APPENDIX H

Assessment of the Potential Impact on Groundwater of the Proposed Expansion of the Hawaiian Memorial Park – April 2018

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Assessment of the Potential Impact on Groundwater of the Proposed Expansion of the Hawaiian Memorial Park

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Table of Contents

	Page
Introduction	1
Geologic Setting of the Petition Area	1
Regional Groundwater Perspective	1
Information and Analysis of the Dug Well and Seep in the Petition Area	5
Results of the Four Boreholes Drilled Above the Well and Seep	13
Results of Siphon and Pump Testing the Dug Well	13
Summary of Findings, Conclusions, and Recommendations	21

References

Appendix

A	Photos of the Dug Well, Seep, and Downstream Drain Inlet Taken on March 30, 2018
B	Logs of the Boreholes Drilled Above the Dug Well and Seep by Geolabs, Inc.
C	Logs of the B-1 and B-2 Boreholes Drilled in Ocean View Garden by Geolabs, Inc.

List of Figures

No.	Title	Page
1	Project Vicinity Map (by HHF Planners)	2
2	Location of the Koolau Caldera	3
3	Pumpage of Wells in the Koolaupoko Aquifer System in Comparison to the CWRM's Sustainable Yield of the Aquifer System and the Total of Permitted Use	4
4	Locations of Actively Used Wells Nominally Upgradient from the Hawaiian Memorial Park	6
5	Pumpage of the Nine Wells Nominal Upgradient of the Hawaiian Memorial Park	8
6	Pumpage of the Bay View Golf Course Wells as Reported to the State Commission on Water Resource Management	10
7	Locations of the Dug Well and Seep	11
8	Cross Section of the Dug Well	12
9	Cross Section of Possible Retaining Walls an Fill Upslope from the Dug Well and Perennial Seep	14
10	Possible Retaining Wall Locations	15
11	Locations of the Four Geolabs Boreholes above the Dug Well	16
12	Water Level Response to the Siphon and Pump Test of the HMP Dug Well	19
13	Manually Measured Recovered Water Level in the HMP Dug Well	20
14	Conceptual Locations and Alignments of Deep Subsurface Drains	23

List of Tables

No.	Title	Page
1	Summary Information of Active Wells Nominally Upgradient of the Hawaiian Memorial Park	7
2	Summary Information on the Five Bay View Golf Course Irrigation Wells	9
3	Water Level Measurements in the Four Boreholes by Geolabs, Inc.	17
4	Elevations, Depths, and Water Levels in the Four Boreholes in Comparison to the Dug Well	18

Introduction

An expansion of the Hawaiian Memorial Park (HMP) Cemetery is proposed which will require a land use boundary amendment from Conservation to Urban for 53.45 acres of TMK 4-5-033:001. The Petition Area in question is shown on Figure 1. Of the 53.45-acre area, 28.2 acres would be for cemetery use. The remaining area would consist of internal roadways, open space, and a cultural reserve.

This report addresses the potential impact on groundwater resources should the land use boundary amendment be granted and the proposed project is implemented. The assessment addresses groundwater on a regional scale and also deals with a site specific issue regarding a dug well and perennial seep, the discharge from which has created a habitat for the damsel fly which must be preserved.

Geologic Setting of the Petition Area

All of HMP, including the Petition Area, is located within the caldera of the Koolau Mountain (labeled the Kailua Caldera on Figure 2). The caldera filling lavas which lie beneath HMP are a part of the Kailua Member of the Koolau volcanics. Its basalt flows are dense, massive, and relatively impermeable due to almost complete filling of interstices with secondary minerals resulting from hydrothermal alteration. Clinker beds, where they occur, have been cemented into hard and essentially impermeable breccia. Joints of intruded dikes are also filled with secondary minerals. In short, development of even a moderate capacity well anywhere in the Kailua volcanics beneath the HMP property would not be possible. This is in sharp contrast to the permeability most other basalts of the Koolau mountain.

Also of significance is the deep weathering of the Kailua volcanics across the HMP site. This has resulted in stiff silt and clay residual soils underlain by saprolite to depths exceeding 50 feet.

Regional Groundwater Perspective

The HMP site is at the south end of the area designated by the State Commission on Water Resource Management (CWRM) as the Koolaupoko Aquifer System. It is a 27-square mile area bounded by the Koolau Crest and the shoreline and extending from Oneawa Hills at the south end to the north ridge line of Waikane Valley. The CWRM has set the aquifer's sustainable yield at 30 million gallons per day (MGD) and has issued water use permits to 19 wells with a total permitted use of 10.312 MGD. As shown on Figure 3, total use by these wells has closely matched the combined permitted use amount.

Project Vicinity Map (by HHF Planners) **Figure 1**

Hawaiian Memorial Park Cemetery Expansion Project Kāne'ohe, O'ahu, Hawai'i

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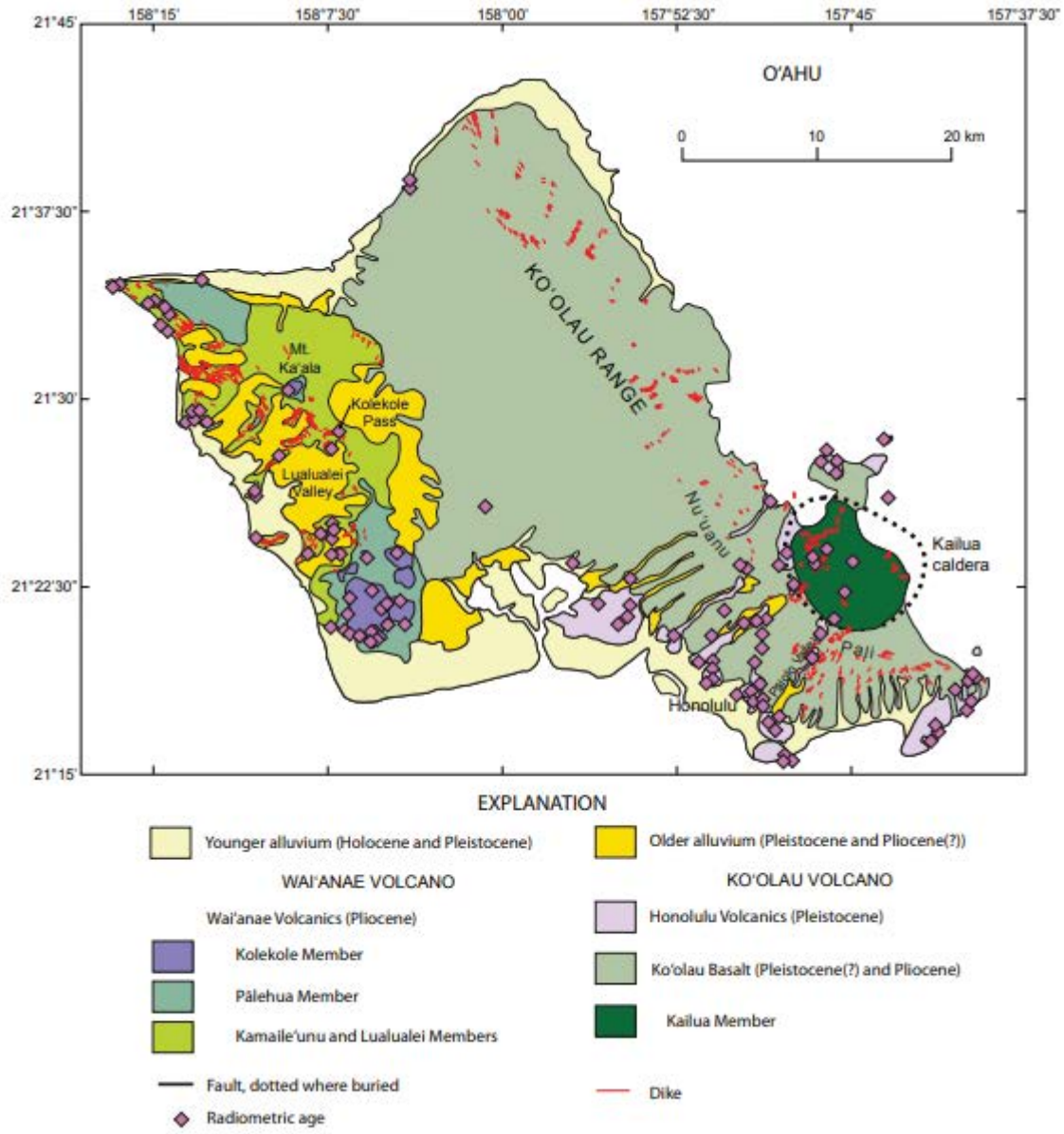
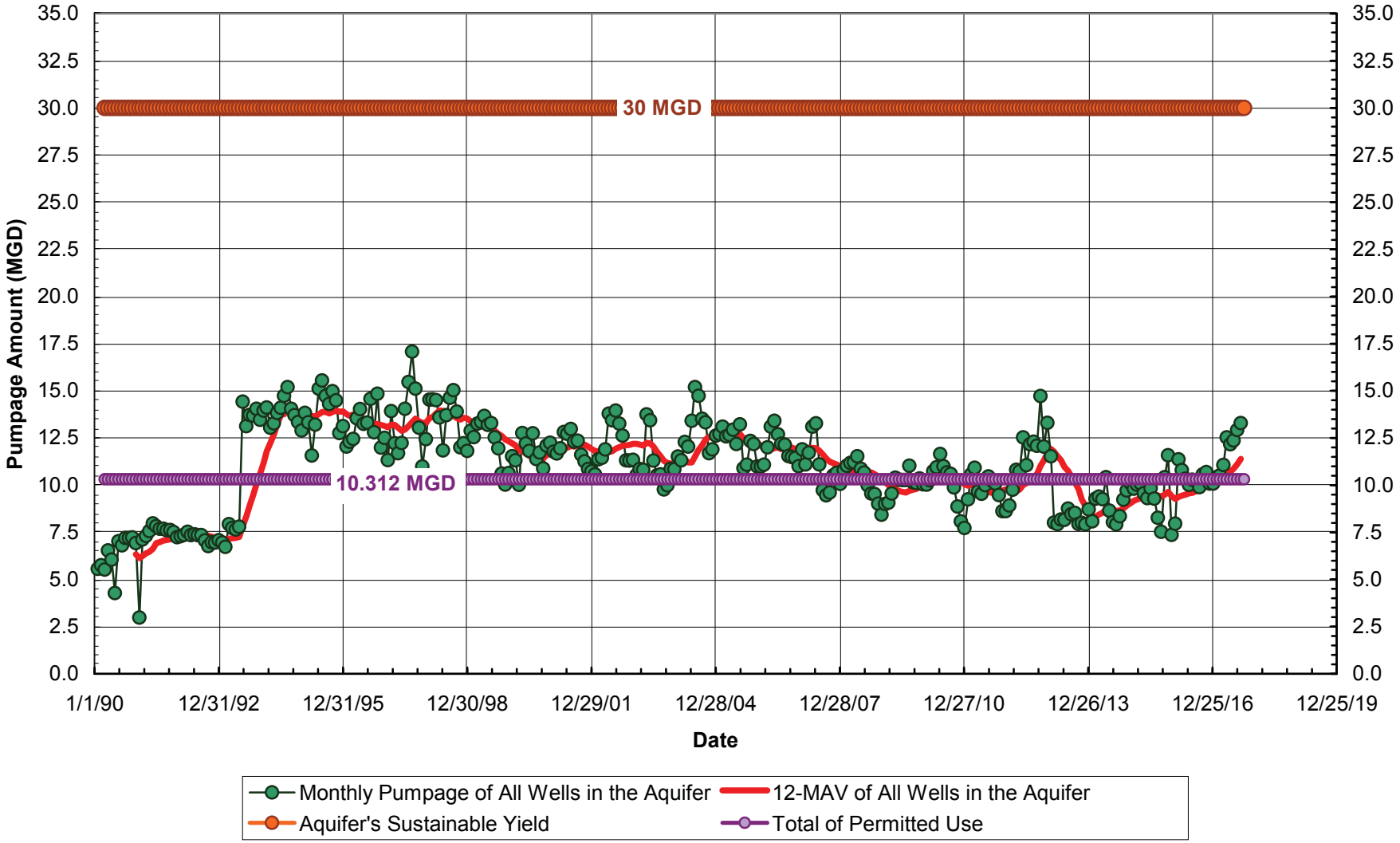


