December 15, 2017

City of Palo Alto
Santa Clara Valley Water District
City of Mountain View

Advanced Water Purification System Preliminary/Conceptual Design Report

PREPARED BY:

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City of Palo Alto, Santa Clara Valley Water District,

and City of Mountain View

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Contents

TABLES

FIGURES

ACRONYMS

µg/l	Micrograms per liter
A	Ampere(s)
AACE	Association for the Advancement of Cost Engineering
AF	Acre-foot
AFY	Acre-feet per year
ARB	Architectural Review Board
asl	Above sea level
AWPS	Advanced Water Purification System
Bay	San Francisco Bay
BW	Backwash
BWW	Backwash water
CEB	Chemically enhanced backwash
CEQA	California Environmental Quality Act
cfm	Cubic feet per minute
CIP	Capital Improvement Plan
CIP	Clean-in-place
City	City of Palo Alto
CMLDI	Cement-mortar lined ductile iron
CPAU	City of Palo Alto Utilities
CPU	Central processing unit
DDW	California Division of Drinking Water
E	Electrical
(E)	Existing
EIR	Environmental Impact Report
EPP	Emergency power panel
ERW	Enhanced recycled water
EUSERC	Electric Utility Service Equipment Requirements Committee
FEMA	Federal Emergency Management Agency
FEP	Fluorinated ethylene propylene
FO	Fiber optic
FRP	Fiber-reinforced plastic
ft	Foot (feet)
FTE	Full-time equivalent
G	Gas
gal	Gallon(s)
GFD	Gallons per square foot per day
GPD	Gallons per day

GPM	Gallons per minute
GRS	Galvanized rigid steel
H	Height
HDPE	High-density polyethylene
HMI	Human machine interface
HOA	Hand-off-auto
hp	Horsepower
HV	High voltage
ID	Identification
in	Inch(es)
I/O	Input/Output
IPR	Indirect Potable Reuse
IRR	Irrigation
kg/d	Kilograms per day
kV	Kilovolt(s)
kVA	Kilovolt-Ampere(s)
kW	Kilowatt(s)
kWh	Kilowatt hour(s)
LAN	Local area network
LCP	Local Control Panel
LED	Light-emitting diode
LID	Low impact design
LPC	Low pin count
LV	Low voltage
Marsh	Renzel Marsh
MCC	Motor control center
MF	Microfiltration
MG	Million gallons
MGD	Million gallons per day
mg/l	Milligrams per liter
MH	Maintenance hole
Mountain View	City of Mountain View
MTS	Manual transfer switch
NA	Not available
NaCl	Sodium Chloride
NAVD88	North America Vertical Datum of 1988
NEMA	National Electrical Manufacturer Association
NF	Nanofiltration

NFIP	National Flood Insurance Program
NHPA	National Historic Preservation Act
NNLI	No net loading increase
No.	Number
NOI	Notice of Intent
NO_x	Nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometric turbidity unit
OA/OE	Owner's Agent/Owner's Engineer
O&M	Operations and Maintenance
P	Phase
PBX	Private branch exchange
PES	Polyether sulfone
PFA	Perfluoroalkoxy
PLC	Programmable logic controller
ppbv	Parts per billion by volume
ppm	Parts per million
ppmv	Parts per million by volume
PR	Potable Reuse
PS	Pump station
PTC	Planning and Transportation Commission
PVC	Polyvinyl chloride
PVDF	Polyvinylidene difluoride
PW	Plant Water
RFP	Request for Proposals
RFQ	Request for Qualifications
RIO	Remote Input/Output
RO	Reverse Osmosis
RW	Recycled water
RWP	Recycled Water Project
RWQCP	Regional Water Quality Control Plant
SCADA	Supervisory control and data acquisition
SCFM	Standard Cubic Feet per Minute
SCVWD	Santa Clara Valley Water District
SD	Storm drain
SF	Square feet
SFBRWQCB	San Francisco Bay Regional Water Quality Control Board
SL	Street light

SS	Sanitary sewer or Stainless Steel
SSA	Abandoned sanitary sewer
SWBD	Switch board
SWPPP	Storm Water Pollution Prevention Plan
TDS	Total dissolved solids
TOC	Total organic carbon
TYP	Typical
UF	Ultrafiltration
UPS	Uninterruptible Power Supply
USFWS	United States Fish and Wildlife Service
UTL	Utility
UV	Ultraviolet
UV/AOP	Ultraviolet Treatment with Advanced Oxidation
UVT	Ultraviolet Transmittance
V	Volt(s)
VFD	Variable frequency drive
VLT	Vault
VOIP	Voice-over internet protocol
W	Water, Watt(s)
WRC	Recycled water system line

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Executive Summary

The City of Palo Alto (City) provides tertiary-treated recycled water to the communities of Los Altos, Los Altos Hills, Stanford University, and East Palo Alto Sanitary District via truck-fill stations and to the City of Mountain View (Mountain View) and Palo Alto via hard piped transmission systems. To improve the quality of this water, particularly the level of total dissolved solids (TDS), the City, in collaboration with Santa Clara Valley Water District (SCVWD) and the City of Mountain View, is interested in implementing an Advanced Water Purification System (AWPS) to initially provide 1.125 million gallons per day (MGD) of permeate, with an option to expand production to 2.25 MGD. The permeate from the AWPS will be blended at a 1:1 ratio with tertiary-treated recycled water from the Regional Water Quality Control Plant (RWQCP) to produce enhanced recycled water (ERW) to serve customers.

This Preliminary/Conceptual Design Report develops the recommended project from the Advanced Water Purification System Feasibility Study (MNS Engineers, May 2017) to a 10 percent design level with additional design criteria and concepts and refines the project costs to an Association for the Advancement of Cost Engineering (AACE) Class 3 level (-20 percent to +30 percent accuracy) for budgetary purposes. The following subsections summarize the project components, describe permitting and compliance with the California Environmental Quality Act (CEQA), and provide preliminary construction costs and implementation schedules.

0.1. Treatment Facilities

The AWPS includes pre-treatment using either microfiltration (MF) or ultrafiltration (UF) followed by reverse osmosis (RO), chemical dosing equipment, and ancillary systems. The conceptual design includes scalability of the treatment system to expand from Phase 1 – 1.125-MGD AWPS to Phase 2 – 2.25-MGD AWPS. Table ES-1 shows the AWPS process mass balance flow rates for the major treatment systems.

Table ES-1: AWPS Process Mass Balance

	Units	1.125 MGD	2.25 MGD
MF Feed	MGD	1.42	2.85
MF Backwash Return	MGD	0.10	0.20
MF Filtrate / RO Feed	MGD	1.32	2.65
RO Permeate	MGD	1.125	2.25
RO Concentrate	MGD	0.20	0.40

Drawing C2 Site Layout Plan shows the proposed layout of the facilities at Site 1 at the RWQCP. Design and performance criteria are included for the pre-treatment (assumed to be MF for simplicity) and RO systems. Anticipated chemical consumption in gallons per day (GPD) was estimated for the purpose of sizing chemical storage tanks. A decarbonator is provided after RO treatment to raise the pH of the permeate to reduce its corrosivity. Design and performance criteria for the decarbonator is included. Equipment needed for Phase 1 and additional equipment needed for Phase 2 is provided in Table ES-2.

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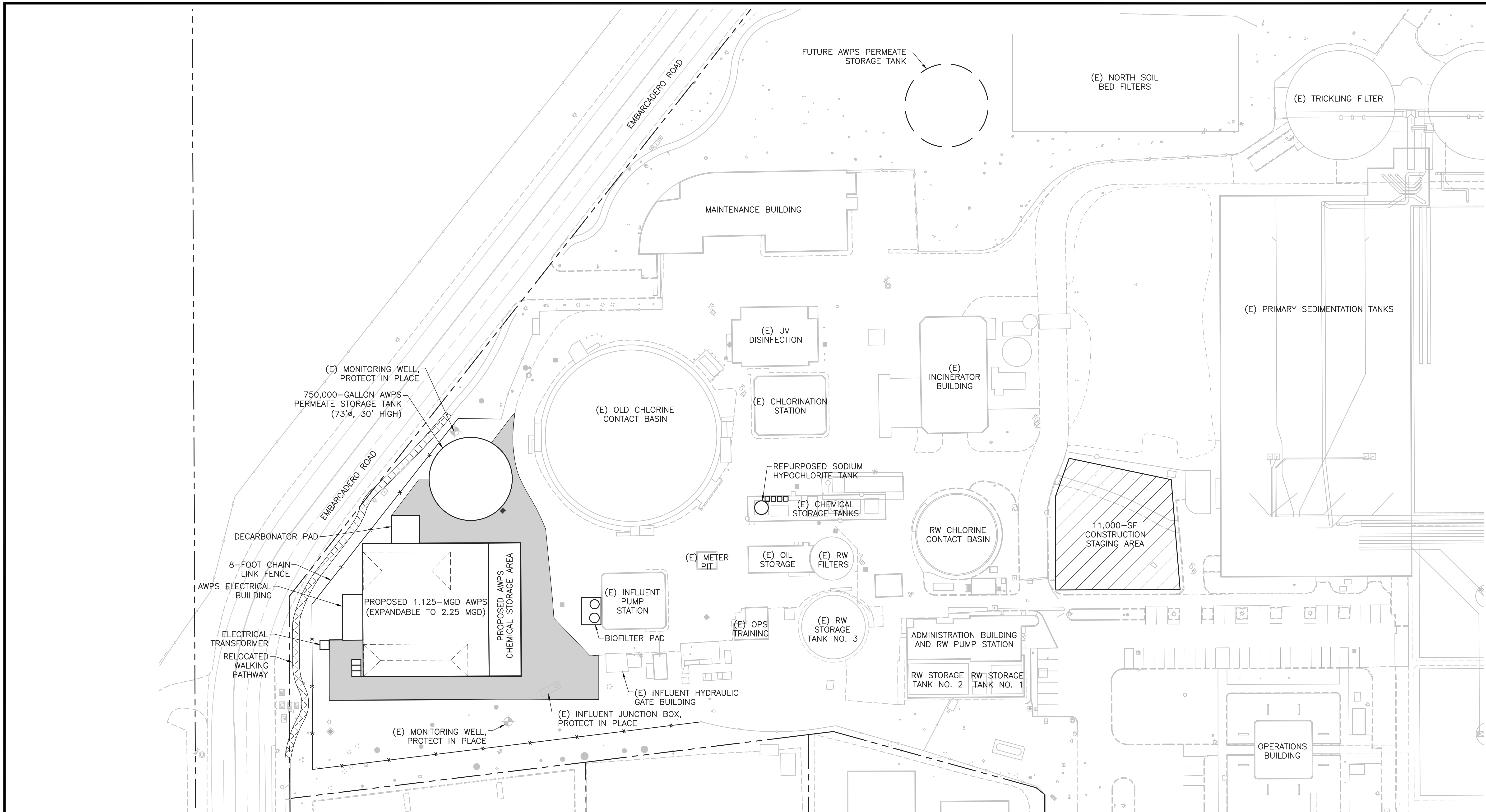

CONCEPTUAL DESIGN - NOT FOR CONSTRUCTION

LEGEND

- PROPERTY LINE
- EXISTING RWQCP FACILITY
- EXISTING EDGE OF PAVEMENT
- EXISTING FENCELINE
- EXISTING TREE
- PROPOSED CHAIN LINK FENCE
- PROPOSED AWPS FACILITY
- PROPOSED PAVEMENT
- RELOCATED WALKING PATHWAY

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DESIGNED BY NEP				
DRAWN BY SPP	REV.	DATE	DESCRIPTION	BY / APP
CHECKED BY JA	SITE LAYOUT PLAN			PUBLIC WORKS DEPT. RWQCP; SCALE: AS SHOWN
APPV'D BY	CITY OF PALO ALTO, CALIFORNIA; ADVANCED WATER PURIFICATION SYSTEM PRELIMINARY DESIGN			SHEET NO. C2

Table ES-2: Major AWPS Equipment Scaling Between Phase 1 and Phase 2

Equipment Description	Phase 1	Additional Equipment for Phase 2	Final	Size/Capacity
MF Feed Pumps	2 Duty, 1 Standby	2 Duty	4 Duty, 1 Standby	30 hp (each)
Backwash Pumps	1 Duty, 1 Standby	0	1 Duty, 1 Standby	30 hp (each)
MF Backwash/Filtrate Pumps to RO	2 Duty, 1 Standby	2 Duty	4 Duty, 1 Standby	25 hp (each)
Chemically Enhanced Backwash (CEB) Chlorination Feed System	2 Pumps, 1 Storage Tank	1 Pump	3 Pumps, 1 Storage Tank	0.17 hp (each) 1,000-gal Tank
CEB Citric Acid Feed System	2 Pumps, 1 Storage Tank	1 Pump	3 Pumps, 1 Storage Tank	0.17 hp (each) 750-gal Tank
CEB Caustic Feed System	2 Pumps, 1 Storage Tank	1 Pump	3 Pumps, 1 Storage Tank	0.17 hp (each) 500-gal Tank
Coagulant Feed System	2 Pumps, 1 Storage Tank	0	2 Pumps, 1 Storage Tank	0.17 hp(each) 1,000-gal Tank
Backwashable 150-micron Automatic Filter	1 Duty, 1 Standby	1 Duty	2 Duty, 1 Standby	1,200 GPM
MF Skid with Instrumentation	3	2	5	
Filtrate Tank to RO Unit	1 Tank	0	1 Tank	12 ft x 36 ft H
Clean-in-Place (CIP) System	2 Pumps, 1 Cleaning Tank	0	2 Pumps,1 Cleaning Tank	15 hp (each) 1,000-gal Tank
Air Compressor with Air Storage Tank	1 Duty, 1 Standby	0	1 Duty, 1 Standby	10 hp (each)
Decarbonator Tower/Clearwell	1	1	2	
Air Blower with Accessories	1 Duty, 1 Standby	1	2 Duty, 1 Standby	20 hp (each)

There is the potential to purchase used equipment or a containerized system; these options have advantages and disadvantages to be considered separately from this Preliminary/Conceptual Design Report.

0.2. Site Improvements

Site-specific geotechnical investigation, topographic survey, and potholing were not performed for the development of this Preliminary/Conceptual Design Report. A desktop geotechnical study was prepared, which included review of existing geotechnical studies and boring logs. The desktop study presented recommendations for equipment foundations and auger-cast displacement piles to support the permeate storage tank and clearwell. Over-excavation and importation of structural fill is recommended for the other facilities. Site-specific geotechnical exploration should be performed during the detailed design phase, as well as topographic survey and potholing of existing utilities.

Most of the site improvements for the AWPS accommodate Phase 1 – 1.125-MGD AWPS and Phase 2 – 2.25-MGD AWPS, with the exception of permeate storage. Drawing C3 Site Improvements Plan shows the recommended site improvements, which include:

- Construction of a 0.75-million-gallon (MG) RO permeate storage tank[1]
- Foundation for the AWPS equipment
- Canopies over the MF and RO equipment
- Relocation of the existing biofilter
- Utility relocations
- Yard piping
- Blending facilities for permeate and tertiary-treated recycled water
- Site grading and drainage
- Landscaping and irrigation

Additionally, piping to a future ultraviolet/advanced oxidation process (UV/AOP) facility to the southeast of the RWQCP can be accommodated in the event potable reuse of the treated water is implemented.

0.3. Electrical Improvements

The existing RWQCP is supplied with power through a 12-kilovolt (kV) power distribution ring around the site. A new electrical service from City of Palo Alto Utilities (CPAU) is provided for the AWPS from Embarcadero Road. The new service allows separation of electrical billing for the AWPS and simplifies construction. The anticipated electrical loads for Phase 1 – 1.125-MGD AWPS and Phase 2 – 2.25-MGD AWPS are provided in Table ES-3.

Table ES-3: Projected Electrical Operating Load

1.125 MGD AWPS (kVA)	2.25 MGD AWPS (kVA)
355	710

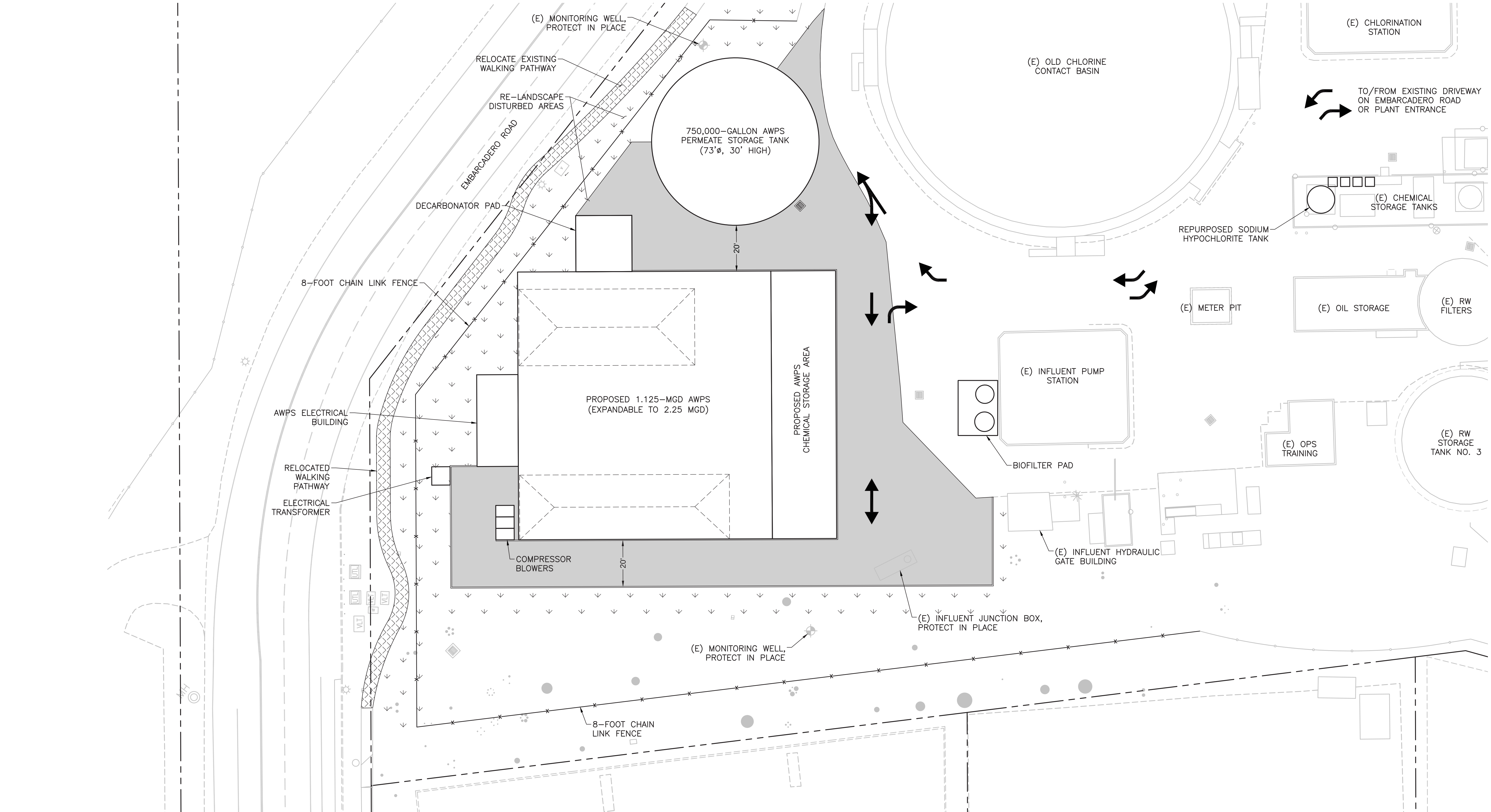
Drawing E1 12-kV Electrical Distribution shows the electrical distribution plan for the AWPS. Electrical design criteria are provided for the main switchboard, transformer, motor control center (MCC), and other major electrical equipment. A new electrical building will be constructed to the north of the AWPS.

An emergency generator is not included; a manual transfer switch is provided, with space to accommodate a portable generator. The expected generator supply is sized to perform a proper shut-down procedure of the AWPS and for system monitoring only; it is not expected to accommodate the full AWPS electrical load. CPAU has two portable generators which could potentially be used to provide temporary power, but further evaluation is required for this future use.

If back-up power were provided, it would enable the AWPS to produce advanced treated water during a power outage; it would not allow, however, distribution of recycled water to customers, as the recycled water pump station does not have back-up power.

Light-emitting diode (LED) lighting is provided outside the AWPS at a level no higher than street lighting, as well as under the canopy structure.

[1] The Feasibility Study identified Site 2 for the permeate storage facilities. Further refinement during this conceptual design report identified enough space at Site 1 for a Phase 1 storage tank. A storage tank for Phase 2 would be constructed at Site 2.



LEGEND

PROPERTY LINE	PROPOSED CHAIN LINK FENCE
EXISTING RWQCP FACILITY	PROPOSED AWPS FACILITY
EXISTING EDGE OF PAVEMENT	PROPOSED CURB
EXISTING FENCELINE	PROPOSED LANDSCAPING
EXISTING TREE	PROPOSED PAVEMENT
	RELOCATED WALKING PATHWAY
	TRAFFIC FLOW DIRECTION

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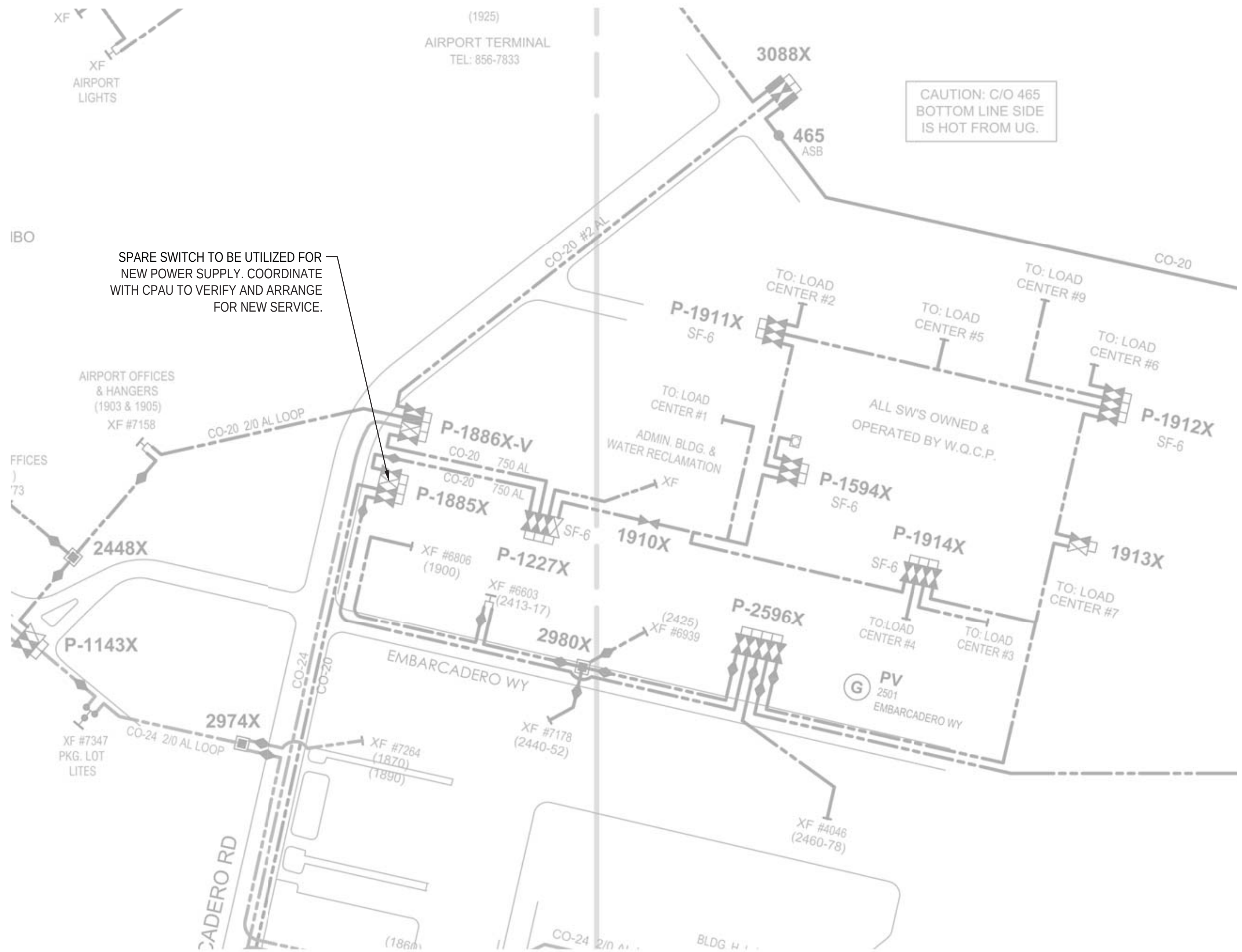
DRAWN BY SPP	REV.	DATE	DESCRIPTION	BY	APP
CHECKED BY JA	AWPS SITE IMPROVEMENTS PLAN				PUBLIC WORKS DEPT. RWQCP
					SCALE: AS SHOWN
APPV'D BY	CITY OF PALO ALTO CALIFORNIA				SHEET NO. C3
	ADVANCED WATER PURIFICATION SYSTEM PRELIMINARY DESIGN				



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AWPS SITE 1
12KV ELECTRICAL DISTRIBUTION

PUBLIC WORKS DEPT. RWQCP

SCALE: AS SHOWN

CITY OF PALO ALTO
CALIFORNIA

ADVANCED WATER PURIFICATION SYSTEM PRELIMINARY DESIGN

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0.4. Controls and Communications

A preliminary control system network architecture drawing is shown in Drawing I1 Concept Network Diagram. The AWPS includes a high level of automation. An operator work station is provided in a control room adjacent to the electrical room. Monitoring and control is also available from the RWQCP Control Room and operator workstations throughout the facility.

The programmable logic controllers (PLCs) are Allen Bradley and interface transparently with Allen Bradley ControlLogix PLCs for the plant. The PLCs connect on a fiber ring which utilizes communications between PLCs without requirement for operation of the servers or supervisory control and data acquisition (SCADA) network level.

The design criteria include provision of spare capacity at each input/output (I/O) module and at the PLC. Spare equipment is specified for PLC I/O cards, backplane, central processing unit (CPU), and power supply.

The AWPS will have a standalone SCADA system with a local historian, but the full screens and data are also available remotely from the RWQCP Administration Building.

0.5. Operational Considerations

Ideally the AWPS will operate continuously. During periods when demand is low, there are several strategies the City can consider:

- Continue to operate the AWPS at the minimum continuous production capacity of approximately 0.5 MGD, and produce a higher quality (lower TDS) ERW.
- Continue to operate the AWPS at the minimum continuous production capacity of approximately 0.5 MGD, and overflow the RO permeate tank to the outfall.
- Cycle the AWPS system on/off several times a day during the duration of the extreme reduced demand period. While this mode of operation is not preferable for an MF/RO system, it can be done with extra operator attention and care. This mode of operation is inefficient, as it requires frequent flushing with RO permeate, and can lead to more frequent membrane cleanings due to increased biofouling.

0.6. Permits and CEQA Compliance

Impacts to the City's existing National Pollutant Discharge Elimination System (NPDES) discharge permit for the RWQCP, as well as potential discharge limitations for a future permit, were evaluated for the implementation of an AWPS, specifically for the nutrients and non-nutrients in concentrate produced from an RO treatment system. The analysis showed although concentrations are elevated in the RO concentrate, maximum daily final effluent concentrations after blending are not projected to exceed the maximum daily water quality criteria in the City's existing NPDES permit for a 1.125- and 2.25-MGD AWPS for all permit parameters.

While there are currently no NPDES permit limits for nutrients except ammonia, the City has been advised water quality criteria for nutrients may become applicable in future NPDES permit renewals. The following analyses in Figures ES-1 and ES-2 estimate the AWPS capacity which would cause an exceedance of the potential limits for total nitrogen (as N) and total phosphorus (as P) loading to the San Francisco Bay (Bay), respectively.

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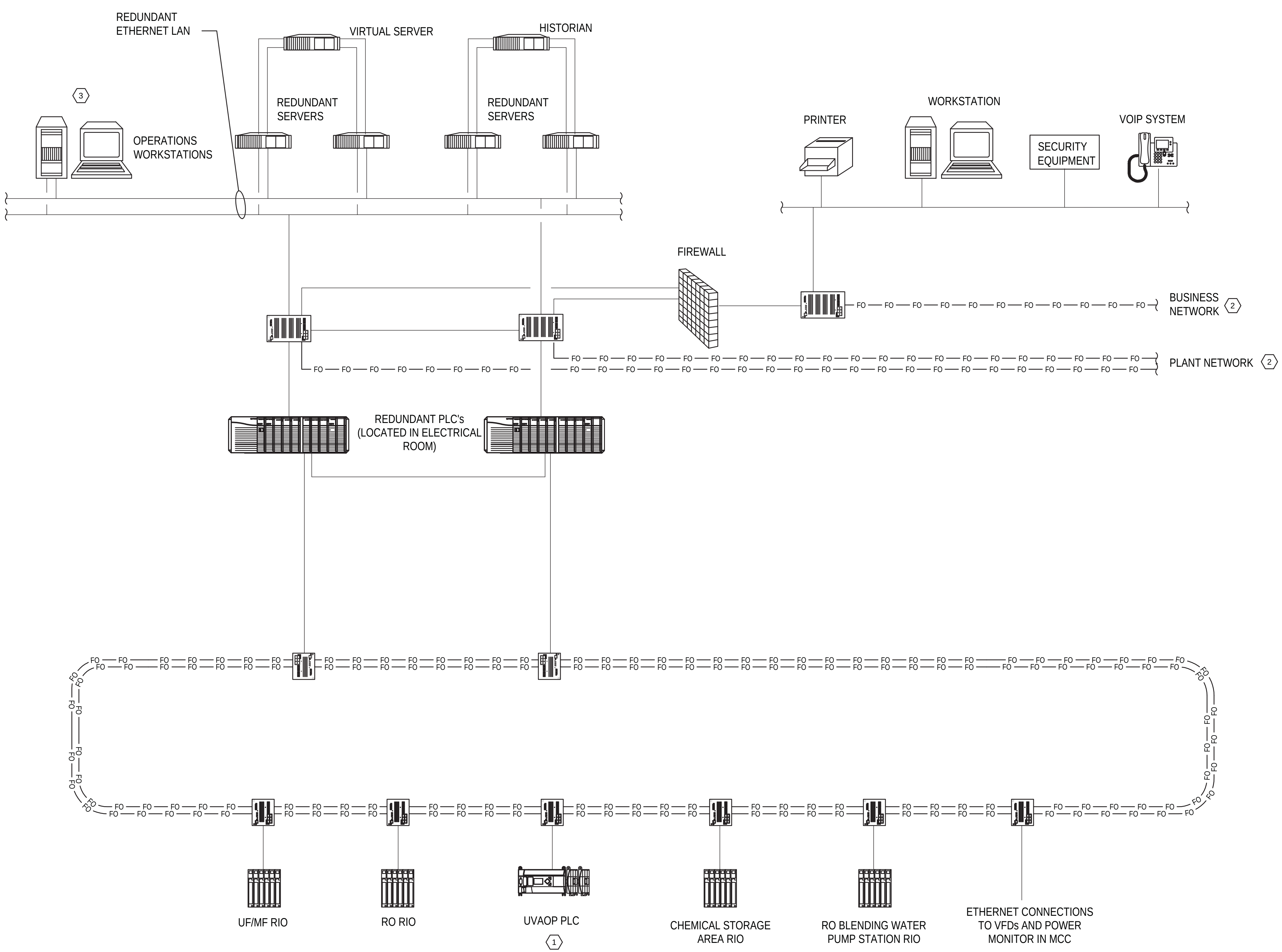

GENERAL NOTES

1. TYPICAL ARRANGEMENT TO INDICATE CONTROL SYSTEM INTENT. SOME EQUIPMENT MAY NOT BE SHOWN. DESIGNER SHALL INCORPORATE ALL NECESSARY EQUIPMENT FOR A FUNCTIONING SYSTEM.

KEYNOTES

1. UV SYSTEM PACKAGE TYPICALLY OFFERED WITH OTHER A-B CONTROLLERS SUCH AS COMPACTLOGIX OR MICROLOGIX. THE DESIGNER SHALL CONSIDER WHETHER ANY OTHER PACKAGE SYSTEMS REQUIRE SEPARATE PLCs OR WHETHER UV SYSTEMS AND OTHERS CAN BE INTEGRATED INTO THE PLANT CONTROLLER. IDEALLY THE PROGRAMMING FOR ALL CONTROLLERS WILL BE ACCESSIBLE FROM THE OPERATOR WORKSTATION WITH AN ENGINEER LOGIN AND WILL NOT BE RESTRICTED ACCESS DUE TO PROPRIETARY SYSTEMS.
2. FIBER OPTIC TO EXTEND TO ADMINISTRATION BUILDING. EQUIPMENT IN ADMINISTRATION BUILDING TO BE PROVIDED BY THE WATER QUALITY CONTROL PLANT (WQCP).
3. PROVIDE OPERATIONS WORKSTATION WITH OPERATOR AND DEVELOPMENT LOGIN. SECURE LOGIN FOR DEVELOPMENT SOFTWARE TO RESTRICT DEVELOPMENT ACCESS TO AUTHORIZED ENGINEERS ONLY.

LEGEND

- WORK STATION
- RACK-MOUNT SERVER
- REMOTE IO
- PROGRAMMABLE LOGIC CONTROLLER
- PROGRAMMABLE LOGIC CONTROLLER (VENDOR PACKAGE SYSTEM)
- FIBER OPTIC ETHERNET SWITCH (TYP)
- FIBER OPTIC ETHERNET SWITCH/HUB (TYP)
- VOICE OVER INTERNET PROTOCOL (VOIP) TELEPHONE HANDSET
- TWISTED PAIR ETHERNET CABLE
- FIBER OPTIC CABLE

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AWPS SITE 1
CONCEPT NETWORK DIAGRAM

PUBLIC WORKS DEPT. RWQCP

SCALE: AS SHOWN

CITY OF PALO ALTO
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ADVANCED WATER PURIFICATION SYSTEM PRELIMINARY DESIGN

SHEET NO. I1

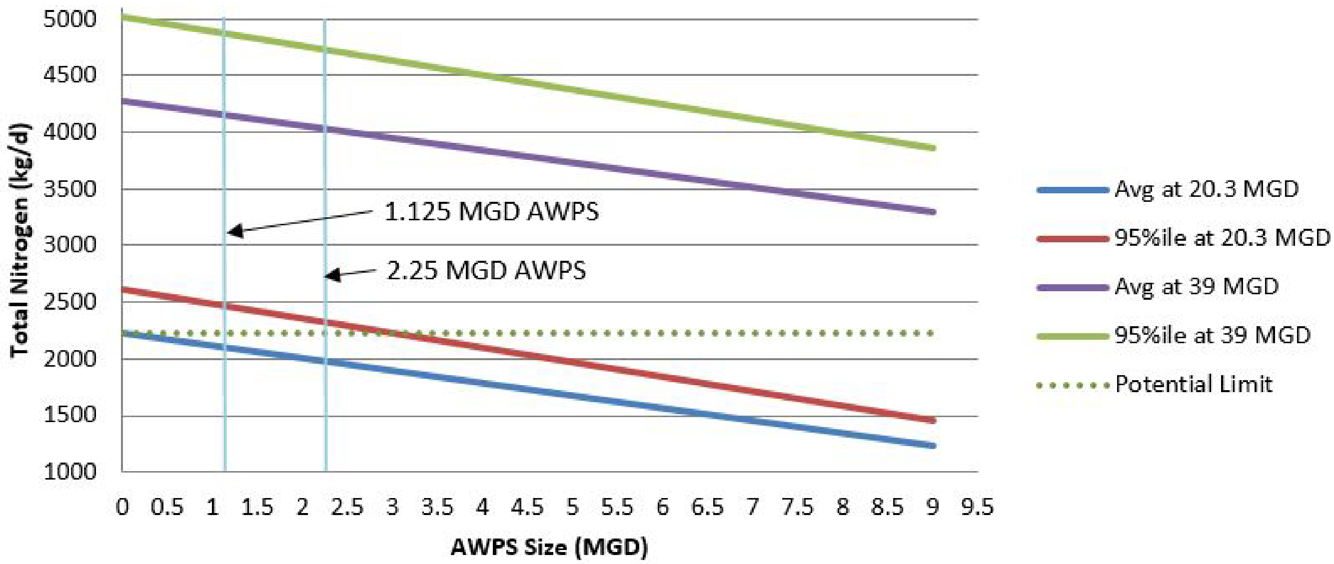

Figure ES-1: Total Nitrogen Loading

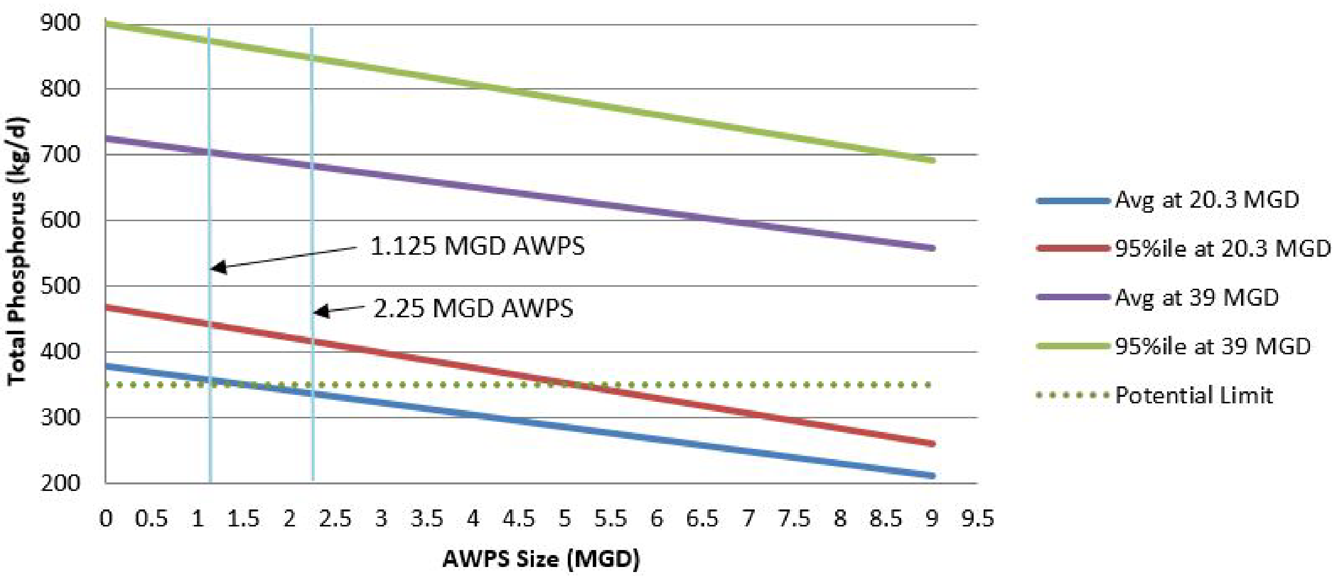

Figure ES-2: Total Phosphorus Loading

There are a number of other land use and resource agency permits required for the construction of the AWPS, as summarized in Table ES-4.

Table ES-4: Land Use and Resource Agency Permits and Approvals Potentially Required

Resource Agency Permits	Permit Required	Submittal Requirements	Estimated Duration after Submittal is Complete
SFBRWQCB – NPDES permit review or update	Yes	Will occur when the City applies for its NPDES Permit Update in 2019	
State WRCB – NPDES Construction General Permit	Yes	• Notice of Intent • SWPPP • Application	Coverage is obtained when submittal is complete
USFWS Section 7	No[1]		
NHPA Section 106	No[2]		
City Permits and Approvals			
Architectural Review Board	Yes	• 90 percent design elevations and site plan • Application	3 months
Planning and Transportation Commission	Yes		1 month
City Council Approval	Yes	• ARB and PTC Approval	1 month
Tree Ordinance CIP Approval	Yes	• Tree Inventory and list of trees to be removed or pruned	2 months
Public Works Engineering FEMA NFIP Flood Elevation Certificate	Yes	• Final grading plan • Final foundation plan • Application • Council approval	3 months
Grading Permit	Yes	• Final grading plan • Application • Council approval	3 months
Building Permit	Yes	• Final plans • Application • Council approval	3 months
Encroachment Permit	Yes	• Final plans for construction phase and permanent changes • Application • Council approval	2 months
Parks and Recreation Commission	Maybe	• 90 percent site plan	3 months
Baylands Design Guidelines	Yes	• 90 percent design elevations • Site plan	3 months

Notes: (1) As noted in the Recycled Water Project EIR Mitigation Monitoring Program, any construction that occurs within 500 feet of marsh areas would be subject to Mitigation Measure BIO-7 and subject to restrictions for the protection of California clapper rail. Nevertheless, a Section 7 consultation under the federal Endangered Species Act is not necessary, so long as Mitigation Measure BIO-7 is implemented resulting in avoidance of impacts to the California clapper rail.

(2) No cultural resources have been identified at the RWQCP site (William Self Associates 2007). However, if federal funding is being sought, the City should inquire whether Section 106 clearance is required.

The City prepared and certified the Recycled Water Project Environmental Impact Report (RWP EIR) in 2015 which identified a future AWPS as a mitigation measure to reduce high TDS in the recycled water. The Final RWP EIR Response to Comments states this mitigation measure does not create new significant environmental impacts. Because the RWP EIR anticipated the implementation of RO treatment of recycled water, an AWPS project constructed to improve the quality of the RWQCP tertiary-treated recycled water is part of the Recycled Water Project and therefore has already been evaluated as part of that EIR.

For an AWPS located at Site 1, which is located on the RWQCP, it appears no further CEQA documentation is required. Nonetheless, if the City desires to prepare a CEQA document for review by the public and decision makers, an Addendum to the RWP EIR could be prepared. Specific studies which may be required include:

- Design for Revised Pathway, Vegetative Buffer, and Screening
- Air Quality NO_x Analysis
- Tree Protection and Preservation Plan
- Implementation Plan for Baylands Design Guidelines
- Biology Assessment and Pre-construction Surveys
- Geotechnical Report
- Health and Safety Plan
- Hazardous Materials Management and Spill Prevention and Control Plan
- Contaminated Soil and/or Groundwater Report
- Prepare Notice of Intent (NOI) for General Permit for Discharges of Storm Water Runoff Associated with Construction Activity and Storm Water Pollution Prevention Plan
- Water Quality Analysis
- Noise Report
- Traffic Control Plan

The budgetary cost estimate for preparation of these studies and plans is $175,000 to $325,000.

0.7. Preliminary Cost Estimates

Preliminary capital cost estimates for a 1.125-MGD AWPS, as well as the capital costs associated with expanding the facility to a capacity of 2.25 MGD, were developed and are shown in Table ES-5. A project-specific geotechnical investigation, a complete topographic site survey, and utility potholing should be performed to reduce the unknowns which have the potential to significantly impact the construction cost of the project.

Design, construction management, and inspection costs are estimated at 12 percent of estimated construction costs. Costs for legal, public outreach, and City administration are not included. The preliminary cost estimates were prepared to AACE Class 3 level (-20 percent to +30 percent accuracy) and are appropriate for budgetary purposes. Costs for treatment system equipment were obtained from recent projects of similar size and scope as well as communication with equipment vendors. Unit costs for civil and electrical improvements are based on reference materials and recent project bids. No contingencies are included in the cost estimates presented but contingencies are accounted for in the level of accuracy of a Class 3 estimate.

Table ES-5: AWPS Estimated Project Construction, Design, and Construction Management Costs

Item	1.125-MGD AWPS	2.25-MGD AWPS
Estimated Bid Price	$13,904,000	$3,659,000
CEQA, Permitting, and Specific Studies	$175,000 to $325,000[1]	-
Design, Construction Management, and Inspection	$1,668,000	$439,000
AACE Class 3 Cost Estimate Total (-20% to +30%)	**$15,897,000**	**$4,098,000**
Cost per MGD Capacity (2.25-MGD Capacity)	**$8,882,222**	

Note: (1) For total costs, the high end of this cost range is assumed.

Preliminary operating costs for the AWPS include labor, equipment repair and replacement, chemicals, electricity, and miscellaneous expenses. Wastewater (feedwater to the AWPS) and RO concentrate disposal costs are not considered (i.e., the City does not have to pay another entity for these). Power costs are assumed at $0.15 per kilowatt hour (kWh). Pumping costs associated with discharge of enhanced recycled water into the distribution system are omitted. For the 1.125-MGD AWPS, one full-time equivalent (FTE) Operations and Maintenance (O&M) staff is assumed based on similarly sized facilities. Table ES-6 includes a detailed breakdown of the estimated annual operating costs.

Table ES-6: AWPS Annual Operations and Maintenance Cost Estimate

AWPS Production Capacity (MGD)	1.125	2.25
AWPS Production Capacity (AFY), 95% Online	1,197	2,394
Number of FTE O&M Staff	1.0	2.0

Item	$/AF[1]	$/Year	$/Year
Operations and Maintenance Labor[2]	-	$191,500	$383,100
Repair and Replacement	$40	$47,900	$95,800
Chemicals	$100	$119,700	$239,400
Electricity ($0.15 / kWh)	$105	$125,700	$251,400
	Totals	**$485,000**	**$970,000**

Notes: (1) $/AF Costs and typical performance values based on industry experience for AWPS
(2) Based on fully burdened staff at $92/hour and assumes maintenance work shared with existing staff

0.8. Preliminary Design and Construction Schedule

The City is interested in the potential advantages of procuring Phase 1 of the AWPS using an alternative delivery method. Schedules showing traditional design-bid-build and design-build were developed and a brief discussion of each is provided. For simplification, permitting activities are not included in these preliminary project schedules. The schedules also assume the CEQA document is a Notice of Exemption. If the City determines an amendment to the EIR is appropriate, the schedule should be revised to include the special studies described in Section 0.6.

A preliminary design and construction schedule using traditional design-bid-build procurement is presented as Figure ES-3. From initiation of the procurement process, the design, bidding, and construction process is anticipated to last approximately 42 months. This includes procurement of an engineering firm for design, detailed design, procurement of a construction management firm, public bidding for a construction contractor, and facility construction. The traditional design-bid-build process is well understood for public agencies. While engineering and construction management firms are selected based on qualifications, the award of a construction contract must follow the Public Contract Code and is based on the lowest responsible, responsive bidder.

The City may decide to implement the AWPS using design-build procurement, a preliminary schedule for which is provided as Figure ES-4. From initiation of procurement of the design-build team, the design and construction period is anticipated to last approximately 36 months. Key to the success of a design-build process is the selection of an Owner's Agent/Owner's Engineer (OA/OE) to facilitate the design-build process and provide oversight of the selected design-build team. The role of the OA/OE is to protect the Owner's interests. The OA/OE will prepare the necessary documents for solicitation of proposals from design-build teams, including Request for Qualifications, Request for Proposals, design and performance criteria, contract, schedule, and risk registry. The OA/OE may also coordinate early design activities such as potholing, survey, and geotechnical investigations. For a project of this size, using design-build procurement is estimated to save six months for completion.

Overall, design-build offers the owner more flexibility in the selection of the construction contractor and an accelerated schedule.

