side.

M = million

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5.0 Next Steps for Advancing Conceptual Engineering of COAs

This section describes some immediate steps for advancing the conceptual engineering of the COAs, divided between true engineering efforts and permitting activities. The list of items included here is preliminary and will need to be updated as the COAs become more defined. These recommendations also will improve the ability to rank and score the COAs. These activities are recommended to occur before 30 percent engineering starts.

5.1 Engineering Activities

5.1.1 Adit 3 Improvements (all COAs)

- **User identification:** Firm commitment of potential users of the water needs to be finalized for each COA to clearly define flow rate and pressure requirements because this impacts most infrastructure that would be required (such as pump and pipe sizing). In addition, better definition of daily and hourly flow rates for each user is needed when the project is advanced to support.
- **Site plan development**: Development of a detailed site plan is required to accurately describe proposed improvements at the Adit 3 site. A topographic survey of the site with base map development is necessary. Geotechnical investigations may be required to support engineering of concrete foundations and buried pipeline engineering. Potholing at strategic locations may be needed to identify locations of suspected buried obstructions.
- **Pump station engineering:** Advancement of the pump station engineering is necessary when flow and pressure requirements for each COA have been more firmly established. Electrical, structural, instrumentation and control, and piping design to support the pump station engineering will also need to be advanced.

5.1.2 Exposed Piping (all COAs)

- **Pipe routing:** Detailed engineering plans of the pipe routing through Adit 3 (all COAs), Harbor Tunnel (COA 2, COA 3, COA 4, and COA 5), and Moanalua Tunnel (COA 1) is required to identify the appropriate routes to avoid existing obstructions while not interfering with ongoing operational activities within the tunnels. Constructability of the proposed routes also requires consideration.
- **Pipe support:** Engineering and selection of the type of pipe support provided will depend on specific tunnel characteristics, nearby obstructions, available clearance, and pipe number and size.
- **Wall penetrations:** Engineering details for pipe penetrations through the tunnel wall (COA 4) and through tunnel bulkhead walls (all COAs) require development.

5.1.3 Buried Piping (all COAs)

- **Pipeline routing:** Although preliminary routes have been identified for the buried piping, a more detailed alternative pipeline routing analysis will be required to support NEPA activities.
- **Utility locates:** A detailed review of all available utility mapping should also be conducted to ensure all available information has been collected and reviewed. Detailed investigations of

utility locations should be conducted near proposed pipeline routes where as-built information is lacking.

- **Potholing:** Potholing at strategic locations may be needed to identify the exact locations and configurations of specific utilities.

5.1.4 Injection Well (COA 3 and COA 5)

- **Test well:** Install a test well at the recommended injection location screened in the target aquifer to confirm subsurface stratigraphy and aquifer characteristics.
- **Hydraulic testing:** Perform hydraulic testing to obtain site-specific estimates of the basalt aquifer transmissivity to support improved estimates of the quantity of water that could be injected into each injection well.
- **Groundwater compatibility analysis:** Collect groundwater samples and perform water quality analyses to characterize the geochemical conditions within the target aquifer. Compare the water quality of the post-treatment effluent with the native groundwater quality to determine whether any physical and/or geochemical adverse reactions are anticipated during injection operations.
- **Hydraulic modeling:** Develop a three-dimensional groundwater flow model to simulate the proposed injection program; simulation results will provide estimates of the groundwater level response to the injection well system long-term operations and support estimates of optimal well spacing.
- **Develop site plan:** Based on drilling, hydraulic testing, and numerical modeling results, develop a detailed site plan to support further implementation of effluent injection option.

5.2 Permitting Plan

A permitting plan should be developed to identify all applicable permits and required documentation. Development of this plan will require regulatory meetings, negotiations, and correspondence.

The following are recommendations to the Navy to streamline and expedite the permitting process. In the interest of time, the Navy should determine the applicability of and its intent to seek CATEXs under NEPA and/or HEPA and engage in discussions with HOEQC on the applicability and opportunities to synchronize NEPA and HEPA requirements. Once in agreement with HOEQC on the NEPA and HEPA requirements, it is recommended the Navy engage stakeholders in multiple platforms and settings to allow for more effective information sharing and collaboration. Preliminary discussions with a few of the agencies that would review, approve, and issue permits, such as HDOT, HDOH, and BWS, provided initial insight into the agencies' thoughts on the beneficial use of the effluent which were generally met with some resistance. However, the discussions were not able to identify meaningful specific concerns or requirements.

More effective methods to obtain feedback can include the following types of meetings:

- Large stakeholder meetings to share general progress and various agency concerns to ensure consistent and transparent communication and streamline requirements to avoid potential conflicts amongst various agency requirements
- Separate meetings and workshops to discuss individual COAs and related agency and permit requirements
- Smaller meetings with individual agencies to work through specific concerns and permit requirements

The Navy could also request support from federal, state, and county leadership (such as the FHWA, the Hawaii congressional delegation, the governor, mayor, and permitting agency directors) to help streamline and harmonize the permit review and approval process.

5.3 Cost Estimate

The capital cost estimate should be updated after the conceptual engineering is advanced through completion of the above activities. The capital cost estimate should be advanced from a Class 5 estimate to a Class 4 estimate with an expected accuracy of plus 50 percent on the high side and minus 30 percent on the low side.

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6.0 Recommendations

Given the preliminary nature of the COA development process, including data gaps and limited regulatory agency and end user interactions, this report presents potentially viable alternatives for beneficial use of the filtered effluent water. However, this report should not solely be relied upon for COA selection.

Some immediate next steps for advancing the conceptual engineering to rank and score the COAs include further interactions with infrastructure owners, local agencies, and potential end users, as well as further engineering and permitting analyses. This work would also support the development of an EA or EIS if that is determined to be the most appropriate NEPA action.

6.1.1 Define Evaluation Criteria

Evaluation criteria should be collectively determined by a project team, but at a minimum should include the following:

- Implementation feasibility
- Schedule
- Capital cost
- Environmental sustainability (for example, energy use, footprint requirements, and land disturbance)
- Daily flow rate diverted for beneficial use
- Projected time the Navy can provide the resource (filtered effluent water); is the time sufficiently long enough to justify the cost of implementing, both for the Navy and potential users?
- Potential risks associated with the COA (for example, regulations, permitting, engineering and construction, operational complexity, and political)
- Other criteria as established

The scoring weights assigned to each of the criteria, which correspond to its relative importance, should be collectively determined by a project team. A workshop may be held to better understand the relative importance of each criterion and to build consensus among the team on the weights selected. All meetings and decisions should be documented for an administrative record. In addition, NEPA professionals should be included early in this process for guidance and support.

6.1.2 Score and Rank COAs

Quantitative scores are recommended to be developed for each evaluation criterion determined for a COA. It would be anticipated that some evaluation criteria scores would be weighted (for example, implementation feasibility). These scores would then be calculated for each COA based on the data gathered and the analysis methodology presented in Part 2 of the project (COA definition). It is anticipated that more data will be populated by the Navy for a full assessment. The weights for each criterion would then be applied to develop a weighted score for each criterion and the total weighted score for a COA. The total weighted scores for each COA would be compared to rank the COAs.

A preliminary ranking of COAs is provided in Table 6-1 based on the information collected and analysis conducted for this interim report. The rankings are preliminary and should be revisited through development of quantitative scores as described here after the COAs are better defined and more complete stakeholder engagement is possible.

Table 6-1 summarizes the estimated flow diversion, pipeline length, regulatory and stakeholder alignment difficulty, order of magnitude capital cost, and significant implementation challenges for each COA. COAs are ranked in the table from top to bottom, with the first row being most preferable and the last row being least preferable. The ranking is based on numerous factors such as cost, anticipated opposition from private and public entities, permitting challenges, and projected water use. COA 4 was ranked highest because it provides a significant amount of water use at the lowest cost and in the shortest duration possible through the use of existing infrastructure. In addition, the regulatory and permitting process is expected to be easier than most other COAs (except COA 2). One significant challenge associated with this COA is that the BWS indicated to the Navy during preliminary discussions that the Navy should maximize the use of the water on Base property before using BWS infrastructure to convey water elsewhere. If BWS is unwilling to allow use of their infrastructure after future discussions, COA 2 is the next highest ranked COA because significant water use is still possible and limited engagement with outside stakeholders is needed as all construction and water use would be on DoD property. However, long pipeline lengths are required for this COA, resulting in much higher costs and a longer construction period.

Table 6-1. COA Summary and Ranking

Rank	COA Number and Name	Estimated Use (mgd)	Exposed Piping (feet)	Buried Piping (feet)	Regulatory and Stakeholder Alignment Difficulty	Order of Magnitude Capital Cost Estimate	Significant Implementation Challenges
1	COA 4: Partner with BWS to Use Existing Non-potable Pipeline	1 to 2	[redacted]	[redacted]	Medium	[redacted]	Requires use of BWS infrastructure (existing non-potable pipeline) to convey water. During preliminary discussions, the BWS told the Navy to prioritize and exhaust all options related to COA 2 prior to selecting COAs that use BWS infrastructure.
2	COA 2: DoD Entity Use of Effluent Water	1 to 2	[redacted]	[redacted]	Low	[redacted]	Significant length of buried pipeline required, resulting in high capital cost and longer construction duration.
3	COA 1: Public/Private Entity and Off-Base DoD Use of Effluent Water	1 to 2	[redacted]	[redacted]	Medium-High	[redacted]	• Requires use of BWS infrastructure (Moanalua Tunnel) to route a portion of the required piping. See COA 4 for BWS coordination challenges. • Requires use of water at Honolulu Country Club to exceed 0.5-mgd minimum water use requirement; Honolulu Country Club has initially indicated that they do not want to use the water. • Buried piping through non-DoD property increases permitting requirements and private/public coordination efforts.
4	COA 3: Aquifer Recharge	Up to 4.6	[redacted]	[redacted]	High	[redacted]	• Requires a UIC permit, which is subject to a public hearing and, given the opposition by some public and private entities, may trigger more extensive requirements. • If injection wells are classified as saltwater intrusion barrier wells, HDOH may require extensive data collection to verify that salt water intrusion is a problem.
5	COA 5a: Aquifer Recharge and Connecting to BWS Non-potable Pipeline	Up to 4.6	[redacted]	[redacted]	Very High	[redacted]	• See COA 3 for aquifer injection challenges. • See COA 4 for BWS coordination challenges.
6	COA 5b: Aquifer Recharge and New Piping to DoD Users	Up to 4.6	[redacted]	[redacted]	High	[redacted]	• See COA 3 for aquifer injection challenges. • Significant length of buried pipeline required, resulting in high capital cost and longer construction duration.

Table 6-1. COA Summary and Ranking

Notes:
COAs are ranked from top to bottom from most preferrable to least preferable. COA 4 is most preferable and COA 5b is least preferable.
All flow rates and pipe lengths are approximate.

7.0 References

[redacted] 2021. Personal Correspondence. Email from [redacted] /CIV USN NAVFAC SE JAX FL to [redacted] /CAPE. March 22, 2022.

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Department of the Navy, State of Hawaii Department of Health, and the United State Environmental Protection Agency. 2022. *Red Hill Shaft Recovery and Monitoring Plan.* January.

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Appendix A
Interviews with Potential Water Users

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Meeting: Data Gathering Call with Moanalua Golf Club

Date: February 3, 2022

Project Name: Red Hill Drinking Water Shaft Short and Long Term Effluent Reuse

Project No: REDHIL22

Prepared By: [redacted] (b)(6)

Location: MS Teams

Participants: [redacted] (b)(6) /Moanalua Golf Club
/Jacobs
/Jacobs
/Jacobs
/Jacobs
/NAVFAC
/NAVFAC
/NAVFAC
/NAVFAC

1003 Bishop Street
Suite 1340
Honolulu, HI 96813
United States

T +1.808.943.1133

F +1 808.954.4400

Jacobs.com

Introduction

[redacted] (b)(6) leads the discussion to gather information necessary to understand Moanalua Golf Club's (MGC) water needs and current infrastructure components.

Questions	Answers
What do you use your water for?	MGC uses majority of their water for irrigating the golf course turf. MGC only waters tees and greens, not the fairways.
What is your current water source?	Potable water from Board of Water Supply (BWS).
How much water do you use? Any seasonal demands?	Currently use 40,000 gallons of water per day. Once the new irrigation system is installed, will use 100,000 to 200,000 gallons of water per day. Their usage is not very seasonal.
How are you getting water to your facility?	The system is connected directly to main line running along Ala Aolani Street. Backflow preventer is located along property line adjacent to Ala Aolani Street.
How are you distributing water within your property/business?	The irrigation lines are directly connected to BWS lines.
Any water quality requirements?	No requirements. MGC's turf is the hardy, brackish-resistant Paspalum sp.
Interest in exploring feasibility of utilizing the effluent reuse water?	Yes, interested.

Discussion

- MGC intends to replace their current irrigation system soon. (b)(6) mentions the timing of this new water source and the installation of the new irrigation system should be beneficial for the golf course.
- (b)(6) schedules a site visit to MGC for February 17, 2022, at 3 p.m.