Source: Sherrod et al (2007 : p. 19)

Figure 2

Location of the Koolau Caldera

Figure 3. Pumpage of Wells in the Koolaupoko Aquifer System in Comparison to the CWRM's Sustainable Yield of the Aquifer System and the Total of Permitted Use



Of the 19 wells in the aquifer with permitted use permits, nine are nominally upgradient of the HMP site. Their locations are shown on Figure 4 and information on them is presented in Table 1. Most notable is that all of these wells tap into high level groundwater standing between 200 and 570 feet above sea level, apparently all drawing from dike confined compartments in the Koolau's dike complex. Since the mid-1990s, total pumpage of all nine wells has been less than their combined permitted use (Figure 5). Based on the locations of these wells and the groundwater occurrence they draw from, nothing at the existing HMP or what is planned for its expansion in the Petition Area has or will have an impact on their ongoing uses.

There are also five wells which are nominally downgradient from HMP. Their locations are also shown on Figure 4 and information on their construction and hydraulic performance are presented in Table 2. All five are shallow irrigation wells of modest capacity within the Bay View Golf Course. They draw water exclusively from the overlying alluvium of clayey silt and gravel rather than from the volcanics at depth. Use of the wells does require a Water Use Permit from the CWRM, but apparently such a permit was never obtained. Their modest use was reported to the CWRM for the 29-month period from the July 1997 to November 1999 (Figure 6), but not since then. It is not known if these wells are still in use. However, the planned expansion of HMP in the Petition Area would have no impact on their viability if they are still in use.

Information and Analysis of the Dug Well and Seep in the Petition Area

There is a dug well and perennial seep in the Petition Area that is of concern. Figure 7 shows their locations about 300 feet northwest of the loop road in the Ocean View Garden. The well is 11.5 feet deep below the top of its square-shaped concrete rim. The opening of the concrete is 2.65 by 2.9 feet. The dug borehole below the concrete is substantially larger than this opening. Figure 8 is a schematic cross section of the well and Appendix A contains photos of it. As measured a number of times during the field investigation, the water level in the well was consistently above the ground level on the downstream side of the well. The well is not registered with the CWRM and no information about its installation or past use could be found. Based on old pipe laying nearby, it may at one time have been a modest source of supply.

A small but perennial seep emerges about four feet downslope from the well. Further down the waterway, the flowrate in the waterway continuously increases enroute to its ultimate discharge into the drain inlet at the upper end of Ohaha Place. Given the additions to the flowrate enroute downslope, it is more accurate to describe the seep as an area of discharge rather than a discharge from a single point.

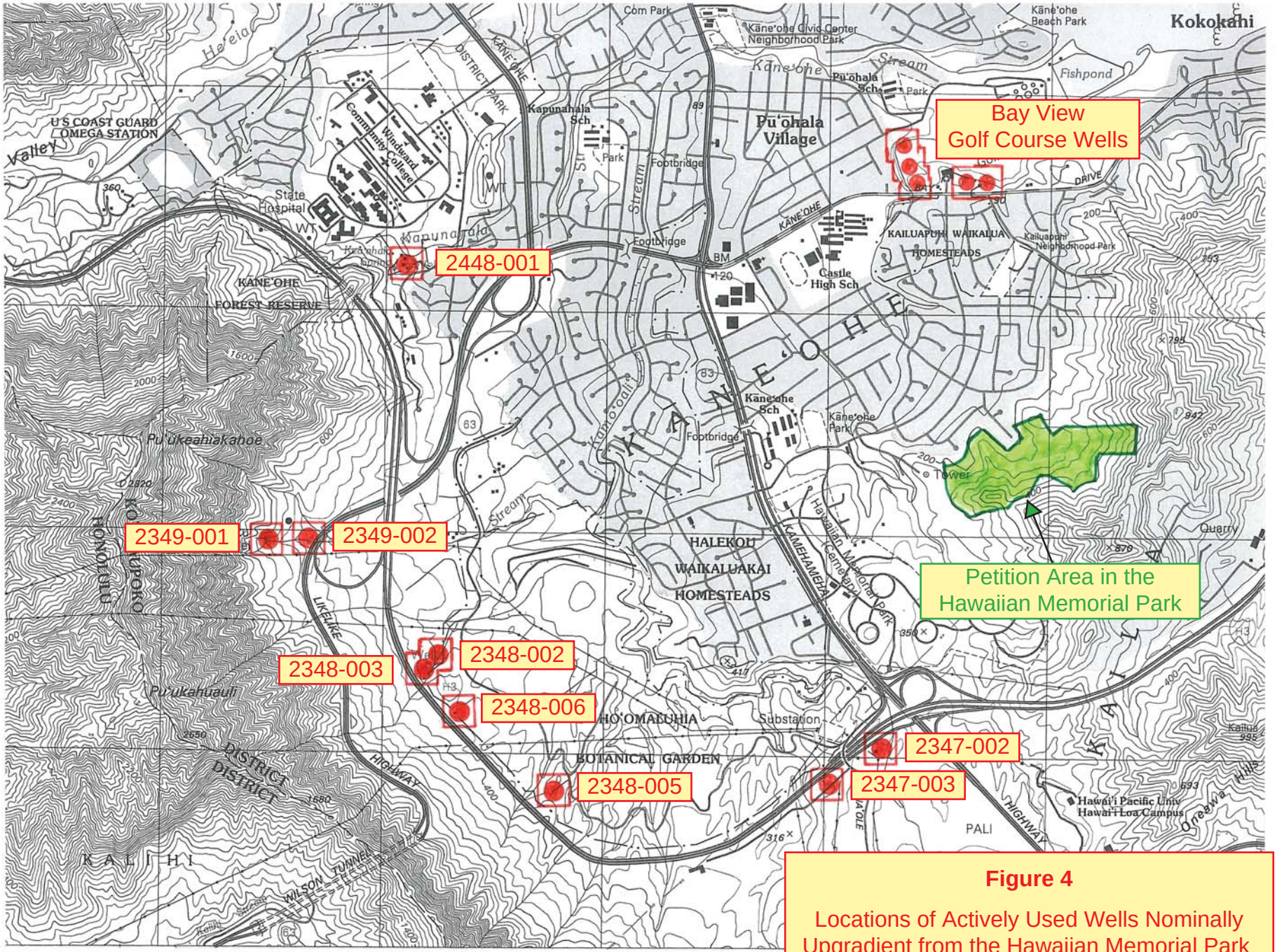


Figure 4

Locations of Actively Used Wells Nominally Upgradient from the Hawaiian Memorial Park

Scale: 1" = 2000'

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Table 1. Summary Information of Active Wells Nominally Upgradient of the Hawaiian Memorial Park

Well No.	Well Name	WUP (MGD)	Year Drilled	Ground Elevation (Ft. MSL)	Well Depth (Feet)	Elevation at Bottom (Ft. MSL)	SWL (Ft. MSL)	Hydraulic Performance (Feet @ GPM)	Installed Pump (GPM)
Wells of the Honolulu Board of Water Supply									
2348-002	Kuou I-1	2.375	1955	274	418	-144	310	262 @ 820	- -
2348-003	Kuou I-2	0.100	1955	293	280	13	290	5.2 @ 1500	2100
2348-005	Kuou II		1986	342	550	-208	258	126 @ 994	700
2348-006	Kuou III	0.700	1984	324	566	-242	255	135 @ 609	500
2349-001	Luluku Tunnel	0.713	1948	570	- -	- -	570	- -	- -
2349-002	Luluku	1.050	1984	412	460	-48	362	120 @ 739	700
Other Nominally Upgradient Wells									
2347-002	Koolau GC-1	0.150	1988	234	130	104	201	4.4 @ 300	350
2347-003	Koolau GC-2		1988	246	130	116	219	6 @ 400	350
2448-001	Hawaii State Hospital	0.088	1946	252	249	3	249	- -	450

Figure 5. Pumpage of the Nine Wells Nominally Upgradient of the Hawaiian Memorial Park