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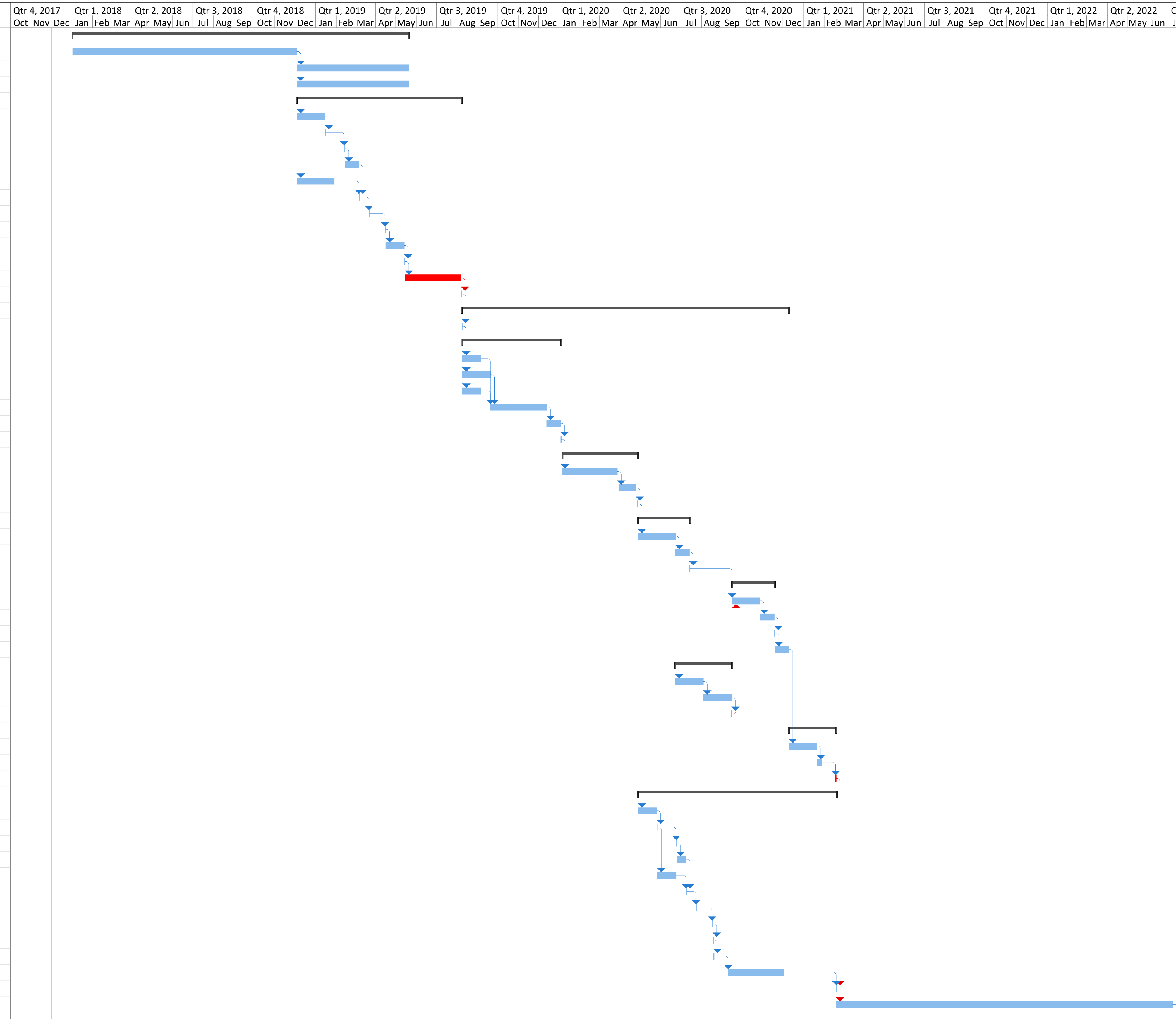
City of Palo Alto - Regional Water Quality Control Plant
1.125 MGD AWPS Design-Bid-Build Schedule

FIGURE ES-3

ID	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1	**Identify and Develop Funding Sources**	**360 days**	**Tue 1/2/18**	**Mon 5/20/19**		
2	Develop MOU with Stakeholders	12 mons	Tue 1/2/18	Mon 12/3/18		
3	Identify Grant Opportunities	6 mons	Tue 12/4/18	Mon 5/20/19	2	
4	Bonds, Loans, Partner Funding	6 mons	Tue 12/4/18	Mon 5/20/19	2	
5	**Design Consultant Procurement**	**177 days**	**Tue 12/4/18**	**Wed 8/7/19**		
6	Develop RFQ for Design	30 days	Tue 12/4/18	Mon 1/14/19	2	
7	Release RFQ	1 day	Tue 1/15/19	Tue 1/15/19	6	
8	Statements of Qualification Due	1 day	Wed 2/13/19	Wed 2/13/19	7FS+20 days	
9	Review SOQs/Shortlist	3 wks	Thu 2/14/19	Wed 3/6/19	8	
10	Develop RFP for Design	2 mons	Tue 12/4/18	Mon 1/28/19	2	
11	Release RFP to Shortlist	1 day	Thu 3/7/19	Thu 3/7/19	9,10	
12	Pre-Proposal Meeting	1 day	Fri 3/22/19	Fri 3/22/19	11FS+10 days	
13	Proposals Due	1 day	Mon 4/15/19	Mon 4/15/19	12FS+3 wks	
14	Review Consultant Proposals	1 mon	Tue 4/16/19	Mon 5/13/19	13	
15	Select Consultant Team	1 day	Tue 5/14/19	Tue 5/14/19	14	
16	Council Action/Contracting	3 mons	Wed 5/15/19	Tue 8/6/19	15	
17	Notice to Proceed	1 day	Wed 8/7/19	Wed 8/7/19	16	
18	**Design**	**350 days**	**Thu 8/8/19**	**Wed 12/9/20**		
19	Project Kick-off Meeting	1 day	Thu 8/8/19	Thu 8/8/19	17	
20	**30% Design**	**106 days**	**Fri 8/9/19**	**Fri 1/3/20**		
21	Topographic Survey	1 mon	Fri 8/9/19	Thu 9/5/19	19	
22	Potholing	6 wks	Fri 8/9/19	Thu 9/19/19	19	
23	Geotechnical Investigation and Engineering	1 mon	Fri 8/9/19	Thu 9/5/19	19	
24	30% Design	3 mons	Fri 9/20/19	Thu 12/12/19	23,22,21	
25	Stakeholder Review of 30% Design	15 days	Fri 12/13/19	Thu 1/2/20	24	
26	30% Design Review Meeting	1 day	Fri 1/3/20	Fri 1/3/20	25	
27	**60% Design**	**81 days**	**Mon 1/6/20**	**Mon 4/27/20**		
28	60% Design	3 mons	Mon 1/6/20	Fri 3/27/20	26	
29	Stakeholder Review of 60% Design	1 mon	Mon 3/30/20	Fri 4/24/20	28	
30	60% Design Review Meeting	1 day	Mon 4/27/20	Mon 4/27/20	29	
31	**90% Design**	**56 days**	**Tue 4/28/20**	**Tue 7/14/20**		
32	90% Design	2 mons	Tue 4/28/20	Mon 6/22/20	30	
33	Stakeholder Review of 90% Design	3 wks	Tue 6/23/20	Mon 7/13/20	32	
34	90% Design Review Meeting	1 day	Tue 7/14/20	Tue 7/14/20	33	
35	**100% Design**	**46 days**	**Wed 9/16/20**	**Wed 11/18/20**		
36	100% Design	6 wks	Wed 9/16/20	Tue 10/27/20	34,43	
37	Stakeholder Review of 100% Design	3 wks	Wed 10/28/20	Tue 11/17/20	36	
38	100% Design Review Meeting	1 day	Wed 11/18/20	Wed 11/18/20	37	
39	Final Design	3 wks	Thu 11/19/20	Wed 12/9/20	38	
40	**CEQA Compliance**	**61 days**	**Tue 6/23/20**	**Tue 9/15/20**		
41	Develop CEQA Document (Exemption)	30 days	Tue 6/23/20	Mon 8/3/20	32	
42	Public Review Period	30 days	Tue 8/4/20	Mon 9/14/20	41	
43	Council Action to Accept Environmental Docume	1 day	Tue 9/15/20	Tue 9/15/20	42	
44	**Bidding**	**51 days**	**Thu 12/10/20**	**Thu 2/18/21**		
45	Bid Period	6 wks	Thu 12/10/20	Wed 1/20/21	39	
46	Review Bids	1 wk	Thu 1/21/21	Wed 1/27/21	45	
47	Council Action	1 day	Thu 2/18/21	Thu 2/18/21	46FS+15 days	
48	**Construction Management Consultant Procuremer**	**214 days**	**Tue 4/28/20**	**Fri 2/19/21**		
49	Develop RFQ for Construction Management	20 days	Tue 4/28/20	Mon 5/25/20	30	
50	Release RFQ	1 day	Tue 5/26/20	Tue 5/26/20	49	
51	Statements of Qualification Due	1 day	Wed 6/24/20	Wed 6/24/20	50FS+20 days	
52	Review SOQs/Shortlist	2 wks	Thu 6/25/20	Wed 7/8/20	51	
53	Develop RFP for Construction Management	20 days	Wed 5/27/20	Tue 6/23/20	50	
54	Release RFP to Shortlist	1 day	Thu 7/9/20	Thu 7/9/20	52,53	
55	Pre-Proposal Meeting	1 day	Fri 7/24/20	Fri 7/24/20	54FS+2 wks	
56	Proposals Due	1 day	Mon 8/17/20	Mon 8/17/20	55FS+3 wks	
57	Review Consultant Proposals	1 day	Tue 8/18/20	Tue 8/18/20	56	
58	Select Construction Management Firm	1 day	Wed 8/19/20	Wed 8/19/20	57	
59	Council Action/Contracting	3 mons	Thu 9/10/20	Wed 12/2/20	58FS+3 wks	
60	Notice to Proceed	1 day	Fri 2/19/21	Fri 2/19/21	59,47	
61	**Construction**	**18 mons**	**Fri 2/19/21**	**Thu 7/7/22**	47	
62	Council Approval of Final Acceptance	1 day	Fri 7/29/22	Fri 7/29/22	61FS+3 wks	



Project: msproj11
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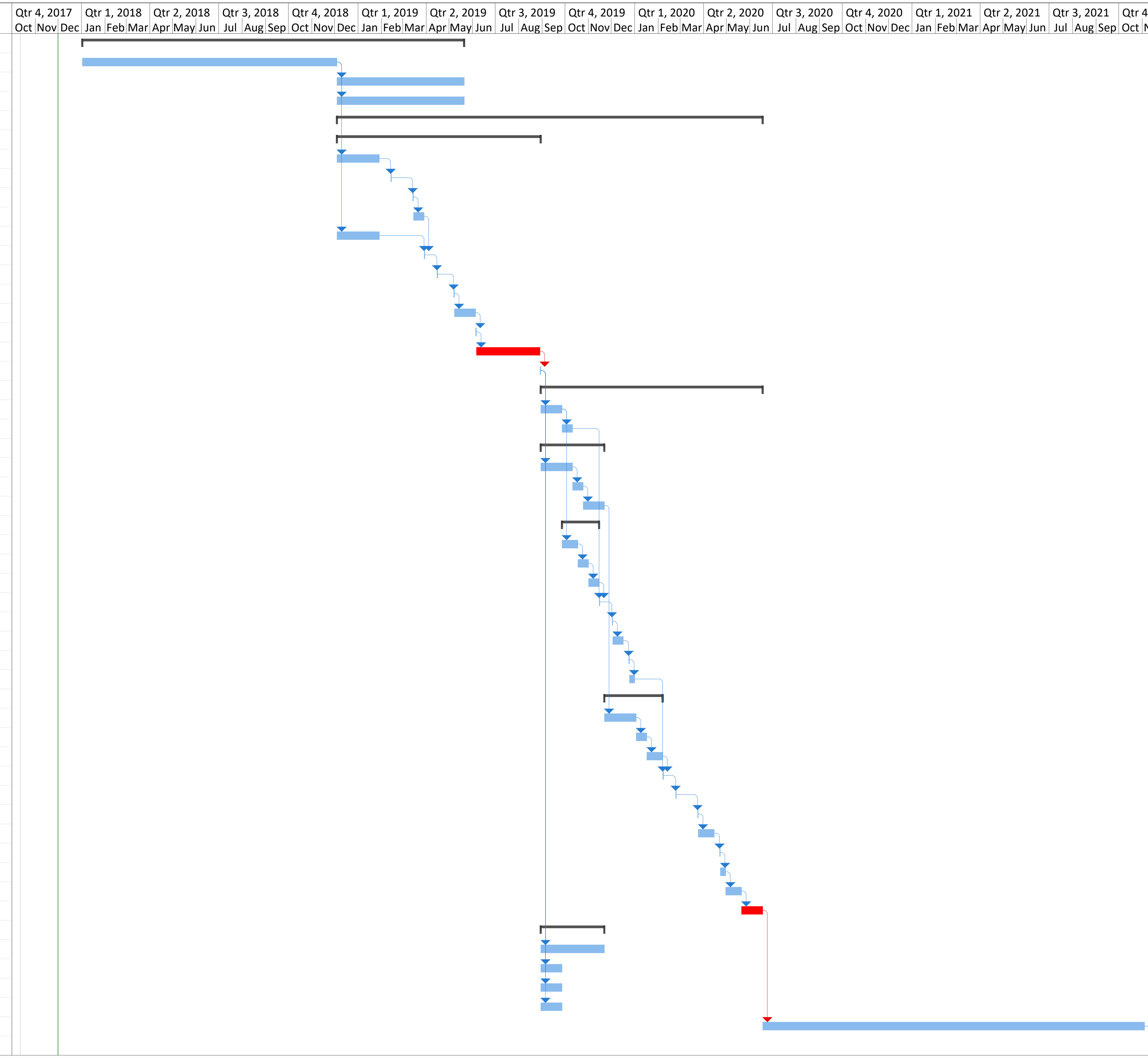
Task | Milestone ◆ | Summary | Manual Progress

City of Palo Alto - Regional Water Quality Control Plant
1.125 MGD AWPS Design-Build Schedule

FIGURE ES-4

ID	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1	**Identify and Develop Funding Sources**	**360 days**	**Tue 1/2/18**	**Mon 5/20/19**		
2	Develop MOU with Stakeholders	12 mons	Tue 1/2/18	Mon 12/3/18		
3	Identify Grant Opportunities	6 mons	Tue 12/4/18	Mon 5/20/19	2	
4	Bonds, Loans, Partner Funding	6 mons	Tue 12/4/18	Mon 5/20/19	2	
5	**Design-Build Procurement**	**402 days**	**Tue 12/4/18**	**Wed 6/17/20**		
6	**Program Management**	**193 days**	**Tue 12/4/18**	**Thu 8/29/19**		
7	Develop RFQ for OA/OE	2 mons	Tue 12/4/18	Mon 1/28/19	2	
8	Release RFQ	1 day	Wed 2/13/19	Wed 2/13/19	7	
9	Statements of Qualification Due	1 day	Thu 3/14/19	Thu 3/14/19	8FS+20 days	
10	Review SOQs/Shortlist	2 wks	Fri 3/15/19	Thu 3/28/19	9	
11	Develop RFP for OA/OE	2 mons	Tue 12/4/18	Mon 1/28/19	2	
12	Release RFP to Shortlist	1 day	Fri 3/29/19	Fri 3/29/19	10,11	
13	Pre-Proposal Meeting	1 day	Mon 4/15/19	Mon 4/15/19	12FS+10 days	
14	Proposals Due	1 day	Tue 5/7/19	Tue 5/7/19	13FS+3 wks	
15	Review OA/OE Proposals	1 mon	Wed 5/8/19	Tue 6/4/19	14	
16	Select OA/OE Team	1 day	Wed 6/5/19	Wed 6/5/19	15	
17	Council Action/Contracting	3 mons	Thu 6/6/19	Wed 8/28/19	16	
18	Notice to Proceed	1 day	Thu 8/29/19	Thu 8/29/19	17	
19	**DB Procurement Documents**	**209 days**	**Fri 8/30/19**	**Wed 6/17/20**		
20	Prepare Request for Letter of Interest (LOI	1 mon	Fri 8/30/19	Thu 9/26/19	18	
21	Review LOIs	2 wks	Fri 9/27/19	Thu 10/10/19	20	
22	**Develop Design Criteria Report (DCR)**	**60 days**	**Fri 8/30/19**	**Thu 11/21/19**		
23	Draft DCR	30 days	Fri 8/30/19	Thu 10/10/19	18	
24	Stakeholder Review	10 days	Fri 10/11/19	Thu 10/24/19	23	
25	Final DCR	20 days	Fri 10/25/19	Thu 11/21/19	24	
26	**Prepare Request for Qualifications**	**35 days**	**Fri 9/27/19**	**Thu 11/14/19**		
27	Draft RFQ	15 days	Fri 9/27/19	Thu 10/17/19	20	
28	Stakeholder Review	10 days	Fri 10/18/19	Thu 10/31/19	27	
29	Final RFQ	10 days	Fri 11/1/19	Thu 11/14/19	28	
30	Distribute RFQ	1 day	Fri 11/15/19	Fri 11/15/19	21,29	
31	RFQ Meeting	1 day	Mon 12/2/19	Mon 12/2/19	30FS+10 days	
32	Evaluate RFQs	2 wks	Tue 12/3/19	Mon 12/16/19	31	
33	Interview shortlist	1 day	Tue 12/24/19	Tue 12/24/19	32FS+5 days	
34	Develop RFP Shortlist	1 wk	Wed 12/25/1	Tue 12/31/19	33	
35	**Prepare RFP**	**55 days**	**Fri 11/22/19**	**Thu 2/6/20**		
36	Draft RFP	30 days	Fri 11/22/19	Thu 1/2/20	25	
37	Stakeholder Review	10 days	Fri 1/3/20	Thu 1/16/20	36	
38	Final RFP	15 days	Fri 1/17/20	Thu 2/6/20	37	
39	Distribute RFP	1 day	Fri 2/7/20	Fri 2/7/20	38,34	
40	Pre-Proposal Meeting	1 day	Mon 2/24/20	Mon 2/24/20	39FS+10 days	
41	Proposals Due	1 day	Tue 3/24/20	Tue 3/24/20	40FS+20 days	
42	Review Proposals	15 days	Wed 3/25/20	Tue 4/14/20	41	
43	Interview DB Teams	1 day	Wed 4/22/20	Wed 4/22/20	42FS+5 days	
44	Select DB Team	5 days	Thu 4/23/20	Wed 4/29/20	43	
45	Negotiate GMP	15 days	Thu 4/30/20	Wed 5/20/20	44	
46	Council Action/Contracting	1 mon	Thu 5/21/20	Wed 6/17/20	45	
47	**Preliminary Design**	**60 days**	**Fri 8/30/19**	**Thu 11/21/19**		
48	Preliminary Design	3 mons	Fri 8/30/19	Thu 11/21/19	18	
49	Topographic Survey	1 mon	Fri 8/30/19	Thu 9/26/19	18	
50	Potholing	1 mon	Fri 8/30/19	Thu 9/26/19	18	
51	Geotechnical Investigation and Engineering	1 mon	Fri 8/30/19	Thu 9/26/19	18	
52	**Detailed Design/Construction**	**18 mons**	**Thu 6/18/20**	**Wed 11/3/21**	**46**	
53	Council Approval of Final Acceptance	1 day	Thu 11/25/21	Thu 11/25/21	52FS+3 wks	



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Date: Fri 12/1/17

Task | Milestone | Summary | Manual Progress

Section 1. Project Summary

The City of Palo Alto (City) provides tertiary-treated recycled water to the communities of Los Altos, Los Altos Hills, Stanford University and East Palo Alto Sanitary District via truck-fill stations and to the City of Mountain View (Mountain View) and Palo Alto via hard piped transmission systems. The City, in collaboration with the City of Mountain View (Mountain View) and the Santa Clara Valley Water District (SCVWD), is interested in a preliminary/conceptual-level design of an Advanced Water Purification System (AWPS) to improve the quality of recycled water from its Regional Water Quality Control Plant (RWQCP). To improve the quality of this water, particularly the level of total dissolved solids (TDS), the stakeholders are interested in blending permeate from the AWPS with tertiary-treated recycled water to produce enhanced recycled water (ERW) to serve customers.

The Advanced Water Purification System Feasibility Study (Feasibility Study) (MNS Engineers, May 2017) evaluated alternative placement, sizing, and potential impacts of implementing an AWPS at five sites at or adjacent to the RWQCP. Based on these evaluated alternatives, a 1.125-million-gallons-per-day (MGD) AWPS, expandable to 2.25 MGD, located at the RWQCP (Site 1 from the Feasibility Study) was selected for further evaluation.

Additionally, the Feasibility Study identified Site 4 for a larger AWPS with a capacity in excess of 6 MGD including ultraviolet treatment with advanced oxidation (UV/AOP), which is required for treated water used for potable reuse. The usage of this site is constrained by Measure E, passed by the voters of Palo Alto in 2011, and is discussed in a separate White Paper (MNS, October 2017). Piping and connections for an AWPS at Site 4 are discussed in this report in the event this larger AWPS project moves forward.

This report includes preliminary/conceptual design of the following components of an AWPS:

Table 1-1: AWPS Facility Components

	AWPS Capacity (MGD)	Permeate Storage Capacity (MG)
Phase 1 - Initial Capacity	1.125	0.75
Phase 2 - Expanded Capacity	2.25	1.50

Appendix A includes preliminary design drawings for Phase 1, a 1.125-MGD AWPS; several sheets show proposed expansion to Phase 2, a 2.25-MGD AWPS. Drawings provided are listed in Table 1-2.

Table 1-2: Phase 1 APWS Preliminary Design Drawings

Sheet No.	Drawing No.	Description
1	G1	Process Flow Diagram – 1.125 MGD
2	G2	Process Flow Diagram – 2.25 MGD
3	C1	Demolition and Utility Relocation Plan
4	C2	Site Layout Plan
5	C3	Site Improvements Plan
6	C4	Site Piping Plan
7	C5	Blending Facilities Demolition and Improvements Plan
8	M1	AWPS Site 1 Equipment Layout
9	E1	12-kV Electrical Distribution
10	E2	Single Line Diagram 1
11	E3	Single Line Diagram 2
12	E4	Electrical Room Layout
13	I1	Concept Network Diagram

1.1. Project Objectives

The main objectives of this report are to:

- Develop the facility design, including treatment process improvements, electrical improvements, and civil site improvements to a ten percent project definition level.
- Develop conceptual control and communication strategies, and consider various operational strategies.
- Evaluate permitting and California Environmental Quality Act (CEQA) compliance requirements.
- Refine construction cost estimates to a Class 3 level estimate (-20 to +30 percent accuracy) in accordance with the Association for the Advancement of Cost Engineering (AACE).
- Estimate total project costs including design, construction management and inspection, construction, and permitting.
- Develop conceptual construction schedules for procuring the project with both design-bid-build and design-build procurement strategies.

Section 2. Treatment Facilities

The Feasibility Study recommended an AWPS to provide enhanced recycled water consisting of MF (or UF) and RO. This section further defines the process flow rates, the treatment process at Site 1, and design criteria for MF, RO, chemical dosing systems, and any ancillary systems. Either MF or UF could be utilized in the AWPS, as both membrane types provide adequate pretreatment to RO[2], and both membrane types can provide pathogen removal credits for use in a potential potable reuse (PR) application in the future. For the purposes of improving the readability of the report, only MF is written, but it is envisioned either MF or UF could be utilized in the final design.

An evaluation of scalability at Site 1 from 1.125 MGD to 2.25 MGD is also outlined in this section. The following assumptions were used for preliminary design:

- AWPS feed water is UV-disinfected final effluent from the RWQCP.
- The target for TDS in the ERW delivered to customers is 400 to 500 milligrams per liter (mg/l).
- The first phase of the AWPS is located at Site 1 and will have a capacity of 1.125 MGD with design for potential future expansion to 2.25 MGD.
- Advanced-treated recycled water is blended with tertiary-treated recycled water at a 1:1 ratio to yield ERW.

Drawing M1 AWPS Site 1 Equipment Layout shows the layout of the AWPS at Site 1 of the RWQCP. Table 2-1 shows the AWPS treatment process sizing for Phases 1 and 2[3].

Table 2-1: AWPS Treatment Process Sizing

	AWPS Capacity (MGD)	ERW Production (MGD)
Phase 1 - Initial Capacity	1.125	2.25
Phase 2 - Expanded Capacity	2.25	4.5

Table 2-2 summarizes the flow rates for the process components of an AWPS to produce 1.125 and 2.25 MGD of permeate.

Table 2-2: AWPS Process Mass Balance

	Units	1.125 MGD	2.25 MGD
MF Feed	MGD	1.42	2.85
MF Backwash Return	MGD	0.10	0.20
MF Filtrate / RO Feed	MGD	1.32	2.65
RO Permeate	MGD	1.125	2.25
RO Concentrate	MGD	0.20	0.40

[2] In the event the City decides to convert the AWPS to produce advanced treated water for potable reuse (PR), both types of membranes could receive credits for pathogen removal.
[3] In the event the City decides to convert the AWPS to produce advanced treated water for IPR, there will be a potential connection point to convey permeate from Site 1 to the feed of a future UV/AOP facility located at Site 4.

2.1. Microfiltration

The first process in the AWPS treatment sequence is the MF system. The purpose of the MF system is to provide pretreatment (particulate removal) ahead of the RO system. The MF treatment process is capable of consistently producing a high-quality filtrate, from the tertiary effluent feed supply, exceeding standard prerequisites (in terms of turbidity and silt density index) for the subsequent RO process.

The AWPS MF system design criteria are outlined in Table 2-3 and estimated monthly MF chemical consumption is outlined in Table 2-4. Membranes, chemicals (such as hydrochloric acid, citric acid, etc.) and MF type used in this evaluation are examples; specifics pertaining to these will be selected during the final design phase. Design criteria are outlined for the 1.125- and 2.25-MGD AWPS capacity scenarios[4]. Provisions have been included for both chlorine and ammonia dosing ahead of the MF system in order to achieve a chloramine residual that will be carried through the MF/RO process to control biofouling. Provisions are also included for the addition of chlorine and ammonia in the final ERW product water to meet final disinfection targets. The required dosing at the feed stream and final product water will be fine-tuned during initial plant operation.

Table 2-3: Microfiltration System Design Criteria

	Units	1.125 MGD	2.25 MGD
MF Feed Flow	MGD	1.42	2.85
MF Filtrate Flow	MGD	1.32	2.65
MF Backwash Flow	MGD	0.10	0.20
Recovery	Percent	93 (minimum)	93 (minimum)
Design Flux	GFD	24	24
MF Strainer Recovery	Percent	99.5	99.5

Table 2-4: Microfiltration Monthly Chemical Consumption

	1.125 MGD (gallons/month)	2.25 MGD (gallons/month)	Target Conc. (mg/l)	Purpose of Chemical
Ferric Chloride	330	660	Up to 5	Coagulant (as necessary)
MF Chemically Enhanced Backwash (CEB)				
Citric Acid	250	500	1,000	Cleaning of scale/mineral deposits
Sodium Hydroxide	105	210	650	Cleaning of organics/ biological fouling
Sodium Hypochlorite	715	1,430	750	To reduce biological fouling
Clean-in-Place				
Citric Acid	20	40	2,000	Cleaning of scale/mineral deposits
Sodium Hydroxide	10	20	1,000	Cleaning of organics/ biological fouling
Sodium Hypochlorite	35	70	2,000	To reduce biological fouling

[4] In the event the City should decide at some point in the future to convert the AWPS to produce advanced treated water for PR, the MF/RO systems equipment design and performance criteria listed herein would help in meeting the California Division of Drinking Water (DDW) total pathogenic microorganism control requirements.

AWPS MF equipment design and performance criteria are outlined in Table 2-5. The intent of the criteria listed in Table 2-5 is to provide the City with flexibility in terms of selecting an initial MF system and also in terms of future MF membrane replacement. Using an “open platform” type MF system design, which could incorporate MF membranes from a variety of manufacturers, will give the City many options for membrane replacement in the future. This will ensure competitive pricing structures, and also allow the City to optimize system performance by selecting alternative membranes, if necessary.

Table 2-5: Microfiltration System Equipment Design and Performance Criteria

Parameter	Criteria
MF Technology	Pressurized Hollow Fiber Membranes
MF System	Allow Interchangeability of Various MF Modules in the Future
MF Modules	Need DDW Approval Letter for Pathogen Reduction
MF Membrane Chemistry	Polyvinylidene difluoride (PVDF) or Polyethersulfone (PES)
MF System	Equipped with Daily Membrane Integrity Test per DDW Regulations
MF Module Configuration	Vertical, Outside-In or Inside-Out
Skid Configuration	Semi-Universal (Open Platform)
Membrane Module Warranty	Absolute and Prorated Warranty, along with Fiber Breakage Warranty
Control System	Control system hardware shall be compatible with the overall site control system.
Ancillary Equipment	
Automatic Strainers	Rated 200 microns (minimum)
Clean-In-Place (CIP) System	CEB – Not More than Once Per Day CIP – Not More than Once Per 4 Weeks
Intermediate Break Tank	Volume Requirement: 10-minute retention time of RO feed flow
Air Compressor with Air Storage Tank	Sizing Requirement: Sized for all MF skids
Air Blower with Accessories	Sizing Requirement: Sized to meet air requirements for backwashing one skid at a time
Water Quality	
MF Filtrate Turbidity	Less than 0.5 nephelometric turbidity units (NTU) at all times and less than 0.2 NTU 95% of the time

2.2. Reverse Osmosis

The goal of the RO system is produce a permeate with a TDS of 50 mg/l or less. The preliminary design criteria are shown in Table 2-6 and are based on an evaluation of the feedwater quality data provided by the City and on industry experience in this type of application.

Table 2-6: Reverse Osmosis System Design Criteria

	Units	1.125 MGD	2.25 MGD
RO Feed Flow	MGD	1.32	2.65
Recovery	Percent	85	85
RO Permeate Flow	MGD	1.125	2.25
RO Product Water TDS	mg/l	50	50
RO Concentrate Flow	MGD	0.20	0.40
Average Design Flux	GFD	Less than 12	Less than 12
Membrane Element Surface Area	SF	400	400
Number of Elements	No.	~250	~500

An analysis of the feedwater quality data indicates the RO system can be operated at 85 percent recovery by using antiscalant and lowering the pH of the feedwater with acid injection to control scaling. Calcium phosphate and silica are the limiting constituents, which is common in municipal water reuse applications.

Table 2-7 summarizes anticipated chemical consumption for the RO system. In addition to the generic chemicals listed below, proprietary cleaning chemicals may be needed periodically. The CIP system will be designed to accommodate both liquid and powder proprietary cleaners.

Table 2-7: Reverse Osmosis Chemical Consumption

	1.125 MGD (gallons/month)	2.25 MGD (gallons/month)	Target Concentration (mg/l)	Purpose of Chemical
Sodium Bisulfite	Intermittent	Intermittent	-	As required to neutralize chlorine
Sulfuric Acid	1,500	3,000	65	Feedwater conditioning
Antiscalant	150	300	4.5	Feedwater conditioning
Clean-in-Place				
Citric Acid	20	40	2,000	Cleaning of scale/mineral deposits
Sodium Hydroxide	10	20	1,000	Cleaning of organics/ biological fouling

Table 2-8 shows future potential performance criteria that may be imposed on the facility by regulators if it is converted to a potable reuse facility in the future. Incorporating these criteria into near-term RO system performance could be considered, with little additional cost.

Table 2-8: Reverse Osmosis System Equipment Design and Performance Criteria

Parameter	Criteria
RO NaCl Rejection	Minimum of 99.2% for each RO element
RO system must demonstrate 1.5-Log removal of Total Organic Carbon (TOC)	Online conductivity and TOC analyzer of feed and permeate
Future RO Product Water Quality	
Total Organic Carbon	Maximum 0.25 mg/l

2.3. Chemical Storage and Dosing Systems

The proposed tank sizes and number of chemical feed pumps for both Phases 1 and 2 are shown on Table 2-9. Four hundred square feet (SF) of secondary containment for drum/tote storage is included in the storage area. Tanks have been sized for a minimum of 30-day storage (with the exception of sodium hypochlorite, which will use an existing onsite tank) and to accept full tank truck loads for highly used chemicals. Due to the possibility of sodium hypochlorite degrading over time, the tank should only be filled enough to supply 30 days of demand for each Phase. Tank materials are fiber-reinforced plastic (FRP), high-density polyethylene (HDPE), or stainless steel (SS) depending on chemical compatibility. Each containment section includes a sump to collect only rainwater or spillage. Portable pumps will be used to pump out sumps. Chemical piping will be perfluoroalkoxy (PFA) or fluorinated ethylene propylene (FEP) tubing inside a polyvinyl chloride (PVC) secondary containment pipe. Clear plastic sections will be used to visually indicate a leak. A summary of the tank materials, and capacities is shown in Table 2-9.

Table 2-9: Chemical Storage Tanks

Chemical	Concentration	Material	Nominal Capacity (gal)	No. of Tanks	Days of Storage	
					Phase 1	Phase 2
Ferric Chloride	40%	HDPE/FRP	1,000	1	90	45
Aqueous Ammonia	20%	HDPE/FRP	1,000	1	70	35
Sulfuric Acid	98%	SS	3,000	1	60	30
Antiscalant	100%	HDPE/FRP	600	2 totes	60	30
Caustic Soda	25%	HDPE/FRP	500	1	120	60
Sodium Bisulfite	40%	HDPE/FRP	600	2 totes	60	30
Sodium Hypochlorite	12.5%	FRP[1]	10,000[1]	1	200	100
Citric Acid	50%	HDPE/FRP	750	1	80	40

Note: (1) Existing reused sodium hypochlorite tank.

2.4. Decarbonator

A decarbonator is included after RO to raise final RO permeate pH before the RO permeate storage tank and ultimate blending as ERW. Raising the pH reduces the corrosivity of the permeate. The decarbonator is sized for a Phase 1 RO permeate flow of 1.125 MGD with the ability to add an additional decarbonator if needed for Phase 2. The decarbonator system consists of a degasifier tower on top of a clearwell reservoir and is equipped with blowers (one duty/one standby). Table 2-10 summarizes the design criteria for the decarbonator.

Table 2-10: Decarbonator Equipment Design and Performance Criteria

Parameter	Criteria
Degasifier tower	7-foot diameter by 20.5-foot side shell height including height of 3,910-gallon clearwell, FRP construction
Degasifier blowers	3,150 cfm at four-inch water column, 20 hp, one duty/one standby
Water Quality	
Feed pH	~ 5.0
Effluent pH	~ 6.3

2.5. Scalability Evaluation

Tables 2-11 and 2-12 indicate how major AWPS components will scale between Phase 1 and Phase 2 of the project for MF and RO systems, respectively. The column for Phase 1 indicates equipment required for Phase 1 of the project (1.125-MGD AWPS capacity), and the column for Phase 2 indicates additional equipment required to expand to Phase 2 capacity (2.25-MGD AWPS capacity).

Table 2-11: Major MF Equipment Scaling Between Phase 1 and Phase 2

Equipment Description	Phase 1	Additional Equipment for Phase 2	Final	Size/Capacity
MF Feed Pumps	2 Duty, 1 Standby	2 Duty	4 Duty, 1 Standby	30 hp (each)
Backwash Pumps	1 Duty, 1 Standby	0	1 Duty, 1 Standby	30 hp (each)
MF Backwash/Filtrate Pumps to RO	2 Duty, 1 Standby	2 Duty	4 Duty, 1 Standby	25 hp (each)
CEB Chlorination Feed System	2 Pumps, 1 Storage Tank	1 Pump	3 Pumps, 1 Storage Tank	0.17 hp (each) 1,000-gal Tank
CEB Citric Acid Feed System	2 Pumps, 1 Storage Tank	1 Pump	3 Pumps, 1 Storage Tank	0.17 hp (each) 750-gal Tank
CEB Caustic Feed System	2 Pumps, 1 Storage Tank	1 Pump	3 Pumps, 1 Storage Tank	0.17 hp (each) 500-gal Tank
Coagulant Feed System	2 Pumps, 1 Storage Tank	0	2 Pumps, 1 Storage Tank	0.17 hp(each) 1,000-gal Tank
Backwashable 150-micron Automatic Filter	1 Duty, 1 Standby	1 Duty	2 Duty, 1 Standby	1,200 GPM
MF Skid with Instrumentation	3	2	5	
Filtrate Tank To RO Unit	1 Tank	0	1 Tank	12 ft x 36 ft. H
CIP System	2 Pumps, 1 Cleaning Tank	0	2 Pumps,1 Cleaning Tank	15 hp (each) 1,000-gal Tank
Air Compressor with Air Storage Tank	1 Duty, 1 Standby	0	1 Duty, 1 Standby	10 hp (each)
Decarbonator Tower/Clearwell	1	1	2	
Air Blower with Accessories	1 Duty, 1 Standby	1	2 Duty, 1 Standby	20 hp (each)

Table 2-12: Major RO Equipment Scaling Between Phase 1 and Phase 2

Equipment	Phase 1	Additional Equipment for Phase 2	Final	Size/Capacity
Cartridge Filters, Pretreatment	2	2	4	460 GPM (each)
RO Feed/Booster Pumps	2 Duty, 1 Standby	2 Duty	4 Duty, 1 Standby	40 hp (each)
RO Skids with Instrumentation and Panels	2 Duty	2 Duty	4	
RO High Pressure Pumps	2 Duty	2 Duty	4 Duty	40 hp(each)
Second/Third Stage RO Booster pumps	2 Duty	2 Duty	4 Duty	5 hp(each)
Permeate Blending	1	0	1	
CIP Cleaning for RO	2 Pumps, 1 Cleaning Tank	0	2 Pumps, 1 Cleaning Tank	30 hp (each) 1,500-gal Tank
Sodium Bisulfite Dosing System	2 Pumps, 2 Chemical Tote	1 Pump	3 Pumps, 2 Chem Tote	60 GPD (each) 300-gal tote each
Acid Dosing System	2 Pumps, 1 Storage Tank	1 Pump	3 Pumps, 1 Storage Tank	6 GPH (each) 6,000-gal Tank
Antiscalant Dosing System	2 Pumps, 2 Chem Totes	1 Pump	3 Pumps, 2 Chem Totes	24 GPD (each) 300-gal tote each
Sodium Hypochlorite Dosing System	2 Pumps, 1 Storage Tank	1 Pump	3 Pumps, 1 Storage Tank	48 GPD (each) 1,000 gal

2.6. Used Equipment

There is a small market for used, refurbished, or even surplus RO equipment which can offer some cost savings to the City. However, it is very unlikely a suitable system will be found matching the exact requirements of the project, so the City may have to make some sacrifices in certain areas of the project, such as in overall capacity, system recovery, system integration, footprint, etc., if it pursues the purchase of used equipment.

One example provider in this market is Watersurplus (www.watersurplus.com). A cursory review of their website does show potential RO systems for use in the capacity range of Phase 1, but a more detailed review is required to fully determine if suitable or not.

2.7. Containerized Equipment

The City may wish to consider the use of containerized, or trailer mounted, MF and RO systems. These systems are available from a number of suppliers, and can be either purchased or leased under various arrangements. All process related equipment such as pumps, membrane racks, instrumentation, and controls are mounted inside the containers. Supporting process equipment, such as break tanks, interconnecting piping, etc. would be located outdoors.

By using containerized or trailer mounted systems, supporting infrastructure may be able to be reduced (canopies, pipe trenches, etc.), and expenditures can be shifted from capital investment to operations via leasing arrangements. Additional work to further define what would be included in such a project is required to provide a basis for estimating the magnitude of a cost reduction, if any exists.

Section 3. Site Improvements

This section describes the anticipated site work to accommodate the AWPS. Potential connection points for conveyance of AWPS permeate to a UV/AOP facility at Site 4 are also discussed.

3.1. Design Limitations

The site improvements discussed in this section are based on limited available data about the project site. Project-specific studies, including site surveys and potholing, were not completed for this report. As a result, assumptions were made about the site for cost estimating purposes; future site-specific studies may identify significantly different conditions, resulting in varying construction costs.

3.2. Geotechnical Study

The City contracted with Cal Engineering & Geology to prepare a geotechnical desktop study of the project site, which included developing recommendations for foundations for the proposed improvements. Project-specific borings for the project were not completed. The completed desktop study, dated September 12, 2017, is included as Appendix B. The recommendations in the geotechnical study are based on available geotechnical data in the vicinity of the project area, and a previous iteration of the site layout. Additional geotechnical subsurface exploration should be performed at the location of the improvements during detailed design to properly characterize the soil and groundwater conditions beneath the proposed AWPS for development of final geotechnical recommendations, including foundation design recommendations. The desktop study recommends auger cast displacement piles to support the RO permeate storage tank and the AWPS clearwell. Other facilities do not need to be pile supported, but do require up to eight feet of over-excavation and backfill with imported structural fill. Additional recommendations are included in the desktop study.

3.3. Site Constraints

The construction of the AWPS will impact several areas of the RWQCP site, including the AWPS site itself, disinfected tertiary treated recycled water storage improvements, AWPS permeate water storage improvements, blending facility improvements, and yard piping improvements. Each of these is discussed in the following subsections.

3.3.1. APWS Site Constraints

The AWPS is located at the northwest side of the RWQCP site. Within the limits of the proposed site, there are below-grade utilities, trees and vegetation, and the RWQCP influent pump station biofilter. There is also a walking pathway along the RWQCP northern property line. Significant utility lines in or near the AWPS site footprint include:

- 36-inch influent sewer line, 24-inch influent sewer line, and influent junction box
- Plant storm drain
- Recycled water lines
- 4-inch gas line
- 12.47-kilovolt (kV) electrical conduit
- Various RWQCP water services, including plant process water and irrigation lines

Two digester gas monitoring wells exist in the AWPS site area. These wells will need to be preserved in place and access must be maintained. The AWPS site and existing site constraints are shown in Figure 3-1.

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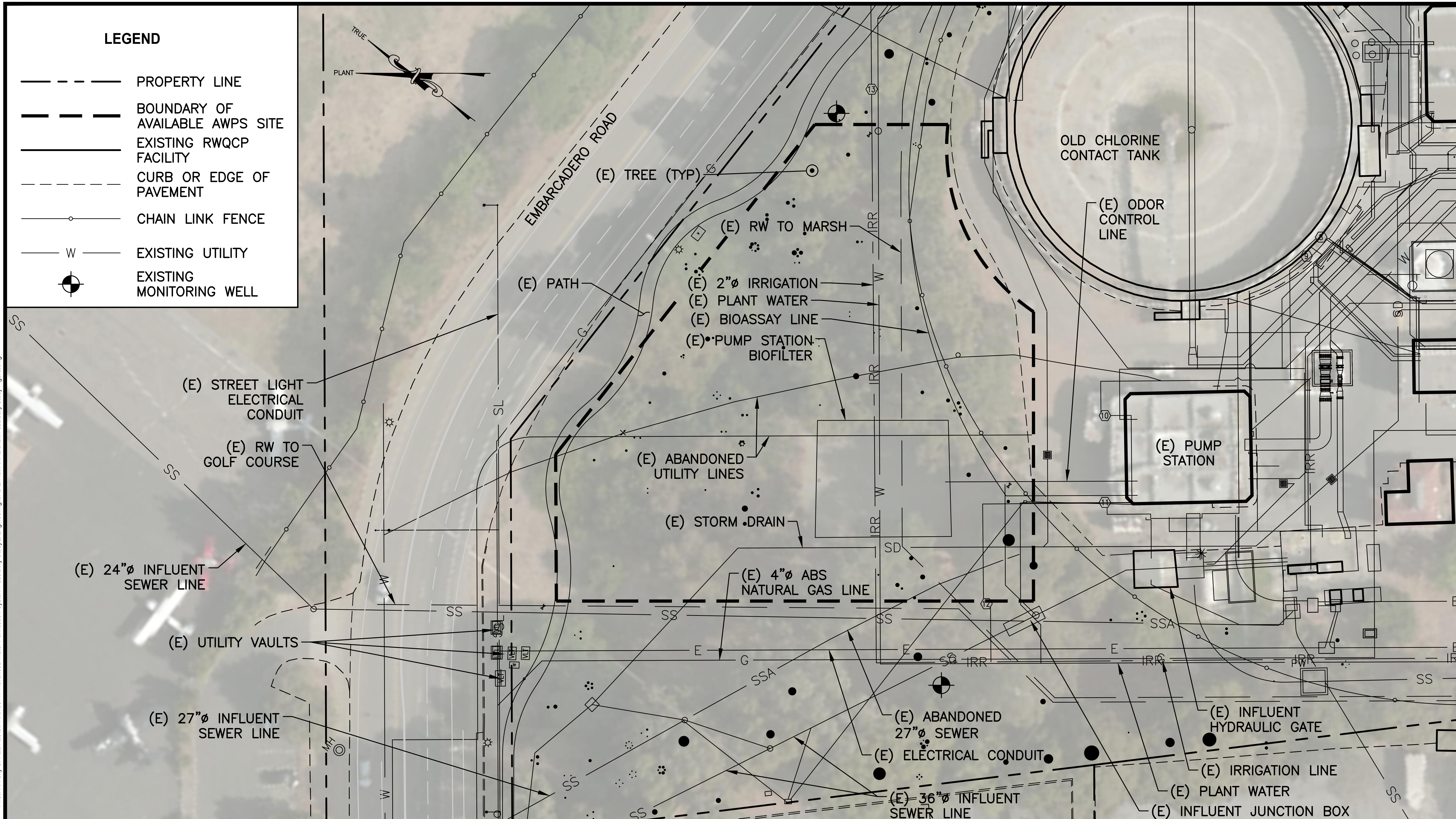

MNS ENGINEERS INC
ENGINEERING | SURVEYING
CONSTRUCTION MANAGEMENT
111 N. Market Street
Suite 440
San Jose, CA 95113
408.610.4202 Phone

FIGURE 3-1: AWPS SITE CONSTRAINTS
ADVANCED WATER PURIFICATION SYSTEM PRELIMINARY DESIGN REPORT
CITY OF PALO ALTO

CIPAA.150417

40' 0' 40'

1" = 40'

A 20-foot buffer from the RWQCP property line to the AWPS building is provided; this was reduced from the Feasibility Study to allow an increase in the spacing between the AWPS and the influent pump station. This buffer provides the ability to maintain a wall of trees and vegetation between the public and the AWPS for an aesthetically pleasing facility.

A portion of the existing pedestrian pathway to the north, which provides access to the Baylands, must be reconstructed to provide additional buffer between the pathway and the AWPS building. There are also office buildings to the west of the site. Vegetation between the office buildings and the AWPS is provided to screen the AWPS.

3.3.2. RO Permeate Storage Site Constraints

The RO permeate storage tank is located directly to the east of the proposed AWPS and north of the old chlorine contact basin. This site contains a chain link fence and small diameter utilities, including irrigation and plant process water, a bioassay line, and the Renzel Marsh (Marsh) outlet line. Requirements to develop storage facilities in these areas is limited to clearing vegetation, utility relocation, and structural and surface improvements. The proposed permeate storage tank maintains 27 feet of clearance to the RWQCP property line. The existing pedestrian pathway along the property line will be reconstructed to provide additional space for the construction of the tank.

A future AWPS expansion to 2.25 MGD requires an additional storage tank which could be located in the northeast corner of the RWQCP (Site 2 from the Feasibility Study), adjacent to the existing maintenance building and soil bed filters. Two parallel 96-inch process lines are located at this site. Structural and surface improvements are required to develop a future storage facility at this site.

3.4. AWPS Structures

The AWPS will be constructed on a concrete slab with canopies over membrane equipment. To visually screen the AWPS facility from the pedestrian walkway and Embarcadero Road to the north, vegetation and landscaping will be installed. The AWPS slab incorporates cast-in-place pipe galleries with traffic-rated gratings to allow equipment to drive on top of the slab and provide access to piping between equipment.

The canopies for the AWPS equipment and the electrical building are pre-engineered steel structures with limited architectural features. No cover or canopy is provided for chemical storage facilities.

3.5. Biofilter Relocation

Located in the footprint of the proposed AWPS building, the existing biofilter must be demolished to accommodate the new AWPS building. The existing biofilter is constructed of gravel and sand, and is designed to remove hydrogen sulfide and ammonia from air collected from the influent pump station. To replace this existing filter, a new biotrickling filter system with an activated carbon polishing filter is proposed adjacent to the influent pump station, as shown on Drawing C3 AWPS Site Improvements Plan. The goal of this filter technology selection is to match the odor control facilities recently installed as part of the sludge dewatering and loadout facility. The new filter must handle approximately 6,000 standard cubic feet per minute (SCFM) of exhaust air, and remove hydrogen sulfide and ammonia as follows:

- Hydrogen Sulfide - 99 percent removal for concentrations above 10 parts per million (ppm) and 100 parts per billion by volume (ppbv) for discharge concentrations at inlet concentrations less than 10 ppmv.
- Ammonia - 90 percent removal for concentrations above 50 ppmv and 5 ppmv maximum outlet concentration for inlet concentrations less than 50 ppmv.

The preliminary design is based on a two-stage odor treatment system consisting of an initial biological treatment stage followed by an activated carbon polishing stage manufactured by BioAir Solutions.

3.6. Utility Relocation

Construction of the AWPS and the storage tank requires relocation of several existing below-grade utilities to provide an unobstructed footprint. The known utilities to be relocated are summarized in Table 3-1.

Table 3-1: Utility Relocation

Utility	Size	Relocation Length (feet)
No. 4 Plant Water	6-inch	300
Storm Drain (Abandoned?)	12-inch	190
Irrigation	1-inch	300
Fresh Water Marsh Outlet	12-inch	270
Bioassay	2-inch	190
Low-Voltage Electrical	-	40

The relocated utilities and proposed new locations of the utilities listed in Table 3-1 are shown on Drawing C1 Demolition and Utility Relocation Plan.

3.7. Yard Piping

The AWPS requires connections to other facilities at the RWQCP. Process streams to be conveyed are summarized in Table 3-2. Proposed locations for yard piping are shown on Drawing C4 Yard Piping Plan.

Table 3-2: Yard Piping

Facility	Fluid	Source	Destination	Flow 1.125-MGD AWPS	Flow 2.25-MGD AWPS	Pipe Material	Pipe Size (in)	Length (ft)
MF Feed	UV-Disinfected RWQCP Effluent	UV Disinfection	UF System	1.42 MGD	2.85 MGD	PVC	14	510
MF Backwash Return	MF Backwash Return	MF System	RWQCP Headworks	0.10 MGD	0.20 MGD	PVC	4	Internal
MF CIP Waste	MF CIP Waste	AWPS (UF System)	RWQCP Headworks	168 GPM	336 GPM	PVC	6	Internal
RO Feed	MF Permeate	MF System	RO System	1.32 MGD	2.65 MGD	PVC	12	Internal
RO Permeate	RO Permeate	AWPS (RO System)	AWPS Storage Facility	1.125 MGD	2.25 MGD	PVC	12	40
RO Concentrate	RO Concentrate (Reject)	AWPS (RO System)	RWQCP Outfall	0.20 MGD	0.40 MGD	PVC	6	270
RO CIP Waste	RO CIP Waste	AWPS (RO System)	RWQCP Headworks	168 GPM	336 GPM	PVC	6	Internal
Sodium Hypochlorite Feed	SHC Solution	RWQCP Chemical Storage Tanks	RO Permeate	0.010 GPM	0.021 GPM	PVC w/ Secondary Containment	3/4	300
Sodium Hypochlorite Feed	SHC Solution	RWQCP Chemical Storage Tanks	UF CEB	3.89 GPM	4.50 GPM	PVC w/ Secondary Containment	3/4	300
Sodium Hypochlorite Feed	SHC Solution	RWQCP Chemical Storage Tanks	CIP	4.48 GPM	5.18 GPM	PVC w/ Secondary Containment	3/4	300
AWPS Product Water	AWPS Permeate	AWPS Storage Facility	RW Pump Station	3.38 MGD	6.75 MGD	PVC	24	760
AWPS Storage Overflow	AWPS Permeate	AWPS Storage Facility	RWQCP Storm Drain (Headworks)	1.125 MGD	2.25 MGD	PVC	12	80
Shower, Hose Bibbs, and Eye Wash	Potable Water	Potable Water System	AWPS	20 GPM	20 GPM	PVC	3/4	175

3.8. Blending Facilities

Blending facilities are needed to mix disinfected tertiary treated water with RO permeate from the AWPS. AWPS sizing is based on a 1:1 blending ratio between these sources; however, in reality, the City may elect to vary the blending ratio to meet specific operational goals. For example, if recycled water demand is less than twice the RO permeate flow rate produced, the City could increase the ratio to utilize more RO permeate and improve water quality to recycled water customers.

The blending ratio between the two sources is controlled based on an input ratio set point established by operations. The flow rates of RO permeate and disinfected tertiary treated recycled water are controlled by a programmable logic controller (PLC) controlling two electrically-actuated v-notch type control ball valves to throttle the flow from each water source, one on the pipeline from the RO storage permeate tank, and one on the pipeline between Recycled Water Storage Tank No. 3. A flow meter is provided upstream of each throttling valve to measure the flow from each source and provide a feedback loop to the PLC. A vault is provided for each flow meter and throttling valve. The vault on the pipeline between Recycled Water Storage Tank No. 3 is located in an area of heavily congested utilities. Additional research, including potholing, is required during detailed design to accurately locate existing constraints for this facility.

Alternatively, blending improvements, including flow meters and throttling valves, could be located in the basement of the administration building or an adjacent room and connect to the existing header upstream of the recycled water pumps. Alternatives to the aforementioned blending facilities should be considered in the next phase of design to avoid the area highly congested with below-grade utilities to the north of the administration building.

Blending occurs in the recycled water pump station and distribution pipelines. A preliminary layout for blending facilities is shown on Drawing C5 Blending Facilities Demolition and Improvements Plan.

At the time of writing this report, it is unclear if the golf course will receive tertiary-treated recycled water or ERW. Additional modifications to the recycled water booster pump station are necessary if the golf course receives ERW.

The supervisory control and data acquisition (SCADA) control screen for blending ratios should include current TDS concentrations of both the AWPS permeate and disinfected tertiary-treated recycled water.

3.9. Storage Requirements

Sufficient recycled water storage must be provided to ensure supplies are available when daily demand exceeds production capacity. For the purpose of sizing water storage facilities, it is assumed all recycled water demand is used for irrigation, occurring during an eight-hour nighttime irrigation period. To meet this demand, system storage must supply the total eight-hour demand, less the system production capacity in an eight-hour period. Storage is intended to meet maximum daily demands, typically occurring during peak summer usage.

By collaborating with customers with higher recycled water demands, and filling offsite recycled water storage facilities during non-peak hours, storage requirements could be reduced; it is typically more cost-effective to implement administrative strategies to distribute demand compared to constructing additional storage and conveyance facilities to address peak demands. Storage facilities to accommodate a 1.125-MGD AWPS are provided in this report; prior to AWPS expansion to 2.25 MGD, storage requirements should be reevaluated based on implemented administrative controls and actual demand curves.

3.9.1. AWPS Permeate

Storage is required for RO permeate during non-peak recycled water demand hours. For a 1.125-MGD AWPS, 0.75 million gallons (MG) of RO permeate storage is required. This volume is sized for a maximum daily enhanced recycled water demand of 2.25 MGD, the maximum production capability of a 1.125-MGD AWPS.

A welded steel storage tank with a diameter of 73 feet, a 30-foot height, and a liquid depth of 24 feet provides this volume of storage (six feet of freeboard). The storage tank, designated RO Permeate Storage Tank No. 1, is located in the northeast corner of the RWQCP site as shown on Drawing C2 Site Layout Plan. It is believed the AWPS permeate tank site is underlain by fill over Bay mud. As a result, a pile supported slab foundation is anticipated to prevent excessive settlement.

Additional storage may be required for expansion of the AWPS to 2.25 MGD. There is no sufficient area adjacent to RO Permeate Storage Tank No. 1 to construct a similarly sized tank. As discussed in Section 3.4.2., a site at the northeast corner of the RWQCP can accommodate a storage tank for Phase 2. Preliminary design of a Phase 2 storage tank is not included herein.

Alternatively, the old chlorine contact basin could provide the necessary RO permeate storage capacity on a temporary basis. This tank is currently available for effluent wet weather storage and this site is ultimately reserved for placement of a new headworks. Additional research and documentation is required to determine if this is a feasible alternative, including operational impacts, procedures for changing over between permeate and equalization storage, potential permitting issues, seasonal use, piping connection requirements, and any required rehabilitation.

3.9.2. Tertiary-Treated Recycled Water

The existing recycled water facilities at the RWQCP include three storage tanks with a total capacity of 593,000 gallons and an operational capacity of 493,000 gallons. These facilities have sufficient capacity to store disinfected tertiary recycled water to meet the demands of a 1.125-MGD AWPS.

Additional storage may be required to accommodate a 2.25-MGD AWPS. To provide this additional storage, the Feasibility Study proposed Recycled Water Storage Tank No. 3 be demolished, and a larger tank constructed in its place. A sufficiently sized tank could be constructed in this location to meet the needs of the expanded 2.25-MGD facility, if used in conjunction with Recycled Water Storage Tanks No. 1 and No. 2. The size of the new tank should be based on actual demands and storage requirements.

This new tank would be hydraulically connected to Recycled Water Storage Tank No. 1 and No. 2, controlling the liquid level in the tank. Relocation of some site utilities, including 12-kV electrical conduits, recycled water site piping, and waste/drainage piping, is required to construct a larger tank in this location.

3.9.3. Reuse of Existing Recycled Water Storage Tanks

It is anticipated the three existing recycled water storage tanks will continue to serve as storage for the disinfected tertiary treated water used for blending with AWPS permeate. To assess the ability of these tanks to continue to perform in this capacity, a review of available information was conducted, including record drawings and a 2006 condition assessment (Ervin, 2006). Known attributes of these tanks are summarized in Table 3-3.