Meeting: Data Gathering Call with Pearl Country Club

Date: February 14, 2022

Project Name: Red Hill Drinking Water Shaft Short and Long Term Effluent Reuse

Project No: REDHIL22

Prepared By: [redacted]

Location: MS Teams

Participants:
[redacted]/Pearl Country Club
[redacted]/Jacobs
[redacted]/Jacobs
[redacted]/Jacobs
[redacted]/Jacobs
[redacted]/NAVFAC

1003 Bishop Street
Suite 1340
Honolulu, HI 96813
United States
T +1.808.943.1133
F +1 808.954.4400
Jacobs.com

Introduction

[redacted] leads the discussion to gather information necessary to understand Pearl Country Club's (PCC) water needs and current infrastructure components.

Questions	Answers
What do you use your water for?	PCC uses majority of their water for irrigating the golf course turf.
What is your current water source?	Water is from a deep well and is tracked by Department of Land and Natural Resources (DLNR). [redacted] did not know the name of the well during the call. PCC reports monthly usage to DLNR.
How much water do you use? Any seasonal demands?	PCC is restricted by DLNR to a 300,000-gallon-per-day limit.
How are you getting water to your facility? How are you distributing water within your property/business?	Half of the golf course is irrigated with a pressure system and the other half is gravity fed from a 90,000-gallon holding tank adjacent to Kaonohi Street. The system is connected directly to main line running along Ala Aolani Street. Backflow preventer is located along property line adjacent to Ala Aolani Street.
Any water quality requirements?	No requirements.
Interest in exploring feasibility of utilizing the effluent reuse water?	Yes, interested.

Discussion

- PCC intends to upgrade their current irrigation system within 12 to 18 months. The upgrades include adding more sprinkler heads, main lines, and controllers. PCC is currently in the feasibility stage and plans to break ground by February 2023.
- [redacted] mentions the timing of this new water source and the installation of the new irrigation system should be beneficial for the golf course.

- [redacted] asks if Navy is willing to supply and build more holding tanks for PCC. [redacted] explains Jacobs/CAPE will investigate the option further.
- [redacted] expresses interests in possibly conducting a site visit to PCC, based on conveyance team's analysis.

Meeting: Data Gathering Call with Walter J. Nagorski Golf Course

Date: February 28, 2022

Project Name: Red Hill Drinking Water Shaft Short and Long Term Effluent Reuse

Project No: REDHIL22

Prepared By: [redacted]

Location: Phone Call

Participants: [redacted]/Walter J. Nagorski Golf Course
/Jacobs

1003 Bishop Street
Suite 1340
Honolulu, HI 96813
United States
T +1.808.943.1133
F +1 808.954.4400
Jacobs.com

Introduction

[redacted] leads the discussion to gather information necessary to understand Walter J. Nagorski Golf Course's (WNGC) water needs and current infrastructure components.

Questions	Answers
What do you use your water for?	WNGC uses majority of their water for irrigating all areas of the golf course.
What is your current water source?	Assumed potable water from U.S. Army Garrison water supply and is monitored by the Directorate of Public Works (DPW).
How much water do you use? Any seasonal demands?	WNGC uses approximately 150,000 gallons per day.
How are you getting water to your facility? How are you distributing water within your property/business?	The U.S. Army Garrison water flows from main backflow preventor to the main pump station then to WNGC. Once on property, the water flows directly to 4-inch main lines, then to 2-inch laterals. The irrigation system is brand new with 400 sprinkler heads.
Any water quality requirements?	No requirement. WNGC uses bermudagrass, which is a hardy species.
Interest in exploring feasibility of utilizing the effluent reuse water?	Yes, interested.

Discussion

- [redacted] mentions historically the current water supply provided by DPW has been free. However, this year WNGC may have to start paying for water due to the island water shortage. DPW is currently monitoring the golf course's usage.
- [redacted] requests assurance that effluent water does not negatively affect the current turf. responds he will investigate the concern further and stated that water quality conditions are being monitored and evaluated.

- (b)(6) [redacted] suggests Jacobs contacts Leilehua Golf Course, which is a sister golf course to WNGC.
- On March 2, 2022, (b)(6) [redacted] informs team that he spoke with (b)(6) [redacted] (Chief Business Operations Officer for U.S. Army Garrison MWR) and she is enthusiastic about the opportunity and would like to be included in further communications.

Appendix B
Field Notes and Photographs

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Jacobs performed a site visit on February 1, 2022, from 8 a.m. to 11 a.m. The purpose of the site visit was to meet with staff who maintain Department of Defense (DoD)-owned properties that could potentially be end users for treated effluent water. In attendance were [redacted]/MWR, [redacted]/MWR, [redacted]/MWR, [redacted]/NAVFAC, [redacted]/NAVFAC, [redacted]/CAPE, [redacted]/Jacobs, [redacted]/Jacobs, and [redacted]/Jacobs. Ten (10) locations evaluated during this site visit, with the following details and general comments for each location noted.

1.0 General Notes

- Backflow preventers are installed at all fields and golf courses. Connections to existing systems will need to connect downstream of existing backflow preventers so that existing potable connection can remain in place.
- Meters are provided at some locations. However, data logs are not maintained by the staff.

2.0 Ward Field

- There is a backflow preventer located at the south end of Ward Field, just west of the bleachers.
- There are four shutoff valves for the field: two are located near the backflow preventer and the other two are on the opposing side of the field near the dugouts.
- A central irrigation computer is used to water the field. The field is irrigated for 4 hours per night.
- The current irrigation system has a pressure rating of 80 pounds per square inch (psi). The sprinkler heads have a minimum 30 psi. However, a pressure of 60 psi is preferred by the maintenance staff.

3.0 Millican Field

- The backflow preventer is in the northwest corner of the field in a gated area that is shared with a sewer lift station.
- Staff mentioned that there is a soil contamination barrier along the field fence line that blocks contaminated oil from entering soil on the field side.
- The field is irrigated for 6 hours per night.

4.0 Quick Field

- Three backflow preventers were identified at this location: one each at the northeast, southwest, and southeast corners.
- Staff noted that there is not enough pressure at this location to support an irrigation system. Staff currently use water cannons to irrigate the field.
- Fields are mostly used for soccer. However, people have been driving their jeeps on the field, so it appears brown for most of the year.

5.0 Mamala Bay Golf Course

- Staff provided as-builts and allowed Jacobs to take photographs of the connections between the Mamala Bay Golf Course irrigation system and the potable main. Plans show connections at two locations, and the system runs in a loop where water is pulled from both connections.
- The existing connections are 6-inch lines that branch from a 12-inch main. Backflow preventers are located along the hedge line of the course.
- A non-functioning pond is located on the north of the course along the roadway. The existing pond is overgrown with foliage and the existing pump system has reoccurring maintenance issues. Staff mentioned that they would like to install a bladder or tank system to retain water at this location.

6.0 Vandenberg Field

This site was not visited due to the minimal water demand that would be required at this location. Staff noted that the field is irrigated manually.

7.0 Hickam Ball Fields (3-plex)

- The Hickam ball fields or 3-plex are not irrigated by Morale, Welfare and Recreation (MWR) staff. MWR only maintains the landscaping work and a separate Public Private Venture (PPV) contractor handles irrigation of the field.
- The backflow preventer is in the center of the three fields. Four valves are in series near the backflow preventer, and each valve controls a separate irrigation system for each of the individual fields. Staff mentioned that the fourth field had been condemned due to contaminated soils.

8.0 Ke’alohi Golf Course

- Staff mentioned that the circuit breaker for the existing pumps could not be located, so a generator needs to be wired to the pump to irrigate the course.
- The course is irrigated from 6 p.m. to 7 a.m. However, this can vary as the course offers night golf.
- The incoming pressure to the pump was read at 68 psi.

9.0 Navy Marine Golf Course

- Two sets of backflow preventers were located along the fence line fronting Kamehameha Highway. The active unit was identified as the one nearest the fairway.
- Staff mentioned that the holding pond takes approximately 8 hours to fill during the day at a rate of 900 gallons per minute.
- The discharge pipe runs diagonally across the 6th hole fairway and discharges into the holding pond.

10.0 Makalapa Park

- The Makalapa area consists of a large field as well as common areas that are irrigated. The main connection point is an aboveground pipe that runs down the side of a hill and enters the ground at a sharp angle, along with several other PVC pipes.
- Staff noted that the system currently serves 32 stations. However, the low pressure only allows for 1 station to be active at a time.

11.0 Gazebos 1, 2, and 3

This field is available for DoD personnel to rent for events and consists of three gazebos spaced across the site. Staff mentioned that sink holes have appeared in the site that are potentially caused by excavation work performed for the nearby Honolulu Authority for Rapid Transportation (HART) rail project. Roundup is sprayed on the site to keep the weeds at bay, and the field is mostly brown.

12.0 Richardson Fields 1, 3, and 6 to 8

This location consists of several different fields in the area. The main backflow preventer was identified near the A-Frame structure along Arizona Memorial Place. There are also two fields located along Kamehameha Highway that are sometimes used for additional parking when Aloha Stadium has overflow from events. Staff indicated that the water systems that are located along Kamehameha Highway would need to be relocated when the State Highway is expanded to add an additional lane. The lines are expected to move 20 feet makai (that is, towards the ocean) of the current location.

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Project Title: **Red Hill Fuel Facility**

Location: DoD-owned Facilities, Oahu, Hawaii

Site Visit Date: February 1, 2022

Ward Field

Photograph 1: Backflow Preventer

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Photograph 2: Location of Backflow Preventer

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Millican Field

Photograph 3: Backflow Preventer

Taken by (b)(6)	Date taken: February 1, 2022

Photograph 4: Backflow Preventer

Taken by (b)(6)	Date taken: February 1, 2022

Millican Field

Photograph 5: Backflow Preventer

Taken by [redacted] (b)(6)	Date taken: February 1, 2022

Photograph 6: Backflow Preventer

Taken by [redacted] (b)(6)	Date taken: February 1, 2022

Millican Field

Photograph 7: Backflow Preventer

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Photograph 8: Backflow Preventer ID Tag

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Quick Field

Photograph 9: Backflow Preventer

Taken by [redacted] (b)(6)	Date taken: February 1, 2022

Photograph 10: Backflow Preventer

Taken by [redacted] (b)(6)	Date taken: February 1, 2022

Quick Field

Photograph 11: Backflow Preventer ID Tag

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Photograph 12: Backflow Preventer

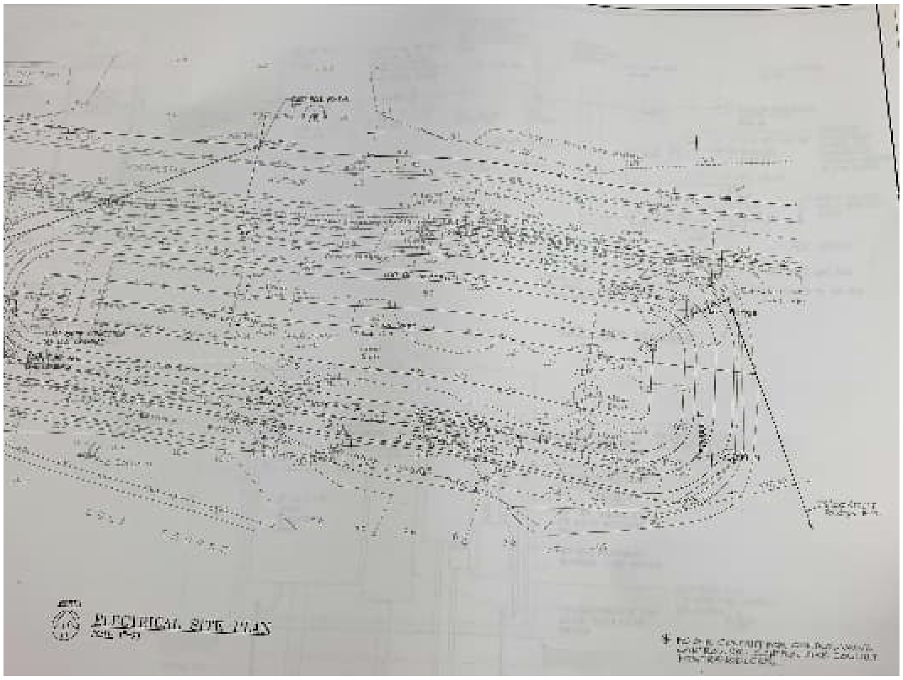
Taken by ((b)(6) [redacted]	Date taken: February 1, 2022