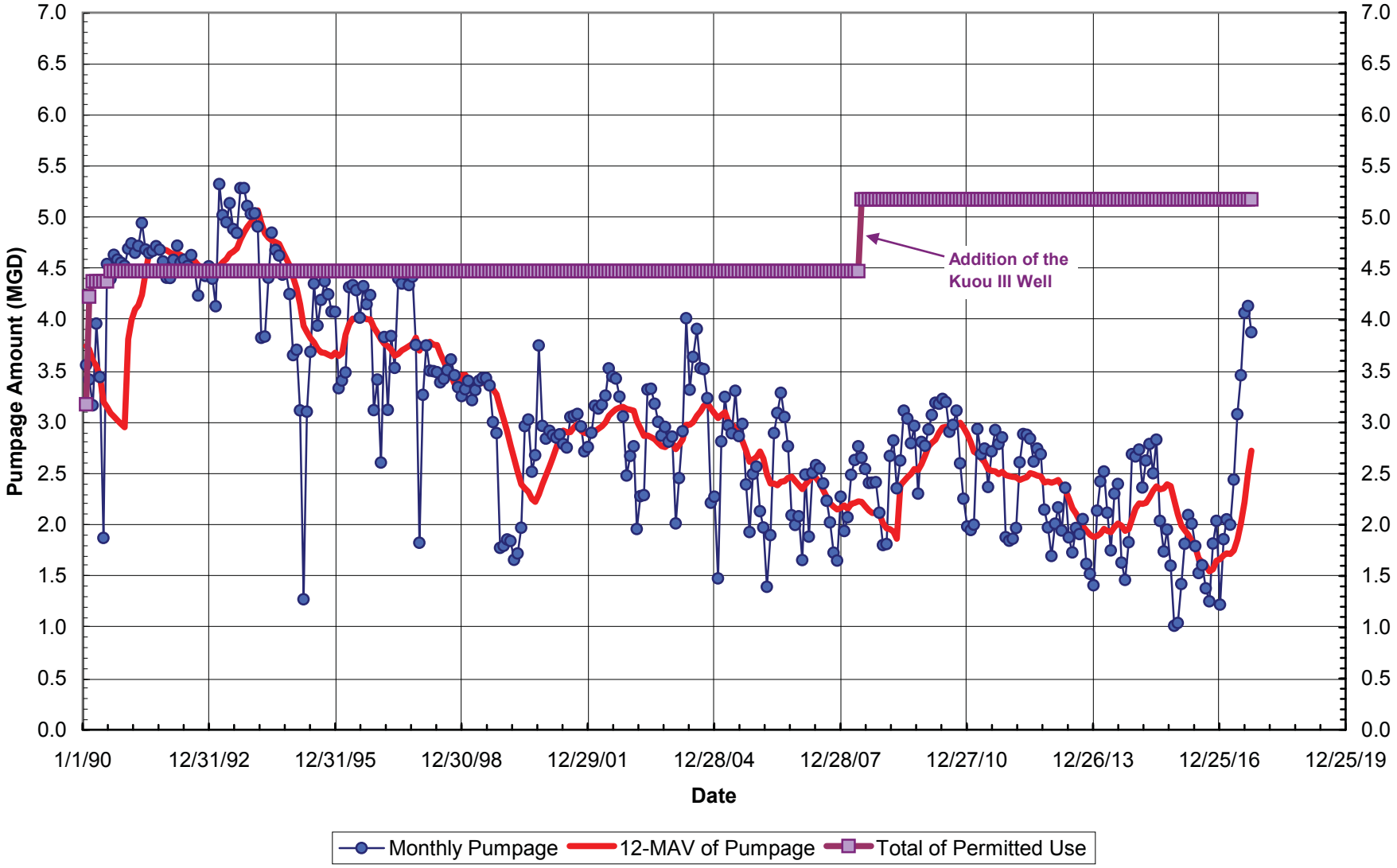
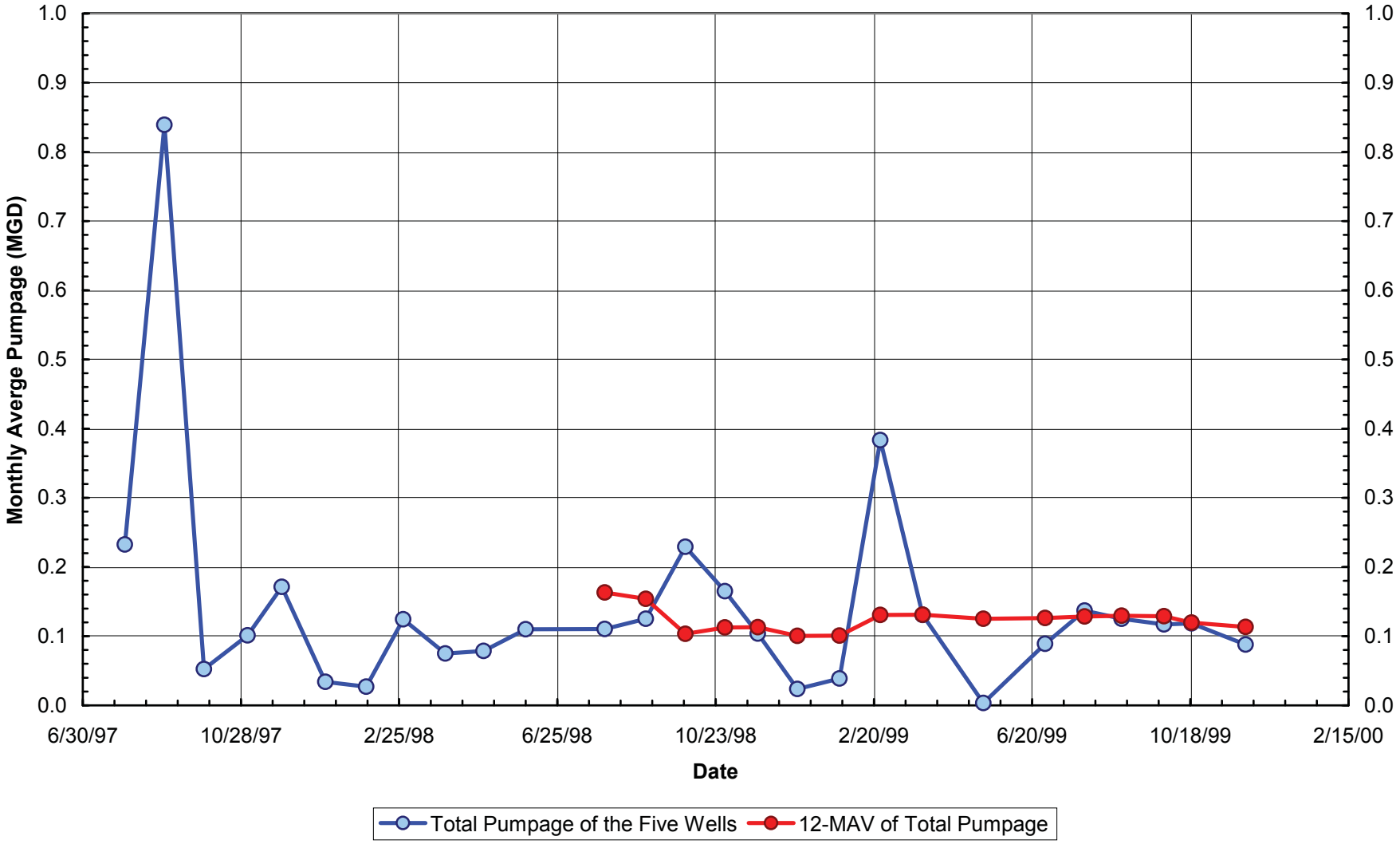


Table 2. Summary Information on the Five Bay View Golf Course Irrigation Wells

Well No.	Well Name	Year Drilled	Ground Elevation (Ft. MSL)	Well Depth (Feet)	Elevation at Bottom (Ft. MSL)	SWL (Ft. MSL)	Hydraulic Performance (Feet @ GPM)	Current Use
2447-002	Bay View 1	1995	13	50	-37	4.4	7.5 @ 50	Irrigation
2447-003	Bay View 2	1995	14	50	-36	5.1	5.8 @ 100	Irrigation
2447-004	Bay View 3	1995	15	50	-35	8.5	12 @ 60	Irrigation
2447-005	Bay View 4	1996	11	50	-39	8.4	7.4 @ 100	Irrigation
2447-006	Bay View 5	1996	22	60	-38	5.3	8.6 @ 100	Irrigation

Figure 6. Pumpage of the Bay View Golf Course Wells as Reported to the State Commission on Water Resource Management