Table 3-3: Existing Recycled Water Storage Tank Attributes

Recycled Water Storage Tank No.	Approx. Operational Capacity (Gallons)	Year Constructed	Asset Age (Years)
1	90,000	1975	42
2	165,000	1975	42
3[1]	238,000	1934	83
Total	493,000		

Note: (1) Recycled Water Storage Tank No. 3 was originally constructed as a clarifier, converted to a flocculation tank, then converted for use as a recycled water storage tank in 2008.

In the 2006 condition assessment, a remaining useful life of 23 years was determined for the Administration Building and Reclamation Plant, which includes Recycled Water Storage Tanks No. 1 and No. 2. With this value, and the present year of 2017, a remaining useful life of 12 years is calculated. No major condition issues with these tanks are currently known. The City should conduct additional investigations into the conditions of these tanks as part of future condition assessment work or as part of a study to increase disinfected tertiary-treated recycled water storage.

Recycled Water Storage Tank No. 3 has served multiple uses since construction. In the 2006 condition assessment, Recycled Water Storage Tank No. 3 is shown as abandoned. When this tank was converted to a recycled water storage tank in 2008, it was in adequate condition for reuse. No additional information on its condition is available since that time. On a similar timeline as Recycled Water Storage Tanks No. 1 and No. 2, additional condition assessment should be completed, unless it will be demolished.

3.10. Site Improvements

Site improvements at the AWPS and permeate storage tank area include grading, paving and access, landscaping, and drainage improvements. These improvements are shown on Drawing C3 AWPS Site Improvements Plan and are discussed further in the following subsections.

3.10.1. Site Grading

The AWPS site must be graded to accommodate the proposed facility, to integrate with the existing landscape, and to provide appropriate drainage. The floor slab elevation of the facility will be set at an elevation above the highest anticipated flood plain elevation. Due to unknown impacts of climate change and sea level rise, the City may elect to establish the floor slab height of the AWPS above the current flood plain elevation of 10.5 feet above sea level (asl). The City is currently developing a City-wide policy regarding climate change and sea level rise, which should be considered during detailed design. Similarly, grading is required for proposed AWPS permeate storage and associated site improvements.

Existing grades at the AWPS vary between an elevation of 7.0 and 11.0 feet asl. A finished floor elevation of 11.0 asl is assumed. Existing grades at the AWPS permeate storage tank site vary between 7.0 and 9.0 feet asl. A tank floor elevation of 11.0 asl is assumed.

3.10.2. Paving and Access

Access for pedestrians and vehicles to the AWPS includes paved access around three sides of the AWPS and permeate storage tank. Proposed paving and access improvements at the AWPS are shown on Drawing C3 AWPS Site Improvements Plan. Curbs and gutters are provided at the edges of areas proposed to be paved. The existing boundary fence in the area of the AWPS will be reconstructed between the AWPS and Embarcadero Road, and between the AWPS and adjoining properties.

Access into the plant for chemical deliveries will be via the existing plant entrance on Embarcadero Road. Vehicles will travel through the interior of the plant to the AWPS, and through the same entrance to Embarcadero Road, or through the main plant entrance on Embarcadero Way.

The existing pedestrian pathway winding along the northern property line of the RWQCP must be rerouted to increase the buffer between the public route and the AWPS and permeate storage tank.

3.10.3. Drainage

Drainage improvements at the AWPS site will direct stormwater to appropriate drainage facilities and to comply with Santa Clara County Stormwater Pollution Control Requirements. The County Stormwater Pollution Control Requirements are anticipated to be met by directing all potentially contaminated stormwater to on-site storm drains, which discharge to the RWQCP headworks. Stormwater facilities are designed in accordance with City standards. The City may elect to implement low impact development (LID) features in landscaped areas to encourage on-site treatment and infiltration of stormwater, and discharge treated stormwater off-site.

3.10.4. Landscaping and Irrigation

Landscaping improvements at the AWPS site are provided in all disturbed areas not otherwise receiving improvements. Large screening vegetation is provided between the AWPS and Embarcadero Road, as well as between the AWPS and adjacent private properties. Water for irrigation of landscaped areas is provided by connecting to the existing recycled water irrigation distribution system.

3.11. Future Connection Points for UV and AOP

The City and project stakeholders are considering a separate project to construct an AWPS, including a UV/AOP to the southeast of the RWQCP at Site 4. This additional UV/AOP is required for potable reuse of treated water. To maximize the usage of AWPS permeate, especially during the winter months when recycled water demands decrease significantly, excess water could be conveyed to the UV/AOP process for additional treatment and potential potable reuse. To provide for this, an additional connection is provided on the AWPS storage tank, anticipating a 14-inch pipeline from the AWPS storage tank to the future UV/AOP facility. This pipeline is sized to convey up to 100 percent of the water produced from a 2.25-MGD AWPS from the storage tank to the UV/AOP. The anticipated pipeline alignment is shown on Drawing C4 Site Piping Plan.

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Section 4. Electrical Improvements

The existing RWQCP is supplied with power through a 12-kilovolt (kV) power distribution ring around the site. The ring is supplied from City of Palo Alto Utilities (CPAU) switches at two separate locations, each of which is metered, as shown on Drawing E-1 12-kV Power Distribution.

All of the switches on the ring were originally designated to be operated and maintained by the RWQCP; however, these are not operated nor maintained on a regular basis and RWQCP staff are not readily available for switching. The ability to provide redundant power supply from the ring is therefore somewhat limited. The normal arrangement is for the ring to be supplied from the southern corner of the plant. CPAU has requested the Switch 1910 which feeds the ring from the other end of the plant, near the pumping plant, be upgraded, replacing the fuses with circuit breakers. RWQCP staff have a preference to keep that as a separate future project, due to the complexity of managing the change-over. In addition, there is also a preference to keep the electric billing separate for the new AWPS.

Based on limited benefits of connecting to the existing ring, and the fact a new meter is desired in any case, it is proposed the AWPS be supplied from a separate metered service from CPAU. There appears to be a spare switch in CPAU four-way switch P-1885X, which would be suitable for this purpose.

An emergency generator is not included; a manual transfer switch will be provided, with space to accommodate a portable generator. The expected generator supply is sized to perform a proper shut-down procedure of the AWPS and for system monitoring only; it is not expected to accommodate the full AWPS electrical load. CPAU has two portable generators which could potentially be used to provide temporary power, but further evaluation would be required for this future use.

If back-up power were to be provided, it would enable the AWPS to produce advanced treated water during a power outage; it would not allow distribution of recycled water to customers, as the recycled water pump station does not have back-up power.

4.1. Projected Electrical Loads

The anticipated electrical loads, in kilovolt-amps (kVA) for the proposed AWPS production capacity of 1.125 MGD and the potential expanded production capacity of 2.25 MGD are compiled in Table 4-1. Power factor correction will be provided as necessary to meet a target 0.97 power factor under normal operating conditions, in order to ensure the CPAU power factor requirement of 0.95 is met under all scenarios and penalties for low power factor are not incurred.

Table 4-1: Projected Electrical Operating Load

1.125 MGD AWPS (kVA)	2.25 MGD AWPS (kVA)
355	710

4.2. Electrical Requirements

Table 4-2 shows the electrical design criteria required for a 1.125-MGD AWPS with provisions for expansion to 2.25 MGD.

Table 4-2: Electrical Design Criteria

Equipment	Description	Location
Main Switchboard	• 480/277 V, 3 Phase, 4W • NEMA 3R, EUSERC, in accordance with the requirements of CPAU Electric Service Requirements • Size suitable for Phase 2 with minimal modification • Customer power monitoring on each outgoing feeder • Manufacturers: Square D, ABB, Eaton, GE	Outside wall of electrical room
12/0.48 kV Transformer	• Meets CPAU Electric Service Requirements. • Size to be determined by CPAU based on load information provided by the design engineer. May require upgrade during Phase 2. • The transformer pad and underground conduits by the contractor. CPAU will provide the transformer and conductors on both the High Voltage (HV) and Low Voltage (LV) side.	North of the electrical building
MCC	• 480/277 V, 3 Phase, 4W • NEMA 1 indoors • Space for Phase 2 equipment plus an additional 20% spare capacity • Fully equip spaces for future devices with bussing and bus connections, insulated and braced for short circuit currents, but do not provide the circuit breakers or starters at this stage. • Power monitoring for every starter/feeder • HOA switch for each starter • Manufacturers: Square D, ABB, Eaton, GE	Electrical Room
Power Distribution Panels	• Surface-mounted • NEMA 1 indoors • Four spare 20A single pole circuit breakers per panel • Space for Phase 2 equipment plus an additional 20% spare capacity, with pole fillers • Labels to be provided on computer, or machine-printed schedule on inside door (not hand-written)	Electrical Room
Dry-Type Transformers	• Ventilated NEMA 1 indoors • Rated for the full anticipated load at Phase 2, with 20% spare capacity	Electrical Room
VFDs	• RO Pump VFDs will require harmonic filtering on the VFD input. This should be considered during the detailed design.	Inside MCC or Local Control Panel

Equipment	Description	Location
VFDs (continued)	• Harmonics mitigation will be designed to meet IEEE-519 requirements. • Maximum tolerable distance for VFD cables needs to be considered. This varies by manufacturer, but is typically between 100 to 250 feet, without any output filtering.	Inside MCC or Local Control Panel
Local Control Panels (LCP)	• NEMA 4X • HOA switches and local indication of chemical pump running/fault • All I/O from LCP shall be hard-wired back to Main Control Panel PLC	Just outside the containment for the Chemical Skid being controlled
Main Control Panel	• NEMA 12 • Refer to Control and Communications Section for network details • Use proprietary Allen Bradley IFM modules for PLC I/O • Terminal strip for PLC digital I/O to allow inputs to be wetted from field or panel (i.e. hot terminal or volt-free terminal for each input)	Electrical Room
Power Factor Correction	• Provide automatic power factor correction connected to the main MCC • Provide adequate capacitor bank switching to maintain a minimum 0.97 power factor for the entire operating load of the plant (from 0% to full load)	Electrical Room
Emergency Backup Power	• No permanent generator • Manual Transfer Switch with connection point and generator laydown area • Not sized for full plant load, only loads required for a correct plant shutdown and for SCADA/monitoring • UPS provided for SCADA/monitoring for 12-hour backup	Transfer switch in Electrical Room, Connection Facility on outside wall of Electrical Building
Conduit Systems	• PVC coated galvanized rigid steel (GRS)	Outdoor, exposed
	• GRS	Corrosive area, exposed
	• PVC Schedule 40 with marker tape • Concrete encased under vehicle trafficked areas	Below grade
Lighting	• Minimize the extent of permanent site lighting and projection of light from the site, to a level no greater than regular street lighting • Apply only where needed for safe performance of common O&M tasks or in areas needing lighting for security or safety purposes • Controlled per Title 24 requirements • LED fixtures unless otherwise approved	As required

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Section 5. Control and Communications

The AWPS includes a high level of automation. A preliminary control system network architecture drawing is shown in Drawing I1 AWPS Site 1 Concept Network Diagram. The plant operators will manually initiate start-up of the plant from the control system. After operator initiation, the plant start-up sequences, normal operation, and plant shut-down sequence will be managed fully automatically by the control system.

An operator workstation is provided in a control room adjacent to the electrical room. Plant operations are monitored and controlled via a local operator station using GE iFix software package. A development workstation is provided which will have the PLC programming software installed as well as the GE iFix human machine interface (HMI) software.

Monitoring and control is also available from the RWQCP Control Room, on Operator Workstations located in the plant administration building, as well as further control available through HMIs located at critical areas of the plant, with locations to be confirmed during project design.

The design enables remote off-site access for operator monitoring, technician diagnostics and control modifications, under agreed security measures.

The vendor equipment PLCs are Allen Bradley and interface transparently with Allen Bradley ControlLogix PLCs for the plant. The PLCs connect on a fiber ring. The PLC ring utilizes communications between PLCs without requirement for operation of the servers or SCADA network level.

Two separate fiber optic cables run between the new AWPS and the existing pumping plant. One single-mode cable connects to the City Network for Voice-Over Internet Protocol (VOIP) and security cameras and the other multi-mode cable connects to the plant control network (SCADA).

5.1. Equipment Manufacturer/Supplier Requirements

Instrumentation and control equipment shall be readily available from local distributors, and shall be fully supported within California. At a minimum, all equipment manufacturers must have been in operation for at least ten years and have a proven track record with the equipment specified in use in industrial facilities under similar environmental and duty conditions in the United States of America. For packaged systems, these requirements shall be fulfilled to the extent possible.

5.2. Redundancy Requirements

Duty/standby unit I/O in all PLCs and Remote Input/Output (RIO) units will be installed in separate I/O cards so a single card failure will not lead to plant loss.

At least 20 percent free space capacity must be available at each kind of I/O Module, and at least 40 percent free space capacity (including 20 percent free slots in plug-in bases) at the PLC. This free space will be distributed inside the cubicles in such a way that additional terminals, equipment, or modules may be added to any group of controls.

The Ethernet interface equipment on the SCADA, PLC, and Remote IO rings allows self-healing of the ring in the event of a failure. The path of the ring shall be such that the two sides are spatially separated and unlikely to be damaged at the same time.

Programs and configuration backups shall be stored for fast upload into new modules or central processing units (CPUs), if the modules are replaced. Spares provided shall be adequate to allow any of the following to be swapped out on failure:

- PLC I/O cards (hot-swapped)
- Backplane
- CPU
- Power supply

5.3. Integration into RWQCP Administration Building

The AWPS will have a standalone SCADA system with a local historian, but the full screens and data are also available remotely from the RWQCP Administration Building. All equipment at the Administration Building location will be integrated by RWQCP staff or a contract integrator. The RWQCP shall grant supervised access for the integrator to update the central SCADA database, historian database, and screens at the RWQCP monitoring location. RWQCP staff must advise the version of iFix required at the time of installation. Testing and commissioning is done end-to-end, such that the SCADA controls will be tested from the AWPS as well as from the central monitoring location all the way through to the AWPS equipment.

5.4. Metering and Monitoring System at Export Interface

Quality control and monitoring of the AWPS is performed near the blending point. This includes flow and conductivity (as a surrogate to TDS) monitoring to enable the blending ratio to be controlled. Additional online water quality monitoring may be required at some point in the future if the AWPS product water is used for potable reuse. Such requirements will be determined by state regulators.

5.5. AWPS Business Network

A separate fiber optic cable is provided for connection to the RWQCP business network. As well as providing RWQCP intranet connections, a VOIP system and IP security camera data are provided over this network.

A VOIP telephone is provided in the control room with additional telephones at strategic locations throughout the AWPS. The wiring for the phone local area network (LAN) utilizes a separate core in the fiber optic ring. The private branch exchange (PBX) system is located in the control room. The VOIP system has a voice mail box on each extension and handsets with displays.

Secure access is provided to the RWQCP intranet at the new AWPS control room. The plant SCADA network and the business network shall be maintained as separate networks with a secure firewall between the two.

5.6. Electronic Site Security and Safety

Electronic security and safety systems installed at the AWPS site include:

- Security Camera system at the gate and around the process area
- Intrusion detection on building entries and field-installed panels
- Allowance for future card readers to be installed on the building doors and gate entry
- Addressable fire alarm detection with voice evacuation and mass notification system
- Night security lighting on buildings and general lighting in all external and internal operating areas for night operations
- Emergency lighting within hazardous operating areas

The security camera system is locally monitored and recorded. Resolution for remote video monitoring is dependent on available bandwidth based on method of remote communications.

Section 6. Operational Considerations

It is envisioned the AWPS normal operating mode will be continuous, with the MF and RO system running 24 hours a day, seven days a week, with planned shutdowns for maintenance activities.

The MF and RO systems will have multiple trains, allowing individual trains to be taken off-line for cleaning, maintenance, etc., while the balance of trains remain in operation and continue production.

During extended periods of reduced demand in winter months, the overall production capacity of the AWPS could be reduced by 50 percent in Phase 1 by taking one of the two RO trains out of service. The second RO train could either be taken offline, with the membranes stored in place (in the pressure vessels on the RO trains) with a preservative solution; or the operation between the two trains could be cycled back and forth every day or two, depending on the expected duration of reduced demand. The RO train not in operation would need to be flushed with RO permeate water for a short term shut down of a day or two.

Additionally, the capacity of each RO train could likely be varied plus or minus 10 percent from the design flow, allowing for additional operating flexibility to meet varying demand. The capacity of MF trains can easily be varied to meet the RO feed flow requirements during these periods.

If enhanced recycled water demand drops below 1.125 MGD (0.56 MGD AWPS production), the City could implement one, or a combination, of the following operating strategies:

- Continue to operate the AWPS at the minimum continuous production capacity of approximately 0.5 MGD, and produce a higher quality (lower TDS) enhanced recycled water.
- Continue to operate the AWPS at the minimum continuous production capacity of approximately 0.5 MGD, and overflow the RO permeate tank to the outfall.
- Cycle the AWPS system on/off several times a day during the duration of the extreme reduced demand period. While this mode of operation is not preferable for an MF/RO system, it can be done with extra operator attention and care. This mode of operation is inefficient, as it would require frequent flushing with RO permeate, and can lead to more frequent membrane cleanings due to increased biofouling.

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Section 7. Permits and CEQA Compliance

This section describes the analysis performed to evaluate compliance with the City's existing and potential future National Pollutant Discharge Elimination System (NPDES) discharge permit for the RWQCP. Additional permits from agencies having jurisdiction are also discussed. Compliance with CEQA is described, including special studies which may need to be performed.

7.1. NPDES Permit

Extensive modeling of water quality to determine permit compliance at various AWPS capacities was conducted for the Feasibility Study; this section summarizes the conclusions of that Study. In order to establish the RO concentrate water quality, AqMB™ software, a predictive model which incorporates speciation, interactions between chemicals, and membrane rejection characteristics, was utilized. The water quality used for the AqMB™ software was the 95th percentile constituent values generated from RWQCP final effluent data provided by the City for the reporting years of 2011 to 2015. The 95th percentile was selected as a conservative approach. Projected RO concentrate water quality varies based on factors such as type of RO membrane elements, rejection efficiencies for different constituents, and recovery rate. A Low Fouling Thin Film Polyamide Membrane with Spiral Wound Configuration and an RO recovery of 85 percent were utilized for this model.

Based on the RO concentrate water quality produced by the AqMB™ software and the NPDES permit, several targeted constituents were identified for further compliance modeling. This included the constituents copper, nickel, cyanide, and selenium and the nutrients nitrogen and phosphorus. RO concentrate for a 1.125- and 2.25-MGD AWPS blended with RWQCP final effluent at the minimum, average, and maximum RWQCP flow was compared to the City's maximum daily and monthly average concentration water quality criteria from their NPDES permit.

Although concentrations are elevated in the RO concentrate, maximum daily final effluent concentrations after blending are not projected to exceed the maximum daily water quality criteria in the City's NPDES permit for a 1.125- and 2.25-MGD AWPS. The scenario which comes closest to exceedance is the minimum flow event under a 2.25-MGD AWPS. However, even in this rare event it was found concentrations of the limiting constituent, maximum daily copper, in the blended effluent are projected to reach only 65 percent of the maximum daily water quality criterion (23.4 vs 36 micrograms per liter (µg/l))[5].

While there are currently no NPDES permit limits for nutrients, the City has been advised water quality criteria for nutrients may become applicable in their next NPDES permit renewal in 2024. Potential future example criteria for "No Net Loading Increase" (NNLI) for total phosphorus and total nitrogen was developed by the City in 2015 and 2016. The hypothetical limits were determined to be 2,230 kilograms per day (kg/d) for total nitrogen and 350 kg/d for phosphorus. Based on these values, it was determined there were several scenarios at an AWPS of 1.125 or 2.25 MGD where blended effluent to the San Francisco Bay (Bay) would exceed these potential limits. This was further elaborated on in the sizing sensitivity analysis for NPDES permit compliance done during the Feasibility Study.

The following analyses in Figures 7-1 and 7-2 estimate the AWPS capacity which would cause an exceedance of the potential limits for total nitrogen (as N) and total phosphorus (as P) loading to the Bay, respectively. The figures present four scenarios: average and 95th percentile nutrient concentrations at average RWQCP flows (20.3 MGD); and average and 95th percentile nutrient concentrations at maximum permitted RWQCP flows (39 MGD). The horizontal green dotted line in Figure 7-1 indicates the potential total nitrogen permit limit of 2,230 kg/d and the horizontal green dotted line in Figure 7-2 indicates the potential total phosphorus limit of 350 kg/d. For relevance to this report, AWPS capacities of 1.125 MGD and 2.25 MGD are indicated by vertical lines in each figure.

[5] Based on water quality modeling done as part of the AWPS Feasibility Study.

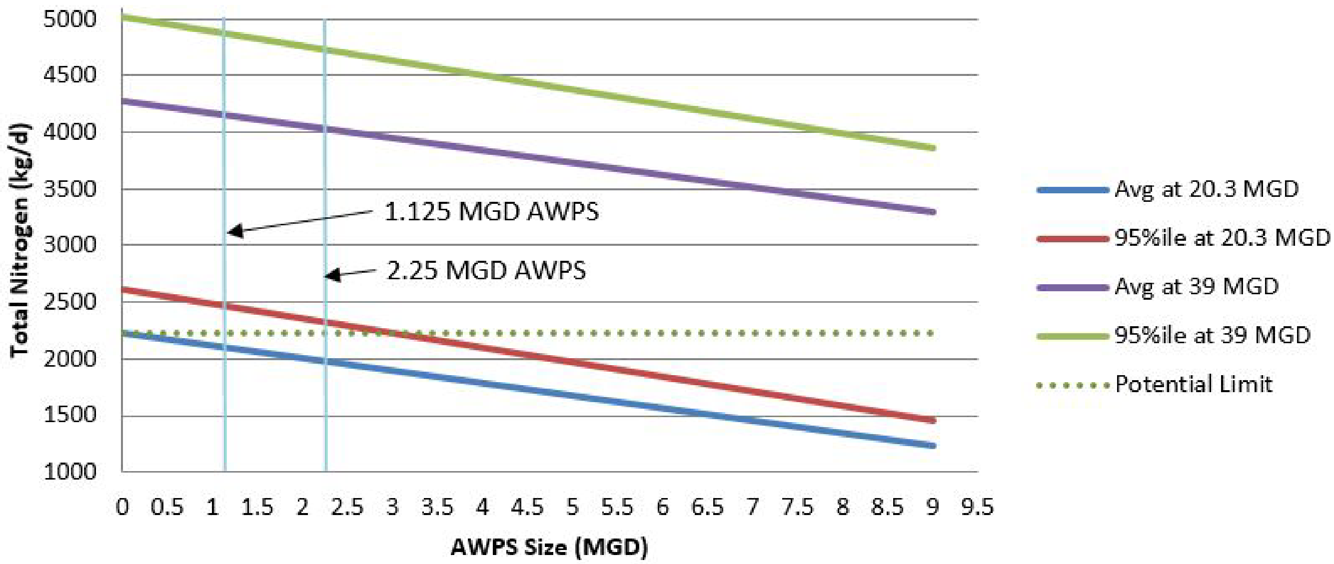

Figure 7-1: Total Nitrogen Loading

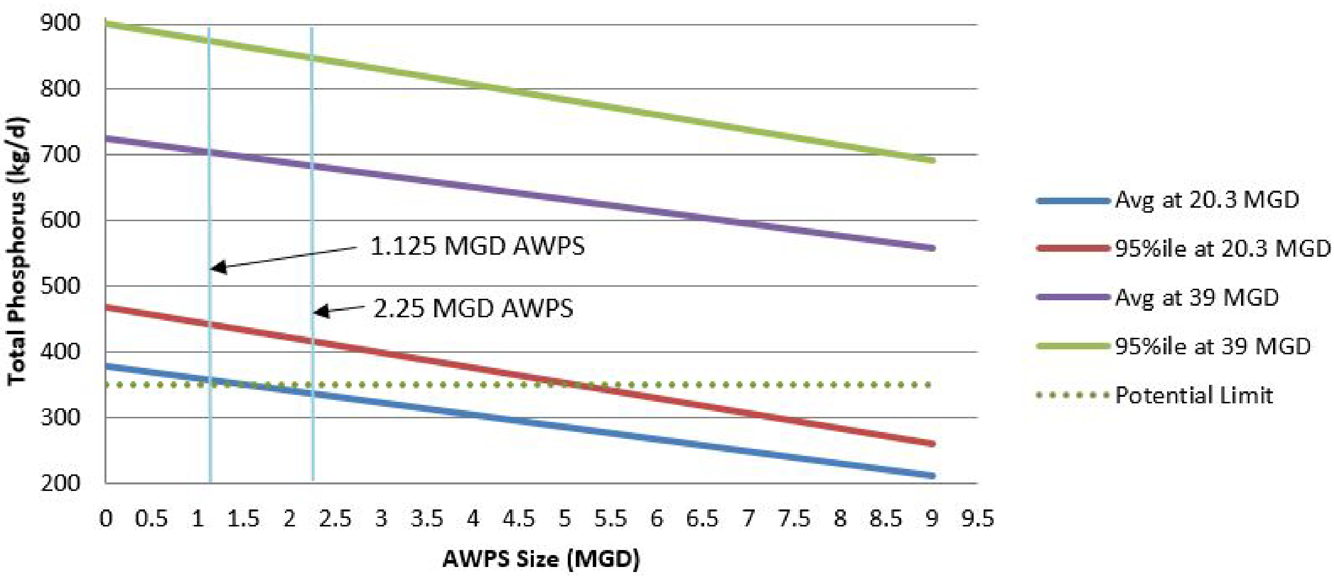

Figure 7-2: Total Phosphorus Loading

7.2. Other Permits

The City will need resource agency permits for construction of an AWPS and changes in discharge water quality. As it is early in the development of the project, the permit requirements can only be estimated. Table 7-1 lists the land use and resource agency permits and approvals that may be required for the AWPS, as well as estimated permit application requirements and schedules. Permit application requirements and the length of time it takes to receive permits vary depending upon the agency, the complexity of the project, and the workload of the permitting staff at the agency.

Table 7-1: Land Use and Resource Agency Permits and Approvals Potentially Required

Resource Agency Permits	Permit Required	Submittal Requirements	Estimated Duration after Submittal is Complete
SFBRWQCB – NPDES permit review or update	Yes	Will occur when the City applies for its NPDES Permit Update in 2019	
State WRCB – NPDES Construction General Permit	Yes	• Notice of Intent • SWPPP • Application	Coverage is obtained when submittal is complete
USFWS Section 7	No[1]		
NHPA Section 106	No[2]		
City Permits and Approvals			
Architectural Review Board (ARB)	Yes	• 90 percent design elevations and site plan • Application	3 months
Planning and Transportation Commission (PTC)	Yes		1 month
City Council Approval	Yes	• ARB and PTC Approval	1 month
Tree Ordinance CIP Approval	Yes	• Tree Inventory and list of trees to be removed or pruned	2 months
Public Works Engineering FEMA NFIP Flood Elevation Certificate	Yes	• Final grading plan • Final foundation plan • Application • Council approval	3 months
Grading Permit	Yes	• Final grading plan • Application • Council approval	3 months
Building Permit	Yes	• Final plans • Application • Council approval	3 months
Encroachment Permit	Yes	• Final plans for construction phase and permanent changes • Application • Council approval	2 months
Parks and Recreation Commission	Maybe	• 90 percent site plan	3 months
Baylands Design Guidelines	Yes	• 90 percent design elevations • Site plan	3 months

Notes: (1) As noted in the Recycled Water Project EIR Mitigation Monitoring Program, any construction that occurs within 500 feet of marsh areas would be subject to Mitigation Measure BIO-7 and subject to restrictions for the protection of California clapper rail. Nevertheless, a Section 7 consultation under the federal Endangered Species Act would not be necessary, so long as Mitigation Measure BIO-7 is implemented resulting in avoidance of impacts to the California clapper rail.

(2) No cultural resources have been identified at the RWQCP site (William Self Associates 2007). However, if federal funding is being sought, the City should inquire whether Section 106 clearance will be required.

7.3. California Environmental Quality Act (CEQA)

The AWPS Feasibility Study identified the likely CEQA needs for an AWPS located on Site 1. The City of Palo Alto Recycled Water Project Environmental Impact Report (RWP EIR) certified in 2015 includes the construction of an advanced water treatment facility and blending with lower salinity water as part of Mitigation Measure HYD-3d. The Final RWP EIR Response to Comments states Mitigation Measure HYD-3d does not create new significant environmental impacts. Because the RWP EIR anticipated the implementation of RO treatment of recycled water, an AWPS project constructed to improve the quality of the RWQCP tertiary-treated recycled water is part of the Recycled Water Project and therefore has already been evaluated as part of that EIR. Appendix D of the Feasibility Study also included a preliminary review (Initial Study) of an AWPS to be constructed at the RWQCP for the purpose of improving the quality of recycled water; no new significant impacts were identified which were not already identified and adequately mitigated in the RWP EIR.

If the AWPS is located at Site 1, which is located on the RWQCP, it appears no further CEQA documentation is required. Nonetheless, if the City desires to prepare a CEQA document for review by the public and decision makers, an Addendum to the RWP EIR could be prepared. The City should consult with their CEQA planner to confirm the desired approach. Such an Addendum, including specific studies such as an Air Quality NO_x Study, Biology Assessment, and a Noise Report, would take approximately three to five months to prepare.

7.3.1. Specific Studies

The City will likely prepare an Addendum to their RWP EIR and may need or desire to prepare the following specific studies.

7.3.1.1. Design for Revised Pathway, Vegetative Buffer, and Screening

As the AWPS Plan needs approval by the City's Architectural Review Board, development of the AWPS design should include attention to the design of the revised pathway along Embarcadero Road, replanting of any vegetation damaged during construction, and planting of trees or shrubs as necessary to screen the new AWPS facility. The design could be prepared by a Landscape Architect retained directly by the City or the Design Engineer.

7.3.1.2. Air Quality NO_x Analysis

An evaluation of NO_x emissions is likely to be required by RWP EIR Mitigation Measure AIR-1. This analysis is usually performed by the CEQA Consultant.

7.3.1.3. Tree Protection and Preservation Plan

The Tree Protection and Preservation Plan is required by the City's Tree Ordinance and by the RWP EIR Standard Project Requirement: Compliance with the Tree Technical Manual. If trees regulated by the Tree Ordinance are to be removed or pruned, the Plan must be prepared by a Certified Arborist. A Certified Arborist could be retained directly by the City or preparation of the Plan could be assigned to the Design Engineer.

7.3.1.4. Implementation Plan for Baylands Design Guidelines

This work may be needed to ensure compliance with the Baylands Design Guidelines and approval from the Baylands Coordination Group. The City may wish to retain a Landscape Architect to perform this work, or have it performed by the Design Engineer.

7.3.1.5. Biology Assessment and Pre-construction Surveys

This work is needed to satisfy the RWP EIR Mitigation Measures BIO-5 (General Measures to Reduce Impacts to Wildlife Species), BIO-6 (Burrowing Owl Pre-construction Surveys), BIO-7 (Buffer for California Clapper Rail or Survey), BIO-8 (Measure to Protect Nesting Birds, and BIO-9 (Bat Preconstruction Surveys).

A qualified biologist(s) could be hired directly by the City or this work could be performed by the CEQA Consultant.

The City could remove potential bird-nesting trees outside of the breeding window, rather than conduct pre-construction surveys and have the potential to find bird nests which must be protected. Such removal would need to occur between September 1 and February 1.

The Biology Assessment should confirm no wetlands would be affected by the project. At this time, it appears the AWPS is sited outside of the 500-foot buffer for California clapper rail (now renamed California Ridgway's rail), and this needs to be confirmed when a final site plan with staging areas is developed.

The City could remove potential bat-roosting trees between September 1 and October 15, when young would be capable of flying, or between February 15 and April 1 to avoid hibernating bats and prior to formation of maternity sites. Otherwise, if bats are found during pre-construction surveys, trees may need to be protected until the young are reared.

The Biology Assessment should investigate the "Gray Fox Habitat Preservation" area shown on Drawing L.1.1, Landscape Improvement Plans prepared by Siegfried, dated October 2, 2013.

7.3.1.6. Geotechnical Report

This report is required by the RWP EIR Standard Project Requirement: Geologic Report for Potentially Affected Facilities. A geotechnical consulting firm can be retained by the City, or the work can be included in the Design Engineer's scope.

7.3.1.7. Health and Safety Plan

The Plan is required by the RWP EIR Standard Project Requirement: Health and Safety Plan and is related to construction activities. The Health and Safety Plan is the responsibility of the Contractor.

7.3.1.8. Hazardous Materials Management and Spill Prevention and Control Plan

The Hazardous Materials Management and Spill Prevention and Control Plan is required by the RWP EIR Standard Project Requirements: Hazardous Materials Management and Spill Prevention and Control Plan and Storage, Handling, and Use of Hazardous Materials in Accordance with Applicable Laws. This Plan is prepared by the Contractor to cover construction-related activities.

7.3.1.9. Contaminated Soil and/or Groundwater Report

This Report is required by the RWP EIR Standard Project Requirement: Proper Disposal of Contaminated Soil and/or Groundwater. The City may retain a qualified geotechnical consultant to prepare the report or this could be assigned to the Design Engineer.

7.3.1.10. Prepare Notice of Intent (NOI) for General Permit for Discharges of Storm Water Runoff Associated with Construction Activity and Storm Water Pollution Prevention Plan

The NOI submittal and SWPPP are required by law and by the RWP EIR Standard Project Requirement: Best Management Practices – Storm Water Quality. These documents can either be prepared by the Design Engineer or the Contractor.

7.3.1.11. Water Quality Analysis

This document will support the City's 2019 NPDES Renewal and may be prepared by the City or the City may retain a qualified consultant.

7.3.1.12. Noise Report

A Noise Report may be useful to the City in complying with the City's Noise Ordinance both during construction and operation. It may also be useful in implementing the RWP EIR Standard Project Requirement: Compliance with Noise Ordinance, and Mitigation Measure NOI-1 (Noise Control Measures to Reduce Construction Noise). This report is usually prepared by a CEQA Consultant.

7.3.1.13. Traffic Control Plan

This Plan is required by the RWP EIR Standard Project Requirement: Traffic Control Plan. The Traffic Control Plan must be prepared by a Registered Traffic Engineer and is usually prepared by the Contractor.

7.4. Estimated Costs

Although it is very early in the project development process, the estimated costs in Table 7-2 are provided for CEQA and specific studies. These costs are provided as general estimates useful for budgeting purposes.

Table 7-2: Estimated Costs for CEQA and Specific Studies

	Cost ($1,000s)
CEQA – Addendum to RWP EIR	$50 - 100
USFWS Section 7	Unlikely
NHPA Section 106	Unlikely
Specific Studies	
Design for Revised Pathway, Vegetative Buffer, and Screening	$25 - 35
Air Quality NO_x Analysis	Included in CEQA cost
Implementation Plan for Baylands Design Guidelines	$10 - 15
Tree Protection and Preservation Plan	$10 - 15
Biology Assessment and Pre-construction Surveys	$20 - 60
Geotechnical Report	Included in Design Cost Estimate
Health and Safety Plan	Included in Construction Cost Estimate
Hazardous Materials Management and Spill Prevention and Control Plan	Included in Construction Cost Estimate
Contaminated Soil and/or Groundwater Report	$30 - 50
Prepare Notice of Intent for General Permit for Discharges of Storm Water Runoff Associated with Construction Activity and Storm Water Pollution Prevention Plan	$30 - 50
Water Quality Analysis for NPDES Discharge Permit	City Staff
Noise Report	Included in CEQA cost
Traffic Control Plan	Included in Construction Cost Estimate
Total	**$175 - 325**

Section 8. Preliminary Cost Estimates

Preliminary capital cost estimates for a 1.125-MGD AWPS and associated improvements, as well as capital costs associated with expanding the facility to a capacity of 2.25 MGD were developed and are described in this section.

Project-specific geotechnical investigation, a complete topographic site survey, and utility potholing should be performed during the detailed design phase to reduce unknowns with the potential to significantly impact the construction cost of the project. The cost estimates presented in this section can be considered Class 3 Estimates (-20 to +30 percent accuracy) in accordance with the AACE international classification system and are appropriate for budgetary purposes. Costs for treatment system equipment were obtained from recent projects of similar size and scope as well as communication with equipment vendors. Unit costs for civil and electrical improvements are based on vendor quotes, reference materials, and recent project bids. All costs are in 2017 dollars and should be updated during the detailed design. Appendix C includes detailed cost estimates. Costs presented in summary tables in this section have been rounded, and as a result may differ slightly from detailed cost estimates.

8.1. Treatment Systems

Tables 8-1 and 8-2 present installed equipment cost estimates for the MF and RO systems, respectively, described in Section 2. This cost estimate for the treatment systems is based on preliminary bill of material and quantity take-offs and includes interconnections and instrumentation.

Table 8-1: MF Treatment System Cost Estimate

Item	1.125-MGD AWPS	Additional Cost for 2.25-MGD AWPS
MF System	$984,000	$650,000
Chemical Feed System	$315,000	$70,000
CIP System	$105,000	-
Ancillary Equipment	$293,000	$114,000
Filtrate Tank to RO Unit	$129,000	-
Control System and Instrumentation	$140,000	$74,000
Total	**$1,967,000**	**$908,000**

Table 8-2: RO System Cost Estimate

Item	1.125-MGD AWPS	Additional Cost for 2.25-MGD AWPS
Primary RO System	$1,762,000	$873,000
Chemical Dosing System	$223,000	$98,000
Cleaning and Flushing Systems	$157,000	-
Ancillary Equipment	$267,000	$224,000
Control System and Instrumentation	$90,000	$56,000
Decarbonator	$154,000	$130,000
Total	**$2,652,000**	**$1,381,000**

8.2. Site Improvements

Costs associated with civil improvements are summarized in Table 8-3. Additional site improvements for expansion of the facility to 2.25 MGD are not anticipated. Future costs for additional permeate storage for Phase 2 and associated piping and appurtenances are not included.

Table 8-3: Site Improvements Cost Estimate

Item	1.125-MGD Capacity Cost
Site Clearing, Grubbing, and Tree Removal	$40,000
Demolition of Odor Control Bio-Filter	$50,000
Chemical Odor Scrubber	$325,000
Demolition of Abandoned Utilities	$28,000
Site Piping, Relocation of Active Utilities, and Blending Facilities	$1,102,000
Site Drainage Improvements	$20,000
Site Grading	$40,000
AWPS Excavation, Piles, Foundations, and Canopies for Treatment Equipment, Electrical Building, and Other Structural Improvements	$1,172,00
Chemical Containment Facilities	$100,000
AWPS Permeate Storage Tank Including Piles and Foundation	$2,018,000
Screening Landscaping	$140,000
Site Access Improvements Including Fences, Gates, Sidewalks, Curbs, etc.	$47,000
Access Roads and AC Paving	$113,000
Total	**$5,195,000**

8.3. Electrical Improvements

Table 8-4 provides installed cost estimates for electrical infrastructure to support the AWPS.

Table 8-4: Additional Electrical Infrastructure Cost Estimate

Item	1.125-MGD Capacity Cost	Additional Cost for 2.25-MGD AWPS
Main Switchboard	$50,000	-
Motor Control Center	$140,000	$125,000
Indoor Dry-Type Transformer and Panelboards	$32,000	$15,000
480V Power Distribution Panel	$10,000	$1,000
Main Control Panel, Programming, SCADA Integration	$300,000	$195,000
IT/Security Equipment	$100,000	$65,000
Lighting Improvements	$60,000	-
Utility Connection Costs (Assume terminations, cabling, and utility transformer)	$60,000	$60,000
Total	**$752,000**	**$461,000**

8.4. Total Bid Prices

Table 8-5 provides a summary of costs for process, civil, and electrical improvements; factors for mobilization, sales tax on materials, and contractor overhead and profit are applied to estimate a total project bid price.

Table 8-5: AWPS Estimated Project Bid Price

Item	1.125-MGD AWPS	2.25-MGD AWPS
Treatment Equipment	$4,618,000	$2,289,000
Site Improvements	$5,195,000	-
Electrical Improvements	$752,000	$461,000
Subtotal	**$10,565,000**	**$2,750,000**
Division 1 Costs and Mobilization (10%)	$1,057,000	$275,000
Taxes on Material Costs (9%)	$697,000	$221,000
Contractor Overhead and Profit (15%)	$1,585,000	$413,000
Total	**$13,904,000**	**$3,659,000**

8.5. Total Project Costs

Design, construction management, and inspection costs are estimated at 12 percent of estimated construction costs. Costs for legal, public outreach, and City administration are not included. The estimated project costs are summarized in Table 8-6.

Table 8-6: AWPS Estimated Project Construction, Design, and Construction Management Costs

Item	1.125-MGD AWPS	2.25-MGD AWPS
Estimated Bid Price	$13,904,000	$3,659,000
CEQA, Permitting, and Specific Studies	$175,000 to $325,000[1]	-
Design, Construction Management, and Inspection	$1,668,000	$439,000
AACE Class 3 Cost Estimate Total (-20% to +30%)	**$15,897,000**	**$4,098,000**
Cost per MGD Capacity (2.25 MGD Capacity)	**$8,882,222**	

Note: (1) For total costs, the high end of this cost range is assumed.

8.6. Operating Costs

Preliminary operating costs for the AWPS include labor, equipment repair and replacement, chemicals, electricity and miscellaneous expenses. Wastewater (feedwater to the AWPS) and RO concentrate disposal costs are not considered (i.e., the City does not have to pay another entity for these). Power costs are assumed at $0.15 per kWh. Pumping costs associated with discharge of enhanced recycled water into the distribution system are omitted. For the 1.125-MGD AWPS, one full-time equivalent (FTE) O&M staff is assumed based on similar-sized facilities. Table 8-7 includes a detailed breakdown of the estimated annual operating costs.

Table 8-7: AWPS Annual Operations and Maintenance Cost Estimate

AWPS Production Capacity (MGD)	1.125	2.25
AWPS Production Capacity (AFY), 95% Online	1,197	2,394
Number of FTE O&M Staff	1.0	2.0

Item	$/AF[1]	$/Year	$/Year
Operations and Maintenance Labor[2]	-	$191,500	$383,100
Repair and Replacement	$40	$47,900	$95,800
Chemicals	$100	$119,700	$239,400
Electricity ($0.15 / kWh)	$105	$125,700	$251,400
	Totals	**$485,000**	**$970,000**

Note: (1) $/AF Costs and typical performance values based on industry experience for AWPS
(2) Based on fully burdened staff at $92/hour and assumes maintenance work shared with existing staff

Table 8-8 outlines the cost of water for each Phase in dollars per acre-foot using the estimated annual O&M cost, and the project design, construction, and construction management costs. The cost of water for Phase 2 is expectedly less than for Phase 1 due in part to the large up-front cost of Phase 1, which accounts for aspects of the Project sized initially for future build-out to 2.25 MGD.

Table 8-8: AWPS $/AF Cost of Water

AWPS Production Capacity (MGD)	1.125	2.25
AWPS Production Capacity (AFY), 95% Online	1,197	2,394
Project Cost Estimate	$15,897,000	$4,098,000
Estimated Annual Capital Repayment[1]	$709,800	$892,400[2]
Estimated Annual O&M Cost	$485,000	$970,000
Cost of AWPS Water at First Year of Operation ($/AF)	**$948**	**$739**

Notes: (1) Cost at first year of project assumes 30-year loan at 2% interest
(2) Value assumes the sum of the Estimated Annual Capital cost for the 1.125-MGD AWPS and the additional cost to expand to 2.25 MGD.

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Section 9. Preliminary Design and Construction Schedule

This section discusses anticipated steps and associated schedules for developing the project with two alternate procurement strategies. For simplification, permitting activities are not included in the project schedules. The schedules also assume the CEQA document is a Notice of Exemption. If the City determines an amendment to the EIR is appropriate, the schedule should be revised to include the special studies described in Section 7.

9.1. Design-Bid-Build

Design-bid-build procurement is the traditional procurement method of engaging a design engineer to develop a complete, finalized set of contract documents, then releasing those documents to publicly solicit bids from any qualified contractor interested in completing the work. A conceptual schedule for delivering the AWPS utilizing a design-bid-build procurement is included as Figure 9-1 and is estimated to take 42 months to complete.

The design-bid-build process is familiar to public agencies and there are processes in place to execute projects in this manner. Depending on the agency, there are numerous milestones at which approval is needed from the governing body, in this case, the City Council. These milestones may include:

- Approval of a contract with an engineering firm for design services
- Approval of a contract with the engineering firm for bidding support
- Approval of a contract with the engineering firm for construction support
- Approval of a contract with a construction management firm
- Approval of award of a construction contract
- Approval of change orders throughout construction
- Approval of the Final Acceptance of the construction contract

Some of these milestones can be combined; for example, the contract with the engineering firm for design services may also include support services during bidding and construction. Typically, the selection of the engineering and construction management firms is based on qualifications with a negotiated scope and fee. The selection of a construction contractor is governed by the Public Contracts Code and the contract award is based on the lowest responsible, responsive bidder with the appropriate Contractor's license.

9.2. Design-Build

Design-build is an alternate procurement method which can accelerate the design and construction process and allow an agency to select a design-build team based on qualifications rather than lowest price. Design-build typically includes a process to select an Owner's Agent/Owner's Engineer (OA/OE) who will act on behalf of the City to: develop a Request for Letter of Interest, Request for Qualifications (RFQ), and Request for Proposals (RFP) for design-build teams; assist in the pre-qualification of design-build teams; develop the bridging documents which include the contract, design and performance criteria, schedule, and risk registry; assist in the selection of a design-build team; and provide construction management services. The OA/OE may also coordinate early design activities such as potholing, survey, and geotechnical investigations. The selected design-build team then collaboratively designs and constructs the project with oversight by the OA/OE to ensure the City's interests are protected. A conceptual schedule for delivering Phase 1 of the AWPS utilizing a design-build procurement is included as Figure 9-2 and is estimated to take approximately 36 months for project completion.

The typical milestones at which City Council action is required for design-build procurement include:

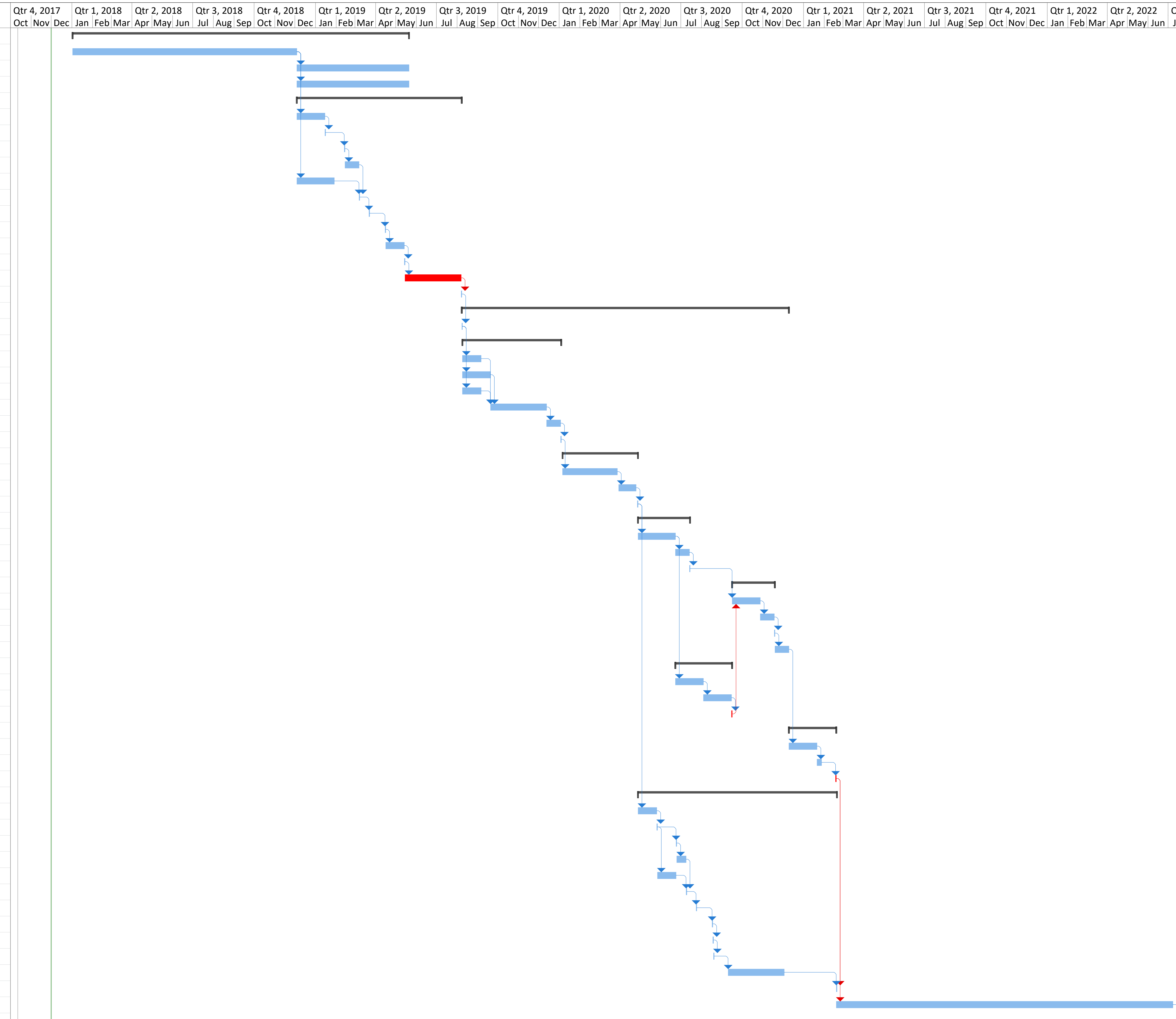
- Approval of a contract for the OA/OE
- Award of a contract with the design-build team
- Approval of change orders throughout construction
- Approval of the Final Acceptance of the construction contract

Overall, design-build offers the owner more flexibility in the selection of the construction contractor and an accelerated schedule.