Quick Field

Photograph 13: Backflow Preventer

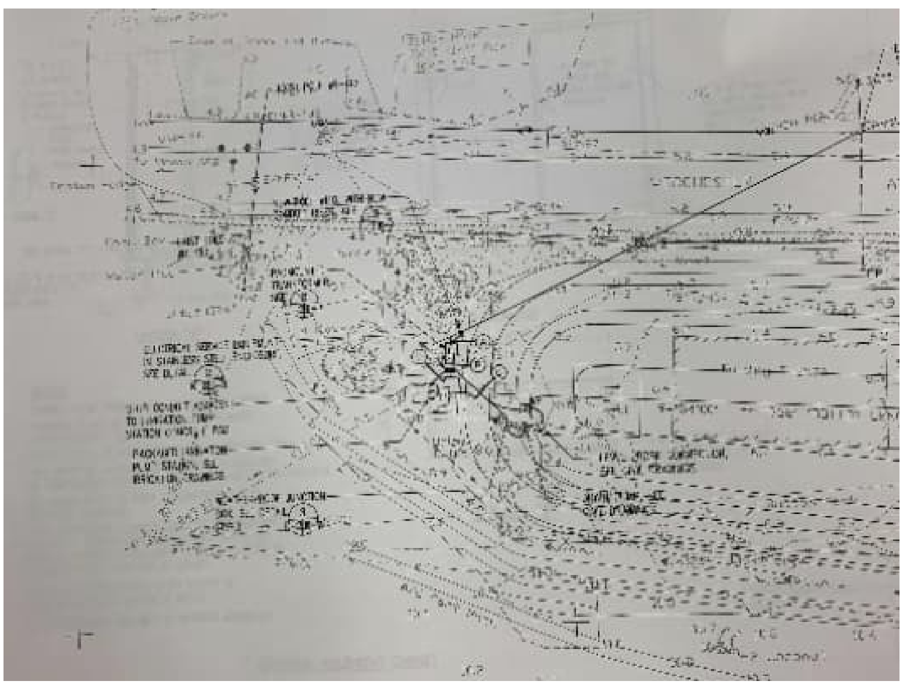
Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Mamala Bay Golf Course



Photograph 14: Golf Course As-built

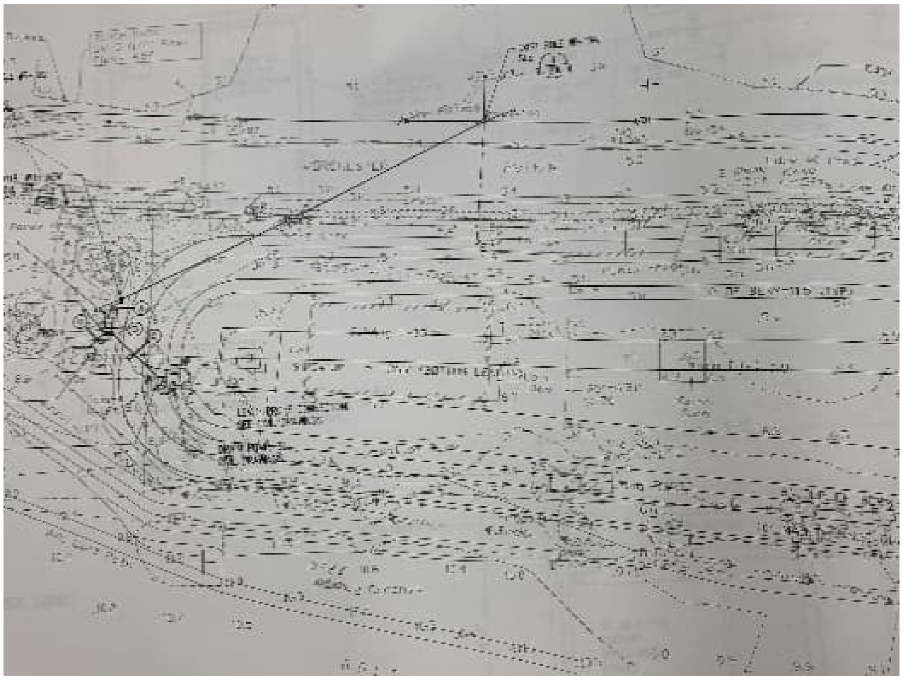
Taken by (b)(6) [redacted]	Date taken: February 1, 2022



Photograph 15: Golf Course As-built

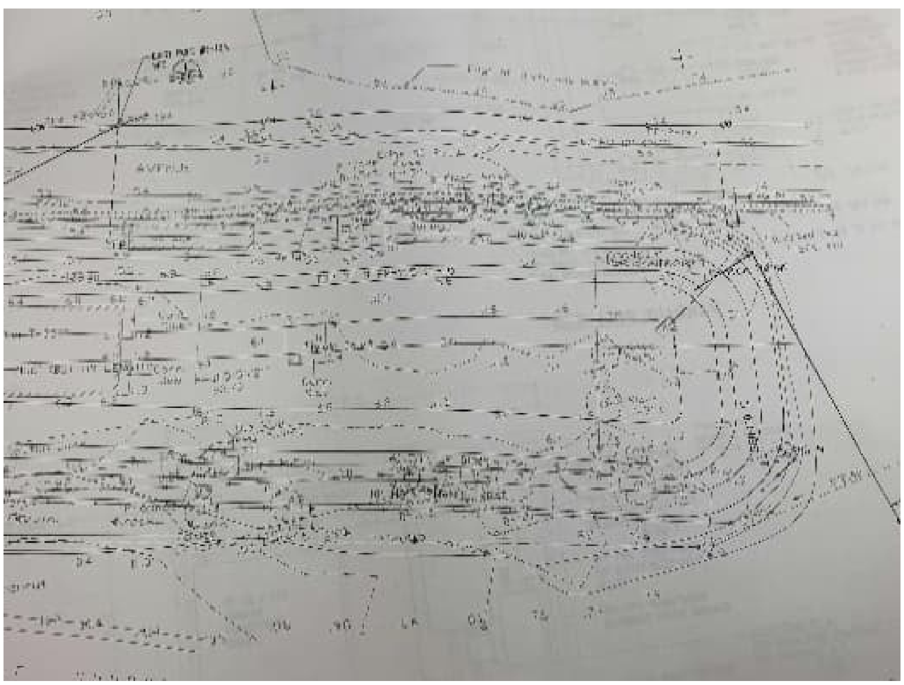
Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Mamala Bay Golf Course



Photograph 16: Golf Course As-built

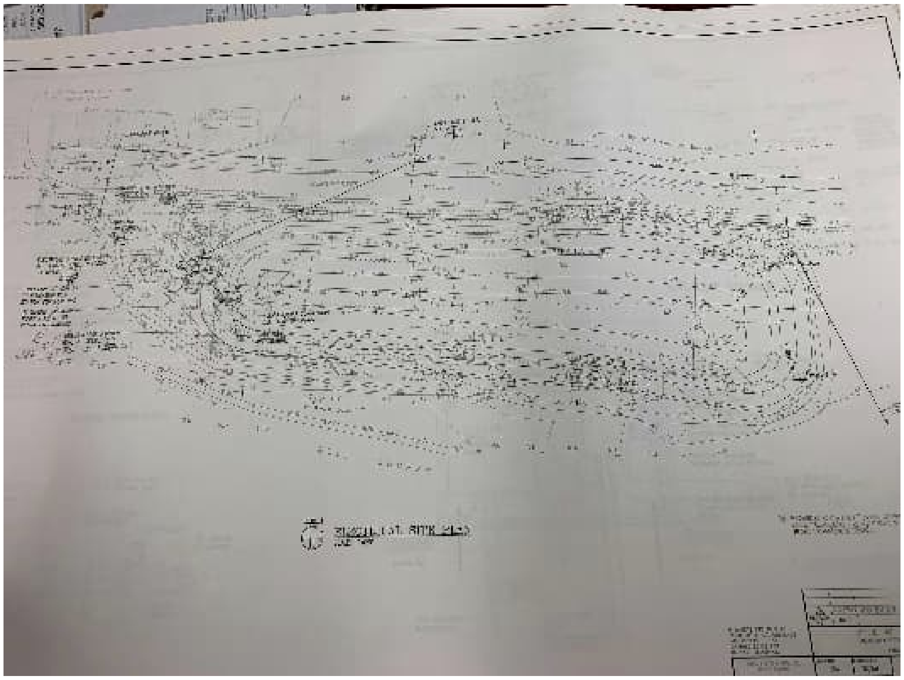
Taken by (b)(6)	Date taken: February 1, 2022



Photograph 17: Golf Course As-built

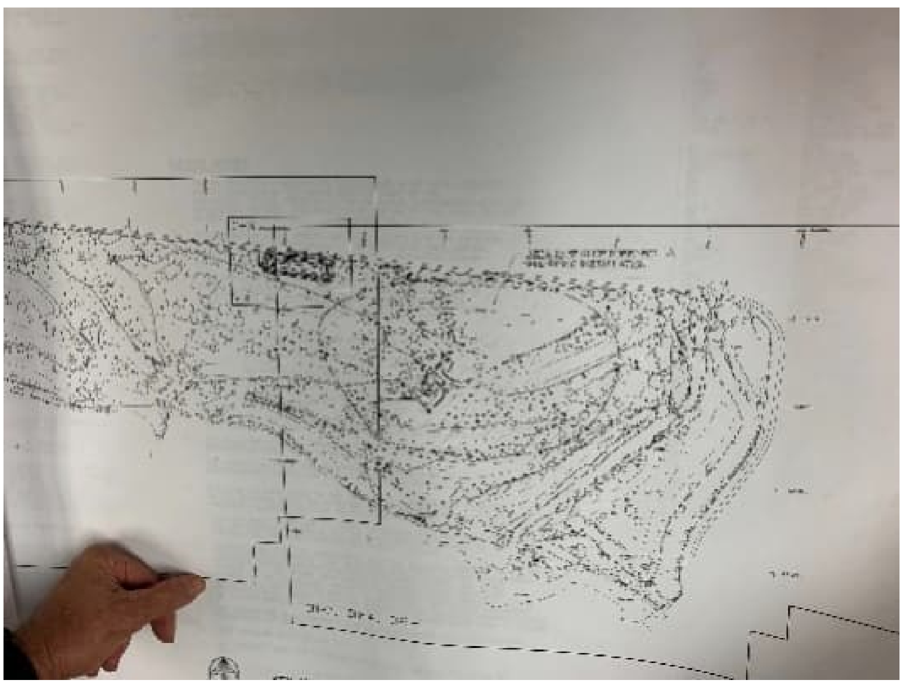
Taken by (b)(6)	Date taken: February 1, 2022

Mamala Bay Golf Course



Photograph 18: Golf Course As-built

Taken by (b)(6)	Date taken: February 1, 2022



Photograph 19: Golf Course As-built

Taken by (b)(6)	Date taken: February 1, 2022

Mamala Bay Golf Course

Photograph 20: Backflow Preventer	
Taken by (b)(6)	Date taken: February 1, 2022

Photograph 21: Backflow Preventer ID Tag	
Taken by (b)(6)	Date taken: February 1, 2022

Mamala Bay Golf Course

Photograph 22: Backflow Preventer

Taken by [redacted] (b)(6)	Date taken: February 1, 2022

Photograph 23: Piping Exiting Building 3574

Taken by [redacted] (b)(6)	Date taken: February 1, 2022

Mamala Bay Golf Course

	
Photograph 24: Existing Pumps	
Taken by (b)(6) [redacted]	Date taken: February 1, 2022
	
Photograph 25: Existing Transformers	
Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Mamala Bay Golf Course

Photograph 26: Area Near Pumps and Transformers

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Photograph 27: Overgrown Holding Pond

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Ke'alohi Golf Course

Photograph 28: Backflow Preventer

Taken by (b)(6)	Date taken: February 1, 2022

Photograph 29: Backflow Preventer

Taken by (b)(6)	Date taken: February 1, 2022

Ke'alohi Golf Course

Photograph 30: Board of Water Supply Utility Box Cover

Taken by (b)(6)	Date taken: February 1, 2022

Photograph 31: Backflow Preventer

Taken by (b)(6)	Date taken: February 1, 2022

Ke’alohi Golf Course

Photograph 32: Backflow Preventer ID Tag	
Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Photograph 33: Backflow Preventer	
Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Ke'alohi Golf Course

Photograph 34: Backflow Preventer

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Photograph 35: Pump House

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Hickam Soft Ball Field

Photograph 36: Backflow Preventer

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Photograph 37: Backflow Preventer

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Hickam Soft Ball Field

Photograph 38: Backflow Preventer	
Taken by [redacted]	Date taken: February 1, 2022

Photograph 39: Irrigation Valves	
Taken by [redacted]	Date taken: February 1, 2022

Makalapa Park

Photograph 40: Existing Service Connection

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Photograph 41: Fire Hydrant near Connection

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Makalapa Park

Photograph 42: Existing Service Connection

Taken by (b)(6)	Date taken: February 1, 2022

Photograph 43: Existing Main along Hillside

Taken by (b)(6)	Date taken: February 1, 2022

Makalapa Park

Photograph 44: Backflow Preventer

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Photograph 45: PVC Piping

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Makalapa Park

Photograph 46: Fire Hydrant and Valve Box

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Photograph 47: Backflow Preventer and Valve Boxes

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Makalapa Park

Photograph 48: Service Connection Area	
Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Gazebo 1, 2, and 3

Photograph 49: Gazebo Parking Lot and Gates

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Photograph 50: Gazebo Field

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Gazebo 1, 2, and 3

Photograph 51: Landscaping Equipment

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Photograph 52: Backflow Preventer