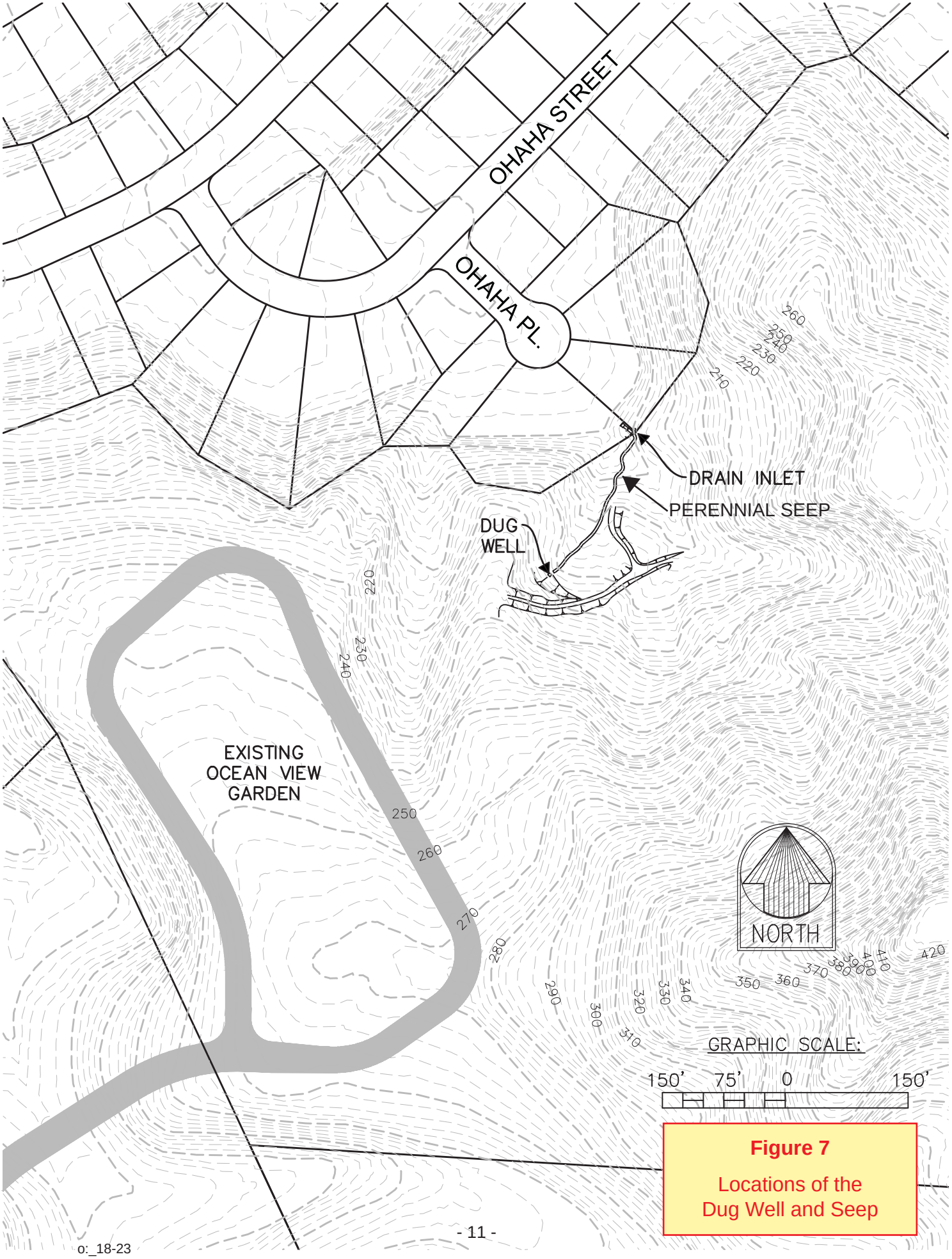


Figure 7

Locations of the Dug Well and Seep

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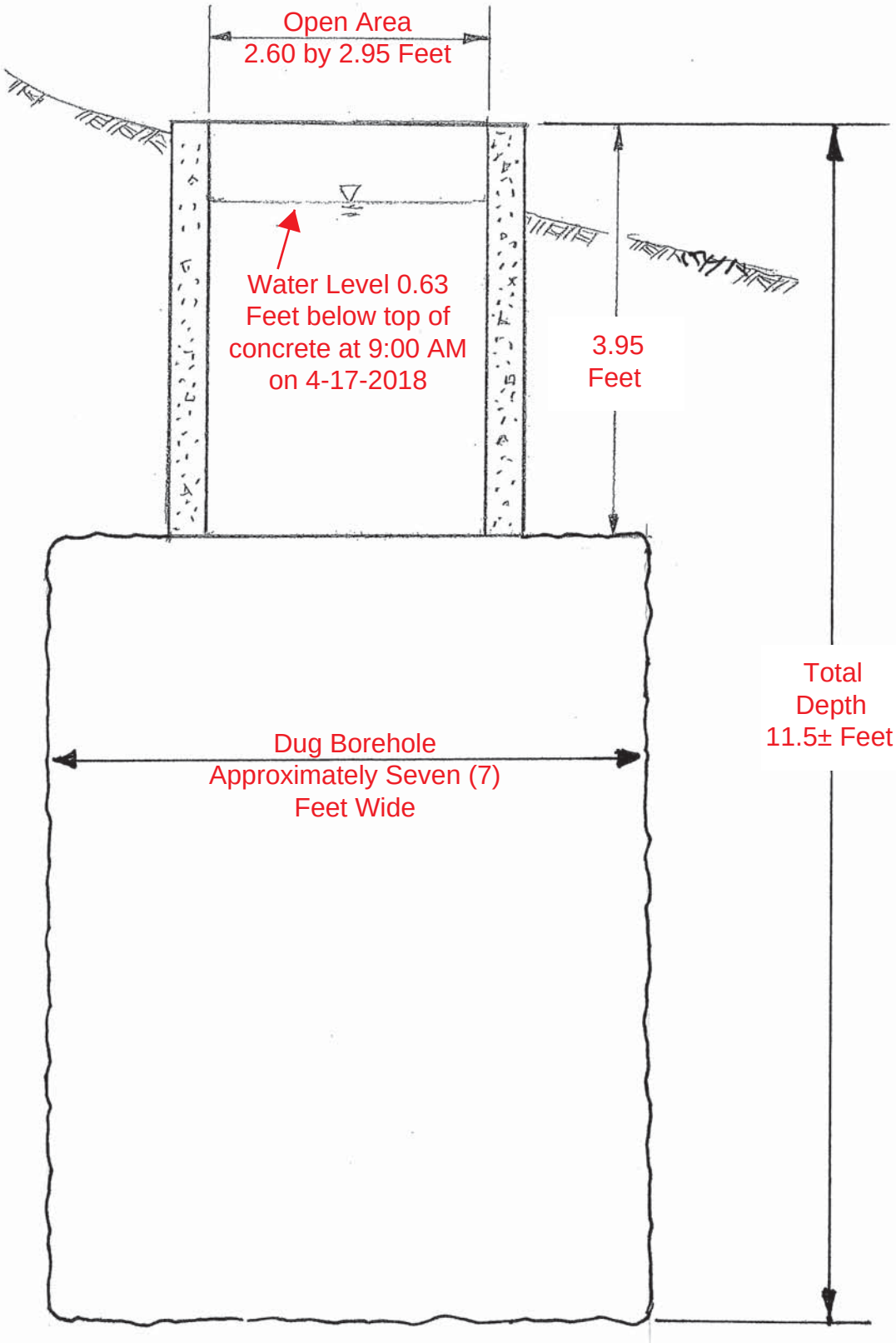

Figure 8

Schematic Cross Section
of Dug Well

Implementation of the HMP expansion into the Petition Area would involve installation of retaining walls and fill of tens of feet in depth in the area upslope from the well and seep. Figures 9 and 10 illustrate these possibilities. On the assumption that supply to the dug well and seep is from a shallow perched water source that might be adversely impacted by footings for the retaining walls and/or compression by the weight of tens of feet of fill, two types of field investigation were undertaken: (1) drilling of four boreholes directly upslope of the well and seep; and (2) a siphon and pump test of the well to determine if subsurface leakage from the well is creating the seep that emerges just four feet downslope. Results of each of these investigations are described in the paragraphs following.

Results of the Four Boreholes Drilled Above the Well and Seep

Figure 11 shows the approximate locations of the four boreholes drilled above the well and seep and Appendix B contains the logs of these boreholes prepared by Geolabs, Inc. Although an obvious perching member was not encountered in the borings, the water level response in all four boreholes was instructive. Water was not encountered in each borehole until each borehole had been drilled down to between 15 to 20 feet below ground. After reaching that depth, the water level in each borehole very slowly rose up (Steven Carr of Geolabs, personal communication). Table 3 prepared by Geolabs documents this slow filing in each of the boreholes. As the tabulation of approximate water levels in the boreholes and the well in Table 4 shows, the semi-confined groundwater residing in the poorly permeable residual soil has a relatively steep downslope gradient

Results of Siphon and Pump Testing the Dug Well

On April 17, 2018, testing of the dug well was undertaken with two basic objectives: (1) to confirm that the semi-confined groundwater occurrence found at the four Geolabs boreholes directly upslope also exists at the dug well; and (2) to confirm that the seep that emerges four feet downslope of the well is a result of subsurface leakage from the well. Both aspects of the groundwater occurrence were confirmed by the test.

The intention was to run the test by siphoning from the well (and discharging downslope to maintain the siphon) rather than by pumping. Siphoning was begun at about 9:30AM at about 30 GPM, but the siphon was lost in less than 10 minutes. An attempt to restart the siphon also failed, this time in less than five (5) minutes. Thereafter, the well was pumped with a small, 1/4 horsepower sump pump, first at 17 GPM and then at about 15 GPM. The several aspects to note from the test data depicted on Figures 12 and 13 are as follows:

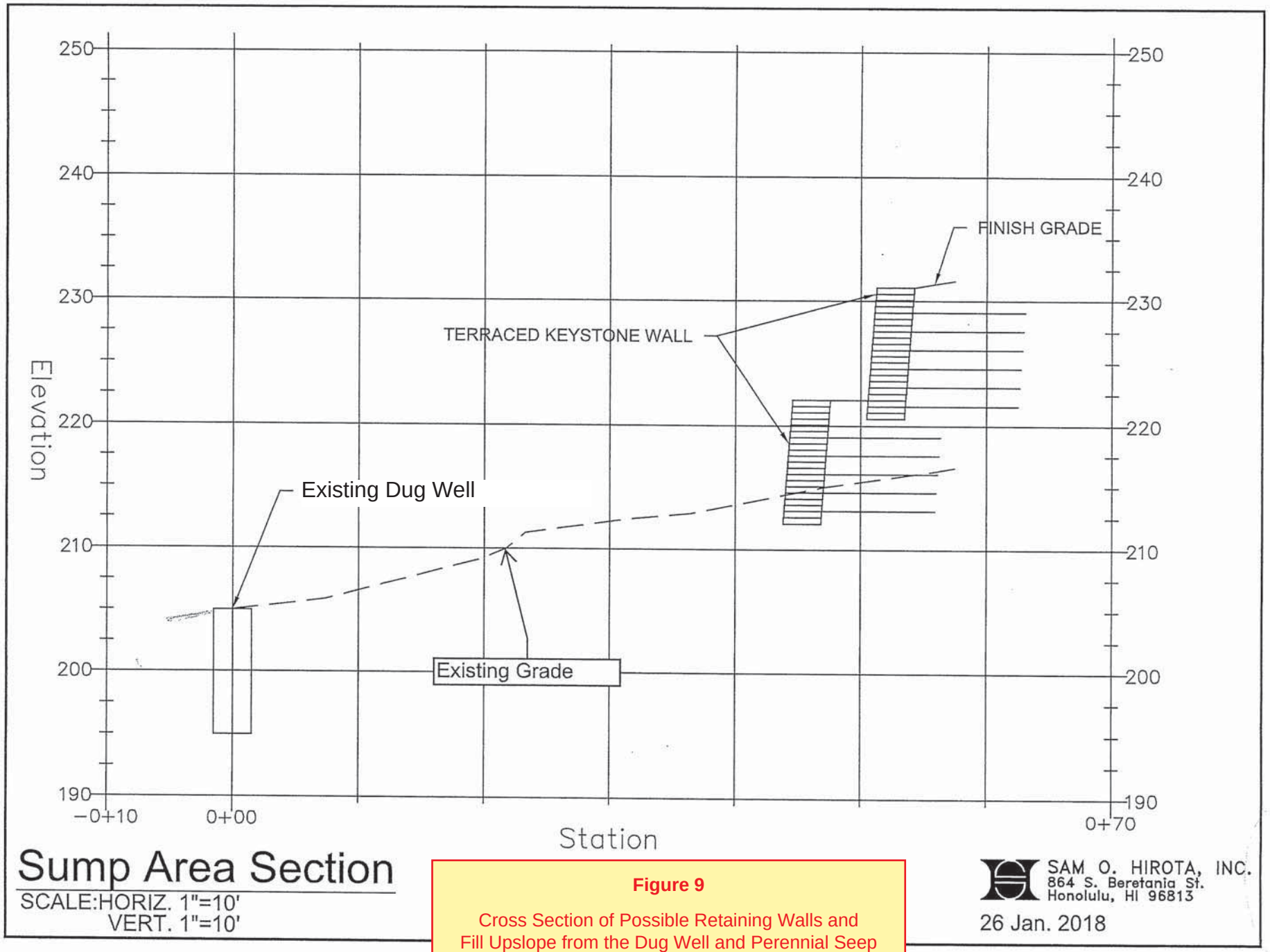

Figure 9

Cross Section of Possible Retaining Walls and
Fill Upslope from the Dug Well and Perennial Seep