City of Palo Alto - Regional Water Quality Control Plant
1.125 MGD AWPS Design-Bid-Build Schedule

FIGURE 9-1

ID	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1	**Identify and Develop Funding Sources**	**360 days**	**Tue 1/2/18**	**Mon 5/20/19**		
2	Develop MOU with Stakeholders	12 mons	Tue 1/2/18	Mon 12/3/18		
3	Identify Grant Opportunities	6 mons	Tue 12/4/18	Mon 5/20/19	2	
4	Bonds, Loans, Partner Funding	6 mons	Tue 12/4/18	Mon 5/20/19	2	
5	**Design Consultant Procurement**	**177 days**	**Tue 12/4/18**	**Wed 8/7/19**		
6	Develop RFQ for Design	30 days	Tue 12/4/18	Mon 1/14/19	2	
7	Release RFQ	1 day	Tue 1/15/19	Tue 1/15/19	6	
8	Statements of Qualification Due	1 day	Wed 2/13/19	Wed 2/13/19	7FS+20 days	
9	Review SOQs/Shortlist	3 wks	Thu 2/14/19	Wed 3/6/19	8	
10	Develop RFP for Design	2 mons	Tue 12/4/18	Mon 1/28/19	2	
11	Release RFP to Shortlist	1 day	Thu 3/7/19	Thu 3/7/19	9,10	
12	Pre-Proposal Meeting	1 day	Fri 3/22/19	Fri 3/22/19	11FS+10 days	
13	Proposals Due	1 day	Mon 4/15/19	Mon 4/15/19	12FS+3 wks	
14	Review Consultant Proposals	1 mon	Tue 4/16/19	Mon 5/13/19	13	
15	Select Consultant Team	1 day	Tue 5/14/19	Tue 5/14/19	14	
16	Council Action/Contracting	3 mons	Wed 5/15/19	Tue 8/6/19	15	
17	Notice to Proceed	1 day	Wed 8/7/19	Wed 8/7/19	16	
18	**Design**	**350 days**	**Thu 8/8/19**	**Wed 12/9/20**		
19	Project Kick-off Meeting	1 day	Thu 8/8/19	Thu 8/8/19	17	
20	**30% Design**	**106 days**	**Fri 8/9/19**	**Fri 1/3/20**		
21	Topographic Survey	1 mon	Fri 8/9/19	Thu 9/5/19	19	
22	Potholing	6 wks	Fri 8/9/19	Thu 9/19/19	19	
23	Geotechnical Investigation and Engineering	1 mon	Fri 8/9/19	Thu 9/5/19	19	
24	30% Design	3 mons	Fri 9/20/19	Thu 12/12/19	23,22,21	
25	Stakeholder Review of 30% Design	15 days	Fri 12/13/19	Thu 1/2/20	24	
26	30% Design Review Meeting	1 day	Fri 1/3/20	Fri 1/3/20	25	
27	**60% Design**	**81 days**	**Mon 1/6/20**	**Mon 4/27/20**		
28	60% Design	3 mons	Mon 1/6/20	Fri 3/27/20	26	
29	Stakeholder Review of 60% Design	1 mon	Mon 3/30/20	Fri 4/24/20	28	
30	60% Design Review Meeting	1 day	Mon 4/27/20	Mon 4/27/20	29	
31	**90% Design**	**56 days**	**Tue 4/28/20**	**Tue 7/14/20**		
32	90% Design	2 mons	Tue 4/28/20	Mon 6/22/20	30	
33	Stakeholder Review of 90% Design	3 wks	Tue 6/23/20	Mon 7/13/20	32	
34	90% Design Review Meeting	1 day	Tue 7/14/20	Tue 7/14/20	33	
35	**100% Design**	**46 days**	**Wed 9/16/20**	**Wed 11/18/20**		
36	100% Design	6 wks	Wed 9/16/20	Tue 10/27/20	34,43	
37	Stakeholder Review of 100% Design	3 wks	Wed 10/28/20	Tue 11/17/20	36	
38	100% Design Review Meeting	1 day	Wed 11/18/20	Wed 11/18/20	37	
39	Final Design	3 wks	Thu 11/19/20	Wed 12/9/20	38	
40	**CEQA Compliance**	**61 days**	**Tue 6/23/20**	**Tue 9/15/20**		
41	Develop CEQA Document (Exemption)	30 days	Tue 6/23/20	Mon 8/3/20	32	
42	Public Review Period	30 days	Tue 8/4/20	Mon 9/14/20	41	
43	Council Action to Accept Environmental Docume	1 day	Tue 9/15/20	Tue 9/15/20	42	
44	**Bidding**	**51 days**	**Thu 12/10/20**	**Thu 2/18/21**		
45	Bid Period	6 wks	Thu 12/10/20	Wed 1/20/21	39	
46	Review Bids	1 wk	Thu 1/21/21	Wed 1/27/21	45	
47	Council Action	1 day	Thu 2/18/21	Thu 2/18/21	46FS+15 days	
48	**Construction Management Consultant Procuremer**	**214 days**	**Tue 4/28/20**	**Fri 2/19/21**		
49	Develop RFQ for Construction Management	20 days	Tue 4/28/20	Mon 5/25/20	30	
50	Release RFQ	1 day	Tue 5/26/20	Tue 5/26/20	49	
51	Statements of Qualification Due	1 day	Wed 6/24/20	Wed 6/24/20	50FS+20 days	
52	Review SOQs/Shortlist	2 wks	Thu 6/25/20	Wed 7/8/20	51	
53	Develop RFP for Construction Management	20 days	Wed 5/27/20	Tue 6/23/20	50	
54	Release RFP to Shortlist	1 day	Thu 7/9/20	Thu 7/9/20	52,53	
55	Pre-Proposal Meeting	1 day	Fri 7/24/20	Fri 7/24/20	54FS+2 wks	
56	Proposals Due	1 day	Mon 8/17/20	Mon 8/17/20	55FS+3 wks	
57	Review Consultant Proposals	1 day	Tue 8/18/20	Tue 8/18/20	56	
58	Select Construction Management Firm	1 day	Wed 8/19/20	Wed 8/19/20	57	
59	Council Action/Contracting	3 mons	Thu 9/10/20	Wed 12/2/20	58FS+3 wks	
60	Notice to Proceed	1 day	Fri 2/19/21	Fri 2/19/21	59,47	
61	**Construction**	**18 mons**	**Fri 2/19/21**	**Thu 7/7/22**	47	
62	Council Approval of Final Acceptance	1 day	Fri 7/29/22	Fri 7/29/22	61FS+3 wks	



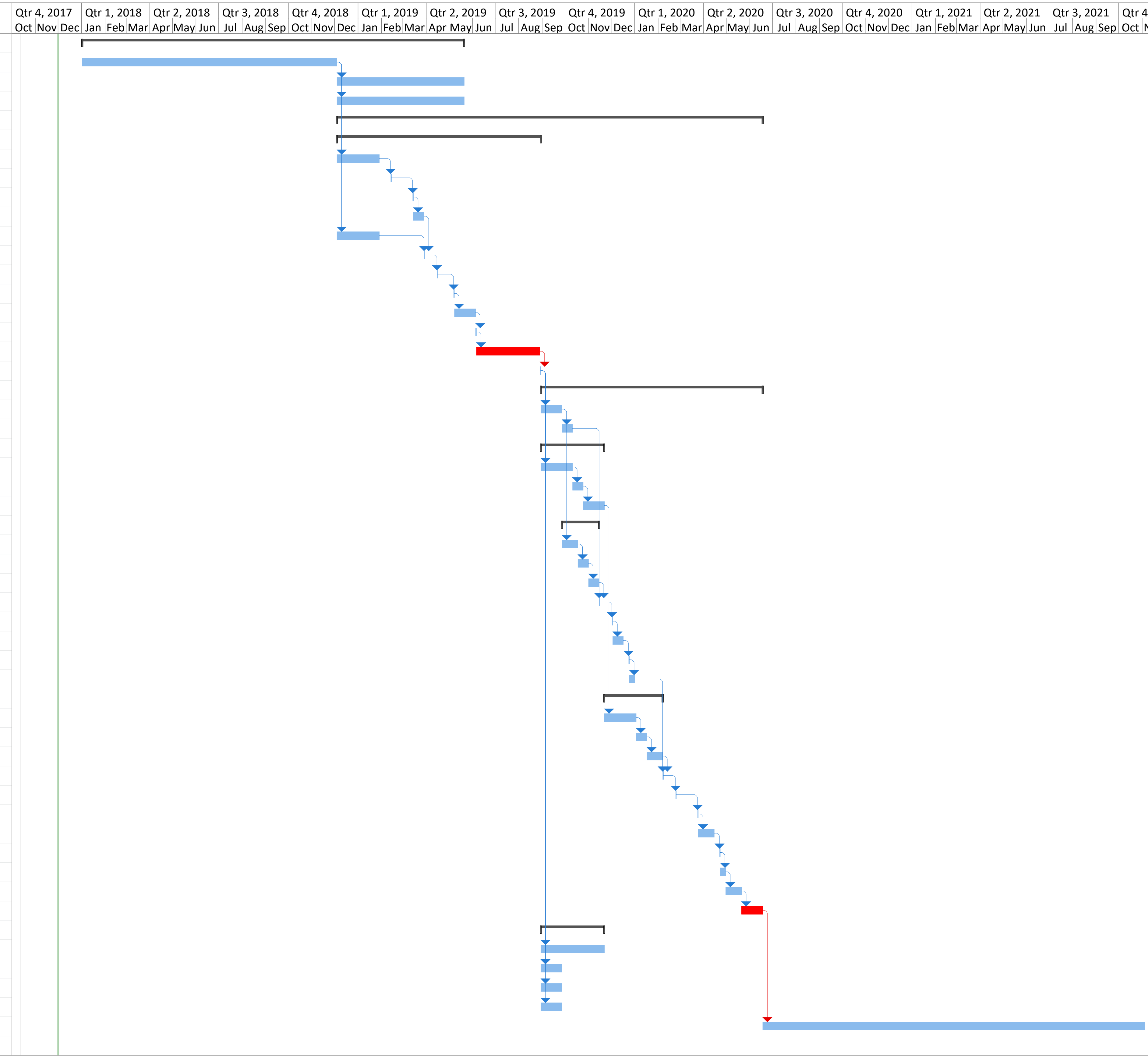
Project: msproj11
Date: Fri 12/1/17

Task | Milestone | Summary | Manual Progress

City of Palo Alto - Regional Water Quality Control Plant
1.125 MGD AWPS Design-Build Schedule

FIGURE 9-2

ID	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1	**Identify and Develop Funding Sources**	**360 days**	**Tue 1/2/18**	**Mon 5/20/19**		
2	Develop MOU with Stakeholders	12 mons	Tue 1/2/18	Mon 12/3/18		
3	Identify Grant Opportunities	6 mons	Tue 12/4/18	Mon 5/20/19	2	
4	Bonds, Loans, Partner Funding	6 mons	Tue 12/4/18	Mon 5/20/19	2	
5	**Design-Build Procurement**	**402 days**	**Tue 12/4/18**	**Wed 6/17/20**		
6	**Program Management**	**193 days**	**Tue 12/4/18**	**Thu 8/29/19**		
7	Develop RFQ for OA/OE	2 mons	Tue 12/4/18	Mon 1/28/19	2	
8	Release RFQ	1 day	Wed 2/13/19	Wed 2/13/19	7	
9	Statements of Qualification Due	1 day	Thu 3/14/19	Thu 3/14/19	8FS+20 days	
10	Review SOQs/Shortlist	2 wks	Fri 3/15/19	Thu 3/28/19	9	
11	Develop RFP for OA/OE	2 mons	Tue 12/4/18	Mon 1/28/19	2	
12	Release RFP to Shortlist	1 day	Fri 3/29/19	Fri 3/29/19	10,11	
13	Pre-Proposal Meeting	1 day	Mon 4/15/19	Mon 4/15/19	12FS+10 days	
14	Proposals Due	1 day	Tue 5/7/19	Tue 5/7/19	13FS+3 wks	
15	Review OA/OE Proposals	1 mon	Wed 5/8/19	Tue 6/4/19	14	
16	Select OA/OE Team	1 day	Wed 6/5/19	Wed 6/5/19	15	
17	Council Action/Contracting	3 mons	Thu 6/6/19	Wed 8/28/19	16	
18	Notice to Proceed	1 day	Thu 8/29/19	Thu 8/29/19	17	
19	**DB Procurement Documents**	**209 days**	**Fri 8/30/19**	**Wed 6/17/20**		
20	Prepare Request for Letter of Interest (LOI	1 mon	Fri 8/30/19	Thu 9/26/19	18	
21	Review LOIs	2 wks	Fri 9/27/19	Thu 10/10/19	20	
22	**Develop Design Criteria Report (DCR)**	**60 days**	**Fri 8/30/19**	**Thu 11/21/19**		
23	Draft DCR	30 days	Fri 8/30/19	Thu 10/10/19	18	
24	Stakeholder Review	10 days	Fri 10/11/19	Thu 10/24/19	23	
25	Final DCR	20 days	Fri 10/25/19	Thu 11/21/19	24	
26	**Prepare Request for Qualifications**	**35 days**	**Fri 9/27/19**	**Thu 11/14/19**		
27	Draft RFQ	15 days	Fri 9/27/19	Thu 10/17/19	20	
28	Stakeholder Review	10 days	Fri 10/18/19	Thu 10/31/19	27	
29	Final RFQ	10 days	Fri 11/1/19	Thu 11/14/19	28	
30	Distribute RFQ	1 day	Fri 11/15/19	Fri 11/15/19	21,29	
31	RFQ Meeting	1 day	Mon 12/2/19	Mon 12/2/19	30FS+10 days	
32	Evaluate RFQs	2 wks	Tue 12/3/19	Mon 12/16/19	31	
33	Interview shortlist	1 day	Tue 12/24/19	Tue 12/24/19	32FS+5 days	
34	Develop RFP Shortlist	1 wk	Wed 12/25/1	Tue 12/31/19	33	
35	**Prepare RFP**	**55 days**	**Fri 11/22/19**	**Thu 2/6/20**		
36	Draft RFP	30 days	Fri 11/22/19	Thu 1/2/20	25	
37	Stakeholder Review	10 days	Fri 1/3/20	Thu 1/16/20	36	
38	Final RFP	15 days	Fri 1/17/20	Thu 2/6/20	37	
39	Distribute RFP	1 day	Fri 2/7/20	Fri 2/7/20	38,34	
40	Pre-Proposal Meeting	1 day	Mon 2/24/20	Mon 2/24/20	39FS+10 days	
41	Proposals Due	1 day	Tue 3/24/20	Tue 3/24/20	40FS+20 days	
42	Review Proposals	15 days	Wed 3/25/20	Tue 4/14/20	41	
43	Interview DB Teams	1 day	Wed 4/22/20	Wed 4/22/20	42FS+5 days	
44	Select DB Team	5 days	Thu 4/23/20	Wed 4/29/20	43	
45	Negotiate GMP	15 days	Thu 4/30/20	Wed 5/20/20	44	
46	Council Action/Contracting	1 mon	Thu 5/21/20	Wed 6/17/20	45	
47	**Preliminary Design**	**60 days**	**Fri 8/30/19**	**Thu 11/21/19**		
48	Preliminary Design	3 mons	Fri 8/30/19	Thu 11/21/19	18	
49	Topographic Survey	1 mon	Fri 8/30/19	Thu 9/26/19	18	
50	Potholing	1 mon	Fri 8/30/19	Thu 9/26/19	18	
51	Geotechnical Investigation and Engineering	1 mon	Fri 8/30/19	Thu 9/26/19	18	
52	**Detailed Design/Construction**	**18 mons**	**Thu 6/18/20**	**Wed 11/3/21**	**46**	
53	Council Approval of Final Acceptance	1 day	Thu 11/25/21	Thu 11/25/21	52FS+3 wks	



Project: msproj11
Date: Fri 12/1/17

Task | Milestone | Summary | Manual Progress

References

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Appendices

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Appendix A. Preliminary Design Drawings

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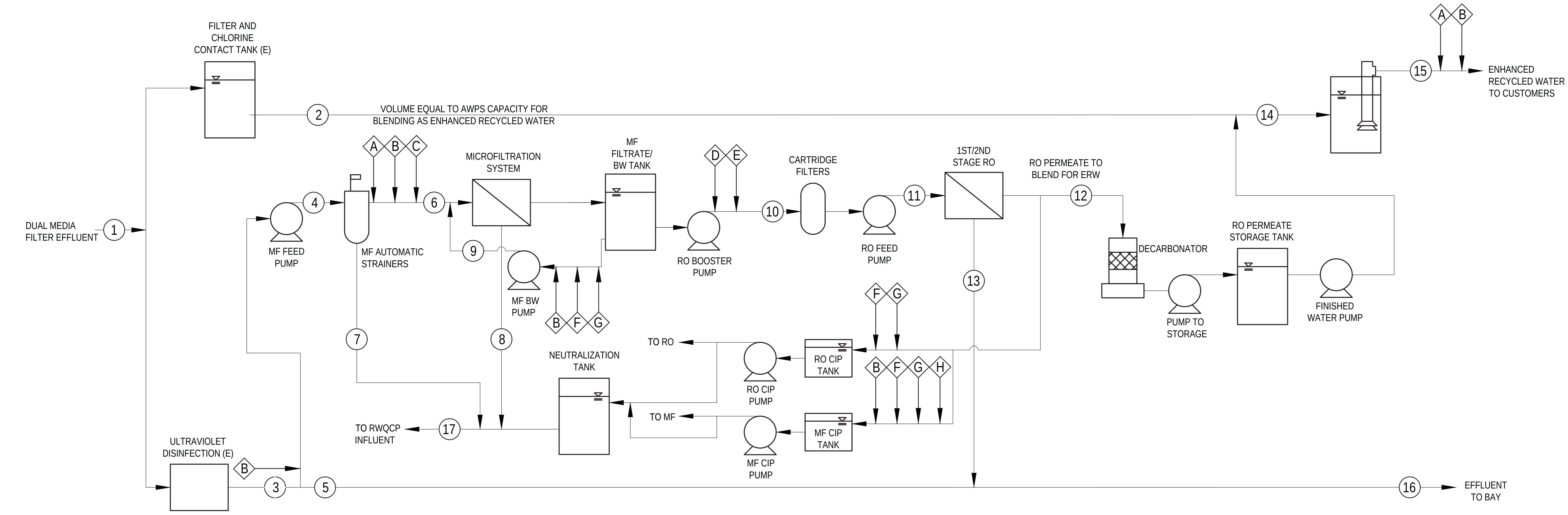


	DUAL MEDIA FILTER EFFLUENT	TERTIARY WATER FOR BLENDING AS ERW	RWQCP FINAL EFFLUENT TO BAY	FEED TO AWPS STRAINERS	REMAINING FINAL EFFLUENT FOR DISCHARGE TO BAY	MF FEED	STRAINERS BWW	MF BWW TO RWQCP INFLUENT	MF BACKWASH FLOW	RO LOW PRESSURE FEED	RO HIGH PRESSURE FEED	RO PERMEATE	RO CONCENTRATE	BLENDED ENHANCED RECYCLED WATER	ENHANCED RECYCLED WATER TO CUSTOMERS	FINAL EFFLUENT TO BAY	PROCESS WASTE TO HEADWORKS
PROCESS STREAM ID	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
RECOVERY (%)						99.5%				93%		85%					
AVERAGE DESIGN FLOW (GPM)	14097	781	13316	992	12324	987	NA	69	1359	918	918	781	138	1562	1562	12462	69
AVERAGE DESIGN FLOW (MGD)	20.3	1.125	19.2	1.43	17.7	1.42	0.01	0.10	NA	1.32	1.32	1.12	0.20	2.25	2.25	17.95	0.10
PRESSURE (PSI)	<20	<20	<20	30–50	<20	30–45	ATM	ATM	30	30	125	10	15–30	<20	65–70	ATM	ATM

CHEMICAL	STREAM	PURPOSE
AQUEOUS AMMONIA	A	CHLORAMINE ADDITION
SODIUM HYPOCHLORITE	B	DISINFECTION/CHLORAMINES, MF MEMBRANE CLEANING
COAGULANT	C	MF PRETREATMENT
SULFURIC ACID	D	RO PRETREATMENT PH ADJUSTMENT
THRESHOLD INHIBITOR	E	RO ANTISCALANT
CITRIC ACID	F	MF/RO MEMBRANE CLEANING, MF BACKWASH
SODIUM HYDROXIDE	G	MF/RO MEMBRANE CLEANING, MF BACKWASH
SODIUM BISULFITE	H	MF CIP WASTE NEUTRALIZATION

CONCEPTUAL DESIGN - NOT FOR CONSTRUCTION

NO SCALE

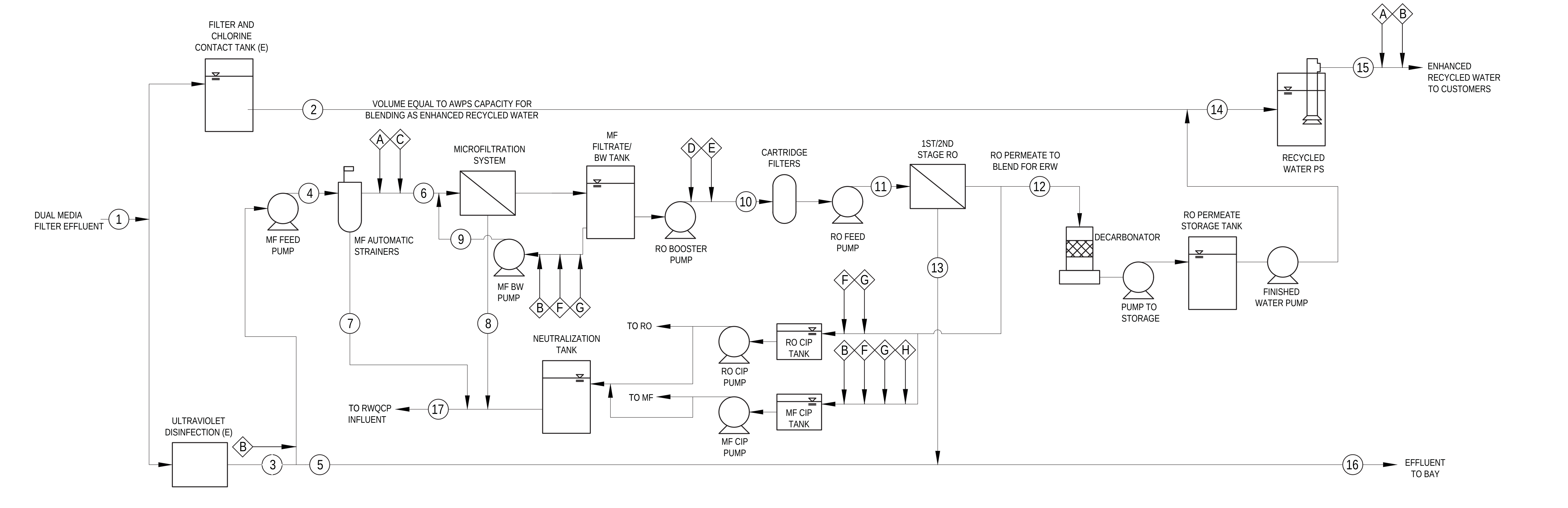
811 Know what's below. Call before you dig.

PROPERTY LINES ARE APPROXIMATE

MNS ENGINEERS INC
ENGINEERING | SURVEYING
CONSTRUCTION MANAGEMENT
2033 Gateway Place
San Jose, CA 95110
408.573.6421 Phone

GHD

DESIGNED BY	NEP				
DRAWN BY	REV.	DATE	DESCRIPTION	BY	APP
CHECKED BY	JA	PROPOSED AWPS FACILITY PROCESS FLOW DIAGRAM 1.125 MGD CAPACITY			PUBLIC WORKS DEPT. RWQCP
					SCALE: AS SHOWN
APPV'D BY		CITY OF PALO ALTO CALIFORNIA			SHEET NO.
		ADVANCED WATER PURIFICATION SYSTEM PRELIMINARY DESIGN			G1



	DUAL MEDIA FILTER EFFLUENT	TERTIARY WATER FOR BLENDING AS ERW	RWQCP FINAL EFFLUENT TO BAY	FEED TO AWPS STRAINERS	REMAINING FINAL EFFLUENT FOR DISCHARGE TO BAY	MF FEED	STRAINERS BWW	MF BWW TO RWQCP INFLUENT	MF BACKWASH FLOW	RO LOW PRESSURE FEED	RO HIGH PRESSURE FEED	RO PERMEATE	RO CONCENTRATE	BLENDED ENHANCED RECYCLED WATER	ENHANCED RECYCLED WATER TO CUSTOMERS	FINAL EFFLUENT TO BAY	PROCESS WASTE TO HEADWORKS
PROCESS STREAM ID	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
RECOVERY (%)						99.5%				93%		85%					
AVERAGE DESIGN FLOW (GPM)	14097	1563	12535	1986	10549	1976	NA	138	1573	1838	1838	1562	276	3125	3125	10825	138
AVERAGE DESIGN FLOW (MGD)	20.3	2.25	18.1	2.86	15.2	2.85	0.01	0.20	NA	2.65	2.65	2.25	0.40	4.50	4.50	15.59	0.20
PRESSURE (PSI)	<20	<20	<20	30-50	<20	30-45	ATM	ATM	30	30	125	10	15-30	<20	65-70	ATM	ATM

CHEMICAL	STREAM	PURPOSE
AQUEOUS AMMONIA	A	CHLORAMINE ADDITION
SODIUM HYPOCHLORITE	B	DISINFECTION/CHLORAMINES, MF MEMBRANE CLEANING
COAGULANT	C	MF PRETREATMENT
SULFURIC ACID	D	RO PRETREATMENT PH ADJUSTMENT
THRESHOLD INHIBITOR	E	RO ANTISCALANT
CITRIC ACID	F	MF/RO MEMBRANE CLEANING, MF BACKWASH
SODIUM HYDROXIDE	G	MF/RO MEMBRANE CLEANING, MF BACKWASH
SODIUM BISULFITE	H	MF CIP WASTE NEUTRALIZATION

CONCEPTUAL DESIGN - NOT FOR CONSTRUCTION

NO SCALE

Know what's **below.** **Call** before you dig.

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MNS ENGINEERS INC
ENGINEERING | SURVEYING CONSTRUCTION MANAGEMENT
2033 Gateway Place
San Jose, CA 95110
408.573.6421 Phone

GHD

DESIGNED BY: NEP
DRAWN BY:
CHECKED BY: JA
APPV'D BY:

REV.	DATE	DESCRIPTION	BY	APP

PROPOSED AWPS FACILITY
PROCESS FLOW DIAGRAM
2.25 MGD CAPACITY

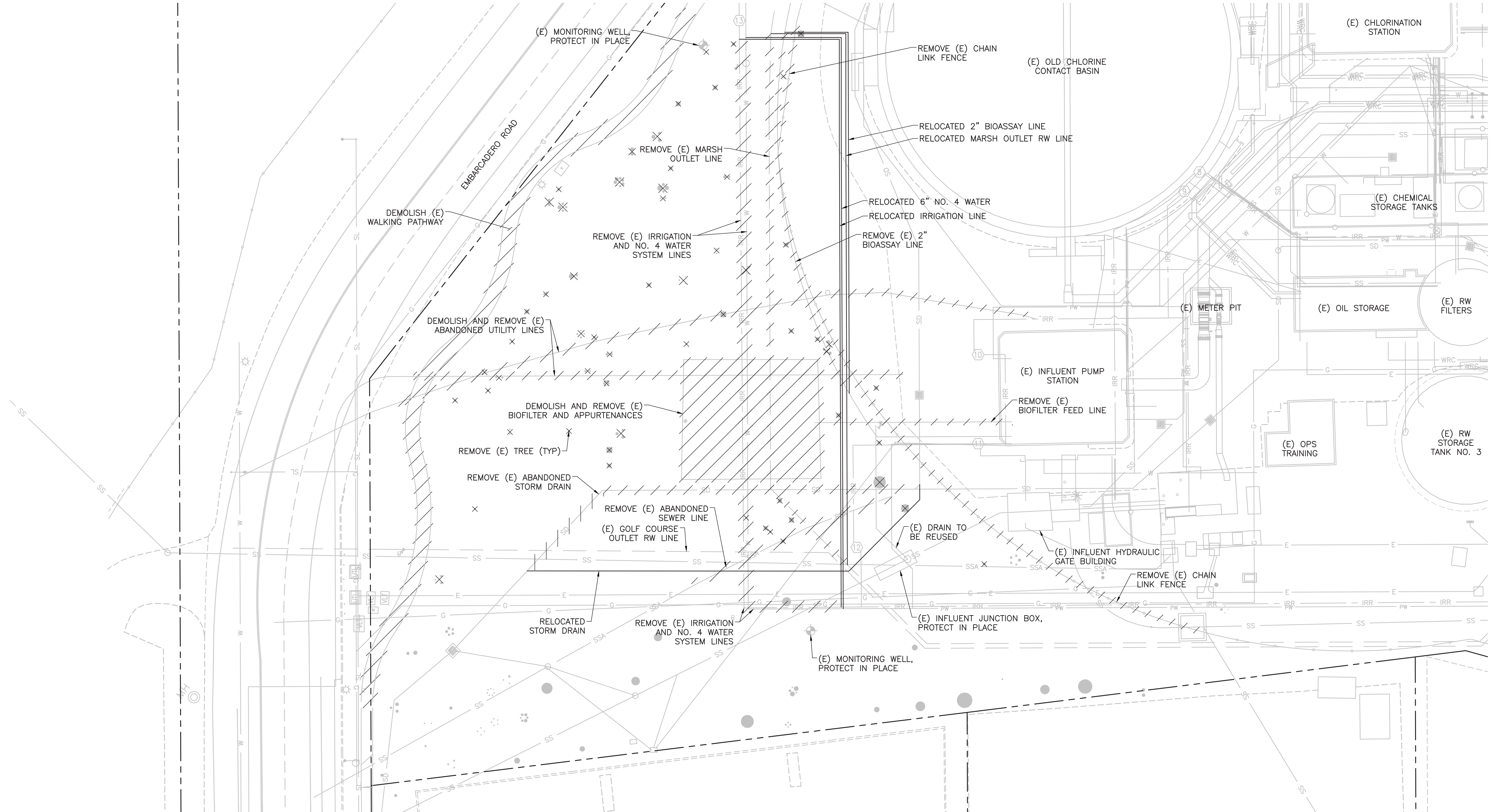
PUBLIC WORKS DEPT. RWQCP

SCALE: AS SHOWN

CITY OF PALO ALTO
CALIFORNIA

ADVANCED WATER PURIFICATION SYSTEM PRELIMINARY DESIGN

SHEET NO. G2



CONCEPTUAL DESIGN - NOT FOR CONSTRUCTION

LEGEND

PROPERTY LINE	DEMOLISHED/REMOVED UTILITY/INFRASTRUCTURE
EXISTING RWQCP FACILITY	RELOCATED UTILITY
EXISTING EDGE OF PAVEMENT	TREE TO BE REMOVED
EXISTING FENCELINE	
EXISTING UTILITY	
EXISTING TREE	

811. Know what's **below.** **Call** before you dig.

TRUE
PLANT

PROPERTY LINES ARE APPROXIMATE

20' 10' 0' 10' 20'
1 inch = 20 ft.

MNS ENGINEERS INC
ENGINEERING | SURVEYING CONSTRUCTION MANAGEMENT

111 N. Market Street
Suite 440
San Jose, CA 95113
408.610.4202 Phone

GHD

DESIGNED BY	NEP				
DRAWN BY	SPP	REV.	DATE	DESCRIPTION	BY / APP
CHECKED BY	JA				
APP'D BY					

DEMOLITION AND UTILITY RELOCATION PLAN

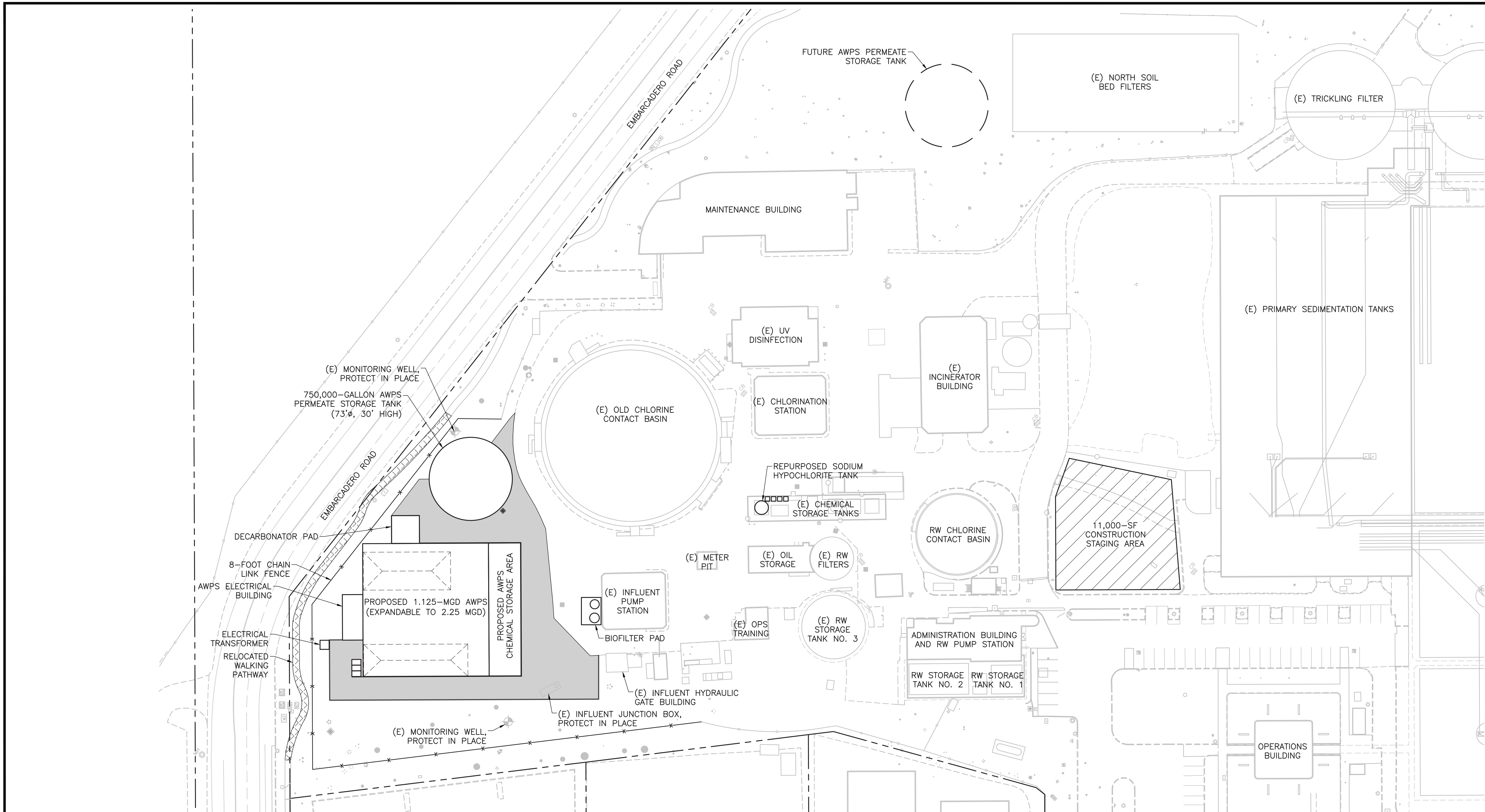
CITY OF PALO ALTO
CALIFORNIA

ADVANCED WATER PURIFICATION SYSTEM PRELIMINARY DESIGN

PUBLIC WORKS DEPT. RWQCP

SCALE: AS SHOWN

SHEET NO. C1



LEGEND

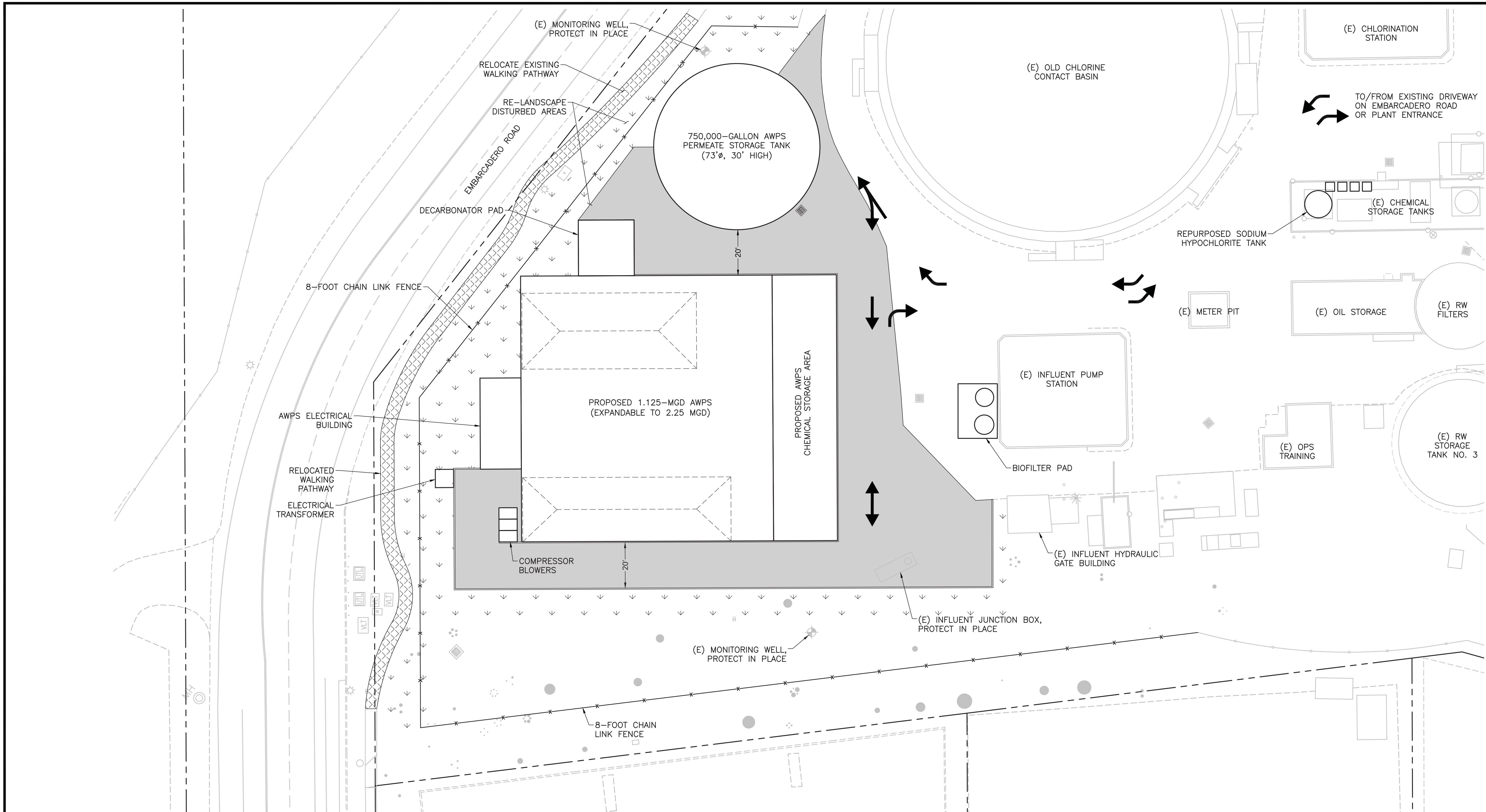
PROPERTY LINE	PROPOSED CHAIN LINK FENCE
EXISTING RWQCP FACILITY	PROPOSED AWPS FACILITY
EXISTING EDGE OF PAVEMENT	PROPOSED PAVEMENT
EXISTING FENCELINE	RELOCATED WALKING PATHWAY
EXISTING TREE	

CONCEPTUAL DESIGN - NOT FOR CONSTRUCTION

MNS ENGINEERS INC
ENGINEERING | SURVEYING
CONSTRUCTION MANAGEMENT
111 N. Market Street
Suite 440
San Jose, CA 95113
408.610.4202 Phone

GHD

DESIGNED BY NEP				
DRAWN BY SPP	REV.	DATE	DESCRIPTION	BY APP
CHECKED BY JA	SITE LAYOUT PLAN			PUBLIC WORKS DEPT. RWQCP; SCALE: AS SHOWN
APPV'D BY	CITY OF PALO ALTO, CALIFORNIA, ADVANCED WATER PURIFICATION SYSTEM PRELIMINARY DESIGN			SHEET NO. C2



LEGEND

PROPERTY LINE	PROPOSED CHAIN LINK FENCE
EXISTING RWQCP FACILITY	PROPOSED AWPS FACILITY
EXISTING EDGE OF PAVEMENT	PROPOSED CURB
EXISTING FENCELINE	PROPOSED LANDSCAPING
EXISTING TREE	PROPOSED PAVEMENT
	RELOCATED WALKING PATHWAY
	TRAFFIC FLOW DIRECTION

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DESIGNED BY	REV.	DATE	DESCRIPTION	BY	APP
NEP					
DRAWN BY SPP					
CHECKED BY JA					
APP'D BY					

AWPS SITE IMPROVEMENTS PLAN

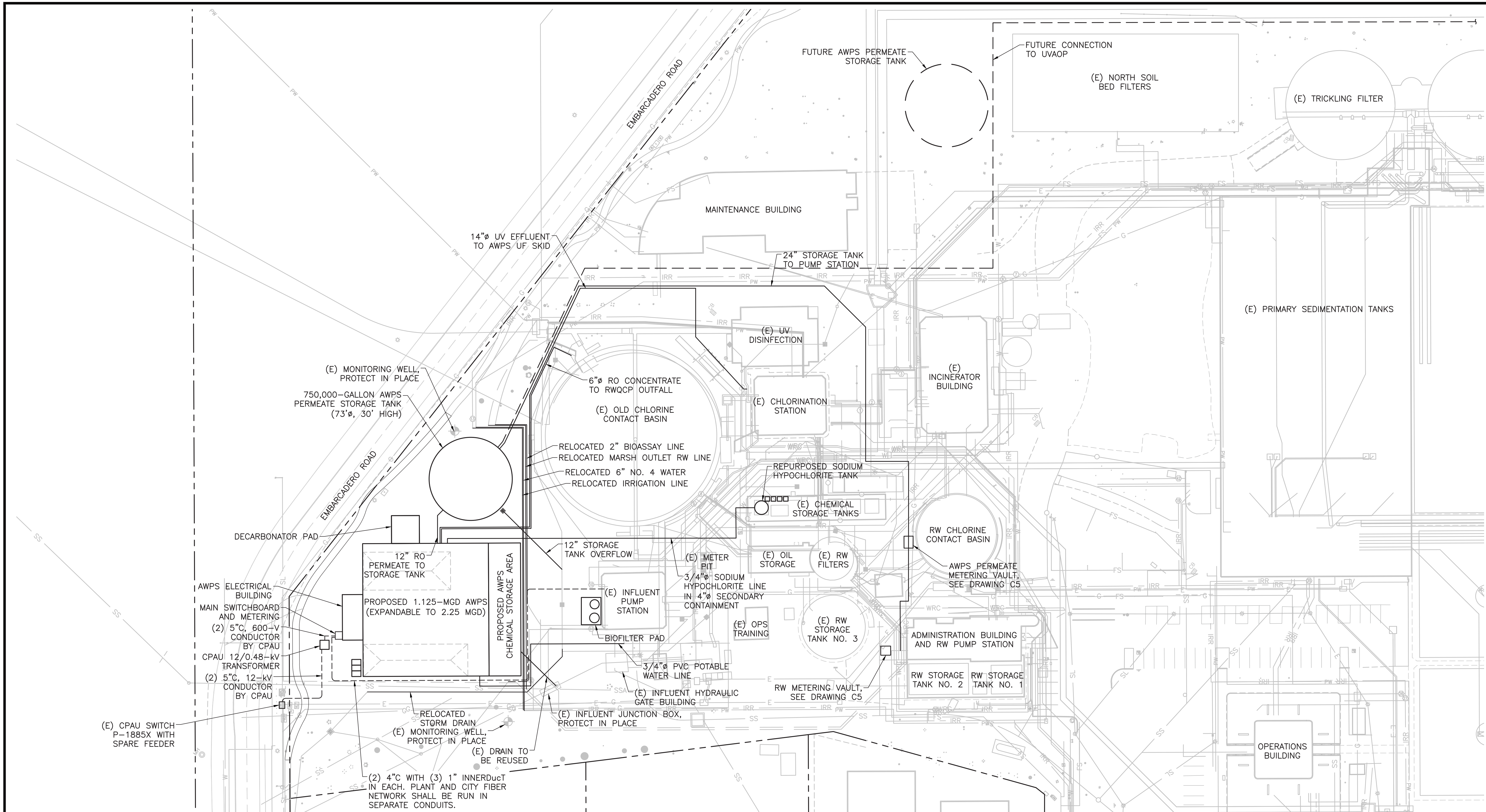
PUBLIC WORKS DEPT. RWQCP

SCALE: AS SHOWN

CITY OF PALO ALTO
CALIFORNIA

ADVANCED WATER PURIFICATION SYSTEM PRELIMINARY DESIGN

SHEET NO. C3



CONCEPTUAL DESIGN - NOT FOR CONSTRUCTION

LEGEND

PROPERTY LINE	RELOCATED/PROPOSED PROCESS UTILITY
EXISTING RWQCP FACILITY	FUTURE PROCESS UTILITY
EXISTING UTILITY	ELECTRICAL UTILITY
EXISTING TREE	

811
Know what's below. Call before you dig.

TRUE
PLANT

PROPERTY LINES ARE APPROXIMATE

40' 20' 0' 20' 40'
1 inch = 40 ft.

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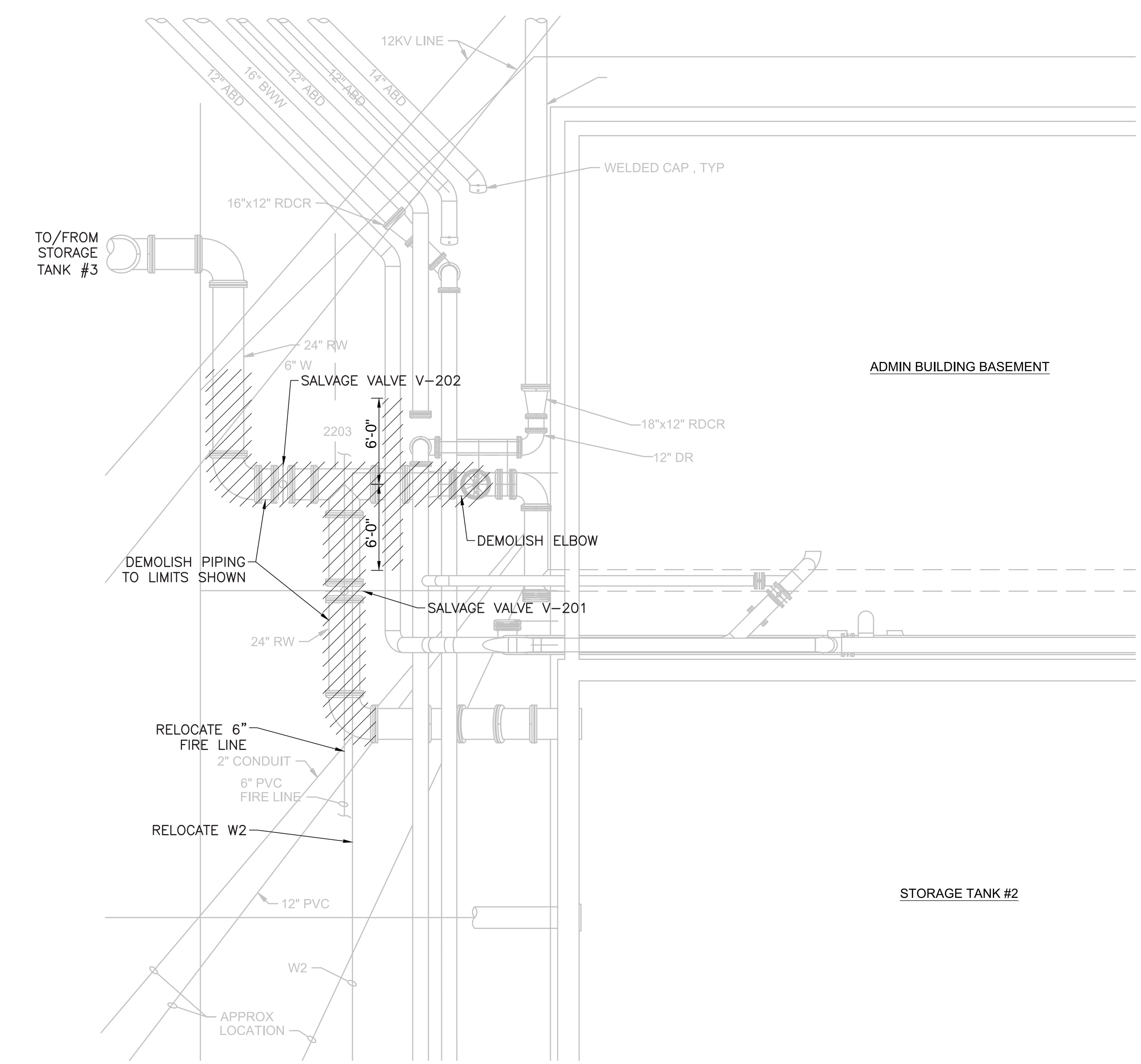
DESIGNED BY	REV.	DATE	DESCRIPTION	BY	APP
NEP					
DRAWN BY SPP					
CHECKED BY JA					
APPV'D BY					

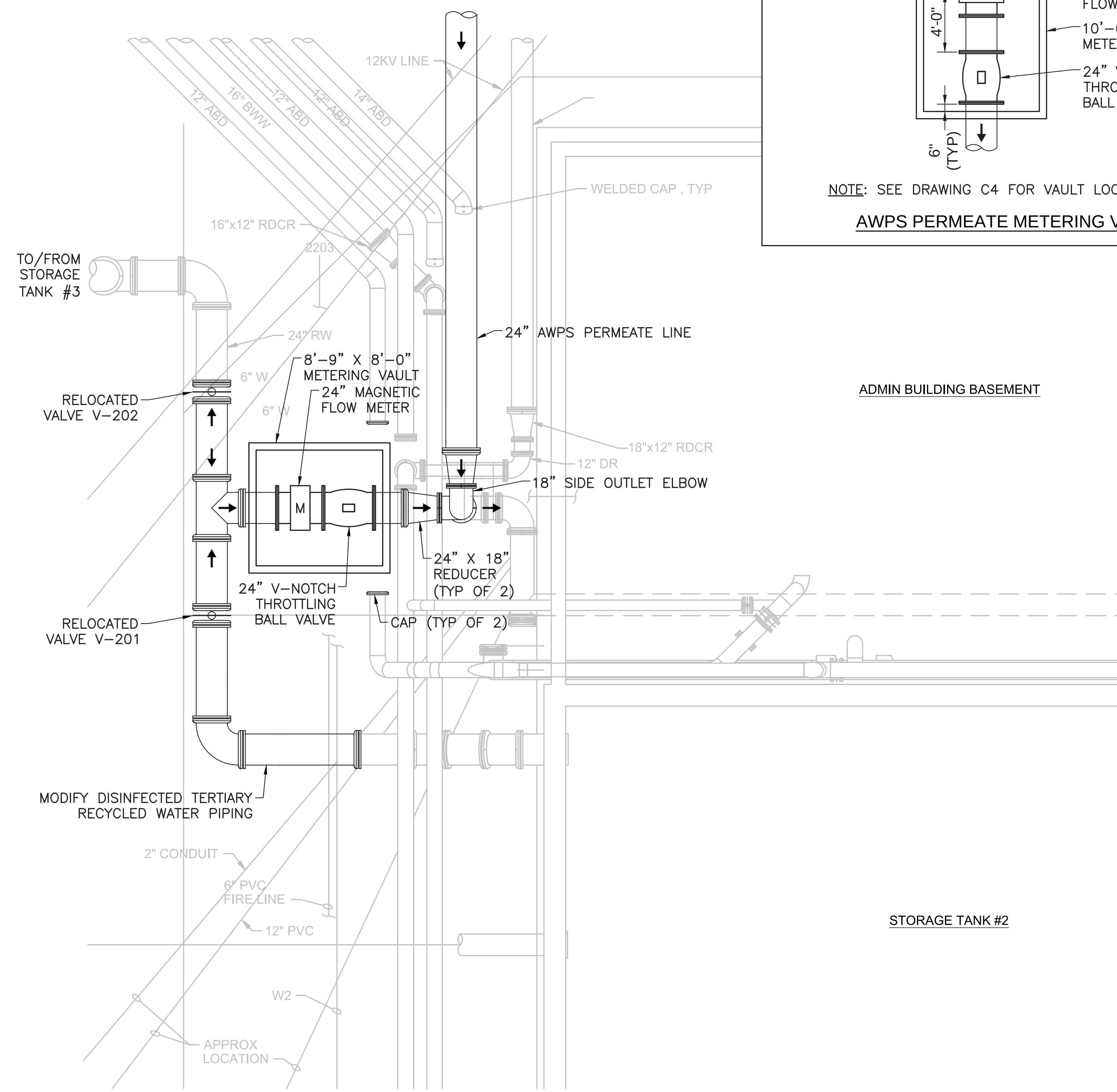
SITE PIPING PLAN

CITY OF PALO ALTO
CALIFORNIA
ADVANCED WATER PURIFICATION SYSTEM PRELIMINARY DESIGN

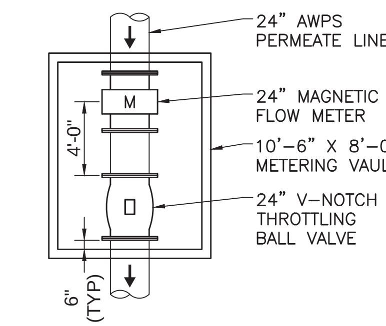
PUBLIC WORKS DEPT. RWQCP
SCALE: AS SHOWN
SHEET NO. C4



DEMOLITION PLAN



BLENDING IMPROVEMENTS PLAN



NOTE: SEE DRAWING C4 FOR VAULT LOCATION.

AWPS PERMEATE METERING VAULT

LEGEND

- EXISTING RWQCP FACILITY/UTILITY
- DEMOLISH PIPING
- PROPOSED PIPING
- FLOW DIRECTION

Know what's **below.** **Call** before you dig.