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Gazebo 1, 2, and 3

Photograph 53: Backflow Preventer

Taken by [redacted] (b)(6)	Date taken: February 1, 2022

Photograph 54: Backflow Preventer

Taken by [redacted] (b)(6)	Date taken: February 1, 2022

Richardson Field

Photograph 55: Gazebo Parking Lot and Gates

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Photograph 56: Gazebo Field

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Richardson Field

Photograph 57: Backflow Preventer near Cabanas and Restaurant 604

Taken by (b)(6) | Date taken: February 1, 2022

Photograph 58: Backflow Preventer near Cabanas and Restaurant 604

Taken by (b)(6) | Date taken: February 1, 2022

Richardson Field

Photograph 59: Richardson Field

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Photograph 60: Richardson Field

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Richardson Field

Photograph 61: Backflow Preventer

Taken by (b)(6)	Date taken: February 1, 2022

Photograph 62: Meter Reading

Taken by (b)(6)	Date taken: February 1, 2022

Richardson Field

Photograph 63: Equipment ID Tags

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Photograph 64: Equipment ID Tags

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Richardson Field

Photograph 65: Backflow Preventer

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Photograph 66: Bathrooms at Far End of Field

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Richardson Field

Photograph 67: Backflow Preventer location in relation to Highway

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Photograph 68: Richardson Field 4 and 5

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Richardson Field

Photograph 69: Richardson Field 4 and 5

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Photograph 70: Richardson Field 4 and 5 Backflow Preventer in the Distance

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Richardson Field

Photograph 71: Backflow Preventer across from the A-Frame

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Photograph 72: Backflow Preventer across from the A-Frame

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Richardson Field

Photograph 73: Backflow Preventer across from the A-Frame	
Taken by (b)(6)	Date taken: February 1, 2022

Photograph 74: Equipment ID Tag, Backflow Preventer across from the A-Frame	
Taken by (b)(6)	Date taken: February 1, 2022

Richardson Field

Photograph 75: Equipment ID Tag, Backflow Preventer across from the A-Frame	
Taken by [redacted]	Date taken: February 1, 2022

Navy Marine Golf Course

Photograph 76: Inactive Backflow Preventer

Taken by [redacted] (b)(6)	Date taken: February 1, 2022

Photograph 77: Active System

Taken by [redacted] (b)(6)	Date taken: February 1, 2022

Navy Marine Golf Course

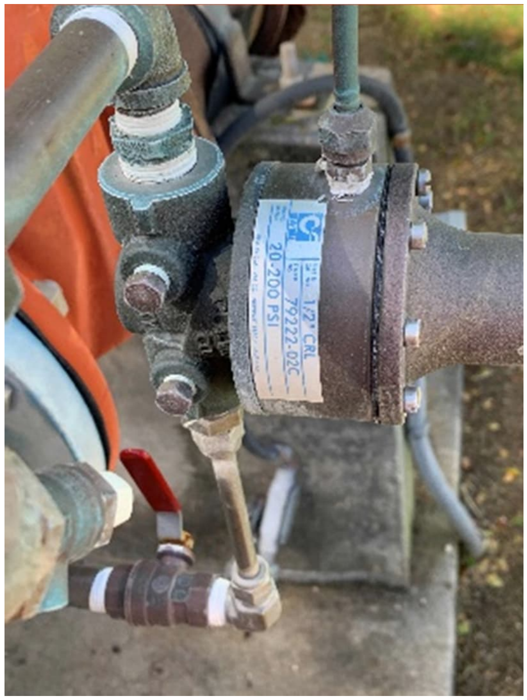
Photograph 78: Pressure Gauge on Active System

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Photograph 79: Active System

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Navy Marine Golf Course



Photograph 80: Active System ID Tag

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Photograph 81: Active System Equipment Tag

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Navy Marine Golf Course

Photograph 82: Active System

Taken by (b)(6)	Date taken: February 1, 2022

Photograph 83: Location of Both Systems relative to Nimitz Highway

Taken by (b)(6)	Date taken: February 1, 2022

Navy Marine Golf Course

Photograph 84: Location of Both Systems relative to Golf Course

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Photograph 85: Existing Foliage between Fence Line and Nimitz Highway

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Navy Marine Golf Course

Photograph 86: Area between Fence Line and Backflow Systems (Looking East)

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Photograph 87: Area between Fence Line and Backflow Systems (Looking West)

Taken by (b)(6) [redacted]	Date taken: February 1, 2022

Navy Marine Golf Course

Photograph 88: Pump House

Taken by (b)(6)	Date taken: February 1, 2022

Photograph 89: Approximate Direction of Discharge Pipe to Holding Pond

Taken by (b)(6)	Date taken: February 1, 2022

Navy Marine Golf Course

Photograph 90: Holding Pond

Taken by [redacted] (b)(6)	Date taken: February 1, 2022

[redacted] (b)(6)

Photograph 91: Site Visit Sign-in Sheet

Taken by [redacted] (b)(6)	Date taken: February 1, 2022

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Jacobs performed a site visit on February 17, 2022, from 3 p.m. to 5 p.m. The purpose of the site visit was to meet with staff who maintain Moanalua Golf Club (MGC), who is identified as a potential user for treated effluent water. In attendance were (b)(6) [redacted]/MGC, (b)(6) [redacted]/MGC, (b)(6) [redacted]/CAPE, (b)(6) [redacted]/Jacobs, (b)(6) [redacted]/Jacobs, and (b)(6) [redacted]/Jacobs.

1.0 General Notes

- The backflow preventer is installed near the east bridge over Moanalua Stream, adjacent to Ala Aolani Street. Staff mentioned the backflow preventer has an upstream pressure of 120 pounds per square inch (psi).
- A new installed backflow preventer for Kaiser Permanente Medical Center is located beside the driveway to the Moanalua Golf Club parking lot, adjacent to Ala Aolani Street.
- The irrigation system is activated every morning, irrigating green to green. The irrigation system has lines in place throughout the other portions of the golf course, however those lines are not in use.
- MGC will potentially install HDPE pressurized lines to reach other areas of the golf course.
- Staff provided map of Moanalua Golf Club. The map also depicts the boundaries of adjacent property, Kaiser Permanente Medical Center, and the Moanalua Tunnel easement.
- Explored access to Moanalua Tunnel easement from southern portion of MGC property. Moanalua Tunnel is located adjacent to the Kaiser Permanente parking garage.
- Staff mentioned contacts for Kaiser Permanente Medical Center to explore potential usage of the Moanalua Tunnel easement.

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[redacted]

Project Title: **Red Hill Drinking Water Shaft Short and Long Term Effluent Reuse**

Location: Moanalua Golf Club, Oahu, Hawaii

Site Visit Date: February 17, 2022

Moanalua Golf Club

Photograph 1: Active Backflow Preventer, close up		**Photograph 2:** Active Backflow preventer, facing north.	
Taken by: (b)(6)	Date taken: February 17, 2022	Taken by: (b)(6)	Date taken: February 17, 2022

Moanalua Golf Club

Photograph 3: Moanalua Tunnel Easement, facing northwest.

Taken by:	Date taken:
[redacted] (b)(6)	February 17, 2022

Photograph 4: Moanalua Tunnel Easement relative to Moanalua Golf Club boundary

Taken by	Date taken:
[redacted] (b)(6)	February 17, 2022

[redacted]

(b)(6)

[redacted]

[redacted]

(b)(6)

[redacted]

(b)(6)

[redacted]

(b)(6)

[redacted]

(b)(6)

[redacted]

[redacted]

[redacted]

(b)(6)

[redacted]

(b)(6)

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[redacted]

(b)(6)

[redacted]

[redacted]

(b)(6)

[redacted]

(b)(6)

[redacted]

[redacted]

(b)(6)

Appendix C
Buried Pipeline Plans

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[redacted]

COA 2 - Branch to Mamala Bay Golf Course Route

[redacted]

(b)(3)(A)

3/9/2022, 1:18:21 PM

1:9,028

0 385 770 1,540 ft

0 115 230 460 m

ArcGIS Web AppBuilder
Jacobs

COA 2 - Branch to Mamala Bay Golf Course Route

[redacted]

(b)(3)(A)

3/9/2022, 1:22:03 PM

1:9,028

0 385 770 1,540 ft

0 115 230 460 m

ArcGIS Web AppBuilder
Jacobs

COA 2 - Branch to Mamala Bay Golf Course Route

[redacted]

(b)(3)(A)

3/9/2022, 1:23:36 PM

1:9,028

0 385 770 1,540 ft

0 115 230 460 m

ArcGIS Web AppBuilder
Jacobs

[redacted]

COA 2 - Branch to Mamala Bay Golf Course Route

[redacted]

(b)(3)(A)

3/9/2022, 1:33:12 PM

1:18,056

0 500 1,000 2,000 ft

0 235 470 940 m

ArcGIS Web AppBuilder
Jacobs

Appendix D
Engineering Drawings

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[redacted]

(b)(3)(A)

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[redacted]

(b)(3)(A)

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[redacted]

(b)(3)(A)

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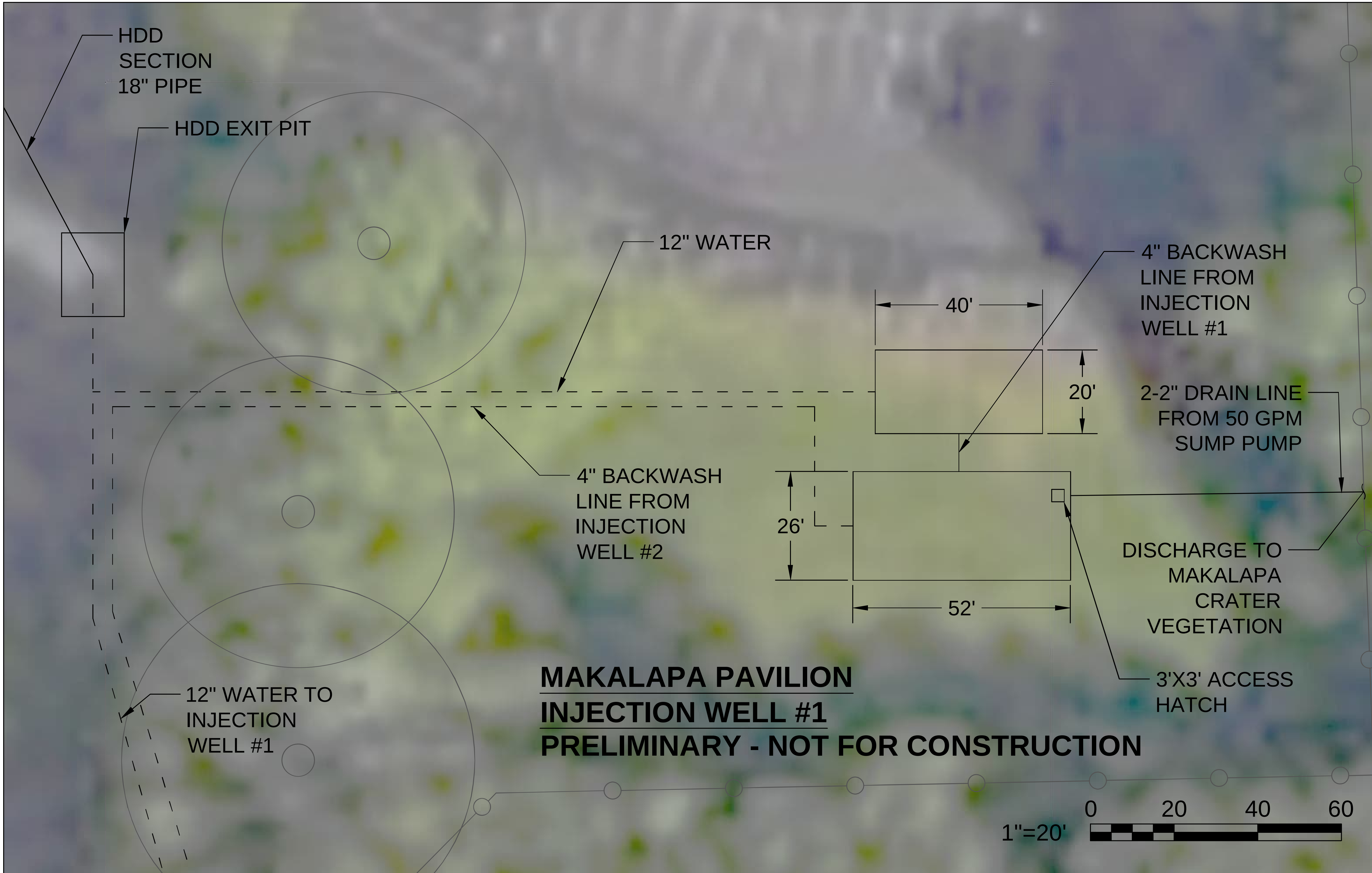
HDD SECTION 18" PIPE
HDD EXIT PIT
12" WATER
4" BACKWASH LINE FROM INJECTION WELL #1
40'
20'
2-2" DRAIN LINE FROM 50 GPM SUMP PUMP
4" BACKWASH LINE FROM INJECTION WELL #2
26'
52'
DISCHARGE TO MAKALAPA CRATER VEGETATION
3'X3' ACCESS HATCH
12" WATER TO INJECTION WELL #1
MAKALAPA PAVILION
INJECTION WELL #1
PRELIMINARY - NOT FOR CONSTRUCTION
0
20
40
60
1"=20'

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COA 3 INJECTION WELL CONCEPTUAL DESIGN