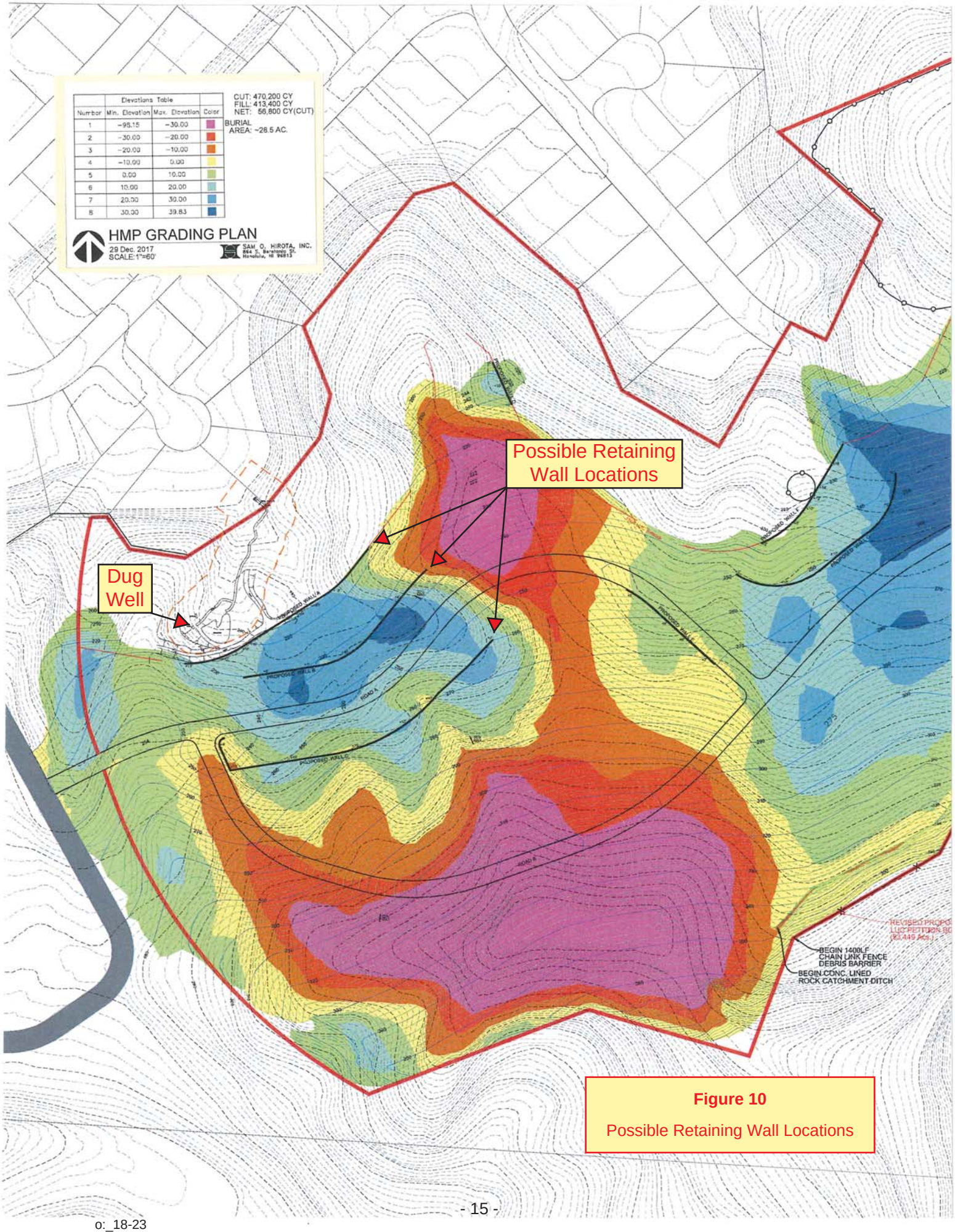

Figure 10

Possible Retaining Wall Locations

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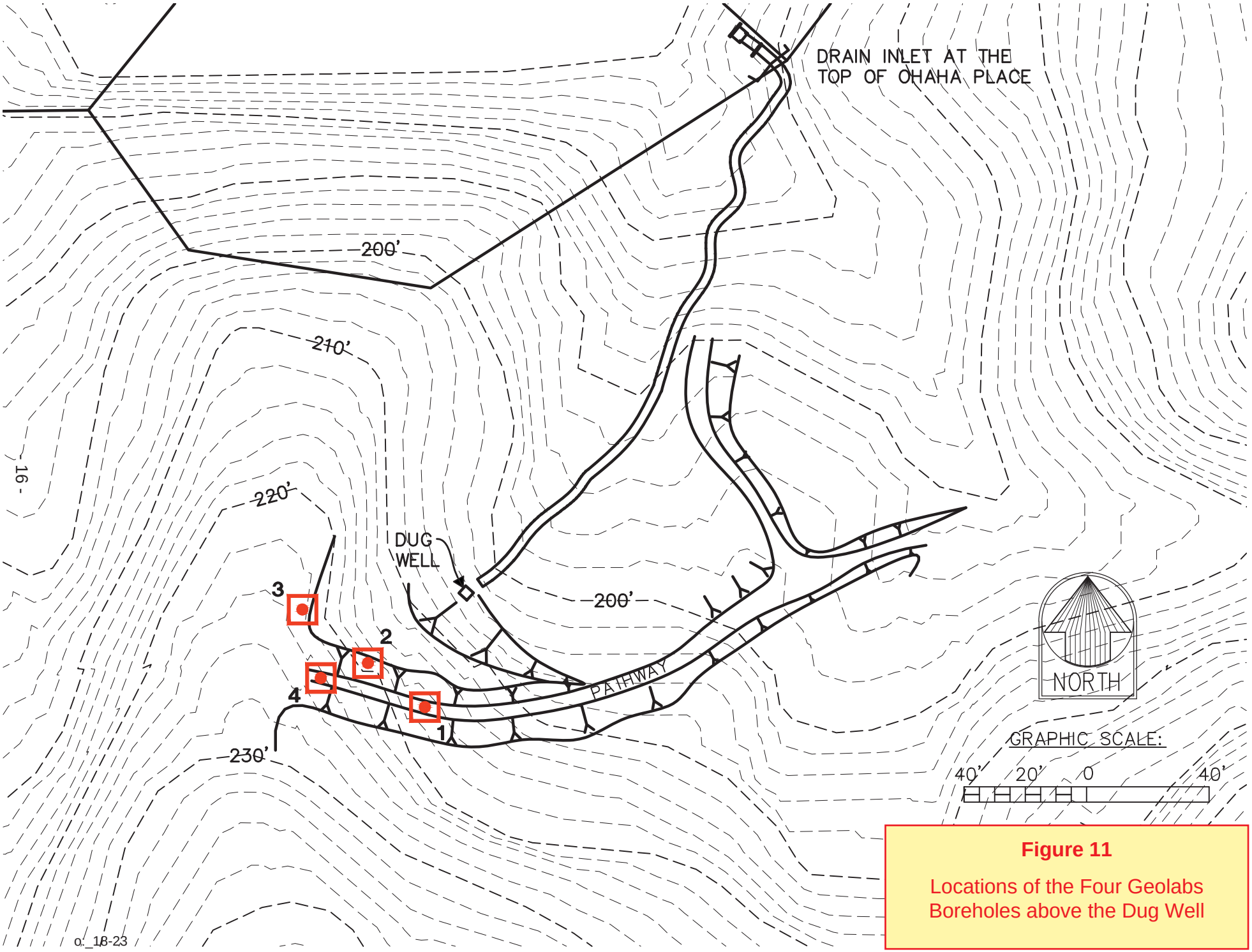


Figure 11

Locations of the Four Geolabs Boreholes above the Dug Well

Table 3. Water Level Measurements in the Four Boreholes by Geolabs, Inc.