TRUE
PLANT

PROPERTY LINES ARE APPROXIMATE

0 4' 8'
3/16"=1'-0"

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San Jose, CA 95113
408.610.4202 Phone

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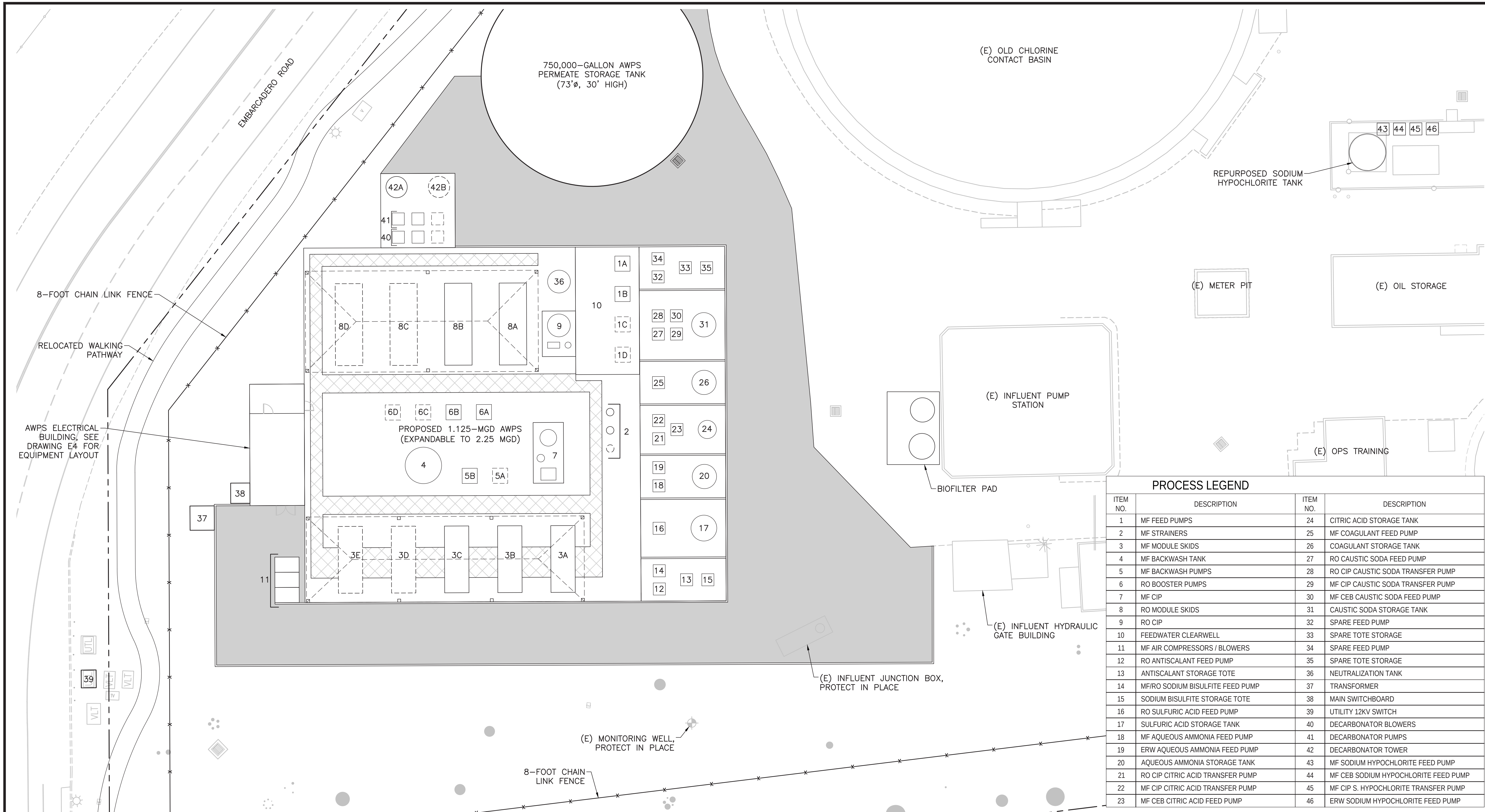
CONCEPTUAL DESIGN - NOT FOR CONSTRUCTION

DESIGNED BY					
NEP					
DRAWN BY	REV.	DATE	DESCRIPTION	BY	APP
SPP	BLENDING FACILITIES DEMOLITION AND IMPROVEMENTS PLAN			PUBLIC WORKS DEPT. RWQCP	
CHECKED BY				SCALE: AS SHOWN	
JA					
APPV'D BY	CITY OF PALO ALTO CALIFORNIA			SHEET NO.	
	ADVANCED WATER PURIFICATION SYSTEM PRELIMINARY DESIGN			C5	



PROCESS LEGEND

ITEM NO.	DESCRIPTION	ITEM NO.	DESCRIPTION
1	MF FEED PUMPS	24	CITRIC ACID STORAGE TANK
2	MF STRAINERS	25	MF COAGULANT FEED PUMP
3	MF MODULE SKIDS	26	COAGULANT STORAGE TANK
4	MF BACKWASH TANK	27	RO CAUSTIC SODA FEED PUMP
5	MF BACKWASH PUMPS	28	RO CIP CAUSTIC SODA TRANSFER PUMP
6	RO BOOSTER PUMPS	29	MF CIP CAUSTIC SODA TRANSFER PUMP
7	MF CIP	30	MF CEB CAUSTIC SODA FEED PUMP
8	RO MODULE SKIDS	31	CAUSTIC SODA STORAGE TANK
9	RO CIP	32	SPARE FEED PUMP
10	FEEDWATER CLEARWELL	33	SPARE TOTE STORAGE
11	MF AIR COMPRESSORS / BLOWERS	34	SPARE FEED PUMP
12	RO ANTISCALANT FEED PUMP	35	SPARE TOTE STORAGE
13	ANTISCALANT STORAGE TOTE	36	NEUTRALIZATION TANK
14	MF/RO SODIUM BISULFITE FEED PUMP	37	TRANSFORMER
15	SODIUM BISULFITE STORAGE TOTE	38	MAIN SWITCHBOARD
16	RO SULFURIC ACID FEED PUMP	39	UTILITY 12KV SWITCH
17	SULFURIC ACID STORAGE TANK	40	DECARBONATOR BLOWERS
18	MF AQUEOUS AMMONIA FEED PUMP	41	DECARBONATOR PUMPS
19	ERW AQUEOUS AMMONIA FEED PUMP	42	DECARBONATOR TOWER
20	AQUEOUS AMMONIA STORAGE TANK	43	MF SODIUM HYPOCHLORITE FEED PUMP
21	RO CIP CITRIC ACID TRANSFER PUMP	44	MF CEB SODIUM HYPOCHLORITE FEED PUMP
22	MF CIP CITRIC ACID TRANSFER PUMP	45	MF CIP S. HYPOCHLORITE TRANSFER PUMP
23	MF CEB CITRIC ACID FEED PUMP	46	ERW SODIUM HYPOCHLORITE FEED PUMP

CONCEPTUAL DESIGN - NOT FOR CONSTRUCTION

LEGEND

- PROPERTY LINE
- EXISTING RWQCP FACILITY
- EXISTING EDGE OF PAVEMENT
- EXISTING FENCELINE
- EXISTING TREE
- PROPOSED CHAIN LINK FENCE
- PROPOSED CURB
- PROPOSED PAVEMENT
- PROPOSED AWPS CANOPY
- PIPE TRENCH

NOTES:
1. DASHED OUTLINES IN THE RO BUILDING ARE DESIGNATED FOR FUTURE EXPANSION TO 2.25 MGD.
2. POSTS ARE SHOWN TO INDICATE TWO CANOPIES COVERING THE MF AND RO SKIDS RESPECTIVELY.

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TRUE PLANT

PROPERTY LINES ARE APPROXIMATE

15' 7.5' 0' 7.5' 15'
1 inch = 15 ft.

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GHD

DESIGNED BY: MD
DRAWN BY:
CHECKED BY: JA
APPV'D BY:

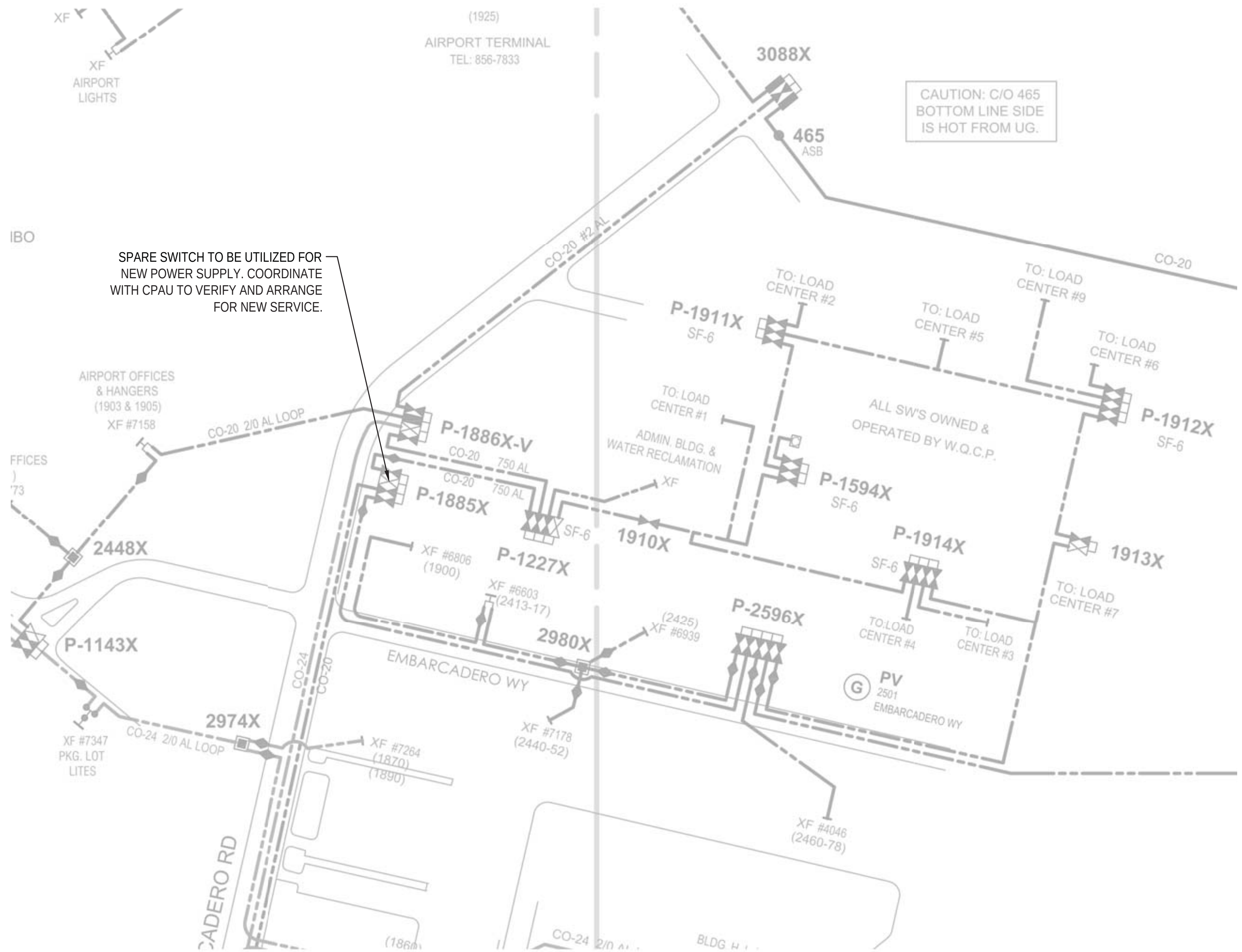
REV.	DATE	DESCRIPTION	BY	APP

AWPS SITE 1 EQUIPMENT LAYOUT - 1.125 MGD EXPANDABLE TO 2.25 MGD AWPS CAPACITY

PUBLIC WORKS DEPT. RWQCP

CITY OF PALO ALTO
CALIFORNIA
ADVANCED WATER PURIFICATION SYSTEM PRELIMINARY DESIGN

SCALE: AS SHOWN
SHEET NO. M1



CONCEPTUAL DESIGN - NOT FOR CONSTRUCTION

DESIGNED BY					
RM					
DRAWN BY	REV.	DATE	DESCRIPTION	BY	APP
AC	AWPS SITE 1 12KV ELECTRICAL DISTRIBUTION			PUBLIC WORKS DEPT. RWQCP	
CHECKED BY -				SCALE: AS SHOWN	
APPV'D BY	CITY OF PALO ALTO CALIFORNIA ADVANCED WATER PURIFICATION SYSTEM PRELIMINARY DESIGN			SHEET NO. E1	

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PROPERTY LINES ARE APPROXIMATE

MNS ENGINEERS INC
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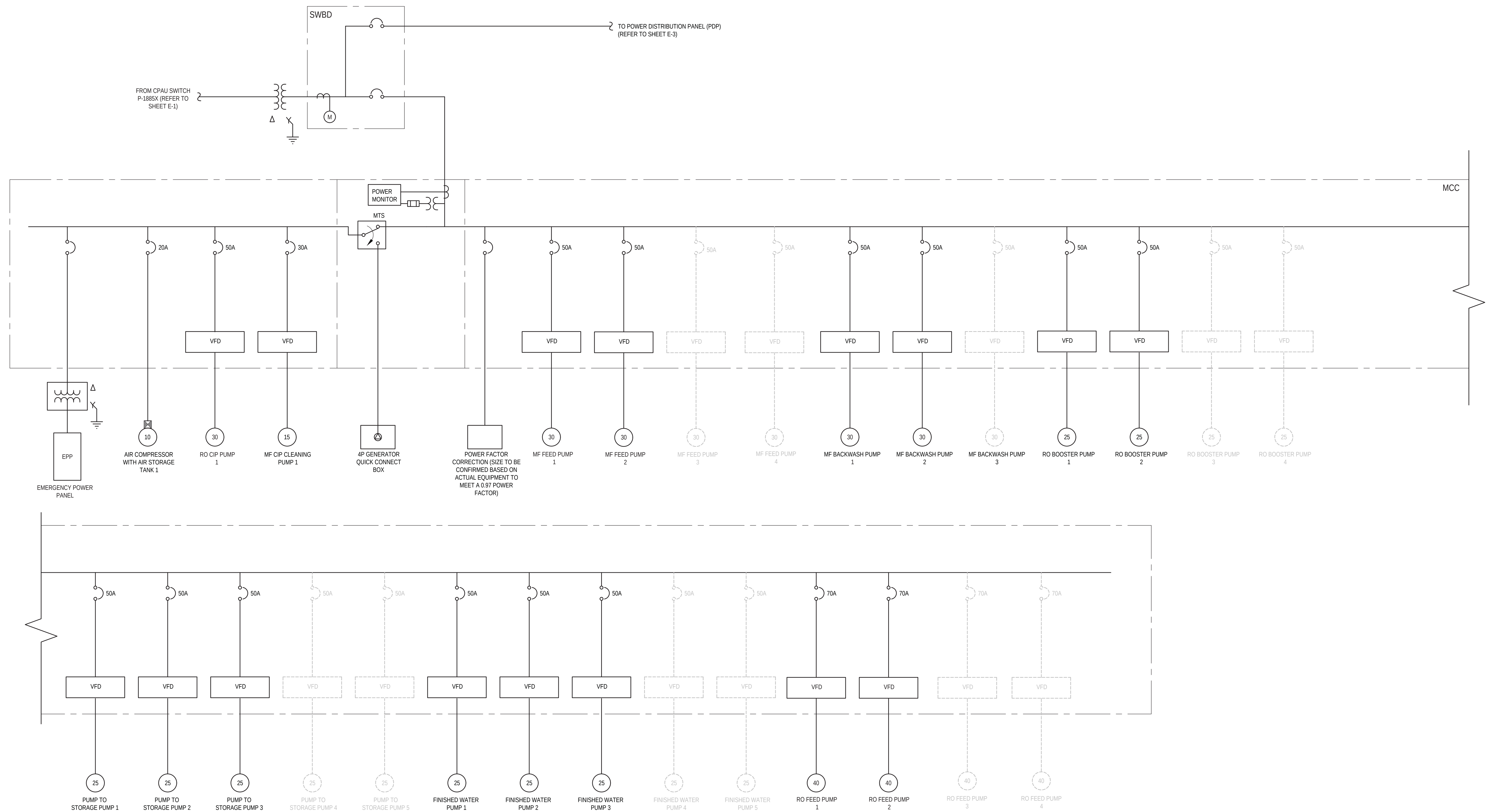
2033 Gateway Place
San Jose, CA 95110
408.573.6421 Phone

GHD



CONCEPTUAL DESIGN - NOT FOR CONSTRUCTION

DESIGNED BY	REV.	DATE	DESCRIPTION	BY	APP
RM					
DRAWN BY AC					
CHECKED BY MD					
APPV'D BY					

AWPS SITE 1 ELECTRICAL - SINGLE LINE DIAGRAM - 1 OF 2

PUBLIC WORKS DEPT. RWQCP

SCALE: NO SCALE

CITY OF PALO ALTO
CALIFORNIA

ADVANCED WATER PURIFICATION SYSTEM PRELIMINARY DESIGN

SHEET NO. E2

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CONSTRUCTION MANAGEMENT

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San Jose, CA 95110
408.573.6421 Phone

GHD

811
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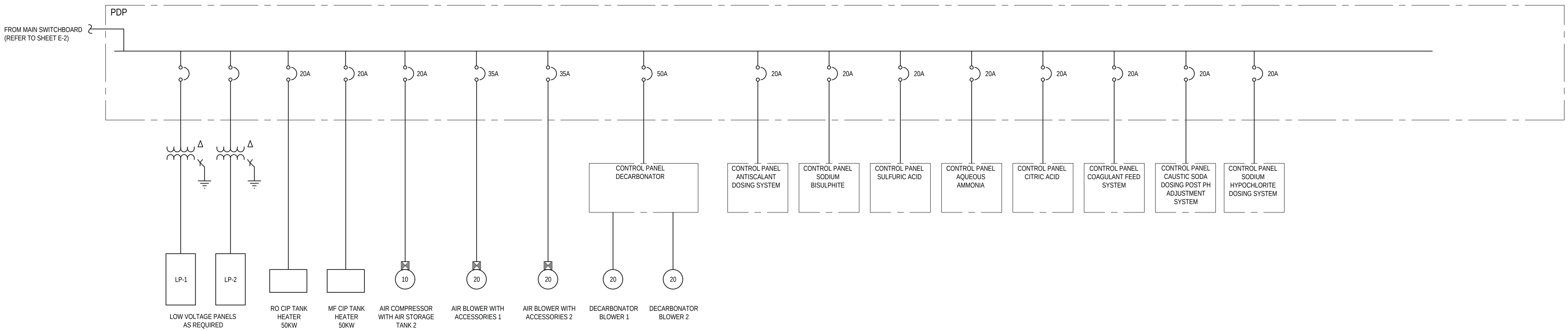
PROPERTY LINES ARE APPROXIMATE



Know what's below. Call before you dig.

PROPERTY LINES ARE APPROXIMATE

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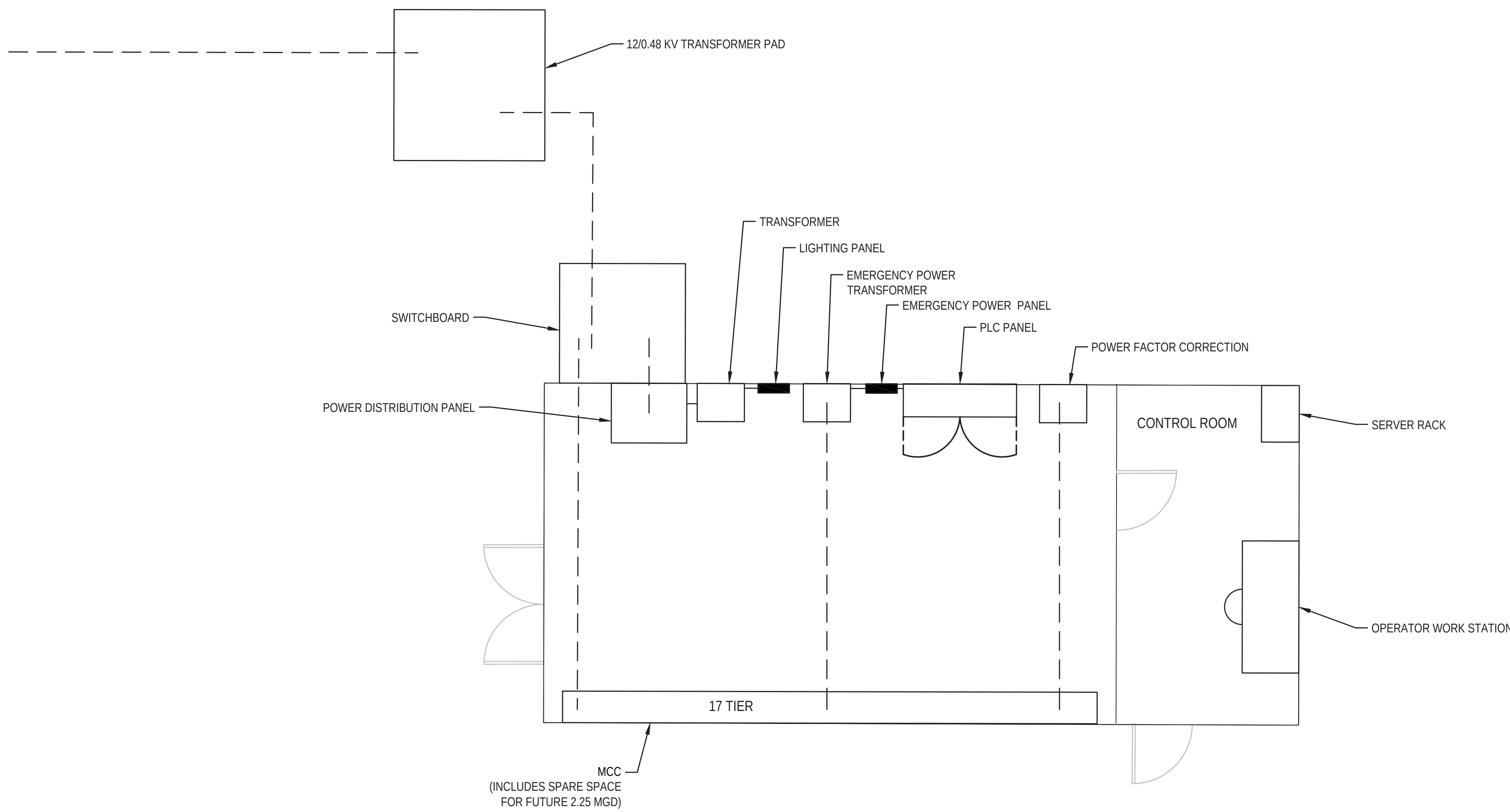
CONSTRUCTION MANAGEMENT
2033 Gateway Place
San Jose, CA 95110
408.573.6421 Phone

CONCEPTUAL DESIGN - NOT FOR CONSTRUCTION

DESIGNED BY RM				
DRAWN BY AC	REV.	DATE	DESCRIPTION	BY / APP
CHECKED BY -	AWPS SITE 1 ELECTRICAL - SINGLE LINE DIAGRAM - 2 OF 2			PUBLIC WORKS DEPT. RWQCP; SCALE: AS SHOWN
APPV'D BY	CITY OF PALO ALTO, CALIFORNIA; ADVANCED WATER PURIFICATION SYSTEM PRELIMINARY DESIGN			SHEET NO. E3



NOTE: SEE CIVIL DRAWINGS FOR ELECTRICAL BUILDING LOCATION.

Know what's **below.**
Call before you dig.

PROPERTY LINES
ARE APPROXIMATE

4' 2' 0' 2' 4'
1/4 inch = 1 foot

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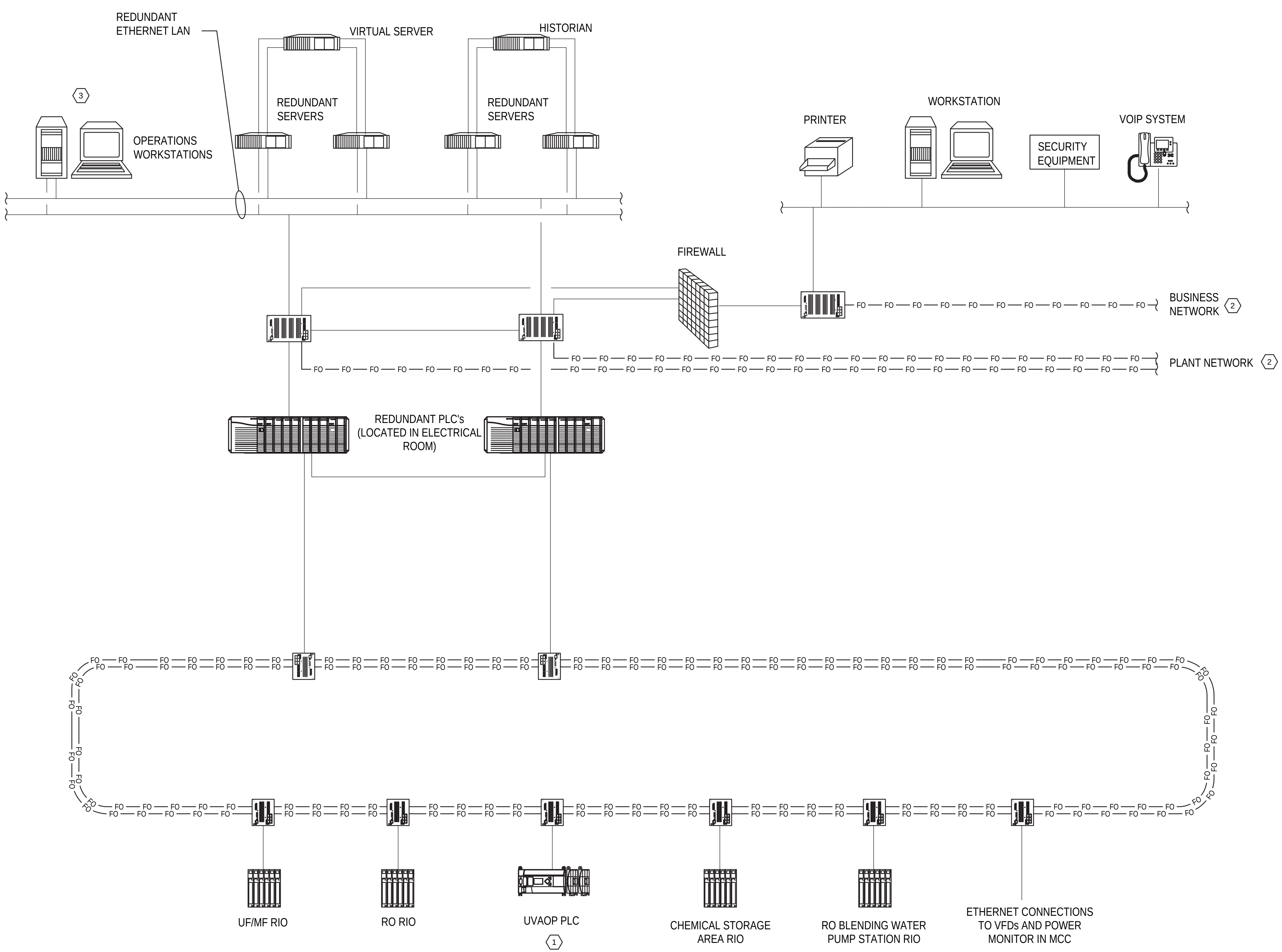
CONCEPTUAL DESIGN - NOT FOR CONSTRUCTION

DESIGNED BY RM				
DRAWN BY AC	REV.	DATE	DESCRIPTION	BY APP
CHECKED BY MD	AWPS SITE 1 ELECTRICAL ROOM EQUIPMENT LAYOUT			PUBLIC WORKS DEPT. RWQCP; SCALE: AS SHOWN
APPV'D BY	CITY OF PALO ALTO, CALIFORNIA; ADVANCED WATER PURIFICATION SYSTEM PRELIMINARY DESIGN			SHEET NO. E4



GENERAL NOTES

1. TYPICAL ARRANGEMENT TO INDICATE CONTROL SYSTEM INTENT. SOME EQUIPMENT MAY NOT BE SHOWN. DESIGNER SHALL INCORPORATE ALL NECESSARY EQUIPMENT FOR A FUNCTIONING SYSTEM.

KEYNOTES

1. UV SYSTEM PACKAGE TYPICALLY OFFERED WITH OTHER A-B CONTROLLERS SUCH AS COMPACTLOGIX OR MICROLOGIX. THE DESIGNER SHALL CONSIDER WHETHER ANY OTHER PACKAGE SYSTEMS REQUIRE SEPARATE PLCs OR WHETHER UV SYSTEMS AND OTHERS CAN BE INTEGRATED INTO THE PLANT CONTROLLER. IDEALLY THE PROGRAMMING FOR ALL CONTROLLERS WILL BE ACCESSIBLE FROM THE OPERATOR WORKSTATION WITH AN ENGINEER LOGIN AND WILL NOT BE RESTRICTED ACCESS DUE TO PROPRIETARY SYSTEMS.
2. FIBER OPTIC TO EXTEND TO ADMINISTRATION BUILDING. EQUIPMENT IN ADMINISTRATION BUILDING TO BE PROVIDED BY THE WATER QUALITY CONTROL PLANT (WQCP).
3. PROVIDE OPERATIONS WORKSTATION WITH OPERATOR AND DEVELOPMENT LOGIN. SECURE LOGIN FOR DEVELOPMENT SOFTWARE TO RESTRICT DEVELOPMENT ACCESS TO AUTHORIZED ENGINEERS ONLY.

LEGEND

WORK STATION

RACK-MOUNT SERVER

REMOTE IO

PROGRAMMABLE LOGIC CONTROLLER

PROGRAMMABLE LOGIC CONTROLLER (VENDOR PACKAGE SYSTEM)

FIBER OPTIC ETHERNET SWITCH (TYP)

FIBER OPTIC ETHERNET SWITCH/HUB (TYP)

VOICE OVER INTERNET PROTOCOL (VOIP) TELEPHONE HANDSET

TWISTED PAIR ETHERNET CABLE

FIBER OPTIC CABLE

CONCEPTUAL DESIGN - NOT FOR CONSTRUCTION

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PROPERTY LINES ARE APPROXIMATE

MNS ENGINEERS INC
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2033 Gateway Place
San Jose, CA 95110
408.573.6421 Phone

GHD

DESIGNED BY	REV.	DATE	DESCRIPTION	BY	APP
RM					
DRAWN BY					
RM					

CHECKED BY: -

APPV'D BY:

AWPS SITE 1
CONCEPT NETWORK DIAGRAM

PUBLIC WORKS DEPT. RWQCP

SCALE: AS SHOWN

CITY OF PALO ALTO
CALIFORNIA

ADVANCED WATER PURIFICATION SYSTEM PRELIMINARY DESIGN

SHEET NO. I1

Appendix B. Geotechnical Desktop Study

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6455 Almaden Expwy.
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San Jose
California 95120

Tel: 408.440.4542
Fax: 408.613.2545
www.caleng.com

September 12, 2017

Samantha Engelage, P.E.
City of Palo Alto
Environmental Services Division
2501 Embarcadero Way
Palo Alto, CA 94303

Subject: Geotechnical Desk Study
Advanced Water Purification System Facility
Palo Alto Regional Water Quality Control Plant
Palo Alto, California

Dear Ms. Engelage:

Cal Engineering & Geology, Inc. (CE&G) is pleased to submit this Geotechnical Study to support the Advanced Water Purification System Facility located at the Palo Alto Regional Water Quality Control Plant in Palo Alto, California. Our investigation included reviewing available geotechnical data and preparing this report.

CE&G appreciates the opportunity to submit this memorandum. If there are questions concerning the information provided herein, please do not hesitate to contact us.

Sincerely,

CAL ENGINEERING & GEOLOGY

Paul Sorci, P.E.
Senior Engineer

Dan Peluso, P.E., G.E.
Principal Engineer

Table of Contents

FIGURES

APPENDICES

1. Introduction

1.1 General

Cal Engineering & Geology, Inc. (CE&G) is assisting the City of Palo Alto (City) with geotechnical engineering services analysis for the planned Advanced Water Purification System (AWPS) Facility to be located at the existing Palo Alto Regional Water Quality Control Plant (RWQCP) in the City of Palo Alto, California. This geotechnical desk study of available existing geologic and geotechnical data is to provide the City with a preliminary foundation design on which a preliminary cost estimate may be made.

1.2 Project and Site Description

The RWQCP is owned and operated by the City of Palo Alto and is in the preliminary design stage for the AWPS at the RWQCP. The RWQCP is located along Embarcadero Road, to the east of Highway 101. The facility is bound by the Palo Alto Airport to the north, the San Francisco Bay to the east, open lands to the south, and commercial buildings to the west. The location of the site is shown on Figure 1, Site Location. The proposed AWPS Facility is to be located at the northern portion of the RWQCP Facility, near Embarcadero Road. The facility is to consist of:

- AWPS Area (1.125 MGD treatment capacity, expandable to 2.25 MGD)
- AWPS Clear Well
- Permeate Storage Tank (75 ft diameter)
- Chemical Storage Area
- Electrical Building
- Decarbonator Pad
- Biofilter Pad

The proposed structures are to be located to the northwest of the existing RWQCP. The topography for the proposed facilities is relatively flat, with an elevation on the order of 10 feet above sea level. Currently, the areas for the proposed AWPS are covered with dense vegetation consisting of various large trees and a biofilter for odor control of the adjacent bar screens. The location of the proposed facilities is shown on Figure 7.

1.3 Purpose and Scope of Services

The purpose of this memorandum is to summarize the available geotechnical data and identify where additional geotechnical data is need to provide design recommendations.

The scope of work completed for this preliminary geotechnical design memorandum included:

1. Completion of an office study of available relevant geologic and geotechnical information near the proposed AWPS structures, including published geologic maps, and previously performed geotechnical investigations and studies.

2. Complete preliminary engineering analysis for the foundation design, including assessment of liquefaction hazard and preliminary settlement estimates of the proposed structures and consideration for shallow and deep foundation systems.

3. Preparation of this geotechnical desk study report.

2. Geologic Setting

2.1 Regional Setting

The project lies within the Coast Ranges geomorphic province of California. This province is characterized by northwest-southeast trending mountain ranges and intervening valleys such as that occupied by San Francisco Bay and the Santa Clara Valley. The project is located overlying the fine-grained Bay margin tidal deposits fringing the San Francisco Bay, near the interface between tidal marsh and non-tidal lands.

Elevations in the project area range between approximately 8 and 10 feet above sea level [based on a telephone conversation with MNS Engineers staff (Panofsky, 2017)].

Elevations noted in this report are referenced to the North American Vertical Datum 1988 (NAVD88).

2.2 Geologic Setting

The geologic setting is shown on our Regional Geology Map (Figure 2). The generalized geology of this area has been mapped by a number of studies.

A relatively recent regional compilation of earlier detailed geologic mapping, with localized reinterpretation and independent mapping, is provided by Brabb and others (2000). An excerpt of this map is used as the base of our Regional Geology Map (Figure 2). Brabb and others (2000) show the soil that underlies the project area as artificial fill, which in turn overlies Holocene Bay Mud deposits.

Knudsen and others (2000) and Witter and others (2006) prepared more recent, detailed geologic maps focusing on non-bedrock earth materials. Witter and others map the project area as overlying artificial fill over estuarine mud (Bay Mud), which is in turn overlying Holocene San Francisco Bay mud. From an overall project standpoint, there is no significant difference between the two maps (Knudsen and Witter).

2.3 Faulting and Seismicity

According to Bryant and Hart (2007) the site is not located within an Alquist-Priolo Earthquake Fault Zone, as mapped by the State of California. The County of Santa Clara Planning Department Geologic Hazard Zone Maps (accessed 2017) show no Fault Hazard Zones as crossing the project area, and no fault hazard zone is established along the project alignment by the local jurisdictions.

As far as tectonic and fault implications for the project goals, the area has been closely scrutinized by numerous researchers for evidence suggestive of Holocene ground rupture, and/or ground deformation. No evidence for fault ground rupture has been reported, and the broad scale of regional deformation is not judged to pose a concern for the project.

The project site is located within the greater San Francisco Bay Area which is recognized as one of the more seismically active regions of California. The seismic activity in this region results from the complex movements along the transform boundary between the Pacific Plate and the North American Plate. Along this transform boundary, the Pacific Plate is slowly moving to the northwest relative to the more stable North American Plate at approximately 40 mm/yr in the Bay Area (Page, 1992). The differential movements between the two crustal plates caused the formation of a series of active fault systems within the transform boundary. The transform boundary between the two plates extends across a broad zone of the North American Plate within which right lateral strike-slip faulting predominates. In this broad transform boundary, the San Andreas fault accommodates less than half of the average total relative plate motion. Much of the remainder in the greater South Bay Area is distributed across faults such as the San Gregorio, Monte Vista-Shannon, Sargent, Hayward, Calaveras, Zayante-Vergeles, and Ortigalita fault zones.

Due to the project's location in the seismically active San Francisco Bay Area, the site will likely experience significant ground shaking due to large (moment magnitude greater than 6.7) earthquakes along one or more of the nearby active faults (WGCEP, 2008). Contributors to seismic risk for the project include the Monte Vista/Shannon, San Andreas, Hayward, Calaveras, Sargent, Zayante-Vergeles, Greenville, and San Gregorio-Hosgri faults.

A large magnitude earthquake on any of these fault systems has the potential to cause significant ground shaking at the site. The intensity of ground shaking that is likely to occur in the project area is generally dependent upon the magnitude of the earthquake and the distance to the epicenter.

2.4 Geohazard Mapping

Witter and others (2006) shows the project site as lying within an area of "very high" liquefaction susceptibility, on a 5-class scale that includes very low (essentially bedrock areas), low, moderate, high and very high susceptibility classes. Generally, the areas closest to the Bay, and the areas underlain by the youngest alluvium have higher liquefaction susceptibility; see Figure 3, Liquefaction Susceptibility Map. No localities of reported liquefaction for the 1906 or 1989 earthquakes are known in the project vicinity.

The project area is shown within a liquefaction hazard zone on a State of California Seismic Hazard Map produced by the California Geological Survey (CGS): the Mountain View 7.5-minute quadrangle (CGS, 2006). This regulatory map relied extensively on the geologic mapping by

Knudsen and others (2000) described above, which was refined by Witter without major changes in the project area.

The project area is shown on County of Santa Clara liquefaction hazard maps as lying within a zone of potential liquefaction that extends to the Bay margin, mirroring the liquefaction mapping of CGS (2006).

The City of Palo Alto Comprehensive Plan (accessed August 2017) lumps geotechnical hazards related to fault ground rupture, seismically-induced landsliding, liquefaction susceptibility and expansive soils (Map N-5). The map shows the project area within a zone of high potential for liquefaction.

2.5 Regional Groundwater

Groundwater within the underlying alluvial sediments in the project site is managed by Santa Clara Valley Water District (SCVWD). The California Department of Water Resources identifies this area as the Santa Clara Basin, which is one of several groundwater subbasins within the Santa Clara Valley groundwater basin.

Groundwater depth records in the vicinity of the project area were obtained from SCVWD (SCVWD, 2017). Groundwater levels have fluctuated historically over the last one hundred years and also fluctuate seasonally. Record low levels occurred in the 1960s due to overdraft and have since rebounded due to recharging of the aquifer system. Seasonal fluctuations can be around 20 feet or more in some areas along creek channels.

Groundwater depth records available from the SCVWD (2017) indicate groundwater depths at the project site are less than 10 feet below the ground surface.

3. Historical Documentation

Below is a list of the available historical documentation provided and reviewed by CE&G in the context of the AWPS Project site. The locations of the subsurface explorations associated with these documents are presented on Figure 5, Historical Boring Locations. Available relevant historical boring logs that were utilized in our assessment are presented in Appendix A.

Cooper-Clark & Associates (1966). *Soil Investigation, Proposed Channing Trunk Sewer, Project No. 65-5, Palo Alto, California, For the City of Palo Alto.* December 2.

Cooper-Clark & Associates (1968). *Report, Foundation Investigation, Proposed Additions, Waste Water Treatment Works, Palo Alto, California.* Report prepared for Jenks & Adamson. August 30.

Cooper-Clark & Associates (1972). *Causes of Large Deflections Along the 72-inch Underground Pipelines, Water Quality Control Plant, Palo Alto, California.* September 1.

Cooper-Clark & Associates (1975). *Report, Foundation Investigation, Proposed Additions, Water Reclamation Facility, Palo Alto, California.* Report prepared for Santa Clara Valley Water District. February 4.

Cooper-Clark & Associates (1976a). *Consultation, Indicator Pile Driving Results and Recommended Driving Criteria, Water Reclamation Facility, Palo Alto, California.* For Santa Clara Valley Water District. January 21.

Cooper-Clark & Associates (1976b). *Report, Foundation Investigation, Proposed Additions, Regional Wastewater Treatment Plant, Palo Alto, California.* For the City of Palo Alto. December 22

Cooper Engineers (1983). *Report, Consultation on Foundation Support, Proposed Storage Tanks, Chlorination Building, Regional Waste Water Treatment Works, Palo Alto, California.* For the City of Palo Alto. December 14.

CH2M-Hill (1986). *Palo Alto WQCP Expansion Project, Geotechnical Exploration*. May 27.

CH2M-Hill (1998). *RWQCP Incinerator Rehabilitation Project – Design Data Report Revised Lateral Pile Capacities – Geotechnical Report*. July 22.

CH2M (2015). *Technical Memorandum, Geotechnical design Recommendations fot the Proposed Sludge Dewatering and Loadout Facility (Component 1), Palo Alto Regional Water Quality Control Plant, Palo Alto, CA.* November 12.

DCM Engineering (2008). *Geotechnical Engineering Investigation Report, Palo Alto RWQCP, UV Disinfection Facility, Palo Alto, California*. Report prepared for RMC Water and Environment. September.

ENGEO (2006). *Phase 3 Facility Condition Assessment, City of Palo Alto RWQCP, Palo Alto, California*. November 29.

James M. Montgomery, Consulting Engineers, Inc (1972). *Report on Remedial Measures to Repair Damaged 60-inch and 72-inch Pipelines at Regional Water Quality Control Plant.* August 16.

Treadwell & Rollo (2005). *Revised Summary of Subsurface Conditions, Facility Condition Assessment, City of Palo Alto, RWQCP, Palo Alto, California*. February 1.

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4. Site and Subsurface Conditions

4.1 General Subsurface Conditions

Our review of historical data included reviewing subsurface data in the area of the proposed AWPS structures. The majority of the borings reviewed were located to the southeast of where the structures are proposed. Borings in the area were typically advanced between 30 and 40 feet below the ground surface, with some borings as deep as 77.5 feet below the ground surface. All borings showed three distinct layers of material: fill, bay mud, and alluvial clay.

Each boring showed a fill layer, ranging in depths from the ground surface to about 10 feet below. Fill layers consisted mainly of clayey soils, with various degrees of consistency and containing various forms of rubble and debris. Beneath the fill soils, bay mud consisting of soft to very soft fat (highly expansive) clays and organic layers were encountered to depths up to about 18 feet below the ground surface. Bay mud layers typically ranged in thickness from 3 to 10 feet. The bay mud soils were characterized as having low densities and high moisture contents. Beneath these soft soils, a deep alluvial clay layer consisting of firm to very stiff clays were encountered to the maximum depths explored. The alluvial clay typically increases in consistency with depth and has similar moisture and densities throughout the geologic unit. Laboratory data from available borings in the northern portion of the RWQCP have been plotted by depth and are presented on Figure 8, Project Site Laboratory Data.

4.2 AWPS Structures

At the AWPS buildings at the northwest corner of the project site, borings CC-1-66, CC-1-68, CC-2-68, WCA-2-56 were within approximately 200 feet of the proposed structures. Boring CC-22-68 was located within the 1.125-MGD AWPS Building, while the others were located outside of the proposed building footprints. Using these four borings, a generalized soil profile was developed consisting of about 8 feet of fill materials consisting of clay, silt, and clayey sands underlain by about 9 feet of bay mud materials consisting of organic soils interbedded with granular material, underlain by alluvial hard clay to the maximum depths explored of 77.5 feet. Laboratory data for these 4 explorations have been plotted by depth and are presented on Figure 9, AWPS Buildings Laboratory Data.

4.3 Groundwater Plumes

Environmental data was accessed online from the Terradex website, WhatsDown, indicating the RWQCP site is located adjacent to mapped groundwater plumes and nearby spill sites, see Figure 4 Groundwater Plumes Map. A large plume is located to the southeast of the RWQCP and a small plume is located to the west. Based on these mapped locations, there is a potential for contaminated soils to be located beneath the project area. We recommend an assessment of the presence of contaminated soils beneath the site be made as part of the final design.

5. Engineering Analysis

5.1 Settlement of Shallow Foundations

The exploratory borings by others encountered moderately to highly compressible soils below the treatment plant site. Settlement analyses were completed to consider short-term compression of the underlying fill soils and long-term consolidation of the native clay deposits. Total settlement occurring in the area of the AWPS Project was indicated to result principally from the loads imposed by the new structures. Approximately 10 feet of fill was encountered during the subsurface exploration typically underlain by 8 to 10 feet of soft, highly compressible Bay Mud.

Settlement of the structures was analyzed using a computer generated 2-dimensional analysis to estimate total settlement and differential settlement along the cross section analyzed using the computer program SIGMA/W.

Loads anticipated to be imposed by the various structures were provided to us by MNS Engineers. A summary of the structures and anticipated loads and associated estimated total settlement are as follows:

Structure	Area (SF)	Soil Loading (psf)	Range of Estimated Total Settlement (in)
AWPS Area	14000	328	5-6
AWPS Clear Well	1012	879	>18
Permeate Storage Tank	4418	1,664	>36
Chemical Storage Area	3192	248	2-4
Electrical Building	720	196	2-4
Decarbonator Pad	600	205	2-4
Biofilter Pad	414	234	2-4

More than half of the estimated settlement is resulting from elastic compression of the loose fill soils overlying the site. The majority of the remaining settlement results from consolidation settlement of the soft bay mud soils.

Based on our preliminary settlement assessment, we recommend the AWPS Clear Well and Permeate Storage Tank be planned to be supported on deep foundations.

5.2 Pile Analysis

5.2.1 Historical Pile Foundation Recommendations

The following table is a summary of foundation recommendations provided by others for various structures at the RWQCP. These previous recommendations were considered in our preliminary foundation design assessment.

Report	Structure	Foundation Type	Settlement	Pile Capacities
1956 – Woodward, Clyde and Associates	Clarifier	Cast-in-place End Bearing Piles	None provided	40 tons (Tip at 35 to 40 ft bgs)
1968 – Cooper Clark & Associates	Various	Piles	Less than 1-inch total and less than ½-inch differential	See chart in report
1975 – Cooper Clark & Associates	Various	12-inch-square Piles	Less than 1-inch total and less than ½-inch differential	See chart in report
1976 – Cooper Clark & Associates	Various	12-inch-square Piles	Less than 1-inch total and less than ½-inch differential	See chart in report
1983 Cooper Engineers	Storage Tanks Chlorination Building	Various Pile Types	Less than ¼-inch total and minimal differential	See chart in report
1986 – CH2M	Secondary Clarifiers, RAS pump station	12-inch-square piles	Minimal settlement for piles	45 tons (Tip at el. -64 to -69 ft)

Report	Structure	Foundation Type	Settlement	Pile Capacities
1998 – CH2MHill	Solids Equalization Tank	12-inch-square piles / mat foundation	0.5 to 6 inches for mat foundations based on size and bearing pressures (see chart)	35 (Tip at el. -50) and 50 ton (Tip at el. -67 ft.
2008 – DCM	UV Disinfection Facility (pile) Generator pad (mat)	12-inch-square piles	1-inch total and ½ inch differential for mat foundation and pipeline	50 tons (tip el. -67 ft)
2015 – CH2M	Sludge Dewatering	12-, 16-, and 24-inch- Auger Cast Piles	0.12 to 0.61 inches total settlement	See tables in CH2M report

5.2.2 Axial Pile Capacity Analysis

Pile analysis was performed to estimate the axial loading capacity associated with deep foundations. Based on the design loading information, settlement considerations and subsurface conditions, RWQCP standard auger cast piles may be used. Given the potential for contaminated soils to be located beneath the project area, using auger cast displacement piles would be preferred to help minimize the potential need for contaminated soil disposal. Driven precast concrete piles were also analyzed, and were excluded due to RWQCP's preference for auger cast piles. This is due to driven piles' potential for disruption to nearby infrastructure, staff, and neighboring facilities.

Based on the design loading information, settlement considerations and subsurface condition, we recommend that the proposed AWPS Clear Well and Permeate Storage Tank structures can be supported by 14- or 18-inch auger cast displacement piles with a concrete compressive strength of 6,000 pounds per square inch (psi). The axial resistance of auger cast displacement piles for the proposed structure is mobilized mainly through skin friction (adhesion) between the pile and surrounding soils, with minimal resistance from end-bearing capacity. These resistance values are used to estimate the pile tip elevations. The results of our axial pile capacity analysis are presented in Figure 10. No group reduction factor needs to be applied to the single pile compression load capacities presented above, provided a center-to-center spacing of at least three pile diameters is used.

6. Discussion, Conclusions and Recommendations

6.1 General

The majority of settlement of the proposed structures under the anticipated loading conditions will result primarily from elastic compression of the on-site poorly compacted fill soils and consolidation of the underlying soft bay mud soils. For the lightly loaded structures, shallow mat foundations may be considered. Heavier loads will result in excessive settlement and will require those structures to be supported on deep foundations. The following sections provide some preliminary foundation design recommendations, based on our current understanding of the site soils.

6.2 Shallow Mat Foundations

It is anticipated shallow mat foundations may be used for the relatively light loaded structures, depending on the sensitivity to settlement for each of these structures. These structures include:

- AWPS Area (bearing pressure below structure = 328 psf)
- Chemical Storage Tank (bearing pressure below structure = 248 psf)
- Electrical Building (bearing pressure below structure = 196 psf)
- Decarbonator Pad (bearing pressure below structure = 205 psf)
- Biofilter Pad (bearing pressure below structure = 234 psf)

To minimize the settlement of each of these structures, we recommend the upper fill soils be subexcavated and recompacted to remove the majority of the potential settlement resulting from the fill soil and to create a uniform fill pad to minimize differential settlement. This operation is anticipated to reduce the total estimated settlement by approximately half of the above-noted estimate.

We recommend that the maximum depth of the subexcavation be at least 2 feet above the top of the bay mud, to avoid encountering the bay mud with heavy construction equipment, as this will likely be very problematic for the grading contractor. Additionally, the depth to groundwater should be considered when determining the final depth of the subexcavation.

The designers may also want to consider cement treating the fill soils, as this can also help to create a stiff soil platform on which to place the reinforced mat foundations, and further reduce the potential for differential settlement. It should be noted that cement treatment will make it difficult to excavate for underground utilities on the building pad.

We anticipate that the above noted new structures may be supported on reinforced concrete mat slabs. The support of the mat slabs should be founded on subexcavated and recompacted engineered fill. The mat slabs may be designed using a net allowable soil bearing pressure of 500 pounds per square foot (psf) for dead plus live loads. This value may be increased by one-third when considering short-term loads such as wind and seismic forces. The mat foundations may be designed using a modulus of subgrade reaction (k_v) of 120 kips per cubic foot. Reinforcement for the foundations should be determined by the project structural engineer.

Total post-construction settlement of the structure is anticipated to be less than 1-inch.

To maintain foundation support, mat slabs located near utility trenches oriented parallel to the structure should be deepened so that the bearing surfaces are below an imaginary plane having an inclination of 1½:1 (horizontal to vertical). This imaginary plane should be drawn extending upward from the bottom edge of the adjacent utility trench.

6.3 Deep Foundations

We recommend deep foundations to be used for the more heavily loaded structures. These structures include the following:

- AWPS Clear Well (879 psf)
- Permeate Storage Tank (1,664 psf)

Based on our analysis in Section 5.2, we recommend these structures be supported on a foundation system using 14- or 18-inch auger cast displacement piles with a concrete compressive strength of 6,000 pounds per square inch (psi). A reinforced concrete mat slab may be used as a pile cap to structurally connect the piles. The thickness of this mat will be determined by the project structural engineer. However, we preliminarily estimate the AWPS Clear Well mat slab should be at least 12 inches thick and the Permeate Storage Tank mat slab should be at least 18 inches thick.

Figure 10 presents our preliminary estimates for auger cast displacement piles load carrying capacity. We anticipate the piles will be designed to carry approximately 50 to 100 kips each and will be installed in a grid pattern with a minimum depth of 50 feet and a spacing between piles of approximately 5 feet in both directions.

Because the bottom of the AWPS Clear Well may be excavated into the bay mud, a working platform at the base of the excavation may need to be prepared before piles are installed.