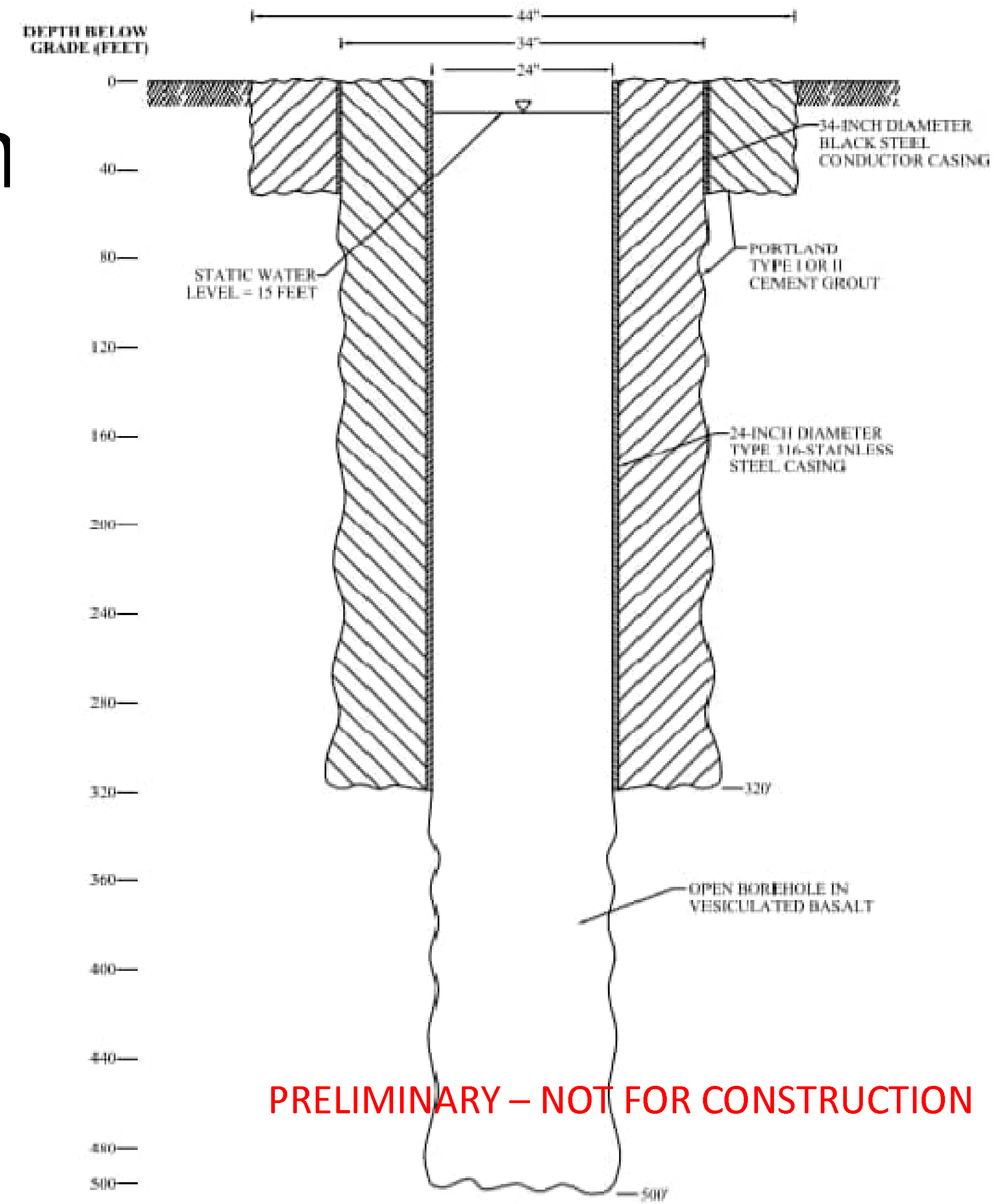
03/04/2022

Basis of Design Assumptions

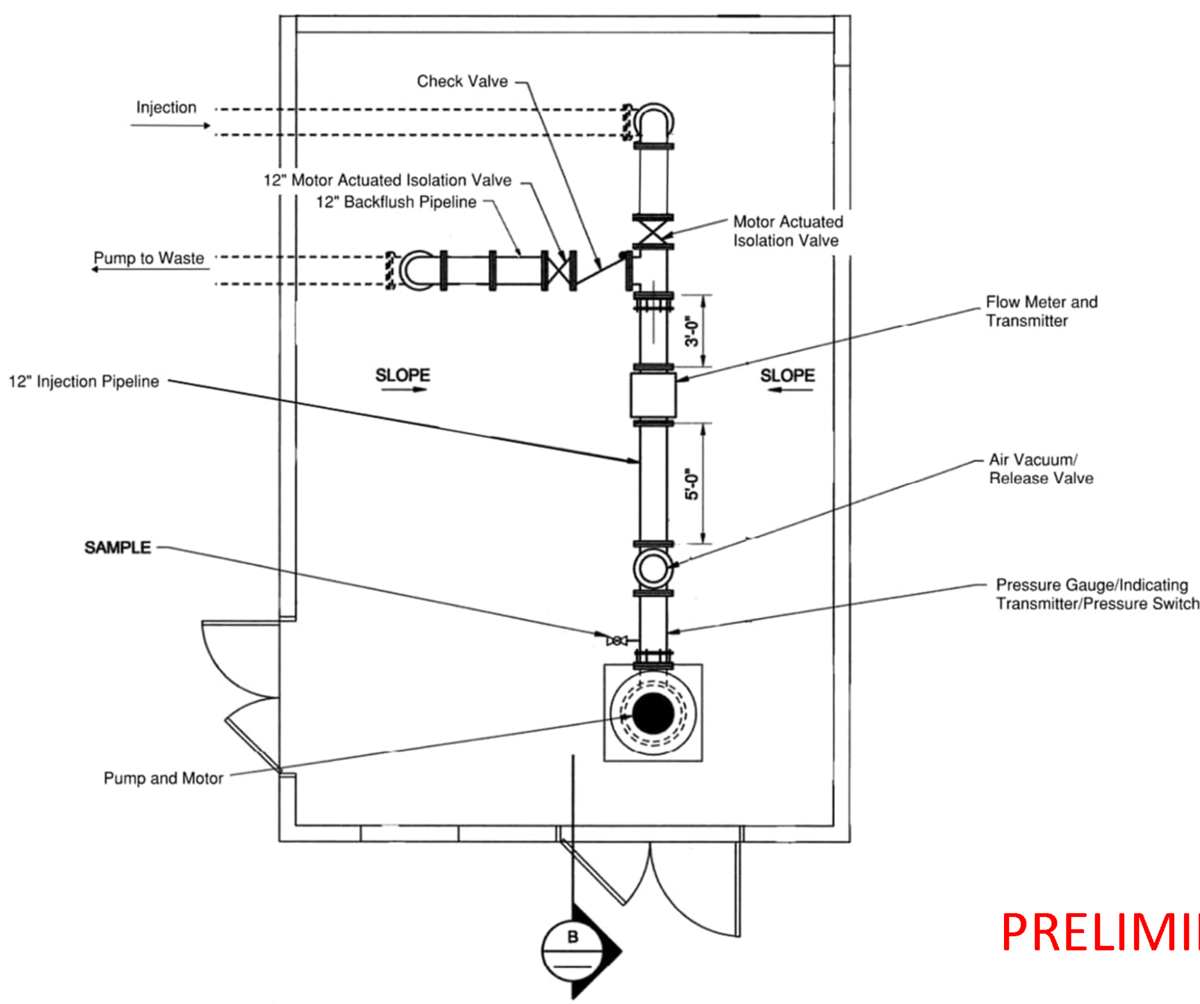
- Depth to top of basalt aquifer = 320 feet below ground surface (ft bgs)
- Depth to bottom of injection well = 500 ft bgs
- Hydraulic conductivity of basalt aquifer = 1,500 feet/day
- Number of injection wells = 2
- Water table head ≈ 5 ft msl
- Basalt aquifer head ≈ 15 ft msl
- 12-inch injection and backflushing pipeline; 5 feet per second velocity
- Wellhead equipped with flow meter, pressure gauge, level transducer
- Motor operated butterfly valves to control injection to the well or backflushing to waste
- 20 by 40 foot building to house each well (2 total buildings)
- Vertical line shaft turbine pump and motor to provide backflushing capabilities and equipped with variable frequency drives

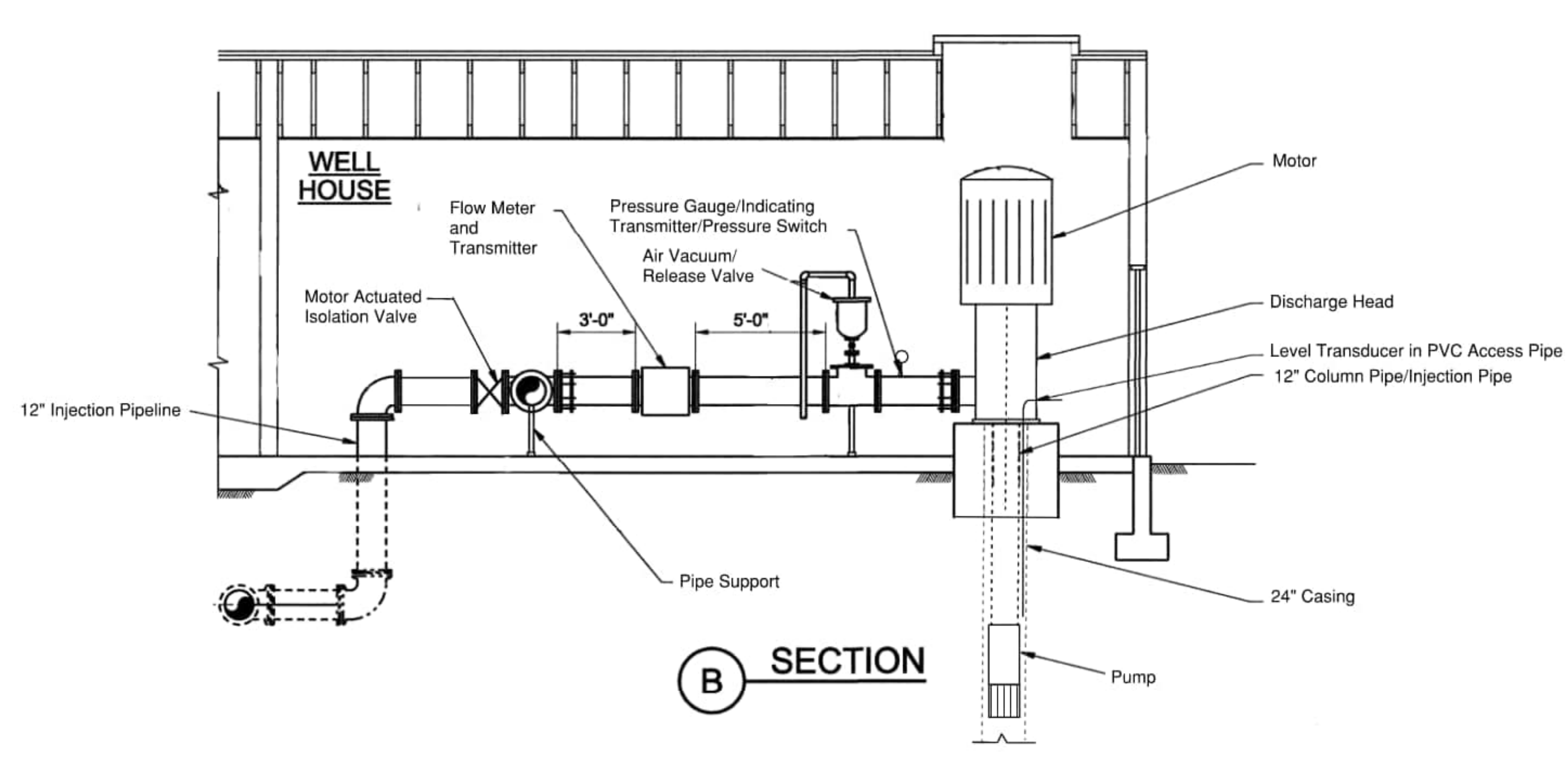
Conceptual Well Design

- 24-inch Diameter casing will accommodate recharging at 3,500 gpm (5 MGD) at velocities less 3 fps.
- Install VTP to allow periodic, routine re-development through backflushing
- Consider other fittings in wellhead to maintain wells through chemical treatments, airlift pumping, and more exotic measures (AQUA-FREED)
- 180-foot thick production zone provides maximum surface area for injection