BORING NO. 1 WATER LEVEL MEASUREMENTS		
DATE/TIME	**DEPTH TO WATER (FT.)**	**BOREHOLE DEPTH (FT.)**
3/20/18 0945 hrs.	11.2	22
3/20/18 1030 hrs.	10.5	22
3/20/18 1120 hrs.	9.9	22
3/21/18 0800 hrs.	9.8	19
3/21/18 1130 hrs.	9.9	19
3/21/18 1435 hrs.	9.8	19
3/22/18 0755 hrs.	9.8	19
3/22/18 1330 hrs.	9.7	19
3/23/18 0745 hrs.	9.7	19

BORING NO. 2 WATER LEVEL MEASUREMENTS		
DATE/TIME	**DEPTH TO WATER (FT.)**	**BOREHOLE DEPTH (FT.)**
3/20/18 1450 hrs.	11.8	23
3/21/18 0805 hrs.	10.5	18.5
3/21/18 1135 hrs.	10.3	18.5
3/21/18 1440 hrs.	10.4	18.5
3/22/18 0750 hrs.	10.5	18.5
3/22/18 1115 hrs.	10.3	18.5
3/22/18 1325 hrs.	9.5	18.5
3/23/18 0750 hrs.	10.3	18.5

BORING NO. 3 WATER LEVEL MEASUREMENTS		
DATE/TIME	**DEPTH TO WATER (FT.)**	**BOREHOLE DEPTH (FT.)**
3/21/18 1245 hrs.	Not Encountered	18.5
3/21/18 1430 hrs.	Not Encountered	18.5
3/22/18 0745 hrs.	15.2	18.5
3/22/18 1110 hrs.	15.3	18.5
3/22/18 1320 hrs.	14.6	18.5
3/23/18 0755 hrs.	15.5	18.5

BORING NO. 4 WATER LEVEL MEASUREMENTS		
DATE/TIME	**DEPTH TO WATER (FT.)**	**BOREHOLE DEPTH (FT.)**
3/22/18 1201 hrs.	15.1	22
3/22/18 1315 hrs.	13.3	22
3/23/18 0800 hrs.	13.5	20

Table 4. Elevations, Depths, and Water Levels in the Four Boreholes in Comparison to the Dug Well

Borehole Number	Approximate Ground Elevation (Ft. MSL)	Borehole Depth (Feet)	Approximate Elevation at Bottom (Ft. MSL)	Depth to Water (Feet)	Approximate Water Level (Ft. MSL)
1	217	22	195	10	207
2	218	23	195	10	208
3	222	19	203	15	207
4	224	19	205	13	211
Well	205	12	193	2	203

Figure 12. Water Level Response to the Siphon and Pump Test of the HMP Dug Well

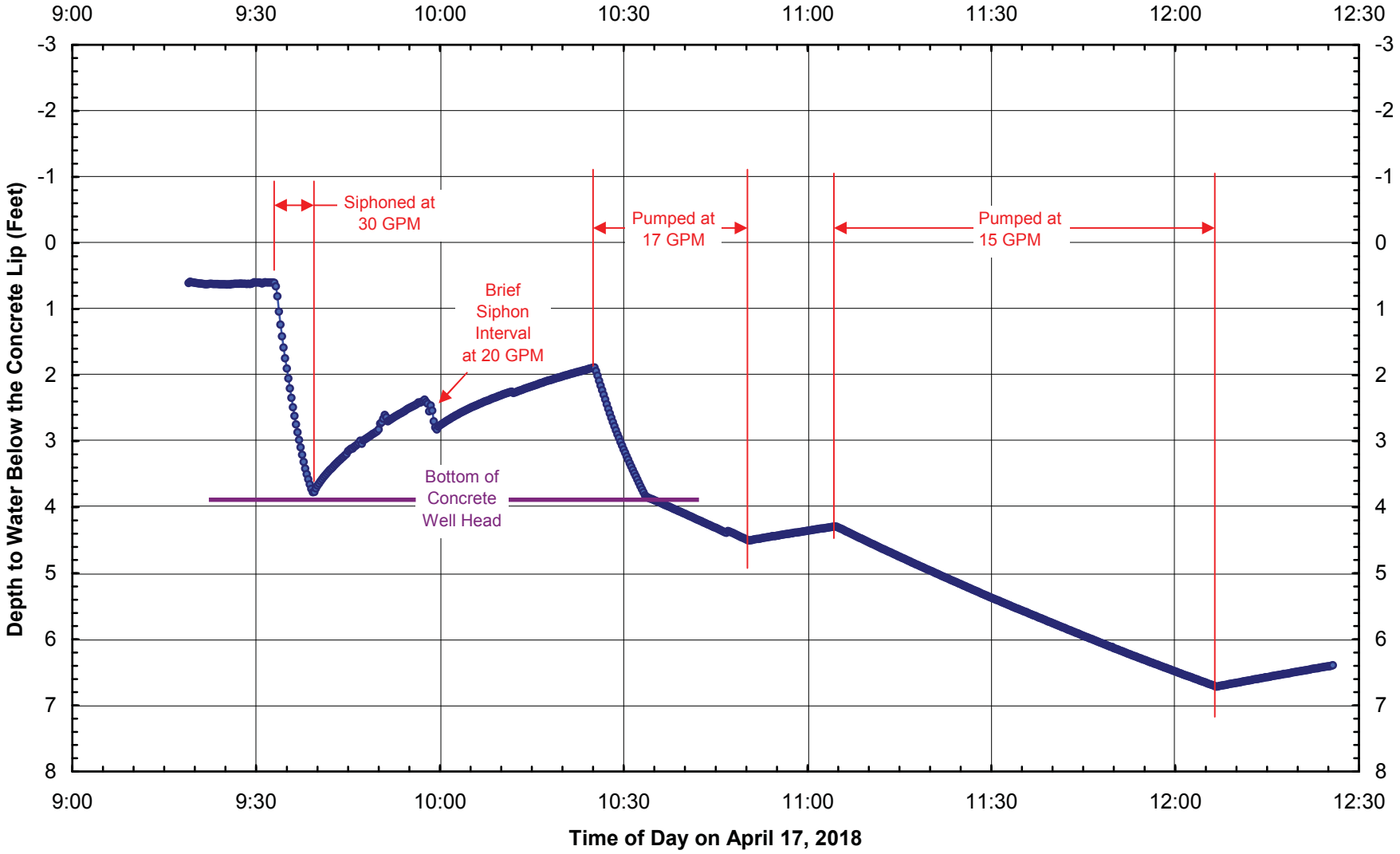
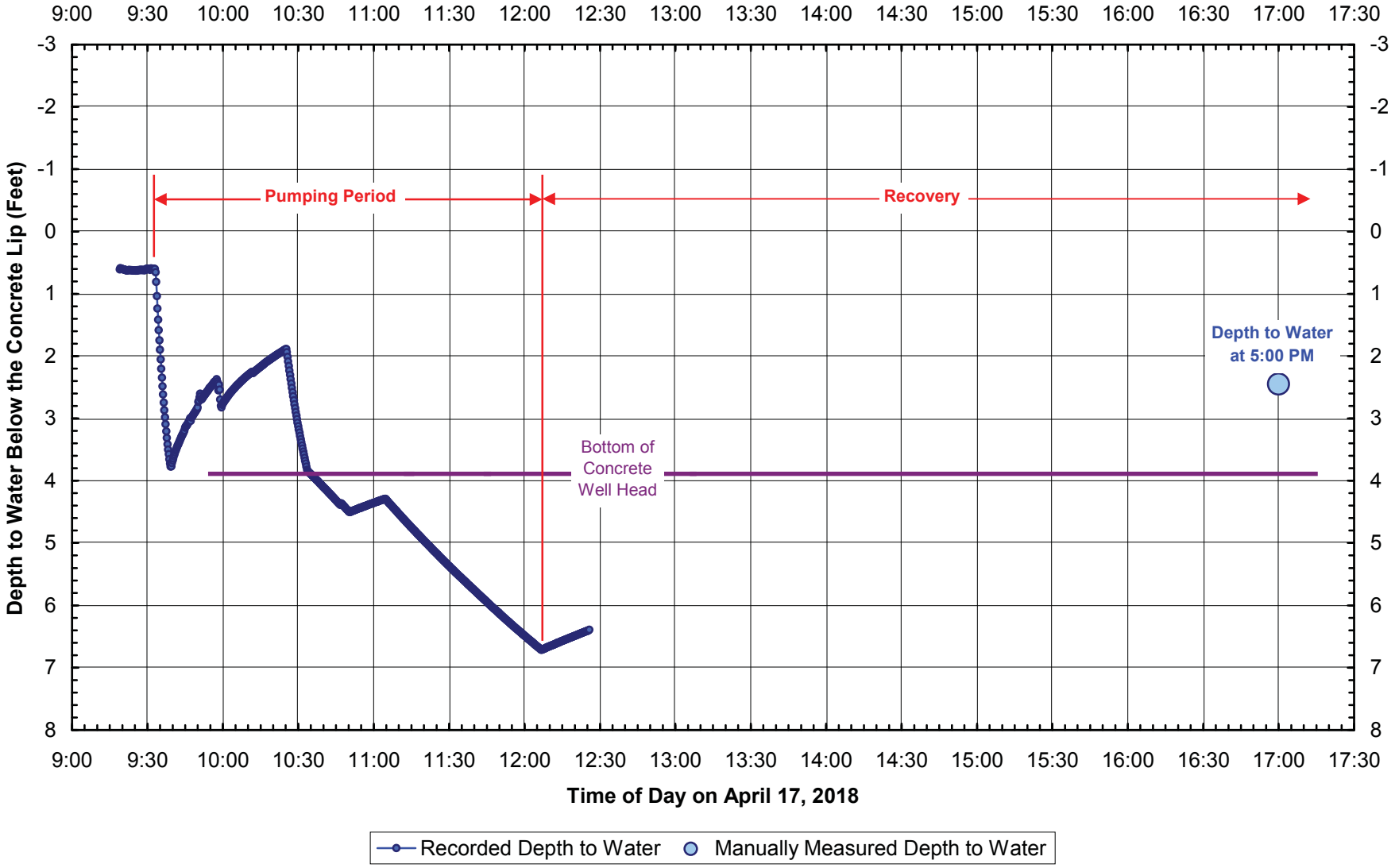


Figure 13. Manually Measured Recovered Water Level in the HMP Dug Well



- When the water level in the well was drawn down about halfway down the concrete well head, the seep that emerges about four feet downslope had stopped flowing. Clearly, the seep is maintained by subsurface leakage from the well.
- Over the period of intermittent siphoning and then pumping, a total of 1615 gallons was removed from the well. Assuming the 7-foot wide borehole below the concrete is approximately round, 950 gallons was removed from storage in the well itself and the remaining 665 gallons flowed from the formation into the well. That inflow was at an average of about 4.3 GPM.
- The recovered water level was manually measured at 5:00PM (Figure 13). The water level had risen up inside the concrete well head, but not high enough to have started flow in the downstream seep. Average inflow to the well from the time pumping was stopped at 12:07PM until the 5:00PM measurement was approximately 3.1 GPM.
- The well's water level was checked at 9:30AM on the day following (April 18th). The water level had fully recovered (actually to a level 0.1-foot higher than at the start of the test the day before). The seep below the well was fully restored at that time.