6.4 Additional Geotechnical Investigation

The conclusions and recommendations provide in this report are based on available geotechnical data in the vicinity of the project area. However, the majority of these explorations are over 200 feet from the proposed AWPS improvements with limited laboratory data. It is recommended additional geotechnical subsurface exploration be performed at the location of the improvements to properly characterize the soil and groundwater conditions beneath the AWPS for development of final geotechnical recommendations, including foundation design recommendations.

7. Limitations

The findings and conclusions of this report are based upon information provided to us regarding the existing improvements, subsurface conditions described on the boring logs prepared by others, the results of the laboratory testing by others, interpretation and analysis of the collected data, and professional judgment.

The evaluation or identification of the potential presence of contaminated soil or groundwater at the site was not requested and was beyond the scope of this investigation and report.

8. References

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FIGURES

BASEMAP REFERENCE

1. BASEMAP FROM ESRI, 2016.
2. STREET CENTERLINES FROM CALTRANS, 2016.

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SITE LOCATION MAP

171410	SEPTEMBER 2017	FIGURE 1

BASEMAP REFERENCE

1. REGIONAL GEOLOGY FROM BRABB, GRAYMER, AND JONES, 2000
   GEOLOGIC MAP AND DATABASE OF THE PALO ALTO 30' X 60' QUADRANGLE, CA.

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MAP UNIT DESCRIPTION

af	ARTIFICIAL FILL (HISTORIC)	Qhb	BASIN DEPOSITS (HOLOCENE)
alf	ARTIFICIAL LEVEE FILL (HISTORIC)	Qhbs	BASIN DEPOSITS, SALT-AFFECTED (HOLOCENE)
Qhasc	ARTIFICIAL STREAM CHANNELS (HISTORIC)	Qhfp	FLOOD-PLAIN DEPOSITS (HOLOCENE)
Qhsc	STREAM CHANNEL DEPOSITS (HOLOCENE)	Qhl	NATURAL LEVEE DEPOSITS (HOLOCENE)
Qhbm	BAY MUD (HOLOCENE)	Qpaf	ALLUVIAL FAN AND FLUVIAL DEPOSITS (PLEISTOCENE)

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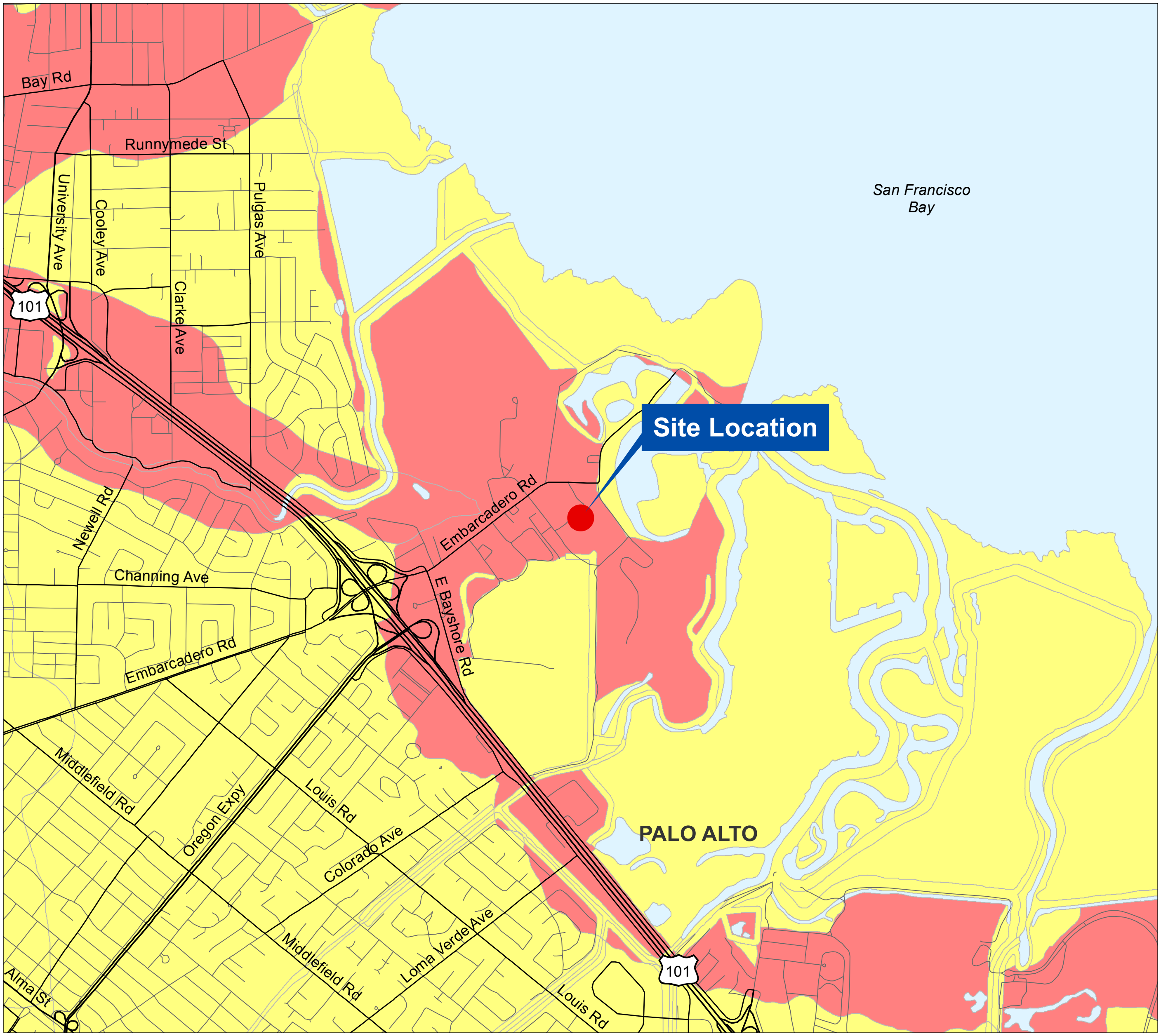
REGIONAL GEOLOGY MAP

171410	SEPTEMBER 2017	FIGURE 2



BASEMAP REFERENCE

1. LIQUEFACTION SUSCEPTIBILITY FROM WITTER AND OTHERS, 2006.
2. STREET CENTERLINES FROM CALTRANS, 2016.

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MAP UNIT DESCRIPTION

VERY HIGH Susceptibility
HIGH Susceptibility
MODERATE Susceptibility
LOW Susceptibility
VERY LOW Susceptibility
WATER
AREA NOT MAPPED

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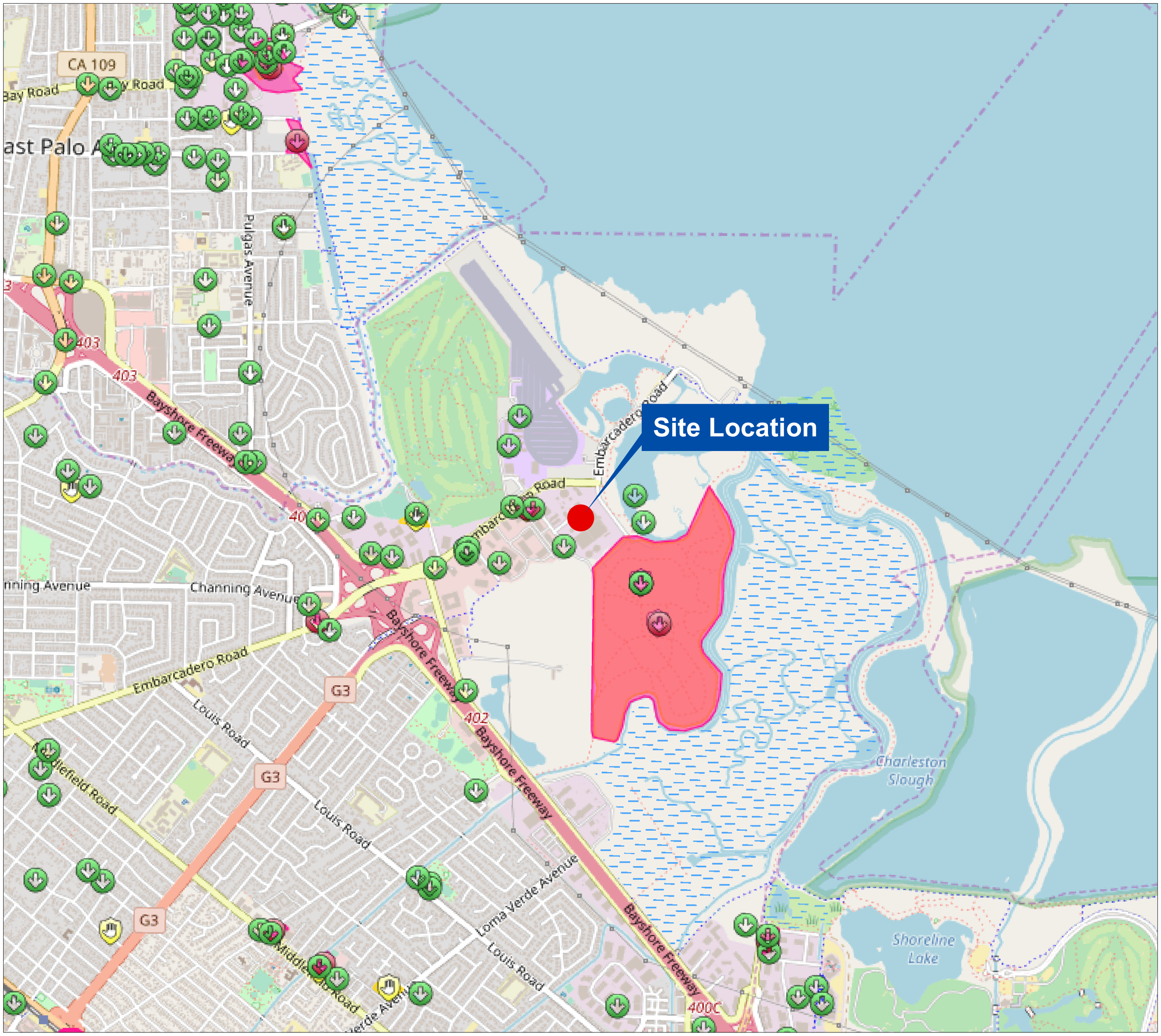
LIQUEFACTION SUSCEPTIBILITY MAP

171410	SEPTEMBER 2017	FIGURE 3



BASEMAP REFERENCE

1. SPILL SITES, GROUNDWATER PLUMES AND ENVIRONMENTAL PRECAUTION DATA FROM WHATSDOWN WEBSITE: https://whatsdown.terradex.com ACCESSED ONLINE 2017/09/06.

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LEGEND

SPILL SITE

GROUNDWATER PLUME

ENVIRONMENTAL PRECAUTION

AREA

LOCATION

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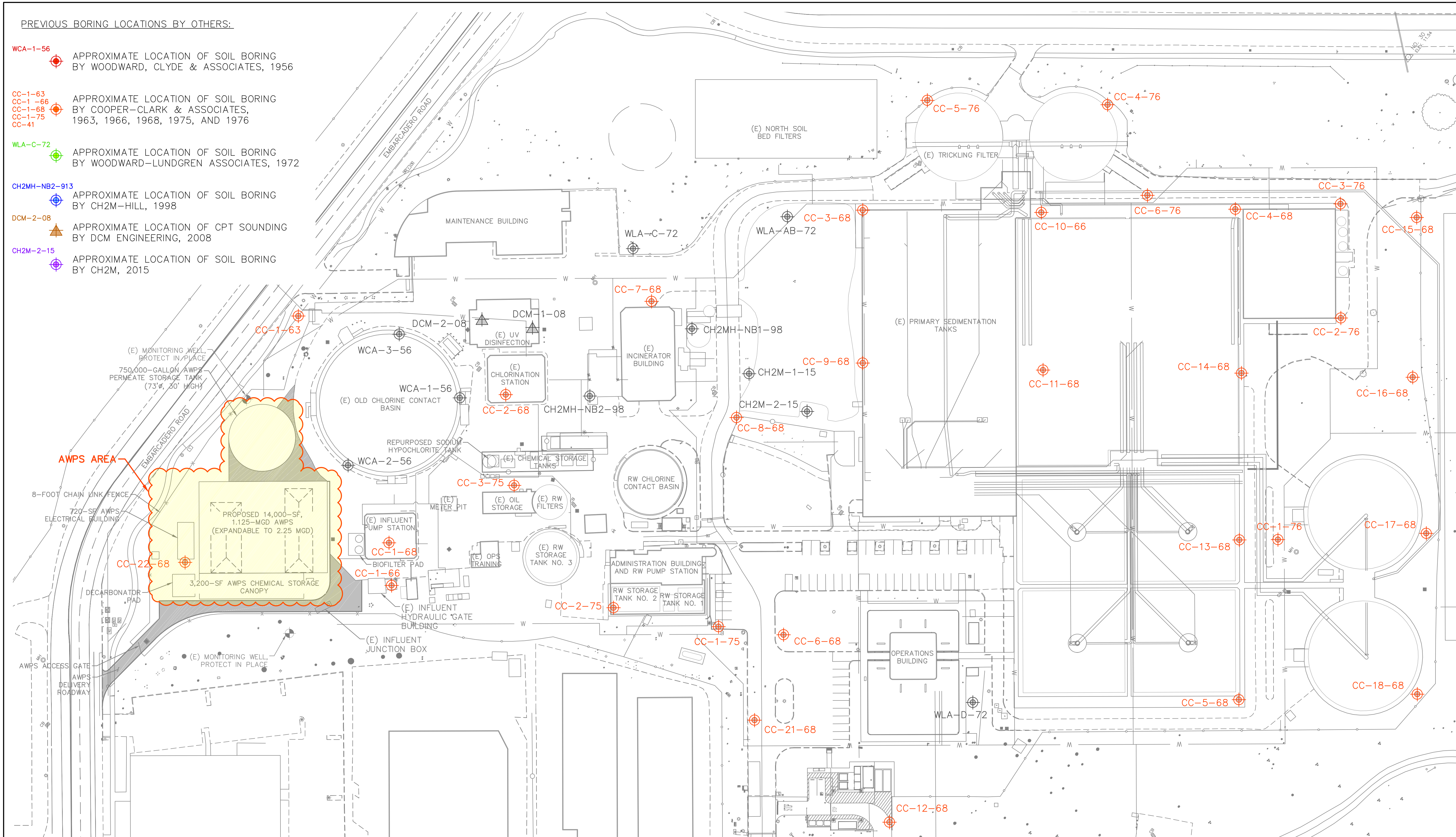
GROUNDWATER PLUMES MAP

171410	SEPTEMBER 2017	FIGURE 4



REFERENCES

1. BASEMAP FROM "SITE LAYOUT PLAN" PREPARED FOR ADVANCED WATER PURIFICATION SYSTEM, PRELIMINARY DESIGN BY MNS ENGINEERS INC

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SCALE FEET

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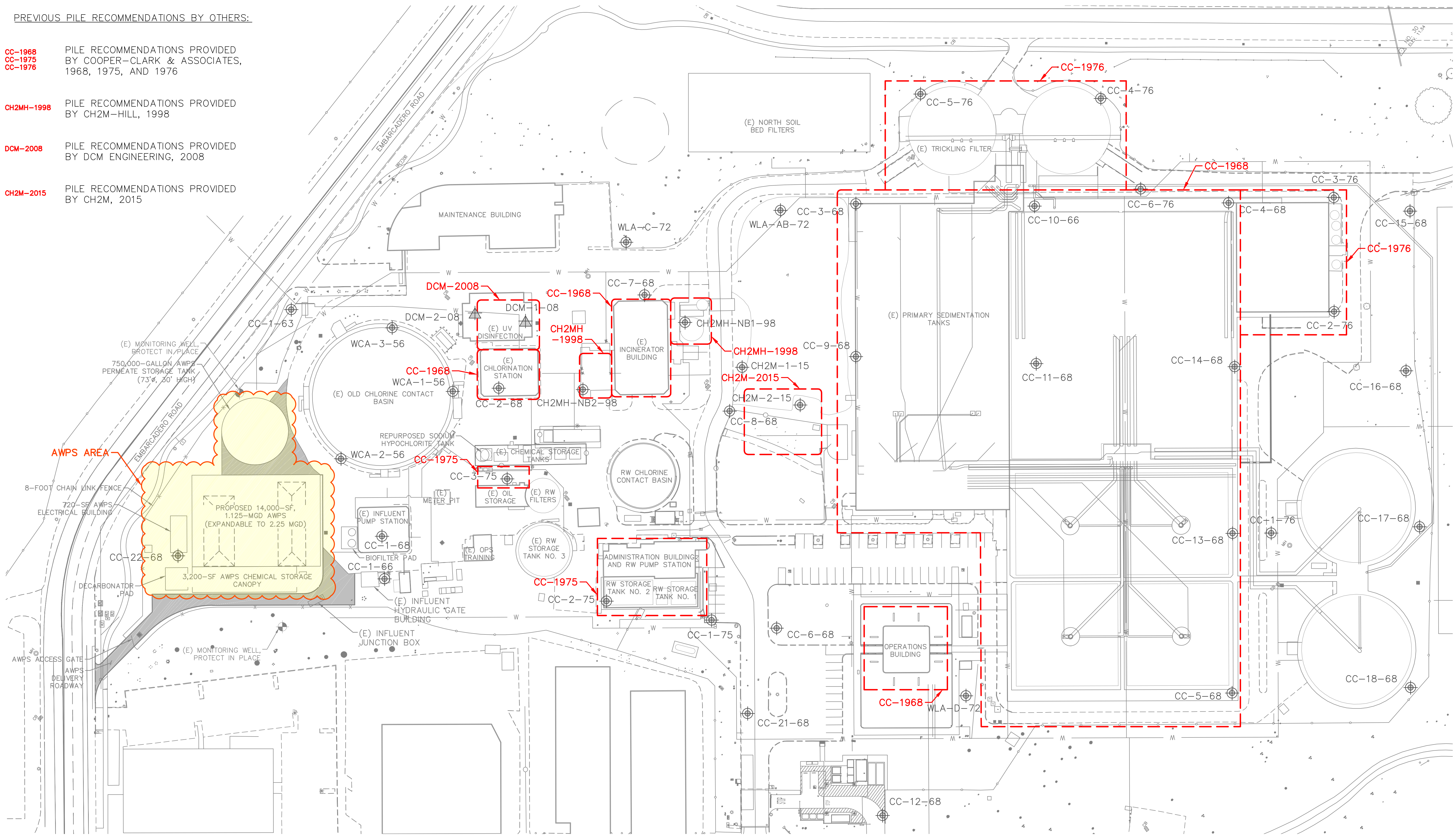
HISTORICAL BORING LOG DATA

171410	SEPTEMBER 2017	FIGURE 5

PREVIOUS PILE RECOMMENDATIONS BY OTHERS:

CC-1968 CC-1975 CC-1976	PILE RECOMMENDATIONS PROVIDED BY COOPER-CLARK & ASSOCIATES, 1968, 1975, AND 1976
CH2MH-1998	PILE RECOMMENDATIONS PROVIDED BY CH2M-HILL, 1998
DCM-2008	PILE RECOMMENDATIONS PROVIDED BY DCM ENGINEERING, 2008
CH2M-2015	PILE RECOMMENDATIONS PROVIDED BY CH2M, 2015



REFERENCES

1. BASEMAP FROM "SITE LAYOUT PLAN" PREPARED FOR ADVANCED WATER PURIFICATION SYSTEM, PRELIMINARY DESIGN BY MNS ENGINEERS INC

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HISTORICAL PILE RECOMMENDATIONS

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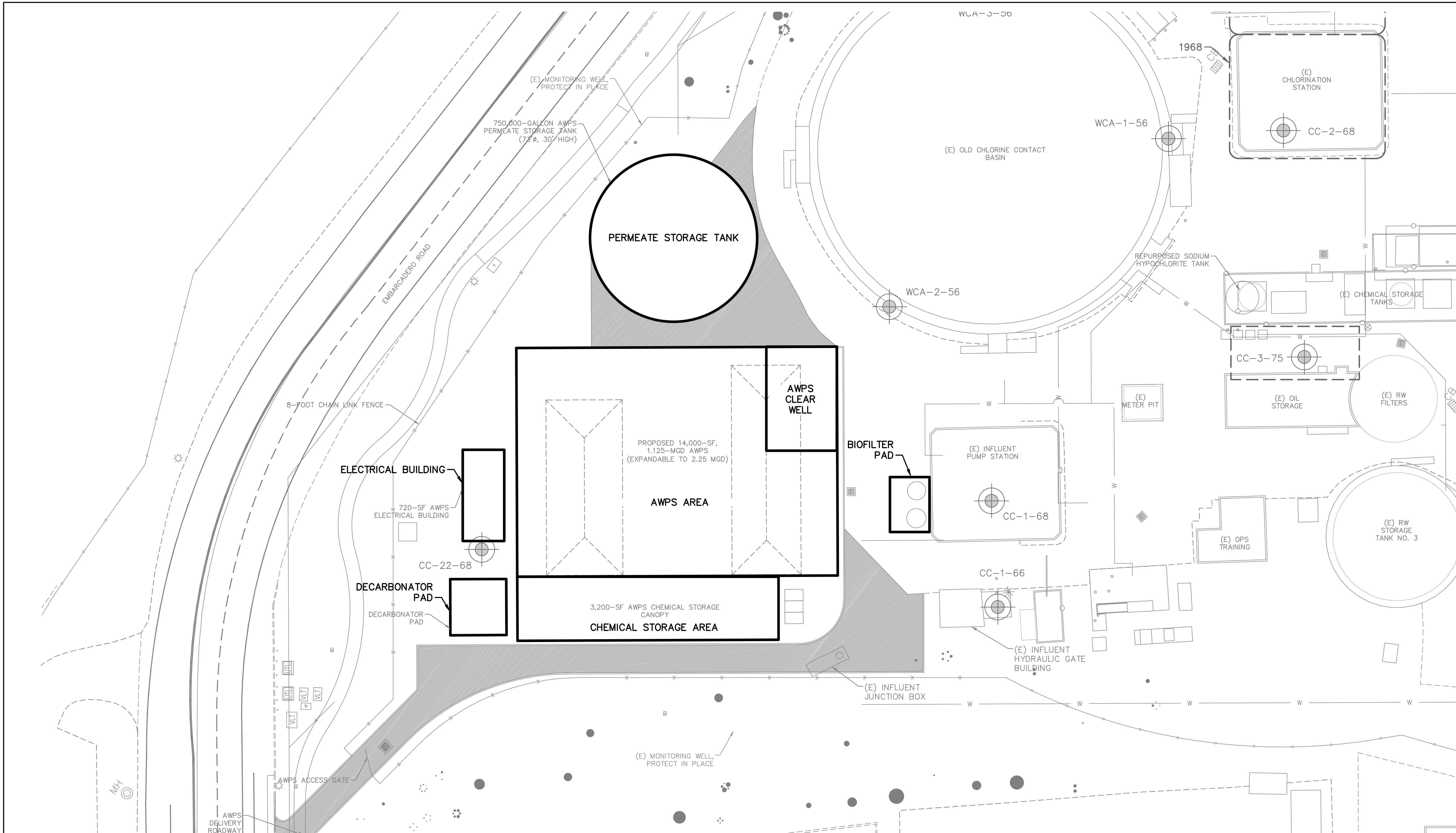

REFERENCES

1. BASEMAP FROM "SITE LAYOUT PLAN" PREPARED FOR ADVANCED WATER PURIFICATION SYSTEM, PRELIMINARY DESIGN BY MNS ENGINEERS INC

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PROPOSED AWPS FACILITIES

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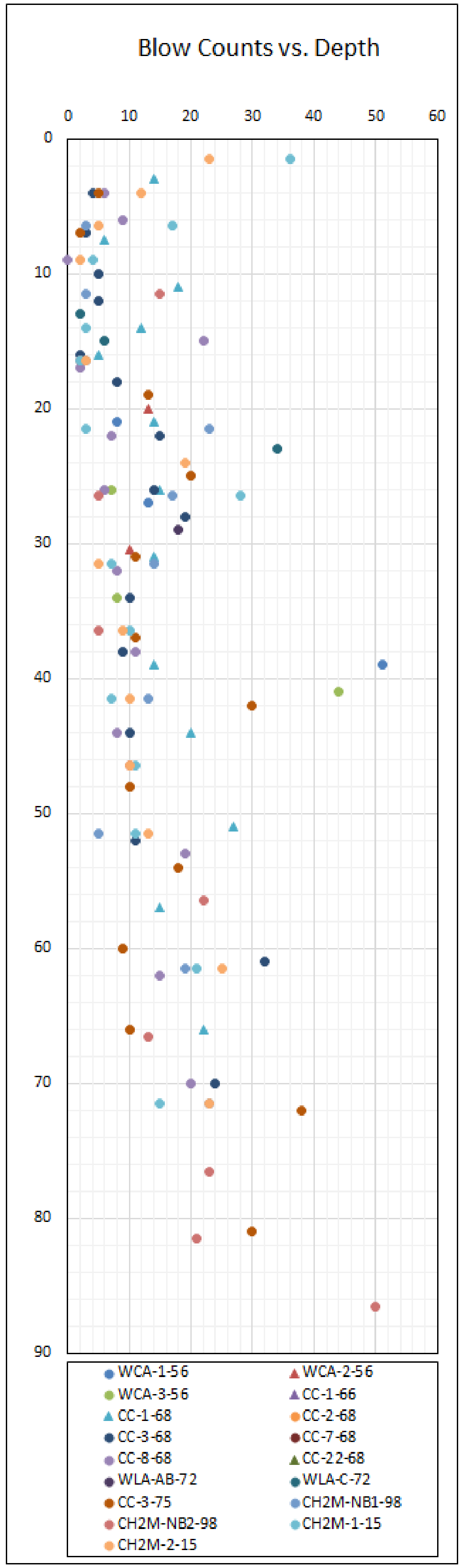

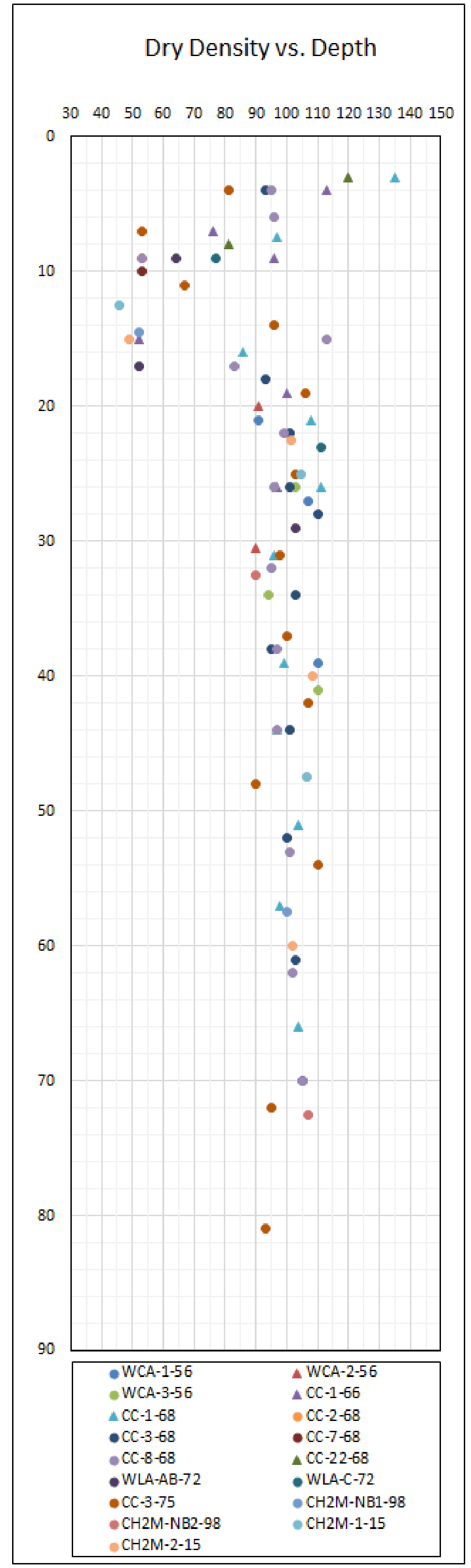

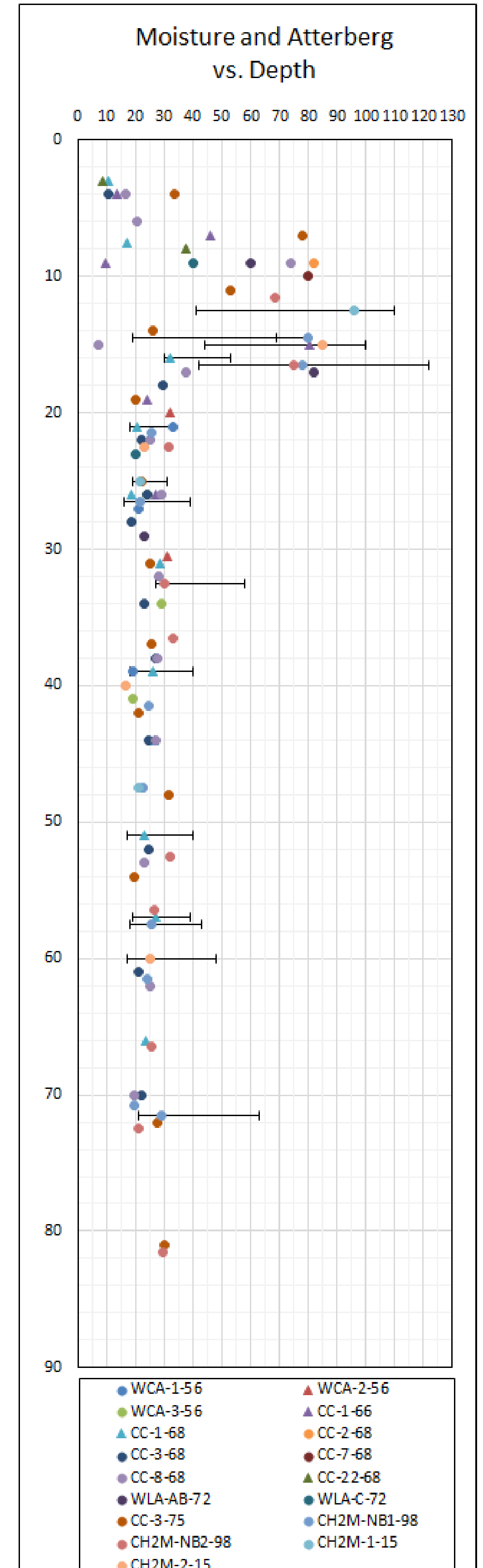

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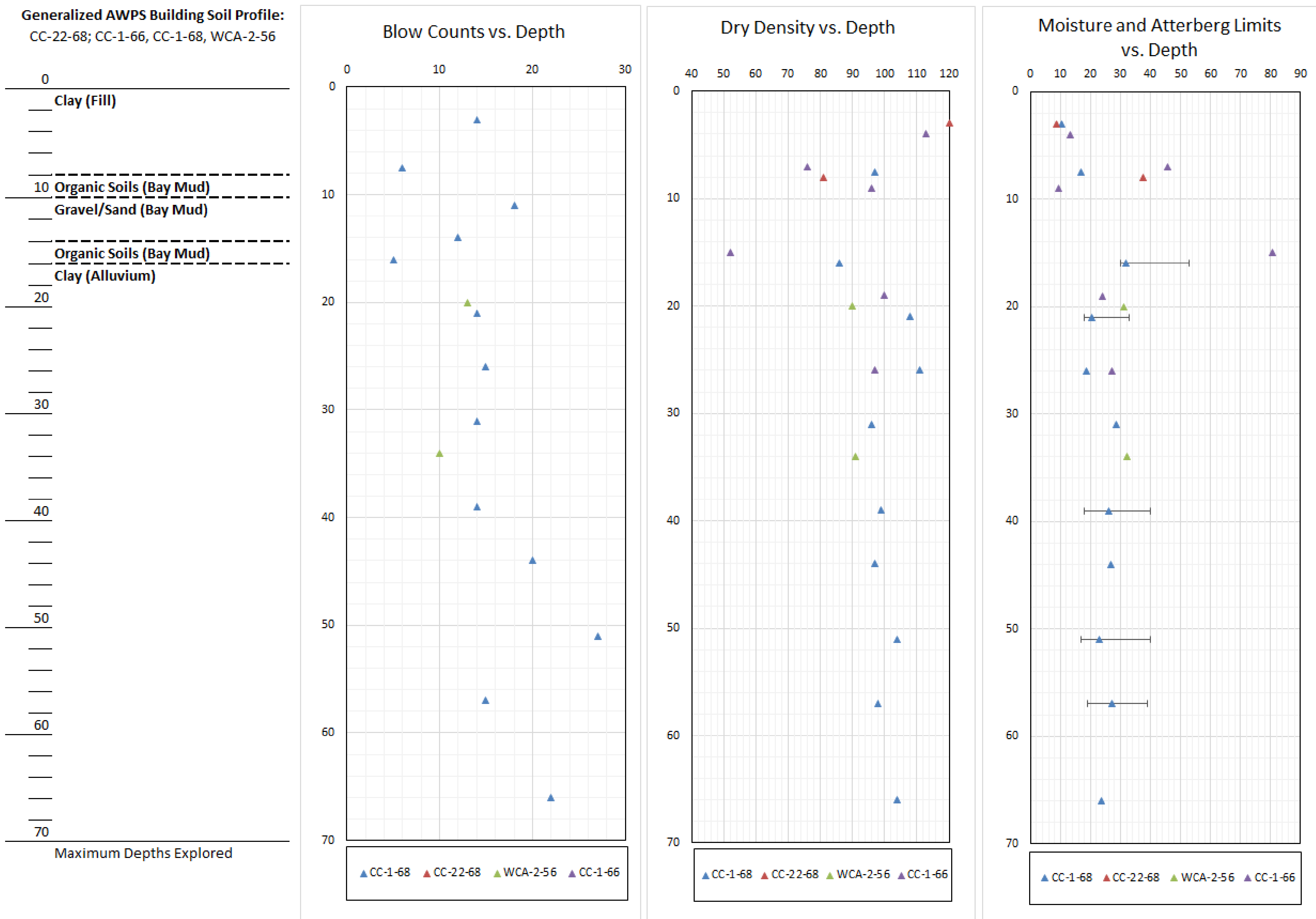
RWQCP FACILITY LABORATORY DATA

171410	SEPTEMBER 2017	FI□□□E 8



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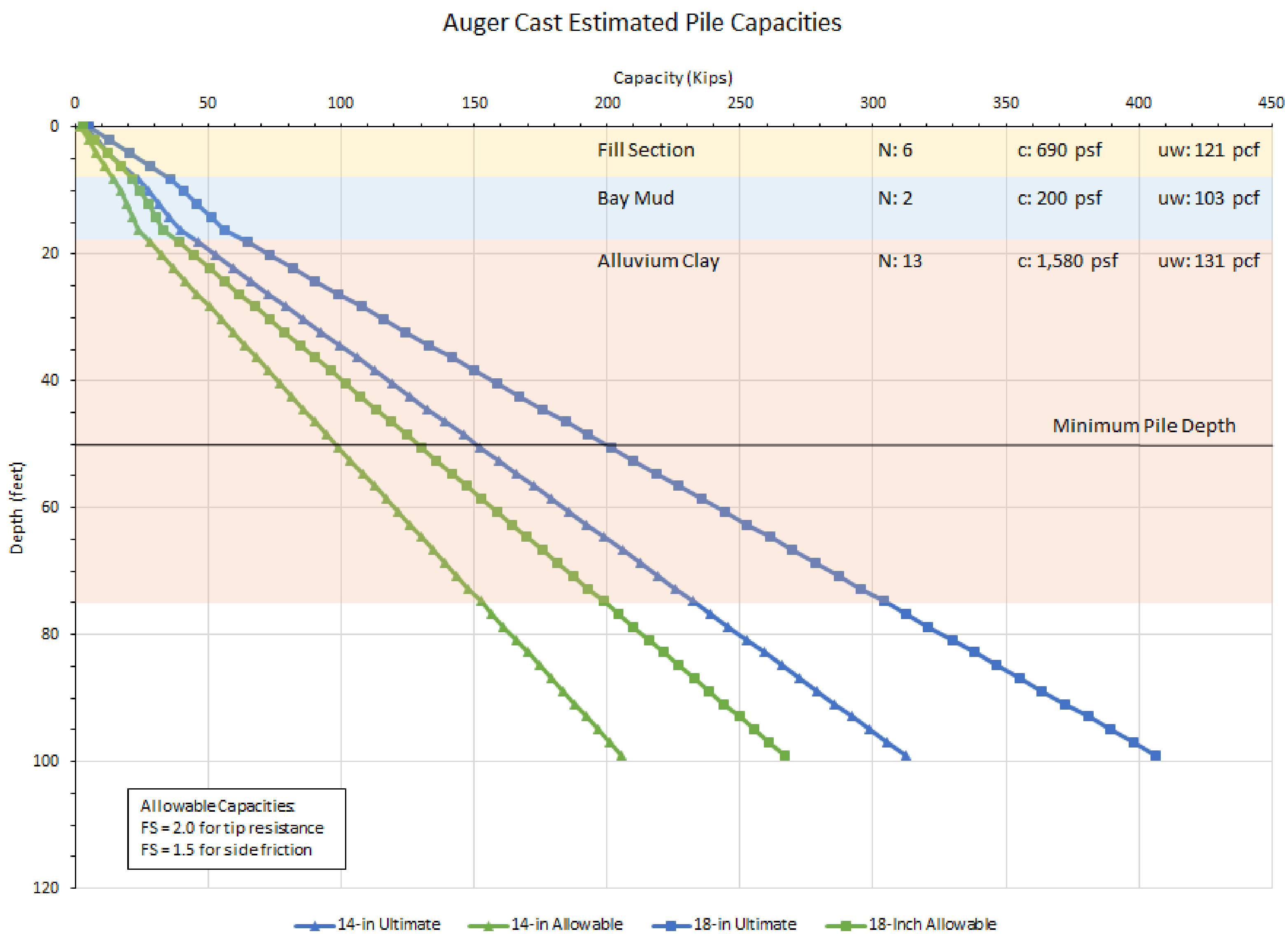
AWPS SITE LABORATORY DATA

171410	SEPTEMBER 2017	FIGURE 9



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AUGER CAST ESTIMATED PILE CAPACITIES

171410	SEPTEMBER 2017	FIGURE 10

APPENDIX A

Available Relevant Historic Boring Logs

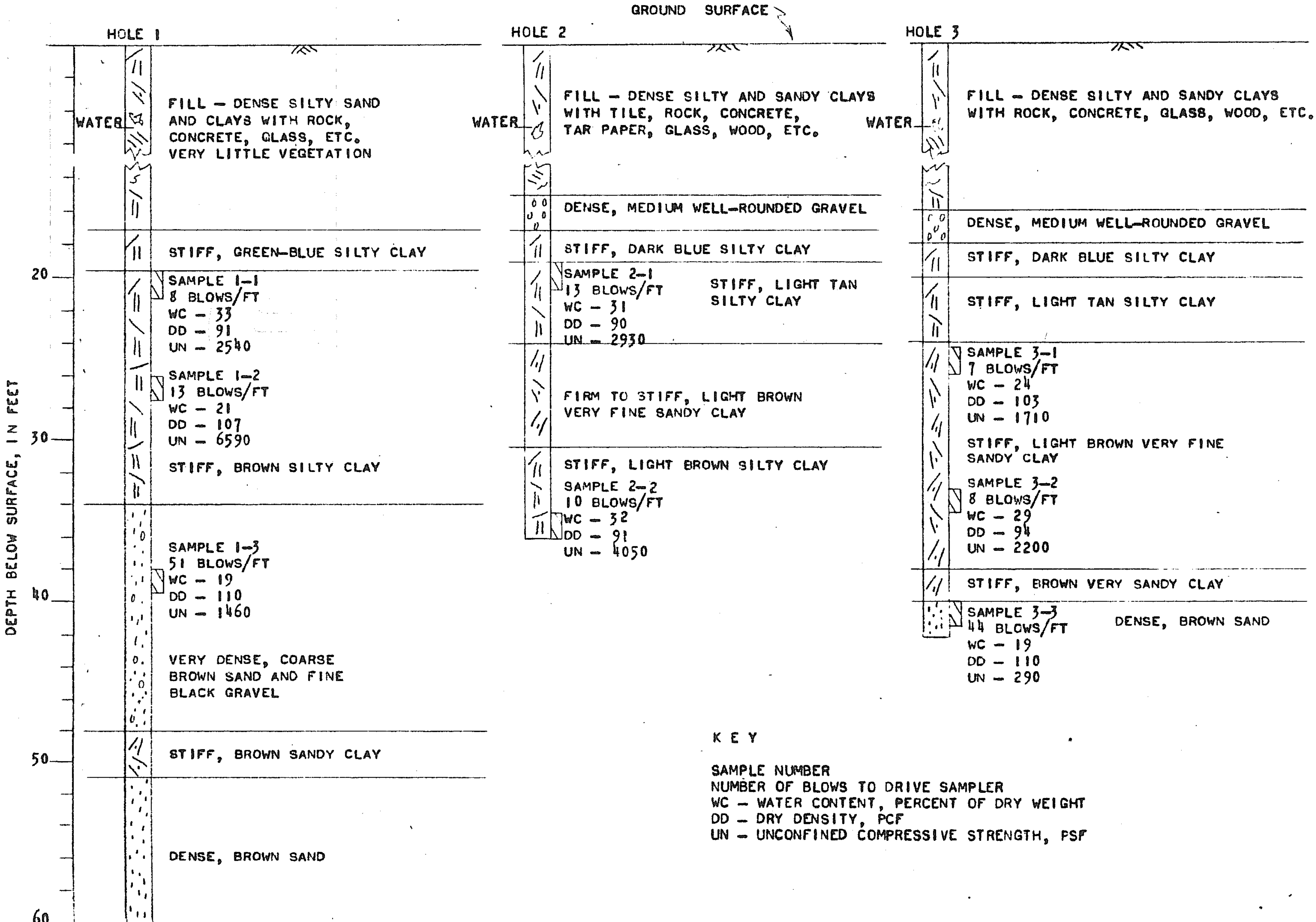
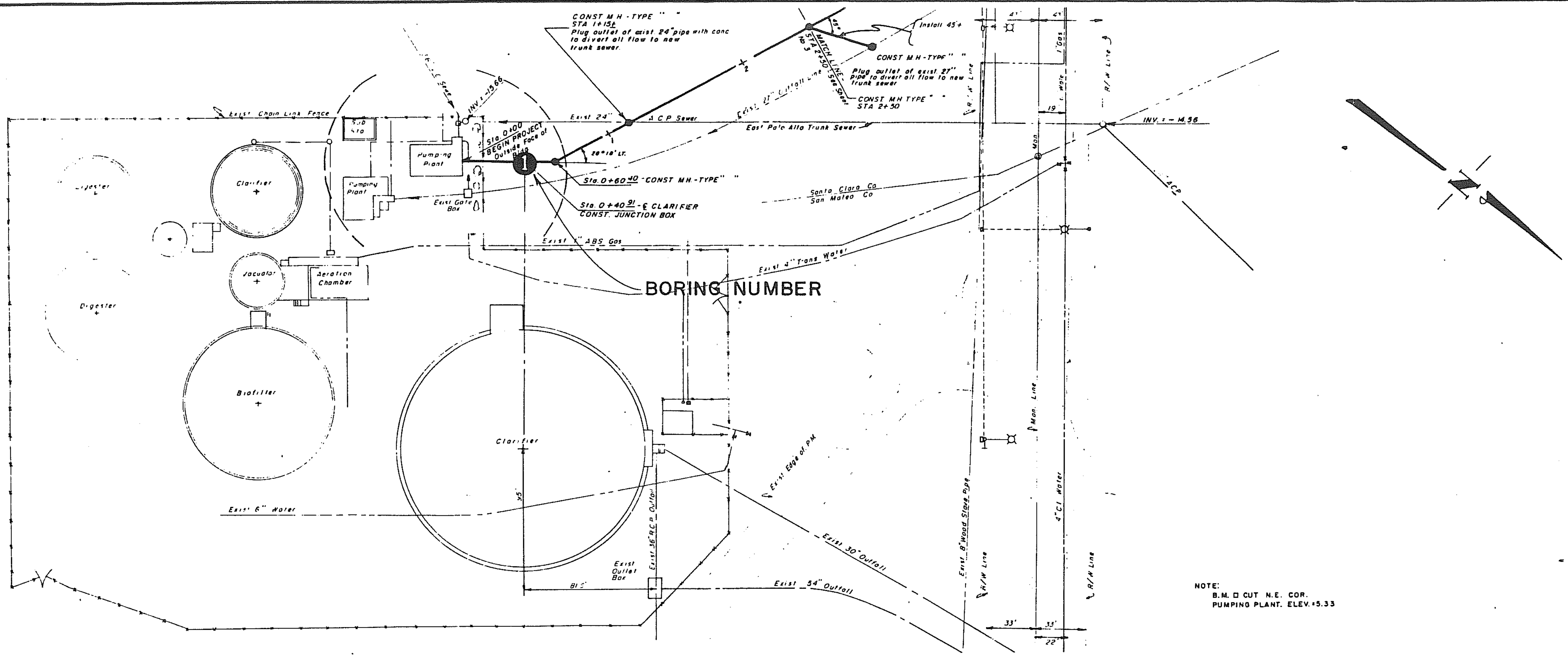


FIG. 2 — LOGS OF BORINGS

CC - 1966



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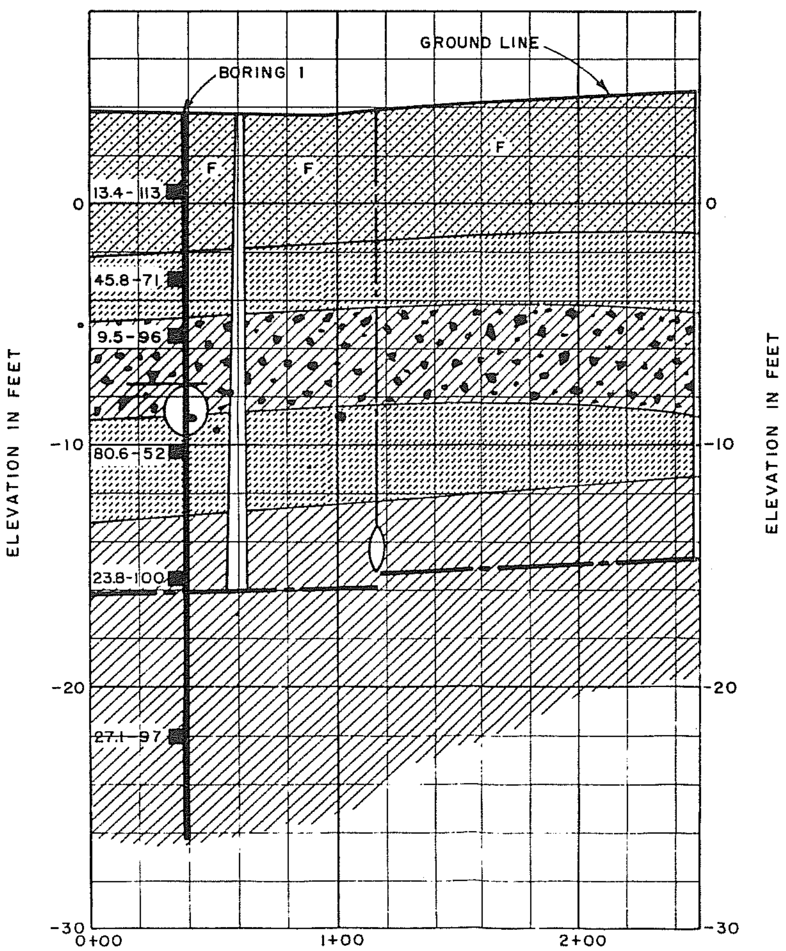


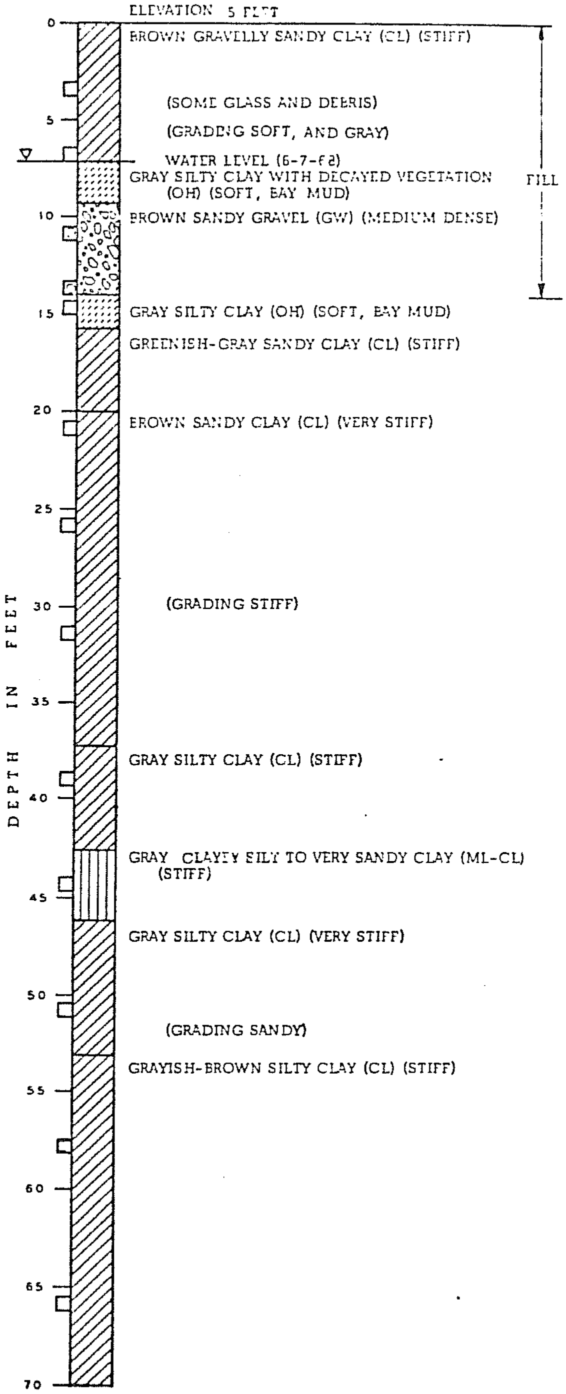
CITY OF PALO ALTO, CALIFORNIA • CHANNING TRUNK SEWER • PROJECT 65-5	
SUBSURFACE SECTION STATIONS 0+00 THROUGH 2+50	COOPER · CLARK & ASSOCIATES FOUNDATION ENGINEERS & ENGINEERING GEOLOGISTS
SEWAGE TREATMENT PLANT	
SCALE: HORIZ: 1" = 80' VERT: 1" = 8'	

CC- 1968

CLASSIFICATION DATA			STRENGTH DATA				MOISTURE-DENSITY DATA		
% FINES (-NO 200)	LIQUID LIMIT	PLASTICITY INDEX	TYPE OF STRENGTH TEST	TEST SURCHARGE PRESSURE, LBS/SQ FT	TEST MOISTURE CONTENT, %	SHEAR STRENGTH, LBS/SQ FT	NATURAL MOISTURE CONTENT, %	DRY DENSITY, LBS/CU FT	BLOWS/FOOT
			DS	375	NATURAL	1550	10.6	135	14
							16.9	97	6
									18
									12
	53	23	DS	1200	NATURAL	400	31.8	86	5
	33	15	DS	1600	NATURAL	2050	20.5	108	•14
			DS	1900	NATURAL	2100	18.7	111	15
			DS	2260	NATURAL	1250	28.6	96	14
	40	22	DS	2600	NATURAL	1900	26.0	99	14
53			DS	3000	NATURAL	2650	26.7	97	20
			DS	4000	NATURAL	3300			
	40	23	DS	3400	NATURAL	3650	23.0	104	27
	39	20	DS	3800	NATURAL	1600	27.1	98	15
			DS	4300	NATURAL	1500	23.6	104	22

BORING 1

ELEVATION 5 FEET



FIELD NOTES

1. THE BORINGS WERE DRILLED ON JUNE 7 THROUGH 13, 1968. BORINGS 1, 3 THROUGH 6, AND 8 WERE DRILLED WITH TRUCK-MOUNTED 5-INCH-DIAMETER, ROTARY WASH EQUIPMENT. THE REMAINDER OF THE BORINGS WERE DRILLED WITH A TRUCK-MOUNTED, POWER-DRIVEN 12-INCH-DIAMETER, SCREW-TYPE AUGER.
2. UNDISTURBED SAMPLES, THE LOCATION OF WHICH ARE SHOWN BY THE FOLLOWING SYMBOL □, WERE TAKEN IN A 2½-INCH-DIAMETER, SPLIT-TUBE BARREL WHICH WAS DRIVEN INTO THE SOIL BY 265-POUND SLIP JARS FALLING APPROXIMATELY 18-INCHES IN THE ROTARY WASH BORINGS. THE NUMBER OF BLOWS PER FOOT REQUIRED TO DRIVE THE SAMPLER INTO THE SOIL IS INDICATED ON THE LOGS NEXT TO THE CORRESPONDING SAMPLE SYMBOLS. THE SPLIT-TUBE BARREL WAS PUSHED INTO THE SOIL BY HYDRAULIC PRESSURE IN THE AUGER BORINGS.
THE SYMBOL ⊡, INDICATES BULK SAMPLE LOCATIONS. THE SYMBOL ⊡, INDICATES DEPTHS OF SAMPLING ATTEMPT WITH NO RECOVERY.
3. THE ELEVATIONS OF THE BORINGS WERE FURNISHED US BY THE CITY OF PALO ALTO (REFERENCE = U.S.C. & GS DATUM).