Conceptual Wellhead Layout





PRELIMINARY – NOT FOR CONSTRUCTION

Plan

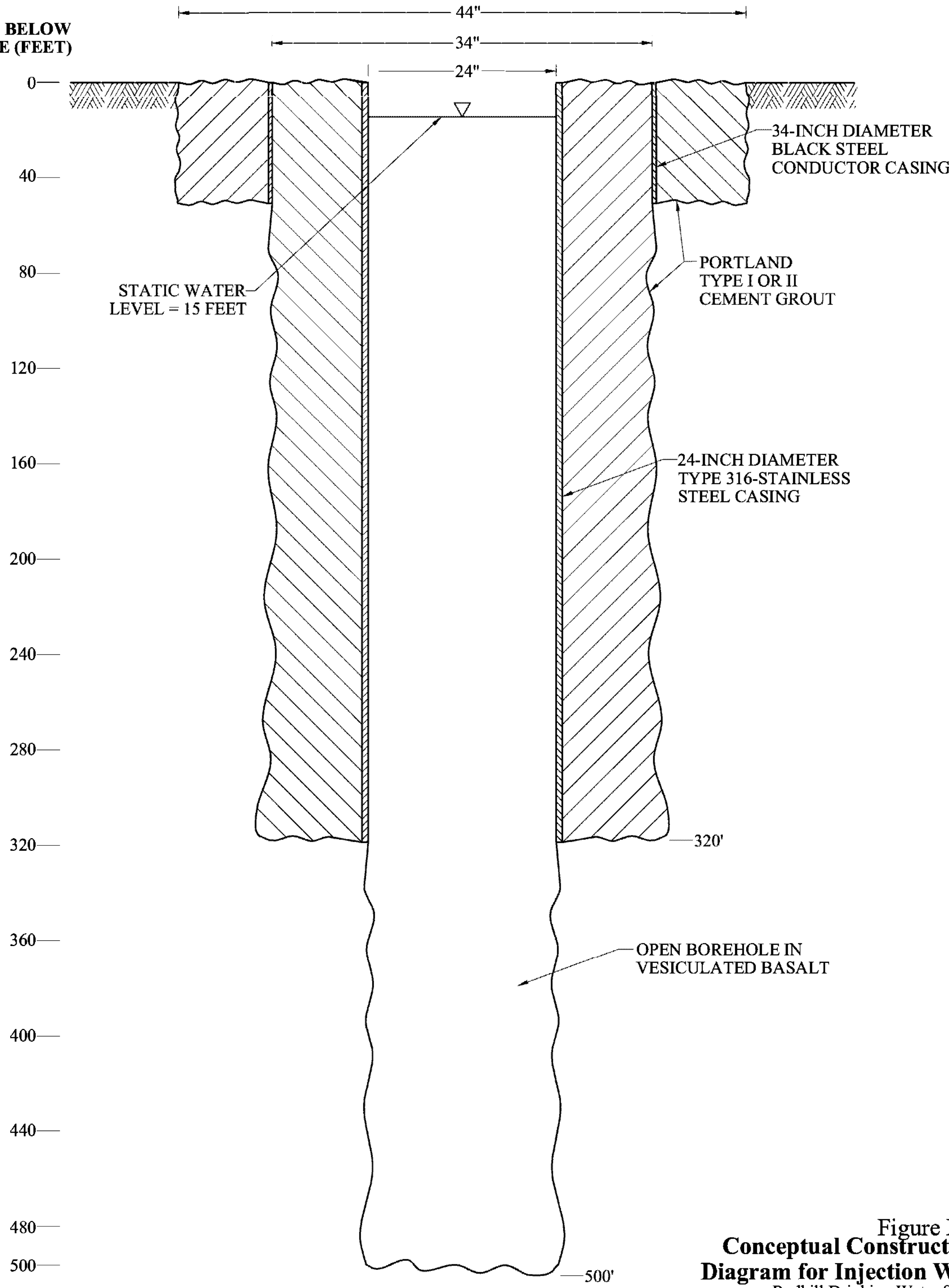


Figure XX
Conceptual Construction Diagram for Injection Well
Redhill Drinking Water Shaft
Short and Long Term Effluent Reuse
Joint Base Pearl Harbor - Hickam
Oahu, HI

Jacobs

PW | DEN001 | DOCUMENTS | 000181 - DEN1 WBG IMPERIAL SF | DESIGNS - SMALL PROJECTS | REDHILL22 - REDHILL DRINKING WATER | FIGURES | F01_REDHILL22.dgn

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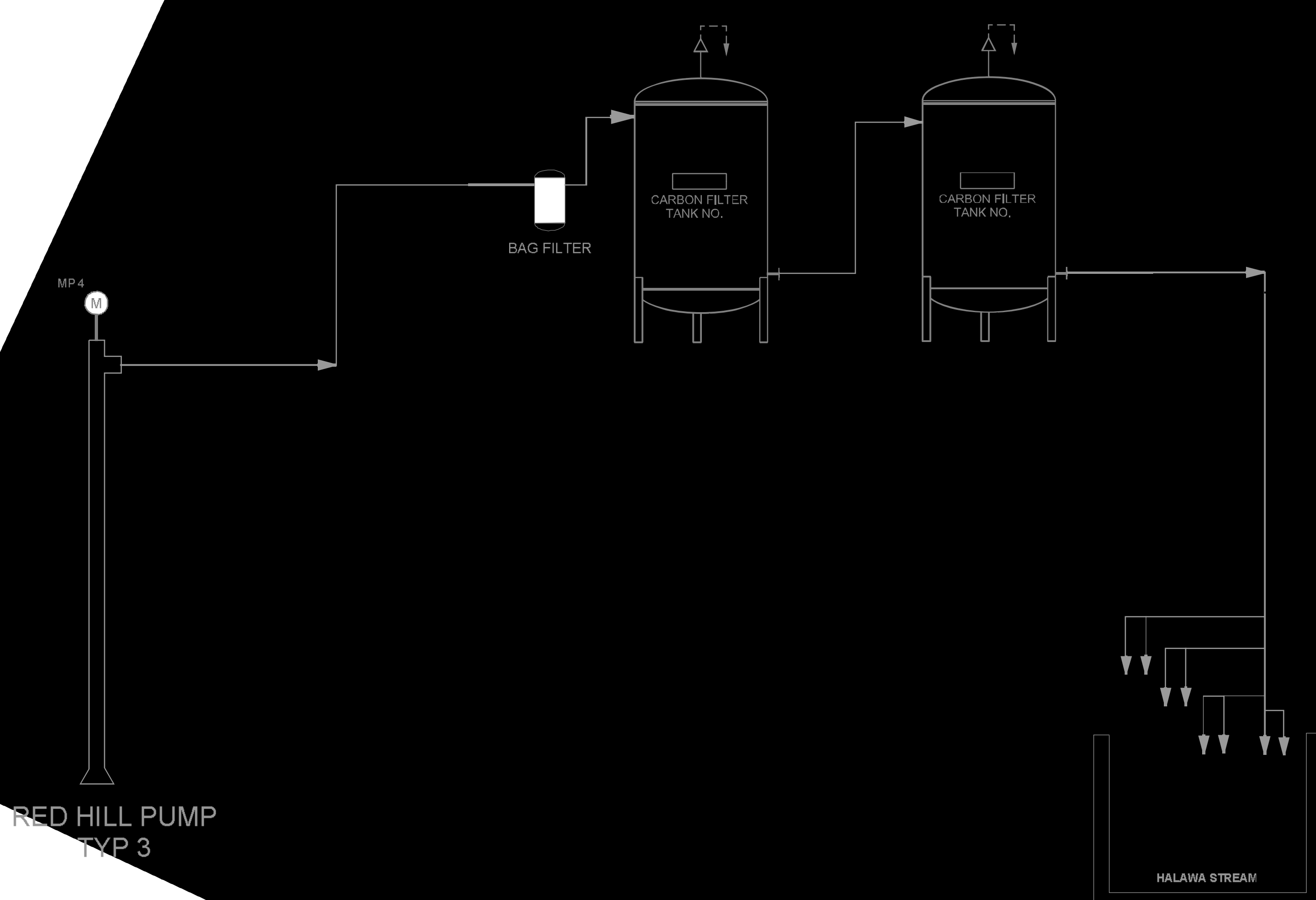
D

RED HILL PUMP[redacted]
TYPE: VERTICAL T[redacted]
CAPACITY: 7 MGD [redacted]
HORSEPOWER[redacted]
1 DUTY / 2 STANDBY [redacted]

[redacted]

BOOSTER PUMPS
TYPE: VERTICAL INLINE, MULTISTAGE
CAPACITY: 1 MGD @ 60 PSIG
HORSEPOWER: 40
2 DUTY / 1 STANDBY

RELIEF VALVE
TYPE: PRESSURE RELIEF/SUSTAINING VALVE
CAPACITY: 2 MGD
RELIEF PRESSURE: 60 PSIG
1 DUTY / 1 STANDBY
SETPOINT: DUTY: 60 PSIG
STANDBY: 65 PSIG



[redacted]

NAVFAC

PRELIMINARY [redacted]

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING SYSTEMS COMMAND

PROCESS FLOW DIAGRAM

SCALE:
EPROJECT NO.:
CONSTR. CONTR. NO.
NAVFAC DRAWING NO.
SHEET OF

FILE NAME: C:\WINDOWS\System32\Drawing1.dwg LAYOUT NAME: Model PLOTTED: Tuesday, March 01, [redacted] 2:02pm USER: pmurphy6

PIPING SCHEDULE

SERVICE	FLOW STREAM	SIZE(S) (INCHES) (NOTE 1)	EXPOSURE (NOTE 2)	PIPING MATERIAL (NOTE 3)	SPECIFICATION SECTION	JOINT TYPE (NOTE 4)	FLANGE	LINING (NOTE 5)	COATING (NOTE 6)	TEST PRESSURE AND TYPE (PSIG) (H = HYDROSTATIC, G = GRAVITY, P = PNEUMATIC) (NOTE 7)	PIPE / BACKGROUND COLOR	LETTER COLOR	NOTES
TREATED WATER	TW	ALL	OUT EXPOSED	SCH 80 PVC	TBD	SLV, FLG	B16.5, CLASS 150	NONE	NA	200, H	PURPLE	WHITE	
				316 SST	TBD	FLG, W, GE	B16.5, CLASS 150	NONE	NONE		PURPLE	WHITE	
			EXPOSED (TUNNEL)	DIP	TBD	FLG, GE	B16.1, CLASS 125	CML	SYSTEM 4	50, H	PURPLE	WHITE	
				SCH 80 PVC	TBD	SLV, FLG	B16.1, CLASS 125	NONE	SYSTEM 25	200, H	PURPLE	WHITE	
			BUR	AWWA C900	TBD	HU	NA	NONE	NONE		NONE	NONE	
				HDPE, SDR 11	TBD	FLG	B16.1, CLASS 125	NONE	NONE	200, H	NONE	NONE	

NOTES:

1. ">" GREATER THAN
"<" LESS THAN
"<=" LESS THAN OR EQUAL TO
">=" GREATER THAN OR EQUAL TO
"ALL" ALL SIZES

2. EXPOSURE TYPE:
ALL - ALL
BUR - BURIED
IN EXP - INSIDE EXPOSED
SUB -SUBMERGED
OUT EXP - OUTDOOR EXPOSED
ENC - ENCASED IN CONCRETE

3. PIPING MATERIAL:
CS - CARBON STEEL
DIP - DUCTILE IRON PIPE
PVC - POLYVINYL CHLORIDE
WS - WELDED STEEL
HDPE - HIGH DENSITY POLYETHYLENE
SST - STAINLESS STEEL

4. JOINT TYPE:
FLG - FLANGED
HU - HUB AND SPIGOT
S - SCREWED
W - WELDED, SOCKET WELDED, BRAZED/SOLDERED
GE - GROOVED END
SLV - SOLVENT WELD OR ADHESIVE
FB - FUSION BONDED
MJ - MECHANICAL JOINT
PRJ - PROPRIATARY RESTRAINED JOINT
RGK - RUBBER GASKET

5. LINING TYPE:
CML-CEMENT MORTAR LINED

6. COATING SYSTEM NUMBER AS SPECIFIED IN SECTION 099000, PAINTING AND COATING.

7. REFER TO SPECIFICATION SECTION 408001 PROCESS PIPING LEAKAGE TESTING FOR PROCESS PIPING.

MATERIAL TAKE OFF

	PIPE LENGTH, FT				SUPPORTS	NOTES
	HDPE			PVC, SCH 80	8"	
	8-INCH	10-INCH	12-INCH	8-INCH	QUANTITY	
COA1	50	210	120	4500	900	1 PENETRATION REQUIRED THROUGH ADIT STRUCTURE
COA2	50	210	120	12625	2525	4 OIL TIGHT PENETRATIONS THROUGH BULKHEADS REQUIRED 1 PENETRATION REQUIRED THROUGH ADIT 2 STRUCTURE
COA4	50	210	120	10408	2082	3 OIL TIGHT PENETRATIONS THROUGH BULKHEADS REQUIRED 1 PENETRATION REQUIRED THROUGH SIDEWALL OF TUNNEL

NAVFAC

PRELIMINARY
NOT FOR CONSTRUCTION

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING SYSTEMS COMMAND - <<AGENCY>>