Summary of Findings, Conclusions, and Recommendations

1. The entire Petition Area overlies on a geologic formation known as the Kailua series volcanics. These caldera-filling volcanics are virtually impermeable. As such, none of the proposed actions within the Petition Area have the potential to impact ongoing or possible future uses of groundwater drawn from the permeable Koolau volcanics of the Koolaupoko Aquifer System.

2. With regard to the perennial groundwater seep which has created the habitat for the damsel fly, field observations, the four boreholes drilled by Geolabs, Inc., and the test of the dug well have established the following regarding this groundwater occurrence:

   (a) The groundwater seep is maintained by the natural discharge of groundwater moving downslope through the poorly permeable residual soils overlying the unweathered Kailua volcanics at depth.

   (b) In the vicinity of the dug well and the four Geolabs boreholes upslope from the wells, the groundwater is actually semi-confined. The groundwater movement is through soils at depths of 10 feet or more rather than through the surface soils.

   (c) The upper end of the seep begins about four (4) feet downslope of the dug well. Based on results of the well test, flow in the upper one third to one half of the linear seep is maintained by subsurface leakage from the well.

(d) Further downslope, flow in the seep increases continuously to its ultimate discharge into the Ohaha Place drainage system.

3. The proposed expansion into the Petition Area would include construction of a sequence of three (essentially parallel) retaining walls upslope of the dug well and perennial seep (Walls A, B, and C on Figure 10) and fill heights of 10 to 30 feet behind these walls (depths of fill are color coded on Figure 10). The concern is that the retaining walls and/or the fill behind them may intercept, impede, or reroute the groundwater flow that maintains the perennial seep and thereby diminish or destroy the damsel fly habitat. This potential impact is addressed in the following:

(a) Based on the groundwater occurrence established by the four Geolabs borings and the dug well, the footings of the proposed retaining walls would be too shallow to intercept the groundwater moving downslope. The walls and the fill behind them will have subsurface drains (Geolabs Inc., 2018: page 30 and Plate 6), but these will be too shallow to intercept the groundwater which maintains the downslope seep.

(b) Loading by the fill behind the retaining walls does have the potential to compress the soils below through which the groundwater is moving downslope. As such, this loading could reduce the permeability of these already poorly permeable soils, impeding or re-routing the downslope direction of the groundwater flow.

(c) To ensure that the quantity and direction of groundwater flow is maintained, at least two and possibly three deeper subsurface drains should be constructed. These would be aligned approximately perpendicular to the retaining walls and installed at depths to intercept and convey the flow of groundwater to the dug well seep. Their possible alignments are shown conceptually on Figure 14. Their exact locations, alignments, and depths would be determined with the drilling of additional boreholes in the project's design phase.

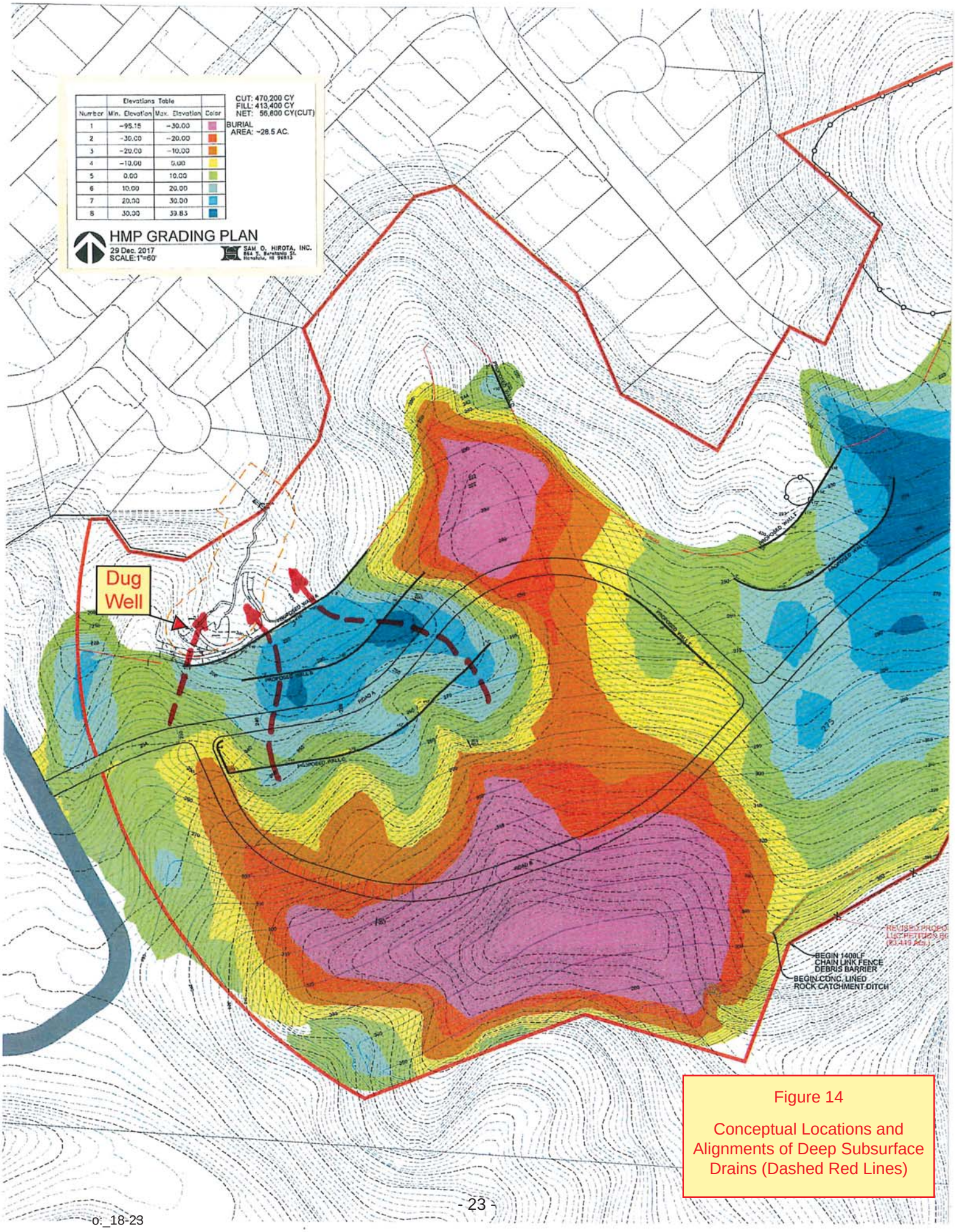


Figure 14

Conceptual Locations and Alignments of Deep Subsurface Drains (Dashed Red Lines)

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Appendix

A. Photos of the Dug Well and Seep Taken on March 30, 2018

B. Logs of the Boreholes Drilled Above the Dug Well and Seep by Geolabs, Inc.

C. Logs of the B-1 and B-2 Boreholes Drilled in Ocean View Garden by Geolabs, Inc.

Appendix A

Photos of the Dug Well and Seep
Taken on March 30, 2018

View of the Concrete Top of the Well
Note the Water Level in Relation to the Adjacent Ground Level

View of the Top of the Well from the Other Side
Note Tree Growth into the Well

Relationship of the Well to the Emergent Seep Four Feet Downslope

Flow from the Seep to the Adjacent Subdivision's Drain Inlet

Appendix B

Logs of the Boreholes Drilled Above the Dug Well and Seep
by Geolabs, Inc.

PLog

GEOLABS, INC.

Geotechnical Engineering

GROUNDWATER SPRING DISCHARGE
Hawaiian Memorial Park

Log of Boring 1

Approximate Ground Surface Elevation (feet): 218 *
Latitude:21.39464
Longitude: -157.7887

Drilling Notes	Field: Sample Quality	Field: Rec. Length/ Sample Length (inches)	Field: RQD Length/ Sample Length (inches)	Field: Blows/ 6"	Field: Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
	Good	10/18"		3/8/11					MH	Orangish brown **CLAYEY SILT**, stiff to very stiff, moist (residual soil)
	Fair	23/24"		5/7/10/13						
						5			CH	Mottled orangish brown and gray **SILTY CLAY**, very stiff, moist (residual soil)
	Good	16/18"		6/10/13					MH	Mottled orangish brown with some gray **CLAYEY SILT**, stiff to very stiff, moist (residual soil)
	Fair	23/24"		3/5/6/9						
						10				grades with gray silty clay seams locally
	Good	15/18"		8/10/12						grades with decomposed gravel
									SM	Brown with trace gray **SILTY SAND (BASALTIC)**, loose to medium dense, very moist to wet (saprolite)
	Fair	22/24"		1/2/1/2		15				
										grades with sandy silt
	Fair	23/24"		2/5/6/4		20			ML	Gray with some brown **CLAYEY SILT** with some fine sand, stiff, moist (residual soil)
										Boring terminated at 22 feet
						25				
						30				
						35				

Date/Time Started:	March 19, 2018 10:45	Water Level: ▼ 9.1 ft. 03/22/2018 1330 HRS	
Date/Time Completed:	March 20, 2018 11:20		
Logged By:	S. Latronic	Driller Name:	K. Vongamath
Project Engineer:	Steven Carr	Drill Rig:	MINUTEMAN
Total Depth:	22 feet	Drilling Method:	3" Solid Stem Auger
Work Order:	7604-10	Driving Energy:	140 lb. wt., 30 in. drop

Plate

BORING LOG DRAFT 7604-10.GPJ GEOLABS.GDT 3/23/18

PLog

GEOLABS, INC.