LABORATORY NOTES AND ABBREVIATIONS

THE TABULATED SHEAR STRENGTHS ARE MAXIMUM VALUES.

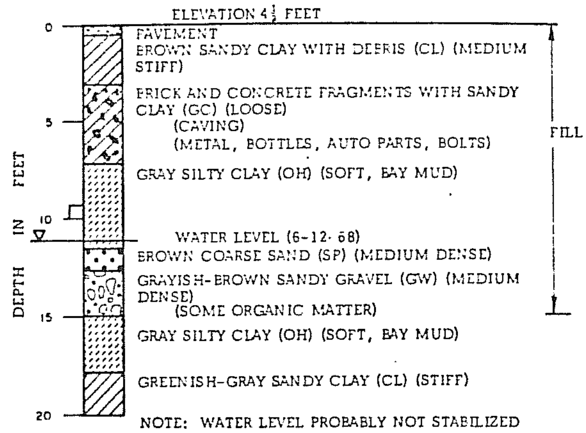
DS = STRAIN CONTROLLED DIRECT SHEAR TEST AT NATURAL MOISTURE CONTENT.

BORING LOG

COOPER · CLARK & ASSOCIATES
FOUNDATION ENGINEERS & ENGINEERING GEOLOGISTS

CLASSIFICATION DATA			STRENGTH DATA				MOISTURE-DENSITY DATA	
% FINES (-NO 200)	LIQUID LIMIT	PLASTICITY INDEX	TYPE OF STRENGTH TEST	TEST SURCHARGE PRESSURE, LBS/SQ FT	TEST MOISTURE CONTENT, %	SHEAR STRENGTH, LBS/SQ FT	NATURAL MOISTURE CONTENT, %	DRY DENSITY, LBS/CU FT
			DS	1100	NATURAL	470	81.7	53

BORING 2

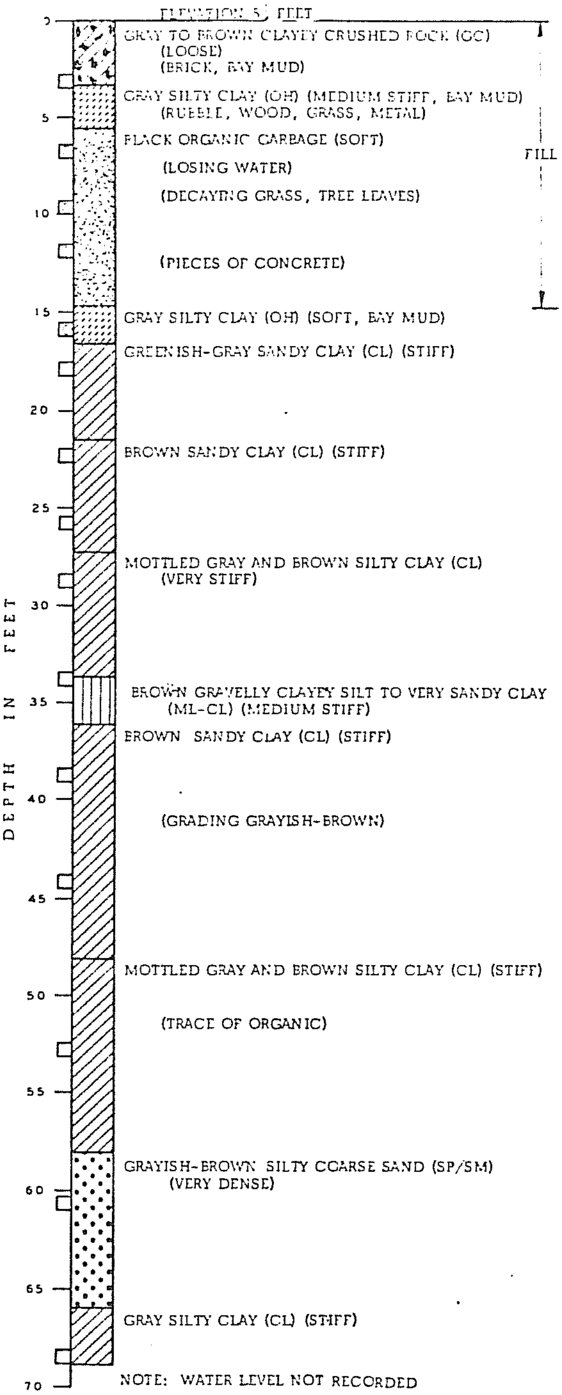


BORING LOG

CC-1968

BORING 3

CLASSIFICATION DATA			STRENGTH DATA				MOISTURE-DENSITY DATA		
% FINES (-NO 200)	LIQUID LIMIT	PLASTICITY INDEX	TYPE OF STRENGTH TEST	TEST SURCHARGE PRESSURE, LBS/SQ FT	TEST MOISTURE CONTENT, %	SHEAR STRENGTH, LBS/SQ FT	NATURAL MOISTURE CONTENT, %	DRY DENSITY, LBS/CU FT	BLOWS/FOOT
			DS	350	NATURAL	775	10.5	93	4
									3
									5
									5
									2
			DS	1400	NATURAL	1200	29.6	93	8
			DS	1700	NATURAL	1425	25.2	101	15
			DS	1900	NATURAL	1150	24.0	101	14
			DS	2100	NATURAL	2450	18.7	110	19
56			DS DS	2400 3400	NATURAL NATURAL	950 1450	23.2	103	10
			DS	2700	NATURAL	1025	26.9	95	9
			DS	3100	NATURAL	1400	24.5	101	10
			DS	3600	NATURAL	1850	24.7	100	11
8							21.2	103	32
			DS	4600	NATURAL	1600	22.0	105	24



CHECKED BY ______ DATE 7-68

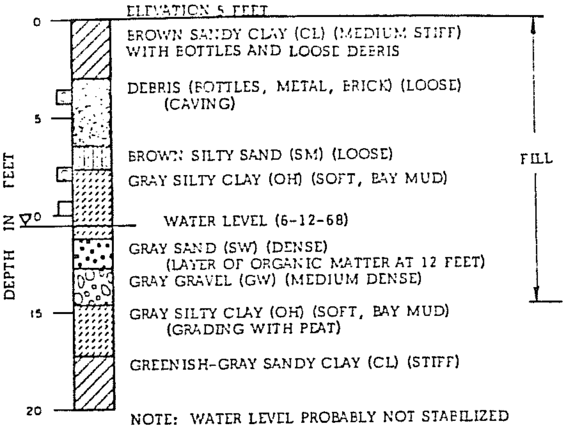
LOCATION ______

BORING LOG

COOPER · CLARK & ASSOCIATES
FOUNDATION ENGINEERS & ENGINEERING GEOLOGISTS

CLASSIFICATION DATA			STRENGTH DATA				MOISTURE-DENSITY DATA	
% FINES (-NO 200)	LIQUID LIMIT	PLASTICITY INDEX	TYPE OF STRENGTH TEST	TEST SURCHARGE PRESSURE, LBS/SQ FT	TEST MOISTURE CONTENT, %	SHEAR STRENGTH, LBS/SQ FT	NATURAL MOISTURE CONTENT, %	DRY DENSITY, LBS/CU FT
							79.7	53

BORING 7



BORING LOG

CHECKED BY K. DATE 7-68

LOCATION Palo Alto

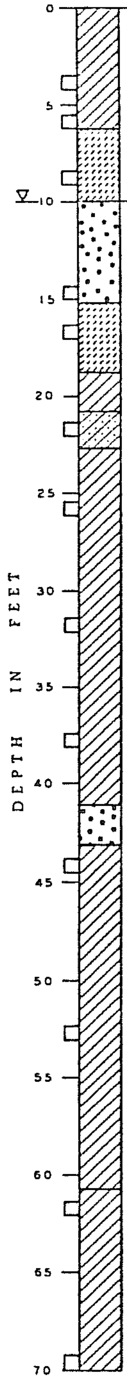
COOPER · CLARK & ASSOCIATES
FOUNDATION ENGINEERS & ENGINEERING GEOLOGISTS

CC-1968

CLASSIFICATION DATA			STRENGTH DATA				MOISTURE-DENSITY DATA		
% FINES (-NO 200)	LIQUID LIMIT	PLASTICITY INDEX	TYPE OF STRENGTH TEST	TEST SURCHARGE PRESSURE, LBS/SQ FT	TEST MOISTURE CONTENT, %	SHEAR STRENGTH, LBS/SQ FT	NATURAL MOISTURE CONTENT, %	DRY DENSITY, LBS/CU FT	BLOWS/FOOT
							16.4	95	6
							20.4	96	9
							84.0	53	0
							74.0	57	0
							7.3	113	22
							37.7	83	2
44							25.1	99	7
							29.1	96	6
							27.8	95	8
							27.6	97	11
							26.8	97	8
							23.2	101	19
							25.2	102	15
							19.3	105	20

BORING 8

ELEVATION 5± FEET



BROWN SANDY CLAY (CL) (STIFF)

(GRADING WITH ROCK AND DEBRIS)

(GRADING WITH BAY MUD)

GRAY SILTY CLAY (OH) (SOFT BAY MUD)

FILL

WATER LEVEL (6-10-68)

GRAY SAND (SW) (MEDIUM DENSE)

(GRADING WITH GRAVEL)

(CAVING)

DARK GRAY SILTY CLAY (OH) (MEDIUM STIFF, BAY MUD)

GREENISH-GRAY SANDY CLAY (CL) (STIFF)

GREENISH-BROWN VERY CLAYEY SAND (SC) (MEDIUM DENSE)

YELLOWISH-BROWN SANDY CLAY (CL) (STIFF)

GRAYISH-BROWN SAND (SW) (DENSE)

GRAYISH-BROWN SILTY CLAY (CL) (STIFF)

(GRADING VERY STIFF)

BROWN SANDY CLAY (CL) (VERY STIFF)

NOTE: WATER LEVEL PROBABLY NOT STABILIZED

BORING LOG

CHECKED BY DATE 7-11-68

LOCATION Palo Alto

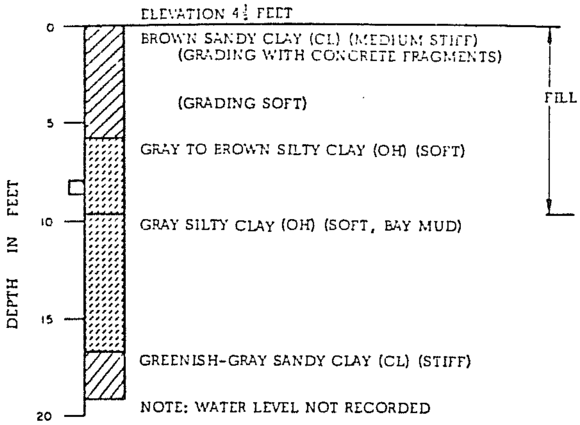
COOPER · CLARK & ASSOCIATES

FOUNDATION ENGINEERS & ENGINEERING GEOLOGISTS

CLASSIFICATION DATA			STRENGTH DATA				MOISTURE-DENSITY DATA	
% FINES (-NO 200)	LIQUID LIMIT	PLASTICITY INDEX	TYPE OF STRENGTH TEST	TEST SURCHARGE PRESSURE, LBS/SQ FT	TEST MOISTURE CONTENT, %	SHEAR STRENGTH, LBS/SQ FT	NATURAL MOISTURE CONTENT, %	DRY DENSITY, LBS/CU FT
							37.6	70

BORING 21

ELEVATION 4½ FEET



BROWN SANDY CLAY (CL) (MEDIUM STIFF)
(GRADING WITH CONCRETE FRAGMENTS)

(GRADING SOFT)

GRAY TO BROWN SILTY CLAY (OH) (SOFT)

GRAY SILTY CLAY (OH) (SOFT, BAY MUD)

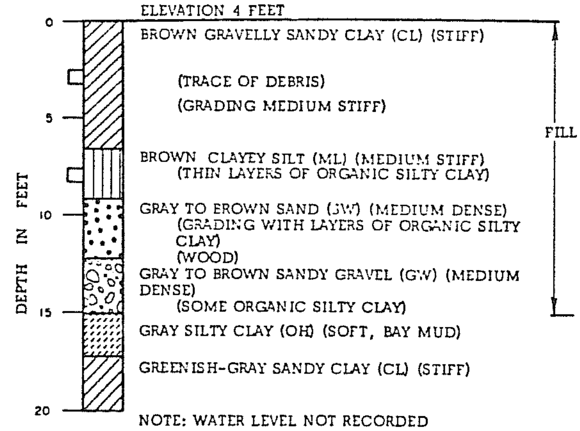
GREENISH-GRAY SANDY CLAY (CL) (STIFF)

NOTE: WATER LEVEL NOT RECORDED

CLASSIFICATION DATA			STRENGTH DATA				MOISTURE-DENSITY DATA	
% FINES (-NO 200)	LIQUID LIMIT	PLASTICITY INDEX	TYPE OF STRENGTH TEST	TEST SURCHARGE PRESSURE, LBS/SQ FT	TEST MOISTURE CONTENT, %	SHEAR STRENGTH, LBS/SQ FT	NATURAL MOISTURE CONTENT, %	DRY DENSITY, LBS/CU FT
							8.5	120
92							37.6	81

BORING 22

ELEVATION 4 FEET



BROWN GRAVELLY SANDY CLAY (CL) (STIFF)

(TRACE OF DEBRIS)
(GRADING MEDIUM STIFF)

BROWN CLAYEY SILT (ML) (MEDIUM STIFF)
(THIN LAYERS OF ORGANIC SILTY CLAY)

GRAY TO BROWN SAND (SW) (MEDIUM DENSE)
(GRADING WITH LAYERS OF ORGANIC SILTY CLAY)
(WOOD)

GRAY TO BROWN SANDY GRAVEL (GW) (MEDIUM DENSE)
(SOME ORGANIC SILTY CLAY)

GRAY SILTY CLAY (OH) (SOFT, BAY MUD)

GREENISH-GRAY SANDY CLAY (CL) (STIFF)

NOTE: WATER LEVEL NOT RECORDED

BORING LOGS

COOPER · CLARK & ASSOCIATES

CHECKED BY K-. DATE ...-68

LOCATION ...

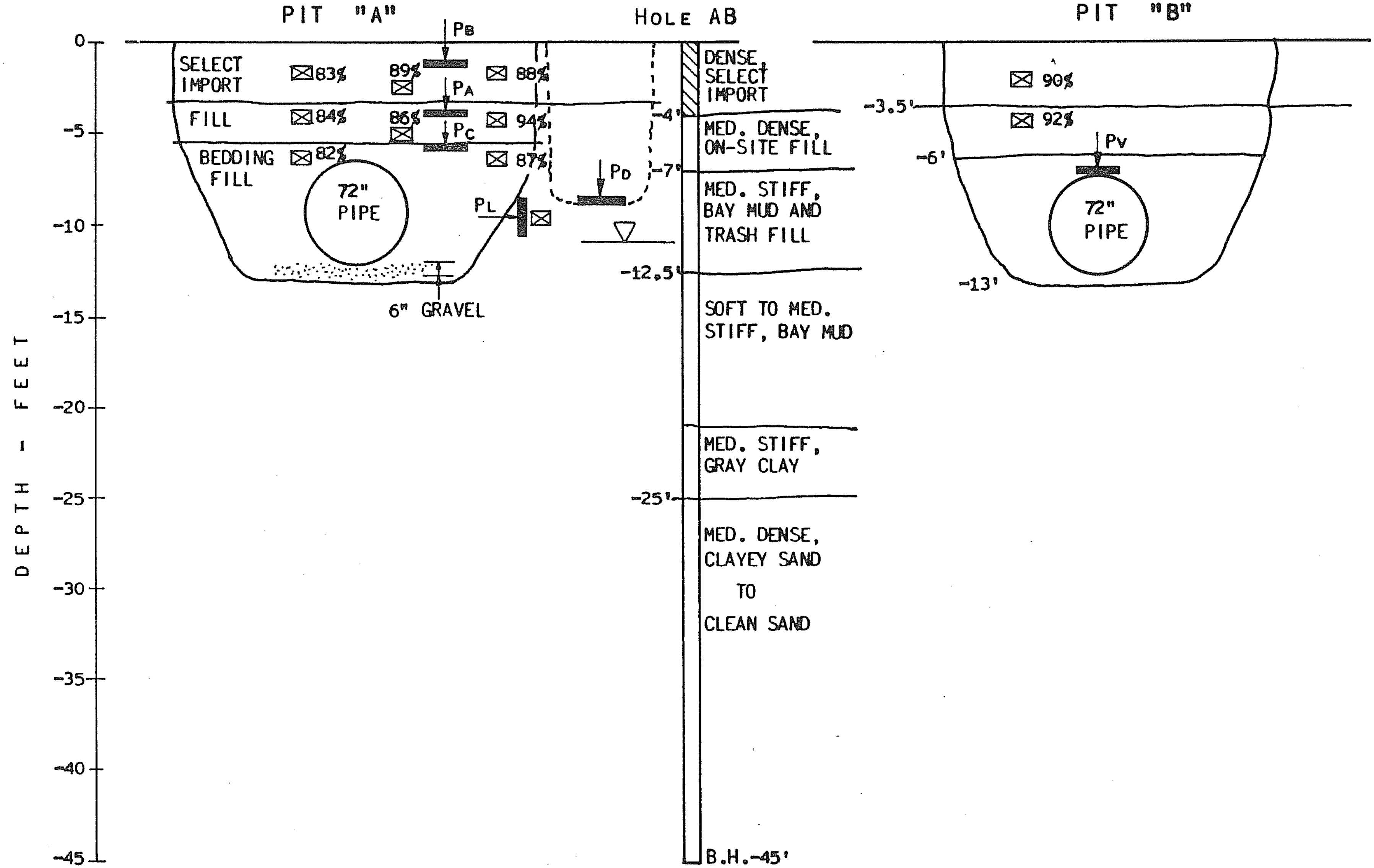


FIGURE 2 - IDEALIZED CROSS SECTION - PITS "A" & "B"

SKETCH - NOT TO SCALE

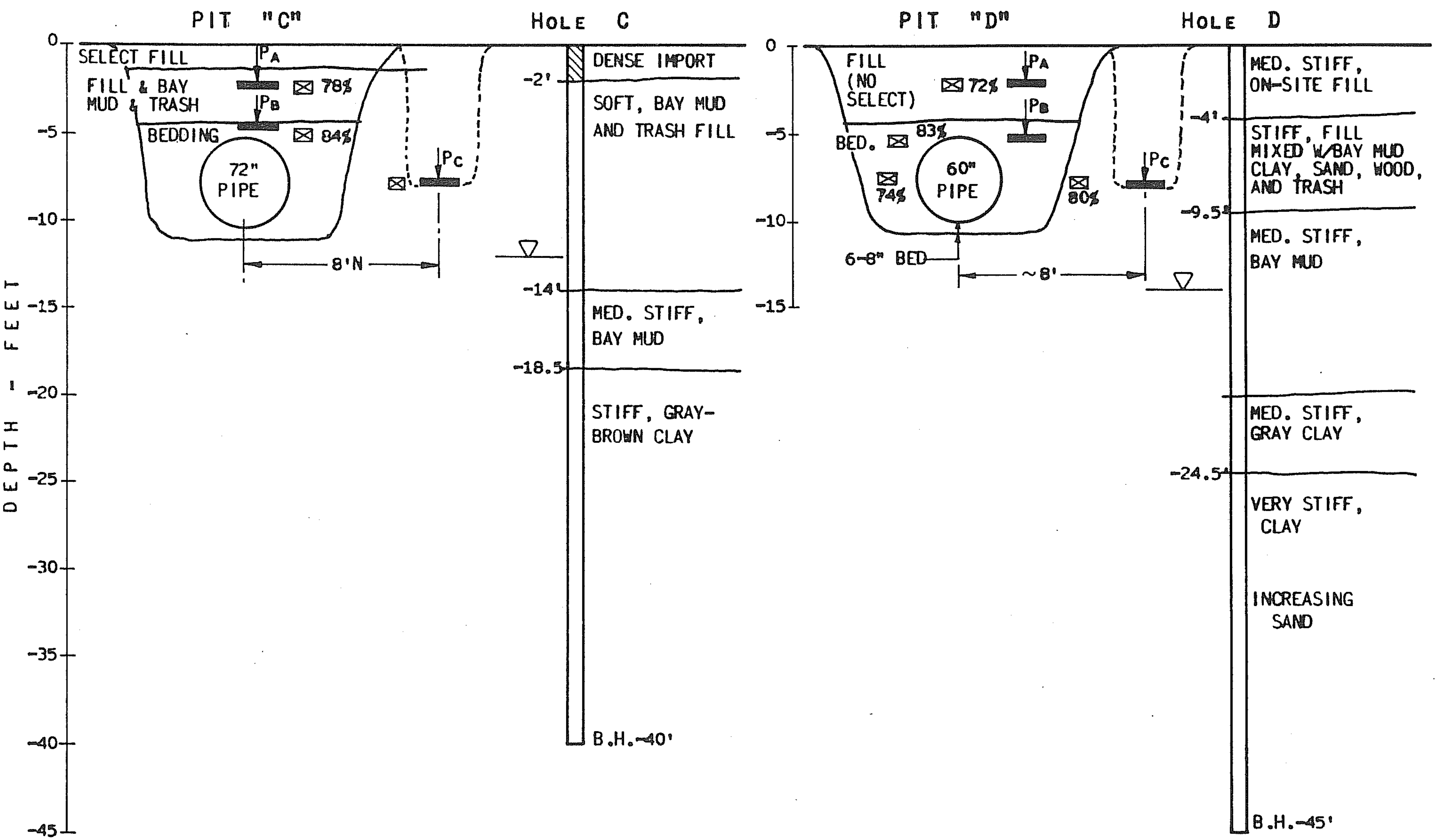


FIGURE 3 - IDEALIZED CROSS SECTION - PITS "C" & "D"

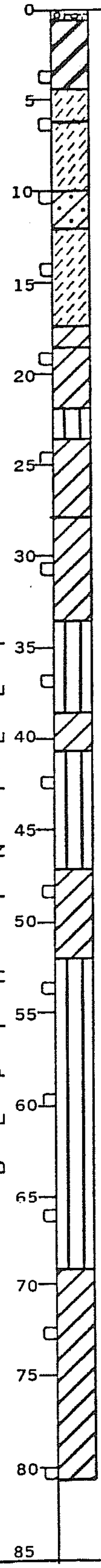
SKETCH - NOT TO SCALE

BORING 3

CLASSIFICATION DATA			STRENGTH DATA				MOISTURE-DENSITY DATA		
% FINES (-NO. 200)	LIQUID LIMIT	PLASTICITY INDEX	TYPE OF STRENGTH TEST	TEST SURCHARGE PRESSURE, LBS/SQ FT	TEST MOISTURE CONTENT, %	SHEAR STRENGTH, LBS/SQ FT	NATURAL MOISTURE CONTENT, %	DRY DENSITY, LBS/CU FT	BLOWS/FOOT
			DS	400	Natural	420	33.5	81	5
			DS	600	Natural	280	77.8	53	2
							53.0	67	
			DS	900	Natural	1050	26.1	96	
			DS	1100	Natural	1550	20.2	106	13
			DS	1400	Natural	1750	22.0	103	20
			DS	1700	Natural	400	25.2	98	11
			DS	2100	Natural	500	25.4	100	11
			DS	2500	Natural	2000	21.1	107	30
			DS	2800	Natural	1000	31.4	90	10
			DS	3000	Natural	1850	19.7	110	18
									9
			DS	3000	Natural	1000	27.7	95	10
			DS	3000	Natural	1900	29.9	93	38
									30

ELEVATION 4.1 FEET

DEPTH IN FEET



- 0 — Asphaltic concrete on rock base
- Dark brown silty clay (CH) with some gravel (moderately firm) — FILL
- Brown organic silty clay (OH) — FILL
- Gray organic silty clay (OH) (soft bay mud)
- 10 — Gray clayey sand (SC) with gravel
- Gray organic silty clay (OH) (bay mud) (grading firm)
- Greenish-gray sandy clay (CL) (firm)
- Brown silty clay (CL) (stiff)
- Brown clayey silt (ML) (firm)
- Grayish-brown silty clay (CL) (stiff)
- Grayish-brown sandy clay (CL) (moderately firm)
- Grayish-brown clayey silt (ML) (moderately firm)
- Grayish-brown silty clay (CL) (stiff)
- Grayish-brown sandy silt (ML) (dense)
- Grayish-brown silty clay (CL) (stiff)
- Grayish-brown clayey silt (ML) (stiff) (grading firm)
- Gray silty clay (CL) (stiff)

Revisions: By____ Date____ By____ Date____ Location Palo Alto, California

By BSK Date 1/20/75
Checked By [illegible] Name S.C. Valley Water District
Job Number 896-A8

BORING LOG

COOPER · CLARK & ASSOCIATES
FOUNDATION ENGINEERS & ENGINEERING GEOLOGISTS

CH2MHILL

PROJECT NUMBER	BORING NUMBER	
135921.C1.23.SF	NB-1	SHEET 1 OF 3

SOIL BORING LOG

PROJECT : Palo Alto RWQCP Incinerator Rehabilitation LOCATION : Palo Alto RWQCP, East Corner of Solids Incineration Bldg.
ELEVATION : Approx. 7.2 ft. (MSL), 1967 Survey DRILLING CONTRACTOR : Pitcher Drilling Co., Palo Alto, CA
DRILLING METHOD AND EQUIPMENT USED : Truck mounted Failing 1500 rotary wash rig with 4-7/8" diam. bit (Auger used for first 5 ft.)
WATER LEVELS : Approx. 5 ft. bgs (6/24/98) START : 6/24/98, 8:30am END : 6/24/98, 2:00pm LOGGER : D. Ritzman

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
	0.0 - 3.0	GRAB	R-1		Sandy Lean Clay with gravel, (CL), brown, moist, loose, with small pieces of gravel and chunks of concrete debris, (fill)	
5	5.0 - 6.5	0.5	S-2	2 - 2 - 1 (3)	Poorly Graded Sand and Gravel, (SP-GP), brown, wet, loose, with debris, concrete fragments, and gravel (fill)	Driller notes water at 5 ft. Begin rotary wash methods
						Driller notes glass, brick, and concrete fragments in cuttings
10	10.0 - 11.5	0.1	S-3	2 - 1 - 2 (3)	Fat Clay, (CH), grey, wet, soft, (Young Bay Mud, fill)	
	12.0 - 14.5	2.5	ST-4	PUSH	Fat Clay, (CH), grey, wet, soft, (Young Bay Mud)	PP < 0.25 tsf
						Driler notes sandy, gravelly cuttings at approx. 14.5 ft.
15	15.0 - 16.5	1.0	S-5	2 - 1 - 2 (3)	Top 1": Poorly Graded Sand, (SP), grey, wet, loose, gap graded with large and smaller particles Bottom 11": Fat Clay, (CH), grey, moist, soft to firm, trace of organics, strong sulfur odor	PP < 0.25 tsf TV = 0.25 tsf
20	20.0 - 21.5	1.5	S-6	7 - 10 - 13 (23)	Top 9": Sandy Fat Clay, (CH), grey, moist, very stiff Bottom 9": Sandy Lean Clay, (CL), grey, moist, very stiff, very sandy, sulfur odor	PP = 2.75, 2.75, 2.75 tsf
25	25.0 - 26.5	1.0	S-7	6 - 7 - 10 (17)	Sandy Lean Clay, (CL), greyish green mottled orange-brown, moist, stiff, with calcium carbonate precipitate	PP = 2.0, 1.5, 1.75 tsf
30						

CH2MHILL

PROJECT NUMBER	BORING NUMBER	
135921.C1.23.SF	NB-1	SHEET 2 OF 3

SOIL BORING LOG

PROJECT : Palo Alto RWQCP Incinerator Rehabilitation LOCATION : Palo Alto RWQCP, East Corner of Solids Incineration Bldg.

ELEVATION : Approx. 7.2 ft. (MSL), 1967 Survey DRILLING CONTRACTOR : Pitcher Drilling Co., Palo Alto, CA

DRILLING METHOD AND EQUIPMENT USED : Truck mounted Failing 1500 rotary wash rig with 4-7/8" diam. bit (Auger used for first 5 ft.)

WATER LEVELS : Approx. 5 ft. bgs (6/24/98) START : 6/24/98, 8:30am END : 6/24/98, 2:00pm LOGGER : D. Ritzman

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
	30.0 31.5	1.0	S-8	5 - 6 - 8 (14)	Sandy Lean Clay, (CL), greyish green mottled orange-brown, moist, stiff to very stiff, calcium precipitate	PP = 1.5, 2.0, 2.5 tsf
35	35.0 37.5	2.5	ST-9	PUSH	Lean Clay, (CL), brown, moist, firm to stiff, with some grey streaks	PP = 1.5, 1.25, 0.75 tsf
40	40.0 41.5	1.5	S-10	4 - 6 - 7 (13)	Lean Clay, (CL), similar to above	PP = 0.75, 1.0, 1.25 tsf
45	45.0 47.5	2.1	ST-11	PUSH	Sandy Lean Clay, (CL), brownish grey, moist, stiff	PP = 1.0, 1.25, 1.25 tsf
50	50.0 51.5	1.2	S-12	2 - 2 - 3 (5)	Sandy Lean Clay, (CL), brownish grey, moist, soft, with calcium precipitate and trace organics	PP = 0.25, 0.25, < 0.25 tsf Driller notes stiff clay at approx. 53.5 ft.
55	55.0 57.5	2.5	ST-13	PUSH	Lean Clay, (CL), brownish grey, moist, stiff to very stiff	PP = 1.5, 2.25, 1.75 tsf
60						

CH2MHILL

PROJECT NUMBER	BORING NUMBER	
135921.C1.23.SF	NB-1	SHEET 3 OF 3

SOIL BORING LOG

PROJECT : Palo Alto RWQCP Incinerator Rehabilitation LOCATION : Palo Alto RWQCP, East Corner of Solids Incineration Bldg.
ELEVATION : Approx. 7.2 ft. (MSL), 1967 Survey DRILLING CONTRACTOR : Pitcher Drilling Co., Palo Alto, CA
DRILLING METHOD AND EQUIPMENT USED : Truck mounted Failing 1500 rotary wash rig with 4-7/8" diam. bit (Auger used for first 5 ft.)
WATER LEVELS : Approx. 5 ft. bgs (6/24/98) START : 6/24/98, 8:30am END : 6/24/98, 2:00pm LOGGER : D. Ritzman

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
	60.0 - 61.5	1.5	S-14	10 - 10 - 9 (19)	Sandy Lean Clay, (CL), brownish grey, moist, stiff to very stiff, with some large sand particles, more sandy towards bottom of sample	PP = 1.75, 2.0, 3.75 tsf
65	65.0 - 67.5	2.5	ST-15	PUSH	Sandy Lean Clay, (CL), brownish grey with some brown-orange mottling, moist, stiff to very stiff, with some sand particles	PP = 2.0, 2.0, 2.0 tsf
70	70.0 - 71.5	1.5	S-16	6 - 10 - 13 (23)	Top half: Sandy Lean Clay, (CL), brownish grey with some tan and grey mottling, moist, stiff, more silty than above Bottom half: Silty Sand, (SM), brownish grey, wet, fine sand particles, some clay	PP (top half) = 1.0, 1.25, 1.5 tsf
75	75.0 - 77.5	2.1	ST-17	PUSH	Fat Clay, (CH), grey with orange-brown mottling, moist, stiff, more plastic than brownish grey clay above	PP = 1.75, 1,75, 2.0 tsf
					Bottom of Boring at 77.5 ft. bgs 6/24/98, 2:00 pm	
80						
85						
90						

CH2MHILL

PROJECT NUMBER	BORING NUMBER	
135921.C1.23.SF	NB-2	SHEET 1 OF 3

SOIL BORING LOG

PROJECT : Palo Alto RWQCP Incinerator Rehabilitation LOCATION : Palo Alto RWQCP, West Corner of Solids Incineration Bldg.

ELEVATION : Approx. 4.5 ft. (MSL), 1967 Survey DRILLING CONTRACTOR : Pitcher Drilling Co., Palo Alto, CA

DRILLING METHOD AND EQUIPMENT USED : Truck mounted Failing 1500 rotary wash rig with 4-7/8" diam. bit (Auger used for first 9 ft.)

WATER LEVELS : Approx. 4 ft. bgs (6/25/98) START : 6/25/98, 8:00am END : 6/25/98, 2:00pm LOGGER : D. Ritzman

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
					2 inches a/c pavement	
					Sand and gravel fill in cuttings (brown)	Sandy Gravel fill, large angular gravel
					Changing to gravel (grey)	Driller notes water at approx. 4 ft. bgs
5						Driller adds bentonite to hole
	7.0 - 8.0		G-1	GRAB	Well Graded Gravel with Sand, (GW), wet, angular gravel particles (fill)	
						Driller notes mud in cuttings (Soft Young Bay Mud) Begin rotary wash methods at 9 ft.
10	10.0 - 11.5	1.5	S-2	0 - 6 - 9 (15)	Top 12": Fat Clay, (CH), grey, wet, soft, sulfur odor, (Young Bay Mud), trace of organics, with a silty sand seam 6" from top of sample Bottom 6": Well Graded Sand, (SW), grey, wet, medium dense, with some fines	PP < 0.25 tsf TV = 0.2 tsf
						Driller notes sand and gravel to 15 feet
15	15.0 - 16.5	1.5	S-3	1 - 1 - 1 (2)	Fat Clay, (CH), grey, wet, very soft, sulfur odor, (Young Bay Mud)	Rock stuck in sampler shoe causes 1/2 recovery for length of 1.5 ft. PP < 0.25 tsf
						Driller notes stiffer green-grey clay at 17.5 ft.
20	20.0 - 22.5	2.2	ST-4	PUSH	(Bay Mud similar to above in top of tube) Sandy Lean Clay, (CL), brown with some grey mottling, moist, stiff, some tan calcium carbonate precipitate	PP = 1.5, 1.75, 1.75 tsf
25	25.0 - 26.5	1.5	S-5	2 - 2 - 3 (5)	Sandy Lean Clay, (CL), brown, moist, soft, with some tan calcium precipitate, more sandy towards bottom of sample	PP < 0.25 tsf TV = 0.2 tsf
						Driller notes stiffer material at approx. 26.5 ft.
30						

CH2MHILL

PROJECT NUMBER	BORING NUMBER	
135921.C1.23.SF	NB-2	SHEET 2 OF 3

SOIL BORING LOG

PROJECT : Palo Alto RWQCP Incinerator Rehabilitation LOCATION : Palo Alto RWQCP, West Corner of Solids Incineration Bldg.

ELEVATION : Approx. 4.5 ft. (MSL), 1967 Survey DRILLING CONTRACTOR : Pitcher Drilling Co.

DRILLING METHOD AND EQUIPMENT USED : Truck mounted Failing 1500 rotary wash rig with 4-7/8" diam. bit (Auger used for first 9 ft.)

WATER LEVELS : Approx. 4 ft. bgs (6/25/98) START : 6/25/98, 8:00am END : 6/25/98, 2:00pm LOGGER : D. Ritzman

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
	30.0 - 32.5	2.1	ST-6	PUSH	Fat Clay with Sand, (CH), brown, wet, soft, with large chunks of calcium precipitate about 1/2" to 3/4" diameter, more sandy than above	PP = 0.25, 0.5 tsf
35	35.0 - 36.5	1.5	S-7	2 - 2 - 3 (5)	Sandy Lean Clay, (CL), brown with grey mottling, moist, very soft to soft, with calcium precipitate (smaller than above), not as sandy as above	PP = 0.25, 0.5, < 0.25 tsf Driller notes stiffer clay at approx. 37.5 ft.
40	40.0 - 42.5	2.5	ST-8	PUSH	Poorly Graded Sand with Clay, (SP-SC), brownish grey, moist, fine sand particles, slightly cohesive	
45	45.0 - 46.5	1.5	S-9	3 - 4 - 6 (10)	Sandy Lean Clay, (CL), brownish grey, moist to wet, soft to firm, with some large sand particles (approx. 1/4" diam.), more sandy towards bottom of sample, some calcium precipitate	PP = 0.75, < 0.25, 0.5 tsf
50	50.0 - 52.5	2.0	ST-10	PUSH	Fat Clay, (CH), brownish grey, moist, stiff to very stiff, medium plasticity	PP = 2.5, 1.75, 2.5 tsf Driller notes very stiff material at approx. 53 ft.
55	55.0 - 56.5		S-11	7 - 9 - 13 (22)	Fat Clay, (CH), grey, moist, stiff to very stiff, medium plasticity, some calcium precipitate	PP = 1.75, 2.5, 3.0 tsf
60						

PROJECT NUMBER	BORING NUMBER	
135921.C1.23.SF	NB-2	SHEET 3 OF 3

CH2MHILL

SOIL BORING LOG

PROJECT : Palo Alto RWQCP Incinerator Rehabilitation LOCATION : Palo Alto RWQCP, West Corner of Solids Incineration Bldg.

ELEVATION : Approx. 4.5 ft. (MSL), 1967 Survey DRILLING CONTRACTOR : Pitcher Drilling Co., Palo Alto, CA

DRILLING METHOD AND EQUIPMENT USED : Truck mounted Failing 1500 rotary wash rig with 4-7/8" diam. bit (Auger used for first 9 ft.)

WATER LEVELS : Approx. 4 ft. bgs (6/25/98) START : 6/25/98, 8:00am END : 6/25/98, 2:00pm LOGGER : D. Ritzman

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
	60.0–62.5	2.5	ST-12	PUSH	Lean Clay, (CL), brownish grey with some orange-brown mottling, moist, stiff	Tube pushed at approx. 200 psf. PP = 1.25, 1.5, 1.5 tsf
65	65.0–66.5	1.2	S-13	5 - 6 - 7 (13)	Lean Clay, (CL), similar to above, firm to stiff	PP = 0.75, 0.75, 0.75 tsf
70	70.0–72.5	2.5	ST-14	PUSH	Sandy Fat Clay, (CH), grey mottled orange-brown, dry to moist, stiff, medium plasticity	PP = 1.5, 1.25, 1.25 tsf
75	75.0–76.5	1.5	S-15	8 - 10 - 13 (23)	Fat Clay, (CH), similar to above, grey mottled orange-brown, dry to moist, stiff to very stiff, medium plasticity	PP = 2.75, 1.75, 1.75 tsf Driller notes sand at approx. 78 ft.
80	80.0–81.5	1.5	S-16	7 - 9 - 12 (21)	Fat Clay, (CH), similar to above, grey mottled orange-brown, moist, stiff to very stiff a few shell fragments, medium plasticity	PP = 1.0 (top), 2.75 (middle 6"), and 1.5 (bottom) tsf
85	85.0–86.5	1.2	S-17	9 - 20 - 38 (>50)	Top 8": Fat Clay, (CH), similar to above, but with fewer orange-brown streaks, moist, stiff Bottom 6": Poorly Graded Sand, (SP), grey with orange-brown streaks, very dense, some fines	PP (top) = 1.0 tsf Driller notes large blow count may be due to full sampler and drilling fluid in rod (rod full)
					Bottom of Boring at 86.5 ft. bgs 6/25/98, 2:00 pm	
90						

PROJECT NUMBER	BORING NUMBER:
658394.01.08.01.10	CH2M15-01 SHEET 1 OF 2

SOIL BORING LOG

PROJECT : RWQCP - Sludge Dewatering & Loadout Facility, Palo Alto   LOCATION : Lat: 37.452610 deg N; Long: 122.110826 deg W

ELEVATION : 5.0 ft. (MSL) (Approximate)   DRILLING CONTRACTOR : Cascade Drilling LP

DRILLING EQUIPMENT AND METHOD : CME 75 Truck Mounted, 8" HSA to 13' bgs; 4" Mud Rotary thereafter; 140-lb/30-in drop Auto-Hammer

WATER LEVELS : 9.33 ft. bgs after stabilizing   START: 10/13/2015 8:40:00 AM   END: 10/13/2015 2:00:00 PM   LOGGER : R. Bethapudi

DEPTH BELOW EXISTING GRADE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	0.0 1.5	0.5	SS-1	47-26-10 (36)	**SILTY SAND with GRAVEL (SM) - FILL** Light gray, dry, dense, mostly fine to coarse sand, few non-plastic fines, some angular gravel - with dark olive clay		* Drilling using hand auger to 5' bgs after collecting SS-1
5	5.0 6.5	1.5	SS-2	5-8-9 (17)	**SANDY CLAY (CH/CL) - FILL** Dark olive with occasional blue gray mottling, dry to moist, very stiff, mostly medium to high plasticity fines, some sand, trace gravel		
	7.5 9.0	1.5	SS-3	2-2-2 (4)	- becomes moist, soft, with high plasticity fines, no gravel		CR (conducted on sample combined from SS-2 & SS-3) w_n = 22.5%
10	10.0 12.5	1.5	ST-4	push	**PEAT - FILL** Black, moist, mostly high plasticity fines with organic odor, trace debris (roots, glass and ceramic chips), grading to FAT CLAY		PP = 0.5 to 1 tsf, LL = 110, PI = 69 UW_d = 45.9 pcf, w_n = 95.8%, q_u = 1,062 psf ST-4 pushed at 0 psi
	12.5 14.0	1.5	SS-5	2-1-2 (3)	- becomes wet		* Groundwater (GW) encountered at 13' bgs during drilling; switched to mud rotary; GW stabilized to 9.33' bgs
15	15.0 16.5	0.1	SS-6	WOH-1-1 (2)	**ORGANIC CLAY (OH) - YOUNG BAY MUD** Black, wet (dripping with water), soft, mostly high plasticity fines with organic odor		
20	20.0 21.5	1.5	SS-7	1-1-2 (3)	- becomes dark gray to brown, trace sand		PP = 0.5 to 1 tsf
	22.5 25.0	2.5	ST-8	push			
25	25.0 26.5	1.5	SS-9	10-13-15 (28)	**CLAYEY SAND (SC) - ALLUVIUM** Blue gray, wet, medium dense, mostly fine to medium sand, some medium plasticity fines		PP > 4.5 tsf, LL = 31, PI = 12 UW_d = 104.8 pcf, w_n = 21.4%, q_u = 7,317 psf ST-8 pushed at 200 psi PP = 3 tsf, F_c = 40%
30	30.0 31.5	1.5	SS-10	2-4-3 (7)	**LEAN CLAY (CL) - ALLUVIUM** Brown, wet, medium stiff, mostly medium plasticity fines, trace fine sand		PP = 0.75 to 1 tsf
35	35.0 36.5	1.5	SS-11	4-4-6 (10)	- becomes stiff, with little fine to medium sand		PP = 1.25 to 1.5 tsf
40							

PROJECT NUMBER	BORING NUMBER:
658394.01.08.01.10	CH2M15-01 SHEET 2 OF 2

SOIL BORING LOG

PROJECT : RWQCP - Sludge Dewatering & Loadout Facility, Palo Alto LOCATION : Lat: 37.452610 deg N; Long: 122.110826 deg W

ELEVATION : 5.0 ft. (MSL) (Approximate) DRILLING CONTRACTOR : Cascade Drilling LP

DRILLING EQUIPMENT AND METHOD : CME 75 Truck Mounted, 8" HSA to 13' bgs; 4" Mud Rotary thereafter; 140-lb/30-in drop Auto-Hammer

WATER LEVELS : 9.33 ft. bgs after stabilizing START: 10/13/2015 8:40:00 AM END: 10/13/2015 2:00:00 PM LOGGER : R. Bethapudi

DEPTH BELOW EXISTING GRADE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	40.0 41.5	1.5	SS-12	2-3-4 (7)	- becomes medium stiff		
	42.5						
45	45.0	0.0	ST-13	push			No sample recovered, ST-13 pushed at 100 psi
	46.5	1.5	SS-14	2-3-8 (11)	- becomes stiff		PP = 0.75 tsf
	47.5						
50	50.0	1.8	ST-15	push	**SILT with SAND (ML) - ALLUVIUM** Olive, wet, very stiff, mostly low plasticity fines, little fine sand		PP = 1 tsf, UW_d = 106.4 pcf, w_n = 20.8%, q_u = 4,096 psf ST-15 pushed at 100 psi
	51.5	1.5	SS-16	4-5-6 (11)	**LEAN CLAY with SAND (CL) - ALLUVIUM** Brown to olive, wet, stiff, mostly low to medium plasticity fines, little fine sand		
55							
60	60.0 61.5	1.5	SS-17	4-8-13 (21)	- becomes very stiff		
65							
70	70.0 71.5	1.5	SS-18	4-6-9 (15)	- becomes stiff		PP = 1.5 tsf
75					Borehole completed to a depth of 71.5' bgs and backfilled with bentonite grout/Portland cement upto 10' bgs and compacted pea gravel to the ground surface.		
80							

PROJECT NUMBER	BORING NUMBER:
658394.01.08.01.10	CH2M15-02 SHEET 1 OF 2

SOIL BORING LOG

PROJECT : RWQCP - Sludge Dewatering & Loadout Facility, Palo Alto LOCATION : Lat: 37.452396 deg N; Long: 122.110844 deg W

ELEVATION : 5.0 ft. (MSL) (Approximate) DRILLING CONTRACTOR : Cascade Drilling LP

DRILLING EQUIPMENT AND METHOD : CME 75 Truck Mounted, 8" HSA to 24' bgs; 4" Mud Rotary thereafter; 140-lb/30-in drop Auto-Hammer

WATER LEVELS : 15.5 ft. bgs after stabilizing START: 10/14/2015 8:00:00 AM END: 10/14/2015 12:30:00 PM LOGGER : R. Bethapudi

DEPTH BELOW EXISTING GRADE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	0.0 – 1.5	1.2	SS-1	16-10-13 (23)	**CLAYEY SAND with GRAVEL (SC) - FILL** Dark gray, dry, medium dense, mostly fine to coarse sand, some medium plasticity fines, some angular to sub-rounded gravel		* Drilling using hand auger to 4' bgs after collecting SS-1
	2.5 – 4.0	1.2	SS-2	4-5-7 (12)	**SANDY CLAY (CL) - FILL** Dark olive brown, moist, stiff, mostly medium plasticity fines, some fine to coarse sand, few to little gravel		* very hard hand augering because of cobbles and gravel F_c = 54%
5	5.0 – 6.5	0.2	SS-3	2-2-3 (5)	- becomes medium stiff		
	7.5 – 9.0	0.5	SS-4	1-1-1 (2)	**PEAT - FILL** Black, moist, soft, mostly high plasticity fines with organic odor, trace fine to medium sand		PP = 0.25 to 0.5 tsf
10							
	12.5 – 15.0	2.2	ST-5	push	**Elastic SILT (MH) - YOUNG BAY MUD** Greenish gray, moist, very soft to soft, mostly high plasticity fines with organic odor, trace to few sand		PP = 0 to 0.25 tsf, LL = 100, PI = 56 UW_d = 48.9 pcf, w_n = 85%, q_u = 1,091 psf ST-5 pushed at 0 psi
15	15.0 – 16.5	0.3	SS-6	WOH-1-2 (3)	- becomes dark gray, soft, clayey with sand		CR (conducted on sample combined from ST-5 and SS-6) w_n = 84.8% * Encountered GW at 17' bgs during drilling; stabilized to 15.5' bgs
20	20.0 – 22.5	2.5	ST-7	push	- becomes wet		ST-7 pushed at 0 psi from 20 to 22' and at 200 psi from 22' to 22.5'
	22.5	1.5	SS-8	7-9-10 (19)	**CLAYEY SAND (SC)/SANDY CLAY (CL) - ALLUVIUM** Dark bluish gray, wet, medium dense/very stiff, mostly medium plasticity fines, some fine sand		PP = 2 to 2. tsf, UW_d = 101.4 pcf, w_n = 22.8%, q_u = 4,542 psf PP = 1.5 to 2 tsf Switched to mud rotary at 24' bgs
25							
30	30.0 – 31.5	1.5	SS-9	3-2-3 (5)	**LEAN CLAY with SAND (CL) - ALLUVIUM** Olive brown, wet, medium stiff, mostly medium plasticity fines, little fine sand		PP = 0.25 to 0.5 tsf
35	35.0 – 36.5	1.5	SS-10	2-4-5 (9)	- becomes stiff		PP = 0.25 to 1 tsf
	37.5 – 40.0	1.5	ST-11	push			ST-11 pushed at 300 psi UW_d = 108.6 pcf, w_n = 16.7%, F_c = 22%, q_u = 9,111 psf
40	40.0						

PROJECT NUMBER	BORING NUMBER:
658394.01.08.01.10	CH2M15-02 SHEET 2 OF 2

SOIL BORING LOG

PROJECT : RWQCP - Sludge Dewatering & Loadout Facility, Palo Alto LOCATION : Lat: 37.452396 deg N; Long: 122.110844 deg W

ELEVATION : 5.0 ft. (MSL) (Approximate) DRILLING CONTRACTOR : Cascade Drilling LP

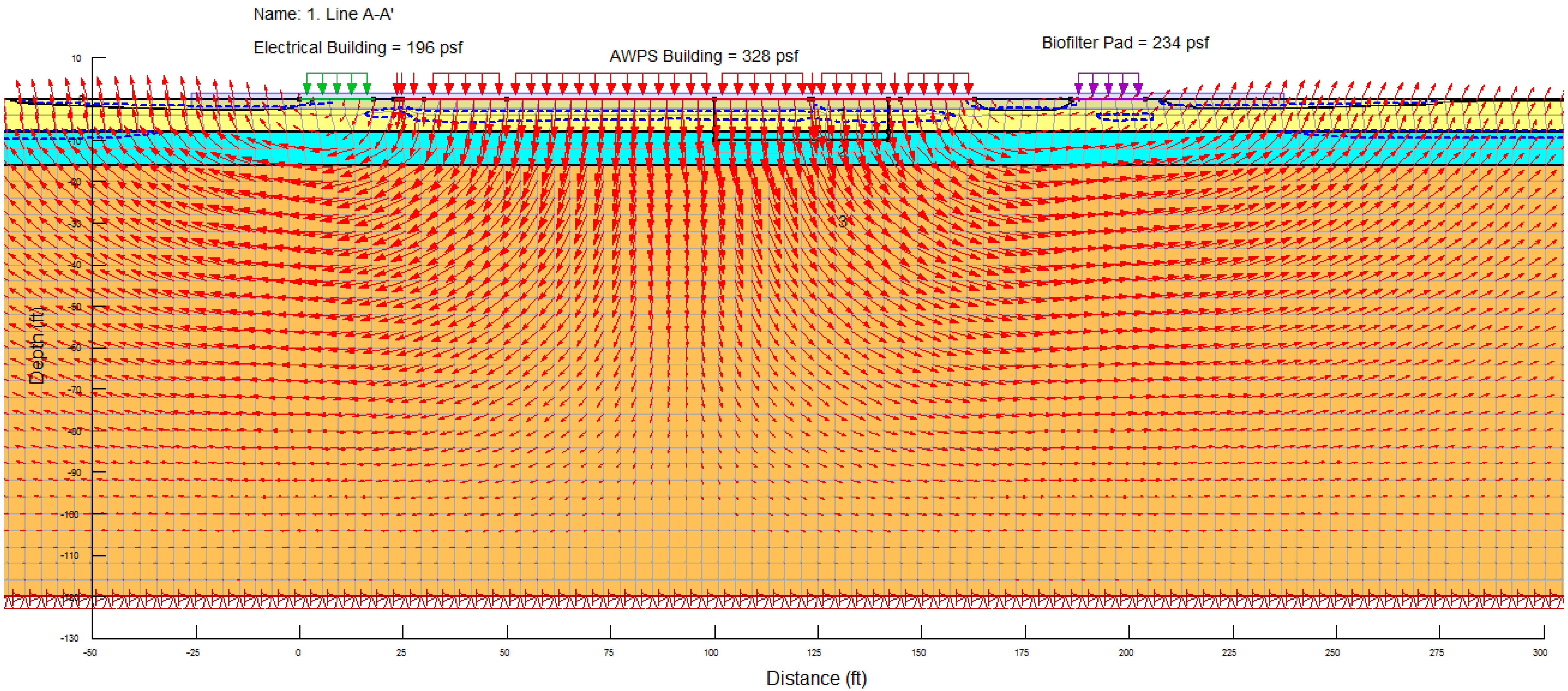
DRILLING EQUIPMENT AND METHOD : CME 75 Truck Mounted, 8" HSA to 24' bgs; 4" Mud Rotary thereafter; 140-lb/30-in drop Auto-Hammer