PIPE SCHEDULE

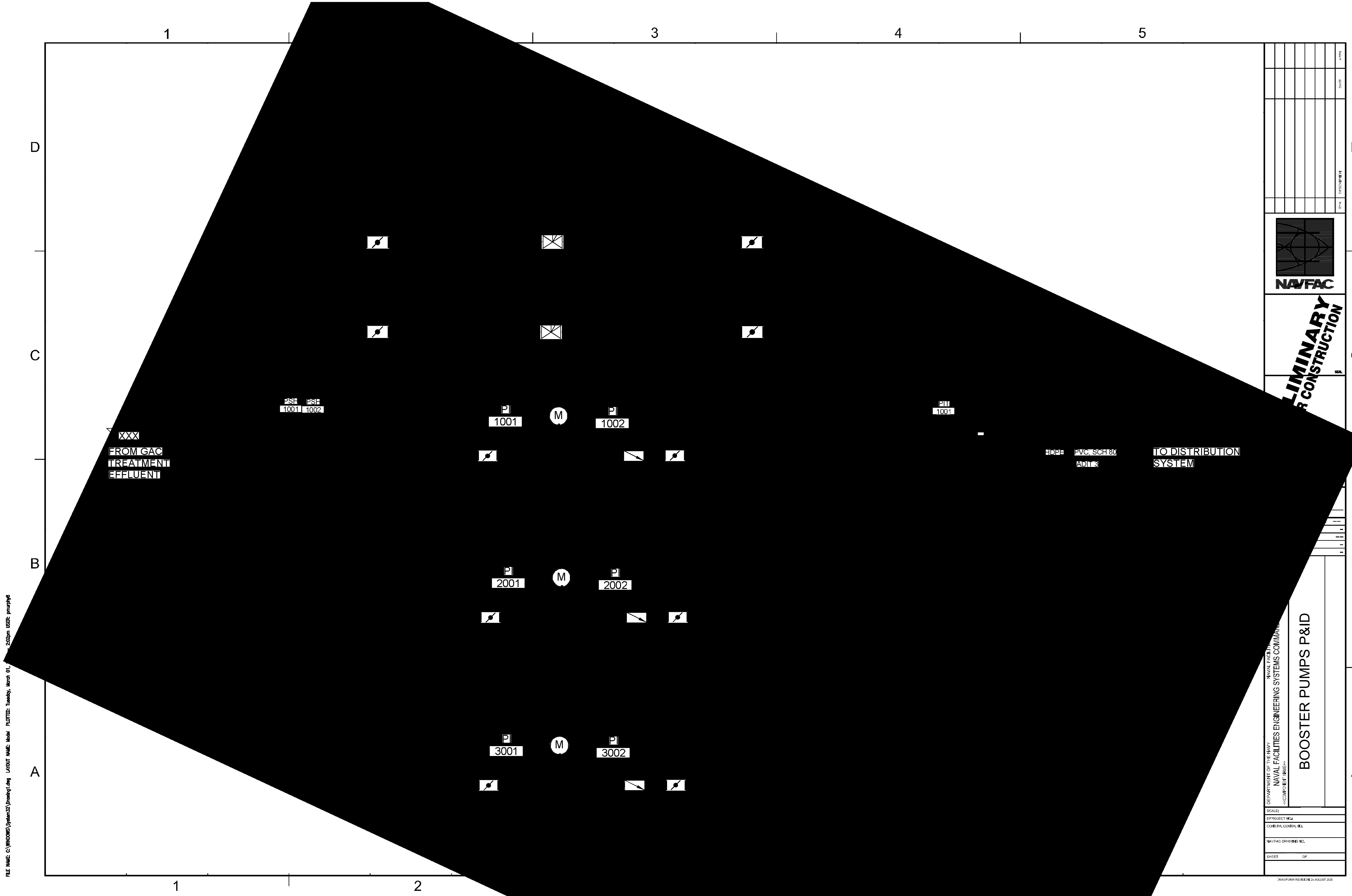
FILE NAME: C:\WINDOWS\System32\Drawing1.dwg LAYOUT NAME: Model PLOTTED: Tuesday, March 01, 2022 – 2:02pm USER: pmurphy6

D

[redacted]

(b)(3)(A)

[redacted]



[redacted]

DEPARTMENT OF THE NAVY
[redacted]
NAVAL FACILITIES ENGINEERING SYSTEMS [redacted]
<<COMPONENT NAME>>

BOOSTER PUMPS P&ID

SCALE:
EPROJECT NO.:
CONSTR. CONTR. NO.
NAVFAC DRAWING NO.
SHEET OF

DRAWFORM REVISION: 26 AUGUST 2020

FILE NAME: C:\WINDOWS\System32\Drawing1.dwg LAYOUT NAME: Model PLOTTED: Tuesday, March 01, [redacted] 2:02pm USER: pmurphy6

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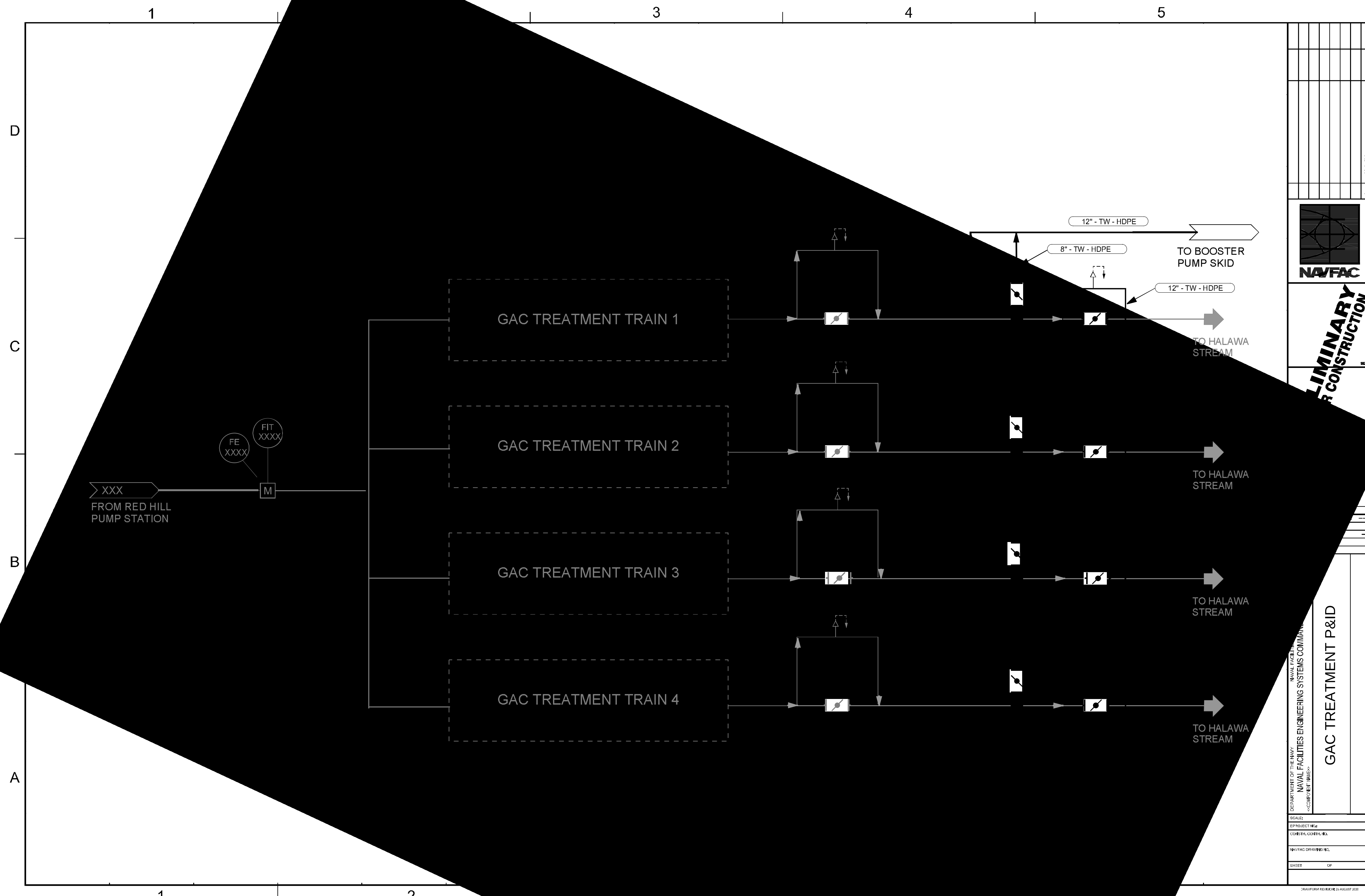
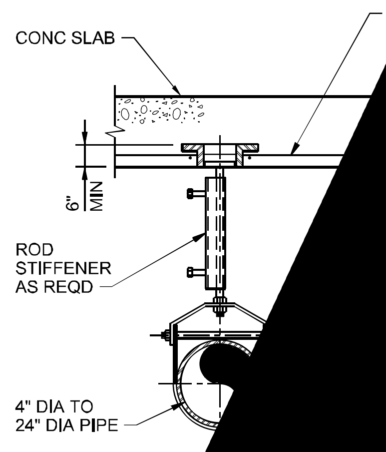


1
2
3
4
5
A
B
C
D
12" - TW - HDPE
TO BOOSTER
PUMP SKID
8" - TW - HDPE
12" - TW - HDPE
NAVFAC
GAC TREATMENT P&ID
DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING SYSTEMS COMMAND

[redacted]

D

1 [redacted] 3 4 5

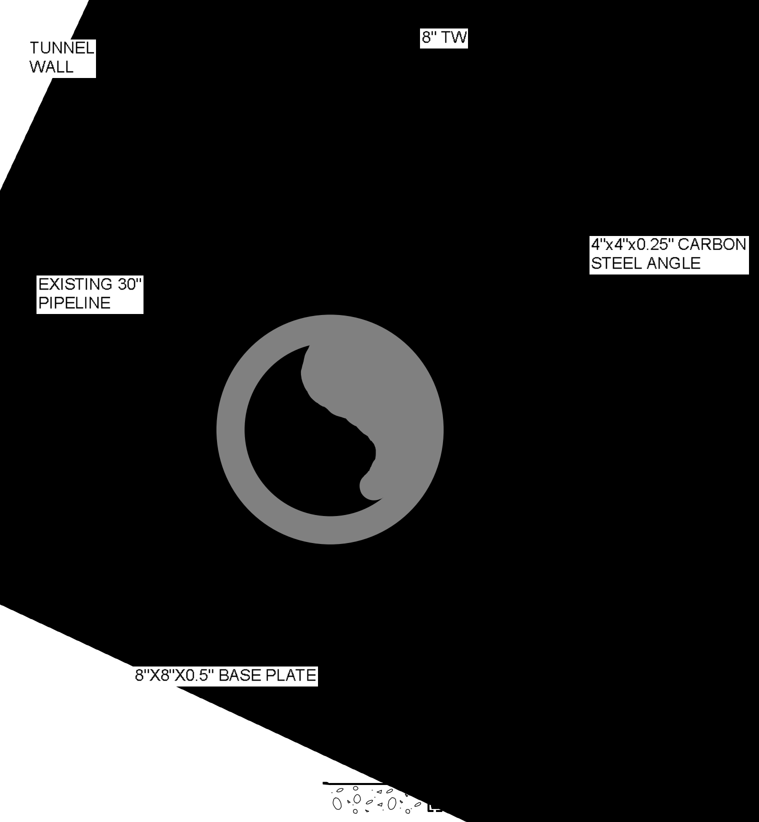


OVERHEAD PIPE [redacted]
NTS

(FOR USE IN THE HARBOR TUNNEL & ADIT 3 ACCESS TUNNEL)

DETAIL SCHEDULE TO BE DEVELOPED AT A [redacted]

[redacted]



FLOOR PIPE SUPPORT
NTS

(FOR USE IN THE HARBOR TUNNEL)

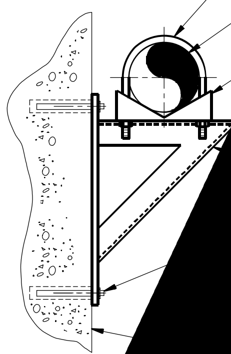
NAVFAC

[redacted]LIMINARY
[redacted] CONSTRUCTION

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING SYSTEMS COMMAND
HARBOR TUNNEL PIPE SUPPORT
DETAILS AND SCHEDULE

SCALE:
EPROJECT NO.:
CONSTR. CONTR. NO.:
NAVFAC DRAWING NO.
SHEET OF

1 2



NOTES:

1. WALL BRACKE[redacted]
2. SUBMIT FIN[redacted] AS SPECIF[redacted]

PIPE SU[redacted]

NTS

(FOR USE IN THE PUMP STATION ROOM)

[redacted]

4" D[redacted] 24" DIA [redacted]

OVERHEAD PIPE HANGER

NTS

(FOR USE IN THE MOANALUA TUNNEL & ADIT 3 ACCESS TUNNEL)

DETAIL SCHEDULE TO BE DEVELOPED AT A [redacted]

NAVFAC

[redacted]

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING SYSTEMS COMMAN[redacted]