Geotechnical Engineering

GROUNDWATER SPRING DISCHARGE
Hawaiian Memorial Park

Log of Boring

2

Approximate Ground Surface Elevation (feet): 220 *
Latitude:21.39451
Longitude: -157.78868

Drilling Notes	Field: Sample Quality	Field: Rec. Length/ Sample Length (inches)	Field: RQD Length/ Sample Length (inches)	Field: Blows/ 6"	Field: Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
	Good	10/18"		5/9/15					MH	Orangish brown with trace gray **CLAYEY SILT**, stiff to very stiff, moist (residual soil)
	Fair	16/24"		5/6/5/7						
						5				grades with gray silty clay seams locally
	Good	10/18"		5/8/13						
						10			CH	Gray with trace brown **FAT CLAY**, stiff, moist (residual soil)
	Fair	24/24"		2/4/4/3					MH	Brown with some gray **CLAYEY SILT**, stiff, moist to very moist (residual soil)
						15				grades with gravel (basaltic)
	Good	16/18"		4/8/11					CH	Mottled brown and gray **SILTY CLAY**, stiff to very stiff, moist (residual soil)
						20				
	Fair	24/24"		3/5/6/6					SM	Brown **SILTY SAND (BASALTIC)** with some decomposed gravel, medium dense, very moist to wet (saprolite)
						25				Boring terminated at 23 feet
						30				
						35				

Date/Time Started:	March 20, 2018 11:30	Water Level: ▼ 9.5 ft. 03/22/2018 1325 HRS		Plate
Date/Time Completed:	March 20, 2018 15:30			
Logged By:	S. Latronic	Driller Name:	K. Vongamath	
Project Engineer:	Steven Carr	Drill Rig:	MINUTEMAN	
Total Depth:	23 feet	Drilling Method:	3" Solid Stem Auger	
Work Order:	7604-10	Driving Energy:	140 lb. wt., 30 in. drop	

BORING LOG DRAFT 7604-10.GPJ GEOLABS.GDT 3/23/18

PLog

GEOLABS, INC.

Geotechnical Engineering

GROUNDWATER SPRING DISCHARGE
Hawaiian Memorial Park

Log of Boring

3

Approximate Ground Surface Elevation (feet): 221 *
Latitude:21.39473
Longitude: -157.78871

Field: Drilling Notes	Sample Quality	Rec. Length/ Sample Length (inches)	RQD Length/ Sample Length (inches)	Blows/ 6"	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
	Good	10/18"		9/17/29					MH	Orangish brown **CLAYEY SILT**, stiff to very stiff, moist (residual soil)
	Fair	15/24"		6/6/6/9						
	Good	9/18"		5/10/10		5				
	Fair	14/24"		4/6/8/7		10			ML-MH	Mottled orangish brown to yellowish brown **CLAYEY SILT**, stiff, moist to very moist (residual soil)
	Good	16/18"		5/11/12		15				grades with decomposed gravel
	Fair	17/24"		6/9/10/13		20			CH	Brownish gray to gray **FAT CLAY**, stiff, very moist (residual soil)
										Boring terminated at 22 feet
						25				
						30				
						35				

Date/Time Started:	March 21, 2018 09:00	Water Level: ▼ 14.6 ft. 03/22/2018 1320 HRS	
Date/Time Completed:	March 21, 2018 14:50		
Logged By:	S. Latronic	Driller Name:	K. Vongamath
Project Engineer:	Steven Carr	Drill Rig:	MINUTEMAN
Total Depth:	22 feet	Drilling Method:	3" Solid Stem Auger
Work Order:	7604-10	Driving Energy:	140 lb. wt., 30 in. drop

Plate

BORING LOG DRAFT 7604-10.GPJ GEOLABS.GDT 3/23/18

PLog

GEOLABS, INC.

Geotechnical Engineering

GROUNDWATER SPRING DISCHARGE
Hawaiian Memorial Park

Log of Boring

4

Approximate Ground Surface Elevation (feet): 225 *
Latitude:21.3946
Longitude: -157.78868

Drilling Notes	Field: Sample Quality	Field: Rec. Length/ Sample Length (inches)	Field: RQD Length/ Sample Length (inches)	Field: Blows/ 6"	Field: Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
	Good	16/18"		11/13/26					MH	Orangish brown with trace yellowish brown **CLAYEY SILT**, stiff to very stiff, moist (residual soil)
	Fair	19/24"		8/8/10/9						
	Good	8/18"		8/9/12		5				grades with trace gray silty clay seams locally
	Fair	13/24"		3/4/5/7		10				grades with decomposed gravel
	Good	17/18"		4/7/8		15			CH	Brownish gray to gray **FAT CLAY**, stiff, moist to very moist (residual soil)
	Fair	24/24"		3/4/4/7		20				grades with brown clayey silt seams locally
										Boring terminated at 23 feet
						25				
						30				
						35				

Date/Time Started:	March 22, 2018 08:30	Water Level: ▼ 13.3 ft. 03/22/2018 1315 HRS		Plate
Date/Time Completed:	March 22, 2018 14:00			
Logged By:	S. Latronic	Driller Name:	K. Vongamath	
Project Engineer:	Steven Carr	Drill Rig:	MINUTEMAN	
Total Depth:	23 feet	Drilling Method:	3" Solid Stem Auger	
Work Order:	7604-10	Driving Energy:	140 lb. wt., 30 in. drop	

BORING LOG DRAFT 7604-10.GPJ GEOLABS.GDT 3/23/18

Appendix C

Logs of the B-1 and B-2 Boreholes Drilled in Ocean View Garden
by Geolabs, Inc.

GEOLABS, INC.

Geotechnical Engineering

PHASE I POTENTIAL ROCKFALL AND SLOPE HAZARD ASSESSMENT
HAWAIIAN MEMORIAL PARK CEMETERY EXPANSION
TMK: 4-5-033: 001
KANEOHE, OAHU, HAWAII

Log of Boring 1

Approximate Ground Surface Elevation (feet): 269 *

Laboratory: Other Tests	Laboratory: Moisture Content (%)	Laboratory: Dry Density (pcf)	Field: Core Recovery (%)	Field: RQD (%)	Field: Penetration Resistance (blows/foot)	Field: Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
	50	62			12	4.0				MH	Orangish brown **CLAYEY SILT** with a little gravel (basaltic), very stiff, moist (fill)
	54				5					MH	Mottled orangish brown **CLAYEY SILT** with some sand, very stiff, moist (residual soil)
Direct Shear	56	62			9	4.0	5			MH	Mottled orangish brown with some dark gray **CLAYEY SILT** with some sand and traces of decomposed gravel, stiff to very stiff, moist (saprolite)
LL=72 PI=22	62				6		10				
TXCU					7	4.0	15				grades with yellowish brown mottling locally
	49				17		20				grades more clayey locally
	53	70			24	4.0	25				
LL=79 PI=30	59				11		30				
							35				

Date Started:	October 12, 2017	Water Level: ▼	Not Encountered	Plate
Date Completed:	October 12, 2017			
Logged By:	S. Latronic	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 78%)*	A - 1.1
Total Depth:	46.5 feet	Drilling Method:	4" Solid Stem Auger	
Work Order:	7604-00	Driving Energy:	140 lb. wt., 30 in. drop	

BORING_LOG 7604-00.GPJ GEOLABS.GDT 1/3/18

GEOLABS, INC. Geotechnical Engineering	PHASE I POTENTIAL ROCKFALL AND SLOPE HAZARD ASSESSMENT HAWAIIAN MEMORIAL PARK CEMETERY EXPANSION TMK: 4-5-033: 001 KANEOHE, OAHU, HAWAII	Log of Boring 1

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
											(Continued from previous plate)
Direct Shear	55	69			18	2.3				MH	
	51				10		40				grades with highly weathered basalt corestones locally
LL=66 PI=33	48				15		45				grades to very moist Boring terminated at 46.5 feet * Elevations based on available Grading Plan for Ocean View Gardens.
							50				
							55				
							60				
							65				
							70				

Date Started:	October 12, 2017	Water Level: ▼	Not Encountered	Plate
Date Completed:	October 12, 2017			
Logged By:	S. Latronic	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 78%)*	A - 1.2
Total Depth:	46.5 feet	Drilling Method:	4" Solid Stem Auger	
Work Order:	7604-00	Driving Energy:	140 lb. wt., 30 in. drop	

BORING_LOG 7604-00.GPJ GEOLABS.GDT 11/30/17

GEOLABS, INC.

Geotechnical Engineering

PHASE I POTENTIAL ROCKFALL AND SLOPE HAZARD ASSESSMENT
HAWAIIAN MEMORIAL PARK CEMETERY EXPANSION
TMK: 4-5-033: 001
KANEOHE, OAHU, HAWAII

Log of Boring 2

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
											Approximate Ground Surface Elevation (feet): 263 *
	34	82			40	4.5				MH	Brown **CLAYEY SILT** with some sand and traces of gravel (basaltic), very stiff to hard, moist (fill)
LL=66 PI=29	34				30						
	32	86			34	4.5	5				
	37				40					MH	Mottled orangish brown **CLAYEY SILT**, very stiff to hard, moist (residual soil)
LL=65 PI=8	35	77			68	4.5	10			MH	Mottled grayish brown with some orange **CLAYEY SILT** with some sand and a little decomposed gravel, hard, moist (saprolite)
	55				6		15			MH	Mottled orangish brown **CLAYEY SILT** with some sand, stiff to very stiff, moist (saprolite)
Direct Shear	54	50			16	3.5	20				grades more sandy locally
LL=81 PI=21	65				5		25				
Direct Shear	71	57			13	2.3	30				grades more clayey
							35				

Date Started:	October 12, 2017	Water Level: ▼	Not Encountered	Plate
Date Completed:	October 12, 2017			
Logged By:	S. Latronic	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 78%)*	A - 2.1
Total Depth:	46.5 feet	Drilling Method:	4" Solid Stem Auger	
Work Order:	7604-00	Driving Energy:	140 lb. wt., 30 in. drop	

BORING_LOG 7604-00.GPJ GEOLABS.GDT 11/30/17

GEOLABS, INC. Geotechnical Engineering	PHASE I POTENTIAL ROCKFALL AND SLOPE HAZARD ASSESSMENT HAWAIIAN MEMORIAL PARK CEMETERY EXPANSION TMK: 4-5-033: 001 KANEOHE, OAHU, HAWAII	Log of Boring 2

Laboratory			Field							
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	(Continued from previous plate) Description
	50				17					MH	Mottled yellowish brown and gray **CLAYEY SILT** with a little gravel (basaltic) and remnant rock structure, very stiff, moist (saprolite)
	44	77			26	3.5	40				
											grades with highly weathered basalt corestones locally
	23				19		45				grades more silty
											Boring terminated at 46.5 feet
							50				
							55				
							60				
							65				
							70				

Date Started:	October 12, 2017	Water Level: ▼	Not Encountered	Plate
Date Completed:	October 12, 2017			
Logged By:	S. Latronic	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 78%)*	A - 2.2
Total Depth:	46.5 feet	Drilling Method:	4" Solid Stem Auger	
Work Order:	7604-00	Driving Energy:	140 lb. wt., 30 in. drop	

BORING_LOG 7604-00.GPJ GEOLABS.GDT 11/30/17