WATER LEVELS : 15.5 ft. bgs after stabilizing START: 10/14/2015 8:00:00 AM END: 10/14/2015 12:30:00 PM LOGGER : R. Bethapudi

DEPTH BELOW EXISTING GRADE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	40.0 – 41.5	1.5	SS-12	2-5-5 (10)	**SILTY SAND (SM) - ALLUVIUM** Olive brown, wet, loose to medium dense, mostly fine to medium sand, little non-plastic to low plasticity fines		* Samples SS-12/A collected from 40-41' and SS-12/B collected from 41-41.5' PP = 0.5 to 1 tsf (SS-12/B)
					LEAN CLAY with SAND (CL) - ALLUVIUM Olive-brown, wet, stiff, mostly medium plasticity fines, little fine sand		
45	45.0 – 46.5	1.5	SS-13	2-4-6 (10)			
50	50.0 – 51.5		SS-14	2-6-7 (13)			
55							
	57.5 – 60.0	2.5	ST-15	push	- becomes very stiff, with trace to few sand		PP = 1.25 to 1.75 tsf, UW_d = 101.7 pcf, w_n = 25% LL = 48, PI = 31, q_u = 4,380 psf
60	60.0 – 61.5	1.5	SS-16	7-11-14 (25)			PP = 1.5 tsf
65							
70	70.0 – 71.5	1.5	SS-17	6-10-13 (23)			PP = 1.5 to 2.25 tsf
					Borehole completed to a depth of 71.5' bgs and backfilled with bentonite grout/Portland cement upto 10' bgs and compacted pea gravel to the ground surface.		
75							
80							

APPENDIX B

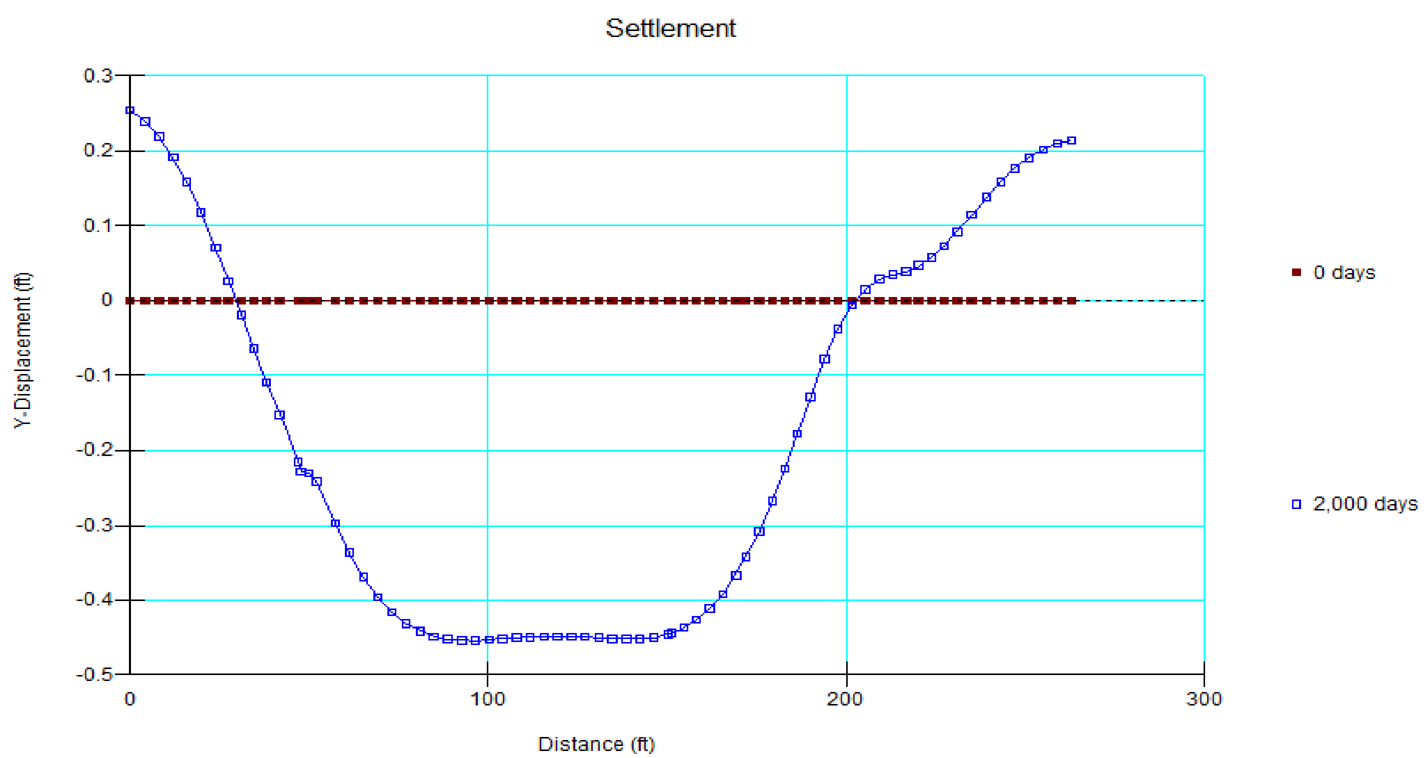
Engineering Calculations



Name: 1. Fill
Effective Young's Modulus (E'): 1,600,000 psf
Unit Weight: 120 pcf
Poisson's Ratio: 0.4
Vol. WC. Function: Alluvium
K-Function: Alluvium
Ky'/Kx' Ratio: 0.5
Rotation: 0 °
Load Response Ratio: 1

Name: 2. Bay Mud
O.C. Ratio: 1.2
Poisson's Ratio: 0.4
Lambda: 0.287
Kappa: 0.052
Initial Void Ratio: 2
Unit Weight: 100 pcf
Phi': 0 °
Vol. WC. Function: Qaf/Qal/YBM
K-Function: Qaf/Qal/YBM
Ky'/Kx' Ratio: 0.5
Rotation: 0 °
Load Response Ratio: 1

Name: 3. Alluvial Clay
O.C. Ratio: 2
Poisson's Ratio: 0.4
Lambda: 0.063
Kappa: 0.016
Initial Void Ratio: 0.8
Unit Weight: 125 pcf
Phi': 0 °
Vol. WC. Function: Alluvium
K-Function: Alluvium
Ky'/Kx' Ratio: 0.5
Rotation: 0 °
Load Response Ratio: 1



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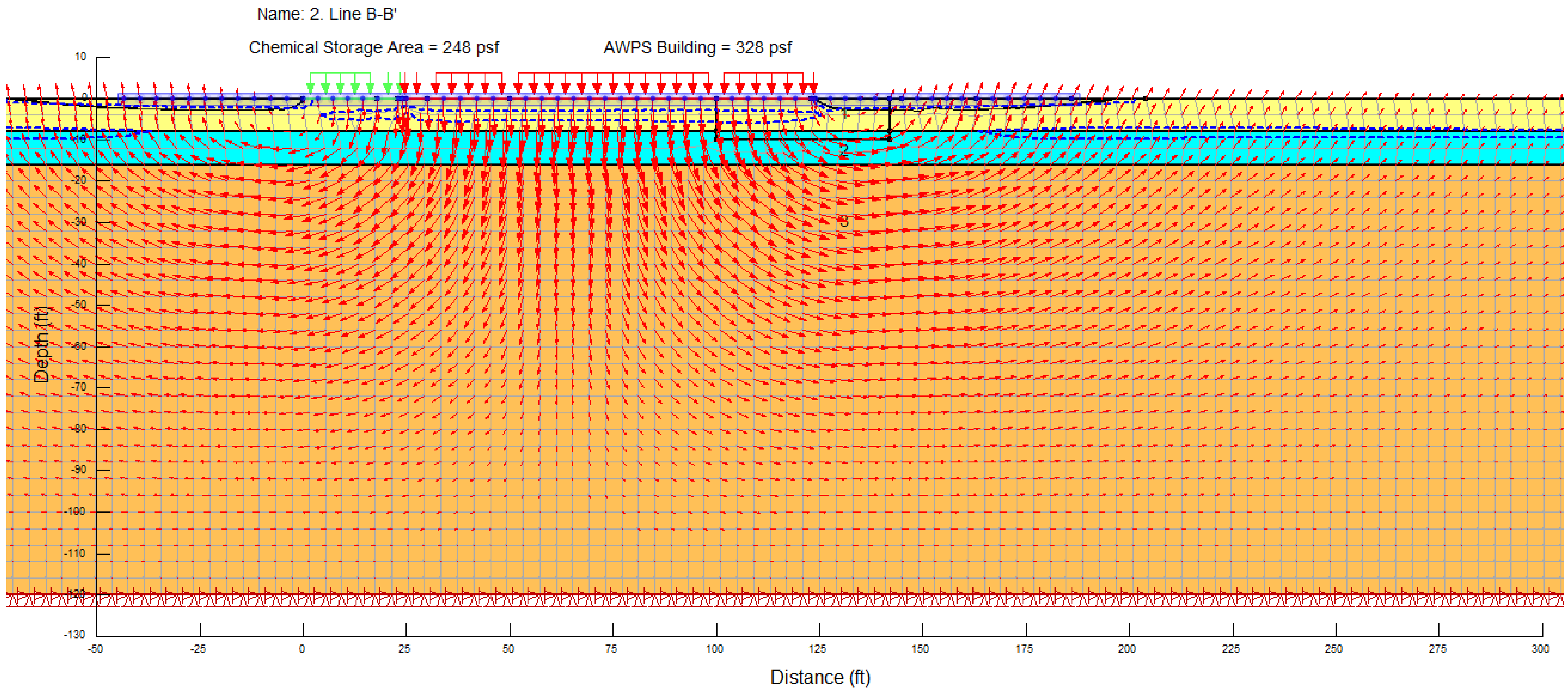
SETTLEMENT ANALYSIS

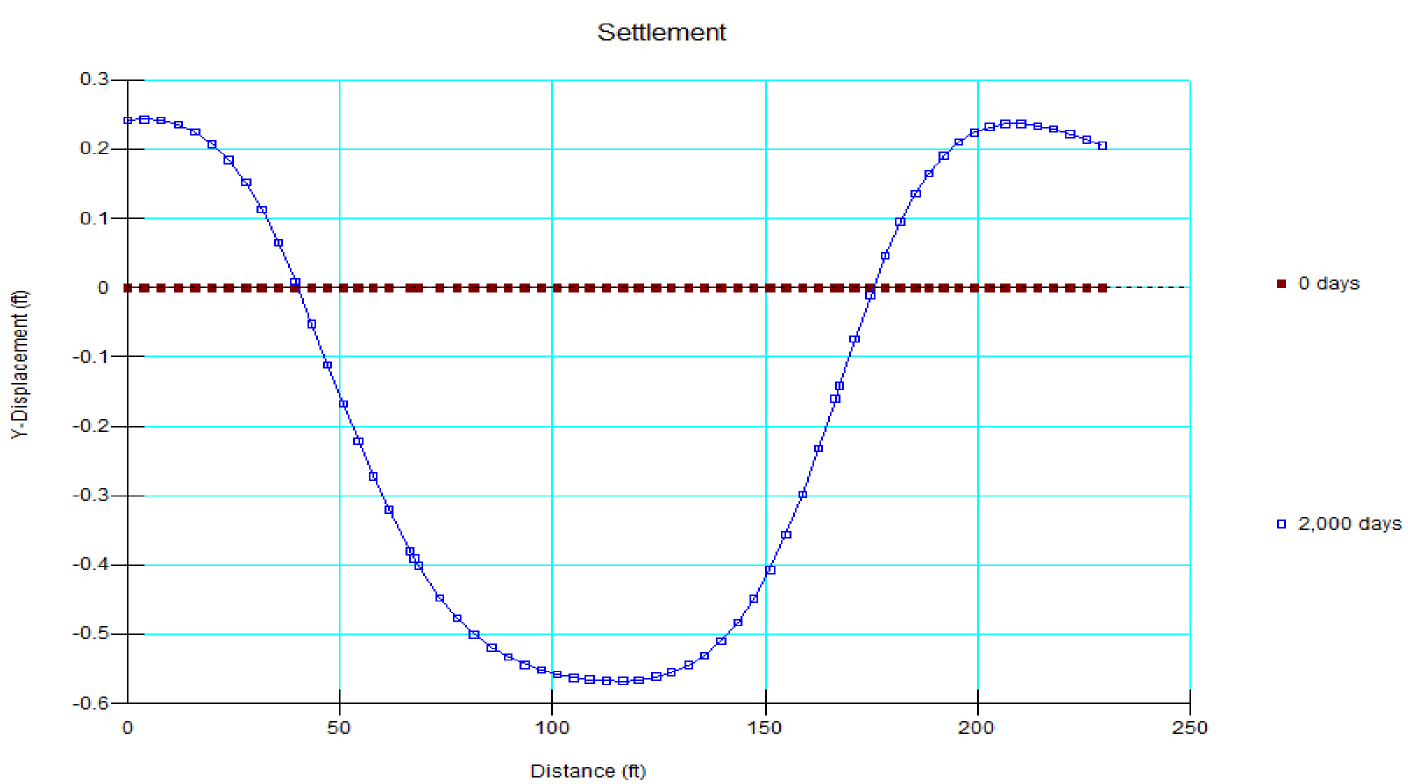
171410	AUGUST 2017	FI□□□E A-1



Name: 1. Fill
Effective Young's Modulus (E'): 1,600,000 psf
Unit Weight: 120 pcf
Poisson's Ratio: 0.4
Vol. WC. Function: Alluvium
K-Function: Alluvium
Ky'/Kx' Ratio: 0.5
Rotation: 0 °
Load Response Ratio: 1

Name: 2. Bay Mud
O.C. Ratio: 1.2
Poisson's Ratio: 0.4
Lambda: 0.287
Kappa: 0.052
Initial Void Ratio: 2
Unit Weight: 100 pcf
Phi': 0 °
Vol. WC. Function: Qaf/Qal/YBM
K-Function: Qaf/Qal/YBM
Ky'/Kx' Ratio: 0.5
Rotation: 0 °
Load Response Ratio: 1

Name: 3. Alluvial Clay
O.C. Ratio: 2
Poisson's Ratio: 0.4
Lambda: 0.063
Kappa: 0.016
Initial Void Ratio: 0.8
Unit Weight: 125 pcf
Phi': 0 °
Vol. WC. Function: Alluvium
K-Function: Alluvium
Ky'/Kx' Ratio: 0.5
Rotation: 0 °
Load Response Ratio: 1



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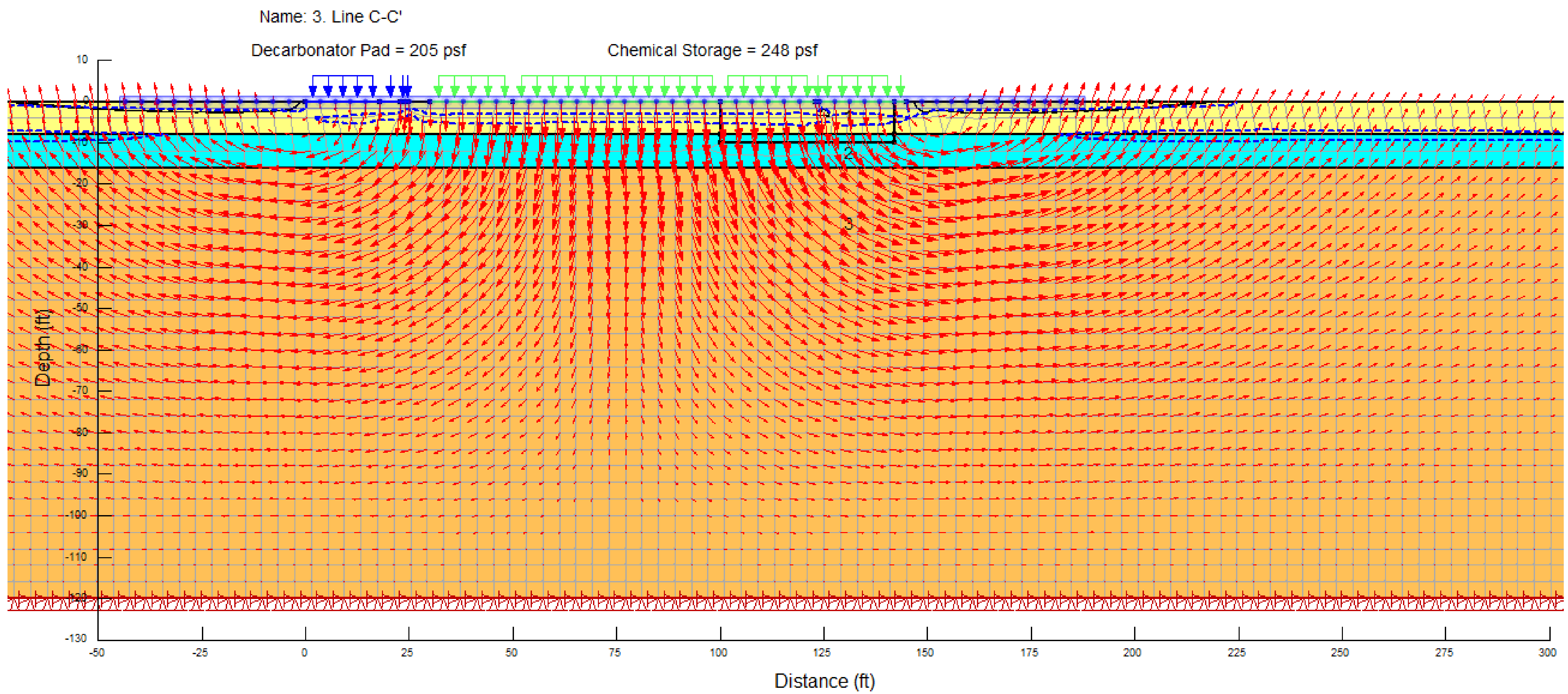
SETTLEMENT ANALYSIS

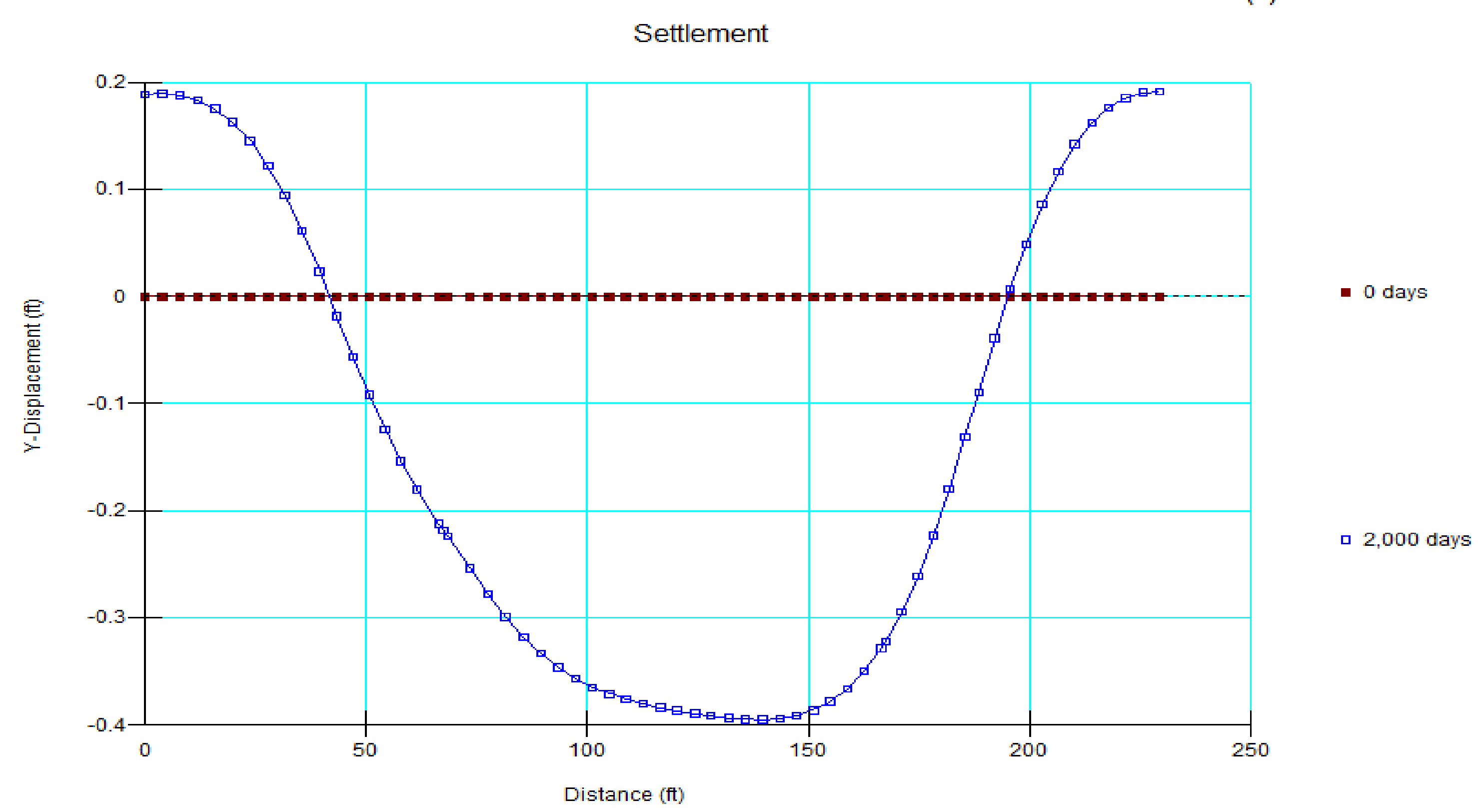
171410	AUGUST 2017	FI□□□E A-2



Name: 1. Fill
Effective Young's Modulus (E'): 1,600,000 psf
Unit Weight: 120 pcf
Poisson's Ratio: 0.4
Vol. WC. Function: Alluvium
K-Function: Alluvium
Ky'/Kx' Ratio: 0.5
Rotation: 0 °
Load Response Ratio: 1

Name: 2. Bay Mud
O.C. Ratio: 1.2
Poisson's Ratio: 0.4
Lambda: 0.287
Kappa: 0.052
Initial Void Ratio: 2
Unit Weight: 100 pcf
Phi': 0 °
Vol. WC. Function: Qaf/Qal/YBM
K-Function: Qaf/Qal/YBM
Ky'/Kx' Ratio: 0.5
Rotation: 0 °
Load Response Ratio: 1

Name: 3. Alluvial Clay
O.C. Ratio: 2
Poisson's Ratio: 0.4
Lambda: 0.063
Kappa: 0.016
Initial Void Ratio: 0.8
Unit Weight: 125 pcf
Phi': 0 °
Vol. WC. Function: Alluvium
K-Function: Alluvium
Ky'/Kx' Ratio: 0.5
Rotation: 0 °
Load Response Ratio: 1



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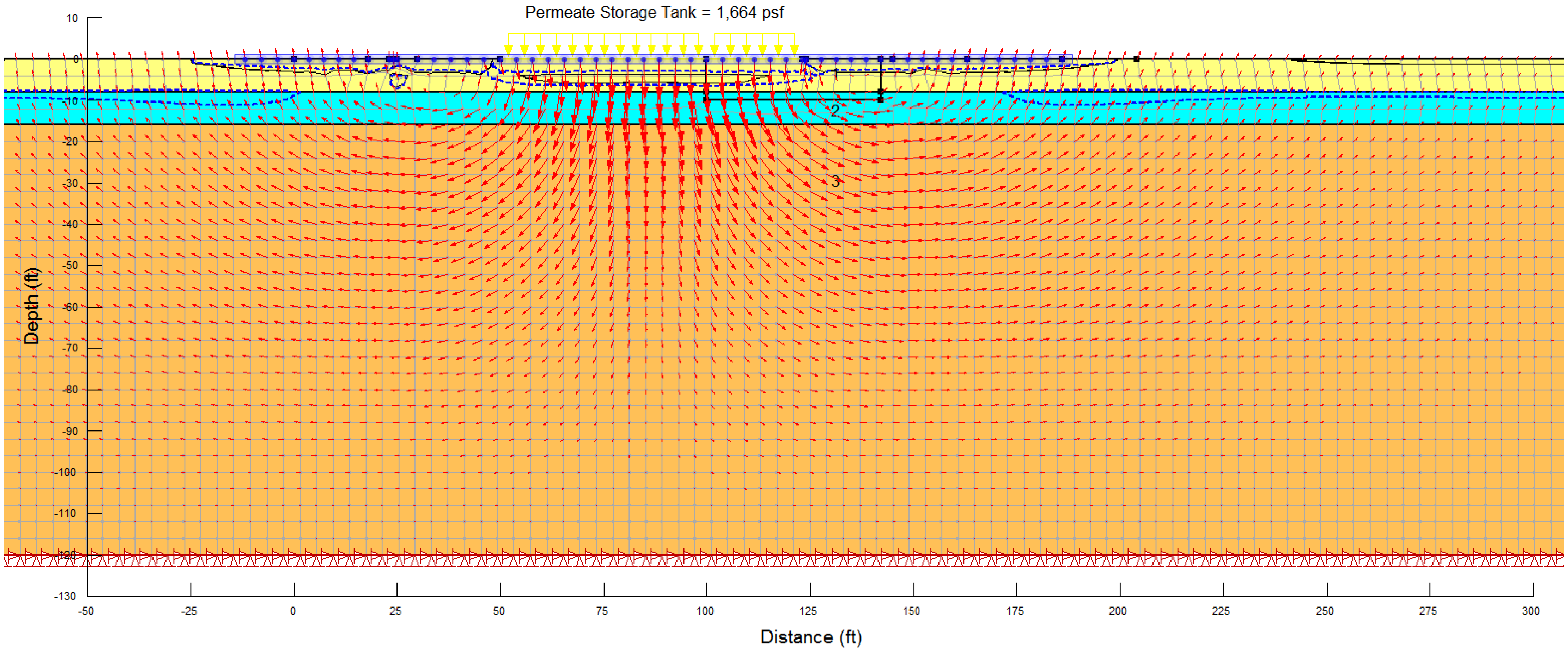
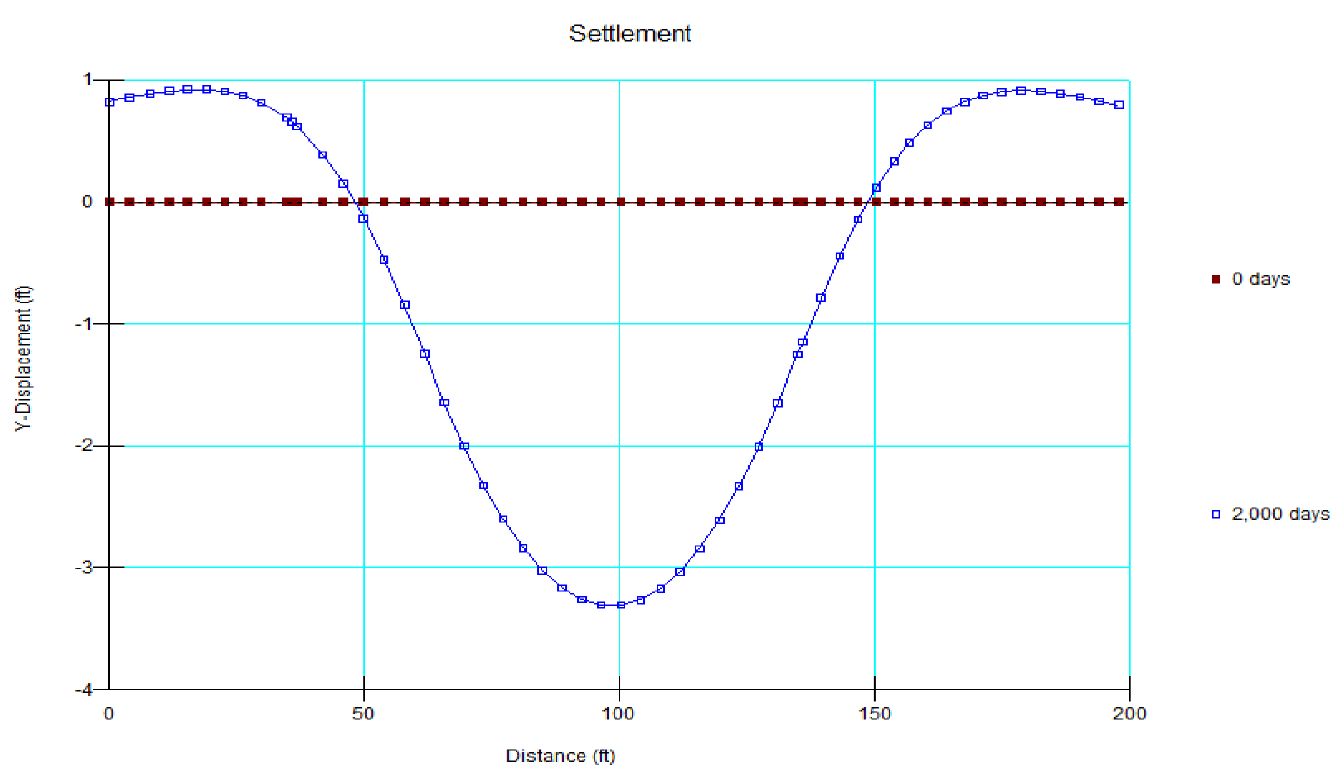
Name: 4. Permeate Storage Tank



Name: 1. Fill
Effective Young's Modulus (E'): 1,600,000 psf
Unit Weight: 120 pcf
Poisson's Ratio: 0.4
Vol. WC. Function: Alluvium
K-Function: Alluvium
Ky'/Kx' Ratio: 0.5
Rotation: 0 °
Load Response Ratio: 1

Name: 2. Bay Mud
O.C. Ratio: 1.2
Poisson's Ratio: 0.4
Lambda: 0.287
Kappa: 0.052
Initial Void Ratio: 2
Unit Weight: 100 pcf
Phi': 0 °
Vol. WC. Function: Qaf/Qal/YBM
K-Function: Qaf/Qal/YBM
Ky'/Kx' Ratio: 0.5
Rotation: 0 °
Load Response Ratio: 1

Name: 3. Alluvial Clay
O.C. Ratio: 2
Poisson's Ratio: 0.4
Lambda: 0.063
Kappa: 0.016
Initial Void Ratio: 0.8
Unit Weight: 125 pcf
Phi': 0 °
Vol. WC. Function: Alluvium
K-Function: Alluvium
Ky'/Kx' Ratio: 0.5
Rotation: 0 °
Load Response Ratio: 1



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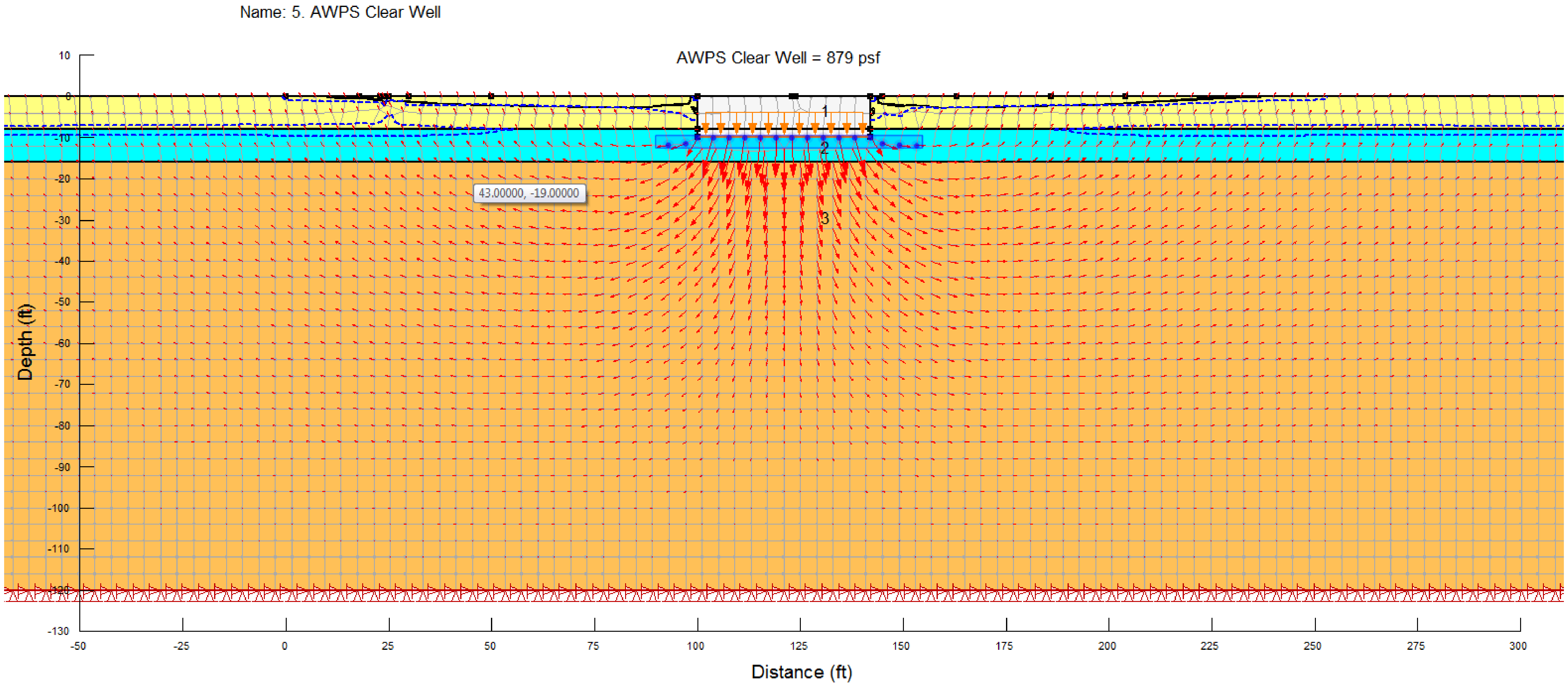
SETTLEMENT ANALYSIS

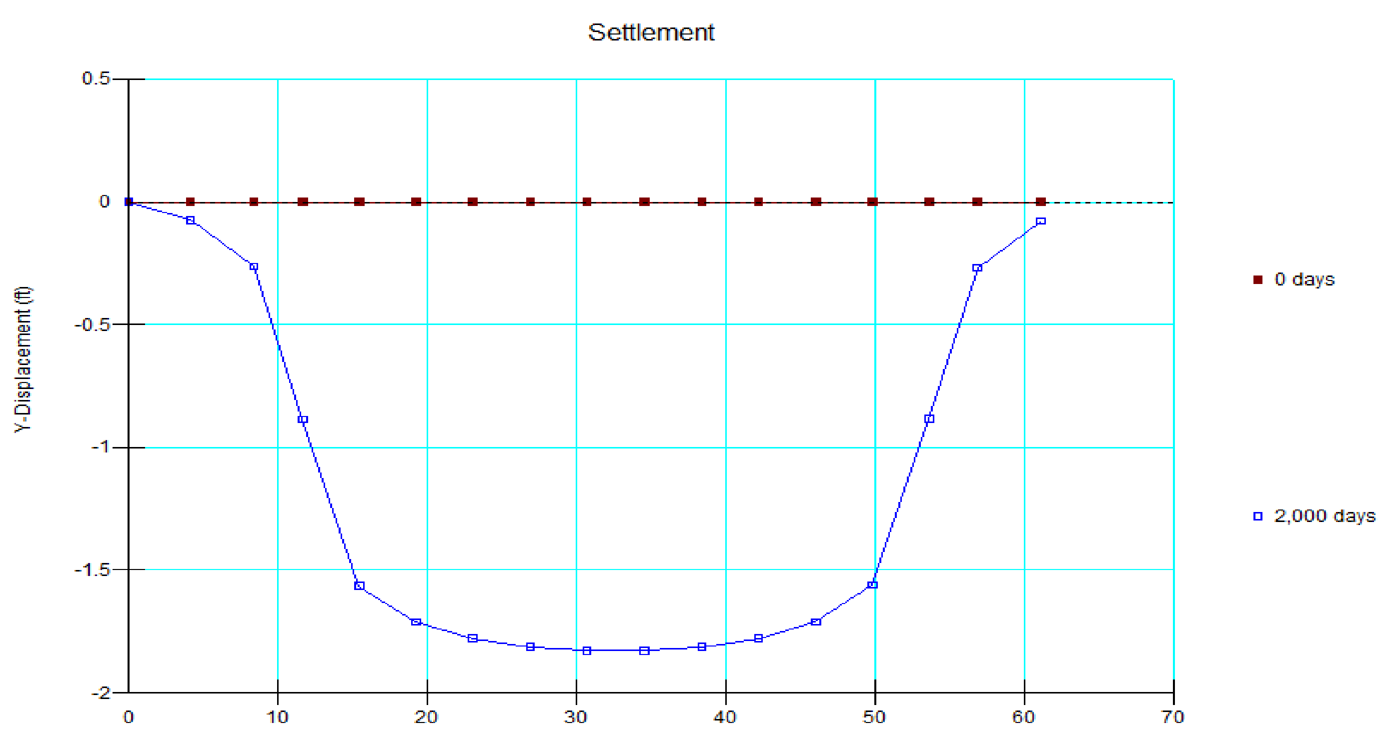
171410	AUGUST 2017	FI□□□E A-4



Name: 1. Fill
Effective Young's Modulus (E'): 1,600,000 psf
Unit Weight: 120 pcf
Poisson's Ratio: 0.4
Vol. WC. Function: Alluvium
K-Function: Alluvium
Ky'/Kx' Ratio: 0.5
Rotation: 0 °
Load Response Ratio: 1

Name: 2. Bay Mud
O.C. Ratio: 1.2
Poisson's Ratio: 0.4
Lambda: 0.287
Kappa: 0.052
Initial Void Ratio: 2
Unit Weight: 100 pcf
Phi': 0 °
Vol. WC. Function: Qaf/Qal/YBM
K-Function: Qaf/Qal/YBM
Ky'/Kx' Ratio: 0.5
Rotation: 0 °
Load Response Ratio: 1

Name: 3. Alluvial Clay
O.C. Ratio: 2
Poisson's Ratio: 0.4
Lambda: 0.063
Kappa: 0.016
Initial Void Ratio: 0.8
Unit Weight: 125 pcf
Phi': 0 °
Vol. WC. Function: Alluvium
K-Function: Alluvium
Ky'/Kx' Ratio: 0.5
Rotation: 0 °
Load Response Ratio: 1



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PALO ALTO RWQCP AWPS
CITY OF PALO ALTO
PALO ALTO□CALIFO□NIA

SETTLEMENT ANALYSIS

171410	AUGUST 2017	FI□□□E A-5

Appendix C. Detailed Cost Estimates

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OPINION OF PROBABLE CONSTRUCTION COST

MNS ENGINEERS INC

Project: City of Palo Alto - Advanced Water Purifications System Preliminary Design

Prepared By: NEP

Date Prepared: 12/1/2017

Building, Area: AWPS Site 1 - 1.125 MGD - Civil

MNS Proj. No. CIPAA.150417

Estimate Type:
- ☐ Conceptual
- ☑ Preliminary (w/o plans)
- ☐ Design Development @ ____ % complete
- ☐ Construction
- ☐ Change Order

Months to Midpoint of Construction 18

Item No.	Description	Qty.	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Total
1	Site Clearing and Grubbing	1	AC			$10,000	$10,000	$10,000
2	Tree Removal	1	LS			$30,000	$30,000	$30,000
3	Demolish and Remove Bio-Filter	1	LS			$50,000	$50,000	$50,000
4	Odor Scrubber	1	LS	$250,000	$250,000	$75,000	$75,000	$325,000
5	Remove or Abandon Existing Utilities	1	LS	$2,500	$2,500	$25,000	$25,000	$27,500
6	Site Piping Improvements (See Separate Spreadsheet)	1	LS	$580,000	$580,000	$522,000	$522,000	$1,102,000
7	Site Drainage Improvments	1	LS	$10,000	$10,000	$10,000	$10,000	$20,000
8	Site Rough and Fine Grading	2000	CY	$10	$20,000	$10	$20,000	$40,000
9	Excavation and Offhaul Below Slabs	5580	CY	$2	$11,160	$12	$66,960	$78,120
10	Structural Backfill Below Slabs	5580	CY	$25	$139,500	$35	$195,300	$334,800
11	Electrical Building - CMU Block	720	SF	$130	$93,600	$150	$108,000	$201,600
12	AWPS/Electrical Building Foundation	707	CY	$100	$70,700	$50	$35,350	$106,050
13	AWPS Canopies	1	LS	$150,000	$150,000	$50,000	$50,000	$200,000
14	AWPS Clear Well	86	CY	$500	$43,000	$500	$43,000	$86,000
15	AWPS Clear Well Piles	40	EA	$2,000	$80,000	$2,125	$85,000	$165,000
16	AWPS Permeate Storage Tank Piles	180	EA	$2,000	$360,000	$2,125	$382,500	$742,500
17	AWPS Permeate Storage Tank Slab	1	LS	$75,000	$75,000	$75,000	$75,000	$150,000
18	AWPS Permeate Welded Steel Storage Tank	750000	GAL	$0.75	$562,500	$0.75	$562,500	$1,125,000
19	Chemical Containment Facilities	1	LS	$50,000	$50,000	$50,000	$50,000	$100,000
20	AC Pavement	1609	SY	$35	$56,319	$35	$56,319	$112,638
21	Curb and Gutter	694	LF	$5	$3,470	$10	$6,940	$10,410
22	6-Foot Wide Pedestrian Pathway Realignment	355	LF	$20	$7,100	$30	$10,650	$17,750
23	Screening Vegetation and Landscaping	1	LS	$70,000	$70,000	$70,000	$70,000	$140,000
24	8' High Chain Link Fence	735	LF	$15	$11,025	$10	$7,350	$18,375
	Subtotals				$2,645,874		$2,546,869	$5,192,743
	Total Estimate							**$5,190,000**

OPINION OF PROBABLE CONSTRUCTION COST

MNS ENGINEERS INC

Project: City of Palo Alto - Advanced Water Purifications System Preliminary Design

Prepared By: NEP

Date Prepared: 12/1/2017

Building, Area: AWPS Site 1 - 1.125 MGD - Electrical Costs

MNS Proj. No. CIPAA.150417

Estimate Type:
- [ ] Conceptual
- [x] Preliminary (w/o plans)
- [ ] Design Development @
- [ ] Construction
- [ ] Change Order

______ % complete

Months to Midpoint of Construction: 18

Item No.	Description	Qty.	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Total
1	Main Switchboard	1	LS	$25,000	$25,000	$25,000	$25,000	$50,000
2	MCC	1	LS	$70,000	$70,000	$70,000	$70,000	$140,000
3	Indoor Dry-Type Transformer and Panelboards	1	LS	$16,000	$16,000	$16,000	$16,000	$32,000
4	480V Power Distribution Panel	1	LS	$5,000	$5,000	$5,000	$5,000	$10,000
5	Main Control Panel, Programming, SCADA Integration	1	LS	$150,000	$150,000	$150,000	$150,000	$300,000
6	IT /Security Equipment	1	LS	$50,000	$50,000	$50,000	$50,000	$100,000
7	Lighting	1	LS	$30,000	$30,000	$30,000	$30,000	$60,000
8	Utility Connection Costs (Assume terminations, cabling and utility tr	1	LS	$30,000	$30,000	$30,000	$30,000	$60,000
	Subtotals				$376,000		$376,000	$752,000
	Total Estimate							**$750,000**

OPINION OF PROBABLE CONSTRUCTION COST

MNS ENGINEERS INC

Project: City of Palo Alto - Advanced Water Purifications System Preliminary Design

Prepared By: NEP

Date Prepared: 12/1/2017

Building, Area: AWPS Site 1 - 2.25 MGD - Electrical Costs

MNS Proj. No. CIPAA.150417

Estimate Type:

- ☐ Conceptual
- ☑ Preliminary (w/o plans)
- ☐ Design Development @ ____ % complete
- ☐ Construction
- ☐ Change Order

Months to Midpoint of Construction 18

Item No.	Description	Qty.	Units	Materials		Installation		Total
				$/Unit	Total	$/Unit	Total	
1	Main Switchboard	1	LS					
2	MCC	1	LS	$75,000	$75,000	$50,000	$50,000	$125,000
3	Indoor Dry-Type Transformer and Panelboards	1	LS	$7,500	$7,500	$7,500	$7,500	$15,000
4	480V Power Distribution Panel	1	LS	$500	$500	$500	$500	$1,000
5	Main Control Panel, Programming, SCADA Integration	1	LS	$100,000	$100,000	$95,000	$95,000	$195,000
6	IT /Security Equipment	1	LS	$30,000	$30,000	$35,000	$35,000	$65,000
7	Lighting	1	LS					
8	Utility Connection Costs (Assume terminations, cabling and utility tr	1	LS	$30,000	$30,000	$30,000	$30,000	$60,000
	Subtotals				$243,000		$218,000	$461,000
	Total Estimate							**$460,000**

OPINION OF PROBABLE CONSTRUCTION COST

MNS ENGINEERS INC

Project: City of Palo Alto - Advanced Water Purifications System Preliminary Design

Prepared By: NEP

Date Prepared: 12/1/2017

Building, Area: AWPS Site 1 - 1.125 MGD Process

MNS Proj. No. CIPAA.150417

Estimate Type:

- ☐ Conceptual
- ☑ Preliminary (w/o plans)
- ☐ Design Development @ ______ % complete
- ☐ Construction
- ☐ Change Order

Months to Midpoint of Construction: 18

Item No.	Description	Qty.	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Total
MF Treatment System Cost Estimate								
1	MF System	1	LS	$856,000	$856,000	$128,400	$128,400	$984,400
2	Chemical Feed System	1	LS	$274,000	$274,000	$41,100	$41,100	$315,100
3	CIP System	1	LS	$91,000	$91,000	$13,650	$13,650	$104,650
4	Ancillary Equipment	1	LS	$255,000	$255,000	$38,250	$38,250	$293,250
5	Filtrate Tank to RO Unit	1	LS	$112,000	$112,000	$16,800	$16,800	$128,800
6	Control System and Instrumentation	1	LS	$122,000	$122,000	$18,300	$18,300	$140,300
							MF Treatment System Subtotal	$1,966,500
RO Treatment System Cost Estimate								
7	Primary RO System	1	LS	$1,532,000	$1,532,000	$229,800	$229,800	$1,761,800
8	Chemical Dosing System	1	LS	$194,000	$194,000	$29,100	$29,100	$223,100
9	Cleaning and Flushing Systems	1	LS	$136,500	$136,500	$20,475	$20,475	$156,975
10	Ancillary Equipment	1	LS	$232,000	$232,000	$34,800	$34,800	$266,800
11	Control System and Instrumentation	1	LS	$78,000	$78,000	$11,700	$11,700	$89,700
12	Decarbonator	1	LS	$133,500	$133,500	$20,025	$20,025	$153,525
							RO Treatment System Subtotal	$2,651,900
	Subtotals				$4,016,000		$602,400	$4,618,400
	Total Estimate							**$4,620,000**

OPINION OF PROBABLE CONSTRUCTION COST

MNS ENGINEERS INC

Project: City of Palo Alto - Advanced Water Purifications System Preliminary Design

Prepared By: NEP
Date Prepared: 12/1/2017
MNS Proj. No. CIPAA.150417

Building, Area: AWPS Site 1 - 2.25 MGD Process

Estimate Type:
- [ ] Conceptual
- [x] Preliminary (w/o plans)
- [ ] Design Development @ ____ % complete
- [ ] Construction
- [ ] Change Order

Months to Midpoint of Construction: 18

Item No.	Description	Qty.	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Total
MF Treatment System Cost Estimate								
1	MF System	1	LS	$565,000	$565,000	$84,750	$84,750	$649,750
2	Chemical Feed System	1	LS	$61,000	$61,000	$9,150	$9,150	$70,150
3	CIP System	1	LS					
4	Ancillary Equipment	1	LS	$99,000	$99,000	$14,850	$14,850	$113,850
5	Filtrate Tank to RO Unit	1	LS					
6	Control System and Instrumentation	1	LS	$64,000	$64,000	$9,600	$9,600	$73,600
							MF Treatment System Subtotal	$907,350
RO Treatment System Cost Estimate								
7	Primary RO System	1	LS	$759,000	$759,000	$113,850	$113,850	$872,850
8	Chemical Dosing System	1	LS	$85,000	$85,000	$12,750	$12,750	$97,750
9	Cleaning and Flushing Systems	1	LS					
10	Ancillary Equipment	1	LS	$195,000	$195,000	$29,250	$29,250	$224,250
11	Control System and Instrumentation	1	LS	$49,000	$49,000	$7,350	$7,350	$56,350
12	Decarbonator	1	LS	$113,000	$113,000	$16,950	$16,950	$129,950
							RO Treatment System Subtotal	$1,381,150
	Subtotals				$1,990,000		$298,500	$2,288,500
	Total Estimate							**$2,290,000**

OPINION OF PROBABLE CONSTRUCTION COST

MNS ENGINEERS INC

Project: City of Palo Alto - Advanced Water Purifications System Preliminary Design

Prepared By: NEP

Date Prepared: 12/1/2017

Building, Area: AWPS Site 1 Yard Piping

MNS Proj. No. CIPAA.150417

Estimate Type:

- ☐ Conceptual
- ☑ Preliminary (w/o plans)
- ☐ Design Development @

- ☐ Construction
- ☐ Change Order

_____ % complete

Current at ENR _____

Escalated to ENR _____

Months to Midpoint of Construction 18

Item No.	Description	Qty.	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Total
1	AWPS Supply - 14 Inch CMLDI	510	FT	$120	$61,200	$120	$61,200	$122,400
2	AWPS Drain - 12 Inch CMLDI	65	FT	$100	$6,500	$100	$6,500	$13,000
3	RO Concentrate - 6 Inch CMLDI	270	FT	$75	$20,250	$75	$20,250	$40,500
4	Sodium Hypochlorite Feed - Dual Contained HDPE Tubing	300	FT	$60	$18,000	$60	$18,000	$36,000
5	AWPS Permeate to Storage - 12 Inch CMLDI	40	FT	$100	$4,000	$100	$4,000	$8,000
6	AWPS Storage Tank to RW Pump Station - 24-Inch CMLDI	760	FT	$250	$190,000	$250	$190,000	$380,000
7	Blending Facility Piping Demolition and Relocation	1	LS	$25,000	$25,000	$35,000	$35,000	$60,000
8	Blending Facility Metering Vaults	2	EA	$25,000	$50,000	$25,000	$50,000	$100,000
9	24" Magnetic Flow Meter	2	EA	$20,000	$40,000	$5,000	$10,000	$50,000
10	24" V-Notch Throttling Ball Valve	2	EA	$25,000	$50,000	$5,000	$10,000	$60,000
11	AWPS Storage Tank Overflow - 12 Inch CMLDI	80	FT	$100	$8,000	$100	$8,000	$16,000
12	Storm Drain Catch Basins	1	EA	$850	$850	$1,000	$1,000	$1,850
13	Relocated 2" Bioassay Line	190	FT	$30	$5,700	$30	$5,700	$11,400
14	Relocated Marsh Outlet RW Line	270	FT	$125	$33,750	$125	$33,750	$67,500
15	Relocated Irrigation Line	300	FT	$20	$6,000	$20	$6,000	$12,000
16	Relocated No. 4 Water	300	FT	$125	$37,500	$125	$37,500	$75,000
17	3/4" PVC Potable Water Line	175	FT	$20	$3,500	$30	$5,250	$8,750
18	Relocated Storm Drain	190	FT	$100	$19,000	$100	$19,000	$38,000
	Subtotals				$579,250		$521,150	$1,100,400
	Total Estimate							**$1,100,000**