MOANALUA TUNNEL PIPE SUPPOR[redacted]
DETAILS AND SCHEDULE

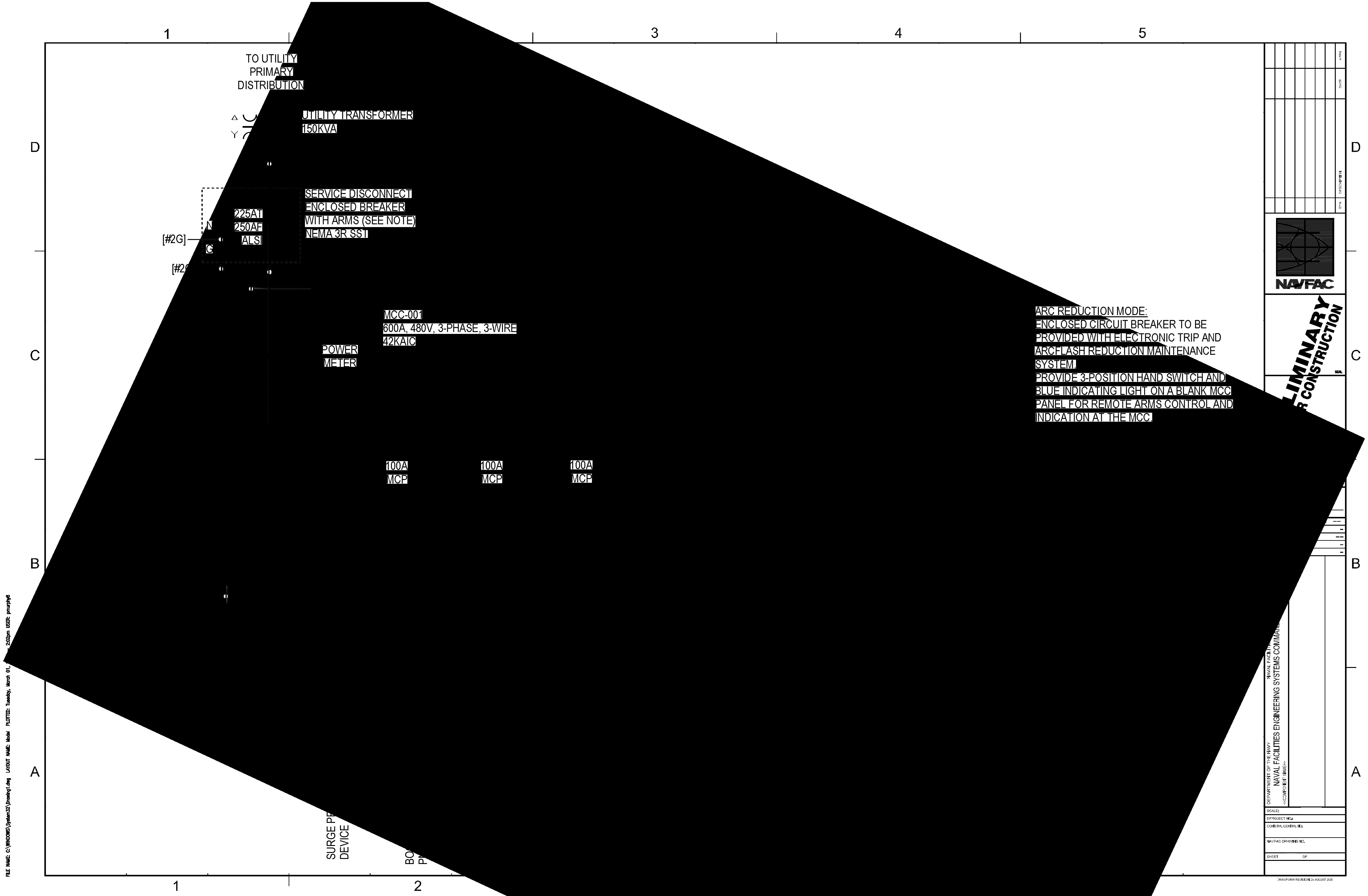
SCALE:
EPROJECT NO.:
CONSTR. CONTR. NO.
NAVFAC DRAWING NO.
SHEET OF

FILE NAME: C:\WINDOWS\System32\Drawing1.dwg LAYOUT NAME: Model PLOTTED: Tuesday, March 01, [redacted] 2:02pm USER: pmurphy6

D

[redacted]

(b)(3)(A)



TO UTILITY
PRIMARY
DISTRIBUTION
UTILITY TRANSFORMER
150KVA
SERVICE DISCONNECT
ENCLOSED BREAKER
WITH ARMS (SEE NOTE)
NEMA 3R SST
225AT
250AF
ALSI
[#2G]
MCC-001
600A, 480V, 3-PHASE, 3-WIRE
42KAIC
POWER
METER
100A
MCP
100A
MCP
100A
MCP
SURGE P
DEVICE
ARC REDUCTION MODE:
ENCLOSED CIRCUIT BREAKER TO BE
PROVIDED WITH ELECTRONIC TRIP AND
ARCFLASH REDUCTION MAINTENANCE
SYSTEM.
PROVIDE 3-POSITION HAND SWITCH AND
BLUE INDICATING LIGHT ON A BLANK MCC
PANEL FOR REMOTE ARMS CONTROL AND
INDICATION AT THE MCC.
NAVFAC
DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING SYSTEMS COMMAND

[redacted]

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Appendix E
Cost Estimate Backup

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Level 5 Cost Estimate

COA	DESCRIPTION	QTY	UNIT	ROM Price	30% Contingency	Total ROM Price With Contingency	-50%	100%
COA 1	PRIVATE USERS, SOUTHEAST OF RED HILL	1	ROM	[redacted] (b)(3)(A)	[redacted] (b)(3)(A)	[redacted] (b)(3)(A)	[redacted] (b)(3)(A)(b)	[redacted] (b)(3)(A)
COA 2	HARBOR TUNNEL - NEW 8" PIPE - Baseline Only	1	ROM	[redacted] (b)(3)(A)	[redacted] (b)(3)(A)	[redacted] (b)(3)(A)	[redacted] (b)(3)(A)	[redacted] (b)(3)(A)
COA 3	REINJECTION AT BASE OF HARBOR TUNNEL	1	ROM	[redacted] (b)(3)(A)	[redacted] (b)(3)(A)	[redacted] (b)(3)(A)	[redacted] (b)(3)(A)	[redacted] (b)(3)(A)
COA 4	PARTNER WITH BWS TO USE EXISITNG ONN POTABLE PIPELINES (tunnel to h-1 option)	1	ROM	[redacted] (b)(3)(A)	[redacted] (b)(3)(A)	[redacted] (b)(3)(A)	[redacted] (b)(3)(A)	[redacted] (b)(3)(A)
COA 5A	AQUIFER RECHARGE AND DOD/PUBLIC USE (Combination of COA 3 plus 4)	1	ROM	[redacted] (b)(3)(A)	[redacted] (b)(3)(A)	[redacted] (b)(3)(A)	[redacted] (b)(3)(A)	[redacted] (b)(3)(A)
COA 5 B	COMBINATION OF 2 &3	1	ROM	[redacted] (b)(3)(A)	[redacted] (b)(3)(A)	[redacted] (b)(3)(A)	[redacted] (b)(3)(A)	[redacted] (b)(3)(A)

ROM Pricing includes cost of plans, management, briefs and reports

[redacted]

ESTIMATE DATE:	14-Jan-22
ESTIMATOR:	Cahill
PROJECT LOCATION:	JBPHH, Hawaii
PROJECT/PROPOSAL NUMBER:	0
PROJECT/PROPOSAL NAME:	Red Hill Drinking Water Shaft Short and Long Term
DATE OF SUBMITTAL:	3-11-22 - ROM
TASK DESCRIPTION:	Task 1 - Project Planning
ESTIMATED QUANTITY:	1 **U/M** Lot

[redacted] (b)(3)(A)

CAPE[SM]

ESTIMATE DATE:	14-Jan-22
ESTIMATOR:	Cahill
PROJECT LOCATION:	JBPHH, Hawaii
PROJECT/PROPOSAL NUMBER:	0
PROJECT/PROPOSAL NAME:	Red Hill Drinking Water Shaft Short and Long
DATE OF SUBMITTAL:	3-11-22 - ROM
TASK DESCRIPTION:	Task 2 - Task Order Management
[redacted]	[redacted] - [redacted] [redacted]

[redacted] (b)(3)(A)

ESTIMATE DATE:	14-Jan-22
ESTIMATOR:	Cahill
PROJECT LOCATION:	JBPHH, Hawaii
PROJECT/PROPOSAL NUMBER:	0
PROJECT/PROPOSAL NAME:	Red Hill Drinking Water Shaft Short and Long Term Effluent Reuse COA ROM Estimates
DATE OF SUBMITTAL:	3-11-22 - ROM
TASK DESCRIPTION:	Task 3 - Pre Work Submittals

[redacted]

(b)(3)(A)

CAPE[SM]

ESTIMATE DATE:	14-Jan-22
ESTIMATOR:	Cahill
PROJECT LOCATION:	JBPHH, Hawaii
PROJECT/PROPOSAL NUMBER:	0
PROJECT/PROPOSAL NAME:	Red Hill Drinking Water Shaft Short and Long Term Effluent Reuse COA ROM Estimates
DATE OF SUBMITTAL:	3-11-22 - ROM
TASK DESCRIPTION:	Task 4- COA 1: Public/Private Entity Use

[redacted]

(b)3)(A)

[redacted]

(b)(3)(A)

[redacted]

ESTIMATE DATE:	14-Jan-22
ESTIMATOR:	Cahill
PROJECT LOCATION:	JBPHH, Hawaii
PROJECT/PROPOSAL NUMBER:	0
PROJECT/PROPOSAL NAME:	Red Hill Drinking Water Shaft Short and Long Term
DATE OF SUBMITTAL:	3-11-22 - ROM

TASK DESCRIPTION: Task 5 - COA 2D DoD Entity Use of Effluent Water

[redacted]

(b)(3)(A)

[redacted]

(b)(3)(A)

ESTIMATE DATE:	14-Jan-22
ESTIMATOR:	Cahill
PROJECT LOCATION:	JBPHH, Hawaii
PROJECT/PROPOSAL NUMBER:	0
PROJECT/PROPOSAL NAME:	Red Hill Drinking Water Shaft Short and Long Term
DATE OF SUBMITTAL:	3-11-22 - ROM
TASK DESCRIPTION:	Task 6 - COA 3: Aquifer Recharge

[redacted]

(b)(3)(A)

[redacted]

(b)(3)(A)

[redacted]

ESTIMATE DATE:	14-Jan-22
ESTIMATOR:	Cahill
PROJECT LOCATION:	JBPHH, Hawaii
PROJECT/PROPOSAL NUMBER:	0
PROJECT/PROPOSAL NAME:	Red Hill Drinking Water Shaft Short and Long Term
DATE OF SUBMITTAL:	3-11-22 - ROM
TASK DESCRIPTION:	Task 7 - COA 4 - HDD to H3 Option, No Tunnel

[redacted]

(b)(3)(A)

[redacted]

(b)(3)(A)

ESTIMATE DATE:	14-Jan-22
ESTIMATOR:	Cahill
PROJECT LOCATION:	JBPHH, Hawaii
PROJECT/PROPOSAL NUMBER:	0
PROJECT/PROPOSAL NAME:	Red Hill Drinking Water Shaft Short and Long Term Effluent Reuse COA ROM Estimates
DATE OF SUBMITTAL:	3-11-22 - ROM
TASK DESCRIPTION:	Task 8 - COA 5 - Inc Tunnel Scope (A - Combo of 3&4)

[redacted]

(b)(3)(A)

[redacted]

ESTIMATE DATE:	14-Jan-22
ESTIMATOR:	Cahill
PROJECT LOCATION:	JBPHH, Hawaii
PROJECT/PROPOSAL NUMBER:	0
PROJECT/PROPOSAL NAME:	Red Hill Drinking Water Shaft Short and Long Term Effluent Reuse COA ROM Estimates
DATE OF SUBMITTAL:	3-11-22 - ROM

[redacted]

(b)(3)(A)

[redacted]

(b)(3)(A)

ESTIMATE DATE:	14-Jan-22
ESTIMATOR:	Cahill
PROJECT LOCATION:	JBPHH, Hawaii
PROJECT/PROPOSAL NUMBER:	0
PROJECT/PROPOSAL NAME:	Red Hill Drinking Water Shaft Short and Long
DATE OF SUBMITTAL:	3-11-22 - ROM
TASK DESCRIPTION:	Task 9 - Immediately Implementable COA Report and Briefs

[redacted]

(b)(3)(A)

ESTIMATE DATE:	14-Jan-22
ESTIMATOR:	Cahill
PROJECT LOCATION:	JBPHH, Hawaii
PROJECT/PROPOSAL NUMBER:	0
PROJECT/PROPOSAL NAME:	Red Hill Drinking Water Shaft Short and Long
DATE OF SUBMITTAL:	3-11-22 - ROM
TASK DESCRIPTION:	Task 10 - Final Report

[redacted]

(b)(3)(A)

ESTIMATE DATE:	14-Jan-22
ESTIMATOR:	Cahill
PROJECT LOCATION:	JBPHH, Hawaii
PROJECT/PROPOSAL NUMBER:	0
PROJECT/PROPOSAL NAME:	Red Hill Drinking Water Shaft Short and Long
DATE OF SUBMITTAL:	3-11-22 - ROM
TASK DESCRIPTION:	Project Closeout Costs - LUMP SUM

[redacted]

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