December 31, 2015

Mr. Jack Bebee, PE
Assistant General Manager
Fallbrook Public Utility District
990 E Mission Rd.
PO Box 2290
Fallbrook, CA 92028

Subject: **Final Preliminary Design Report - Santa Margarita Conjunctive Use Project Facilities**

Dear Mr. Bebee:

Enclosed is the Final Preliminary Design Report for the Santa Margarita Conjunctive Use Project Facilities. All comments from the draft report have been incorporated into the final version. Appendix A, 30% Design Drawings are enclosed and bound separately. The final report includes updated construction costs found in Section 10.0 and Appendix K.

Documents that were not available when the Draft Preliminary Design Report was submitted have been included in the final report including the following:

- Final Version of TM - 1, Raw Water Quality, in Appendix B
- Final Version of TM - 2, Water Quality Goals, in Appendix C
- Final Version of TM - 3, Predesign Treatment Alternatives, in Appendix D
- Final Version of TM - 4, Distribution System Hydraulic Modeling, in Appendix E
- Geotechnical Investigation Report found in Appendix F

Also enclosed is a CD with an electronic, PDF, version of the final report including the 30% drawings located within the inside pouch of the report binder.

If you have any questions or need additional information do not hesitate to contact me at 760-214-2300.

Sincerely,

Richard H. Kennedy, PE
Senior Project Manager

cc: Ross Maxwell, PE, IEC
Rob Weber, PE, IEC
File

Fallbrook Public Utilities District

PRELIMINARY DESIGN REPORT

FOR THE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

December 2015

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1.0 INTRODUCTION & BACKGROUND:

The Santa Margarita River flows from Riverside County, California through Marine Corps Base Camp Pendleton (MCBCP or CPEN), in northern San Diego County terminating at the Pacific Ocean. Water rights to the river have been disputed between MCBCP and the Fallbrook Public Utility District (District or FPUD) for several decades. FPUD has been working with both CPEN and the United States Bureau of Reclamation (USBR) who has been holding the water rights on an interim basis, attempting to reach an agreement. The original settlement approach included the building of two separate dams, but most recently the Santa Margarita Conjunctive Use Project (SMRCUP), which provides for infiltration of the water into the aquifers on base, and which project terms have been negotiated between the parties . The SMRCUP includes facilities to be constructed by each party. CPEN will divert river flows allowing infiltration of the water into the aquifers, as well as provide wells and pumps to deliver groundwater to FPUD's boundary. FPUD will in turn build facilities to treat and deliver the water to the District's customers.

1.1 Existing Related Documents

The United States Bureau of Reclamation produced the USBR Feasibility Design Report, dated September 2013, and a draft Environmental Impact Statement/Environmental Impact Report (EIS/EIR) was jointly prepared with CPEN and FPUD for the SMRCUP, dated May 2014. The United States Marine Corps (USMC) and USBR are the designated co-lead agencies for review under the National Environmental Policy Act (NEPA), and the District is the designated lead agency for review under the California Environmental Quality Act (CEQA). Per the USBR Feasibility Design Report and the EIS/EIR, the District is anticipated to build the following: 1.) Groundwater desalting treatment facilities at a District parcel adjacent to the site of the District Water Reclamation Plant for a maximum daily untreated supply of about 8 mgd with brine disposal through the District's existing ocean outfall; 2.) Approximately 6 miles of product water pipeline designed to deliver water from the proposed treatment plant to Red Mountain Reservoir; 3.) Piping and valves to deliver treated water back from Red Mountain to Camp Pendleton when the region experiences an extended drought; and 4.) An operational storage tank and booster pump station at the existing Gheen Reservoir site. The water deliveries from CPEN to the District will vary based on the Santa Margarita River flow. The expected annual average yield of the project is 3,100 acre-feet per year (AFY) with an expected yield of zero following an "extremely dry year," and with a maximum daily influent flow of about 8 mgd following a "very wet year."

These documents reveal the importance of this project to the District since it is anticipated to provide an average of 30% of the District's total water demands and at reduced rates when compared to costs of imported water. The financials clearly reflect the value of the project with an estimated present worth of nearly $115,000,000 per the USBR Feasibility Design Report. The same report estimates the total construction cost of the facilities at about $56,000,000, which could result in taking on substantial debt for the District. It is essential to assess the design of the project to minimize District cost, debt and financing.

1.2 Recently Created Documents - Technical Memoranda TM-1, TM-2, TM-3 and TM-4

After reviewing the available documents, including the existing USBR Feasibility Design Report and draft EIR/EIS, four separate technical memoranda (TMs) listed below have been developed to define the project that the District should build and operate:

TM 1 - Raw Water Quality Characterization for the Fallbrook Public Utility District's Santa Margarita River Conjunctive Use Project Facilities (See Appendix B)

TM 2 - Water Quality Goals for the Fallbrook Public Utility District Santa Margarita River Conjunctive Use Project Facilities (See Appendix C)

TM 3- Evaluation and Feasibility of Processes to Achieve Recommended Water Quality Goals (See Appendix D)

TM 4 - Water Distribution System Hydraulic Modeling (See Appendix E)

These documents are included in the appendix. A brief synopsis of each is presented below:

TM 1, Raw Water Quality Characterization for the Fallbrook Public Utility District's Santa Margarita River Conjunctive Use Project Facilities, summarizes the quality of the water to be supplied to the new SMRCUP facilities and recommends the anticipated water quality for the design of those facilities. It also provides recommendations for gathering any additional water quality data, sampling, or testing.

The TM refined a raw water quality summary of key constituents related to design, which is shown here in Table 1-1.

The new SMRCUP facilities will receive groundwater from existing and new wells located on MCBCP. The raw water quality summary presented Table 1-1 was developed from water quality samples collected from the existing wells. An evaluation of the raw water quality shows that all water quality constituents with Primary Maximum Contaminant Levels (pMCLs) and Notification Levels (NL) are well below their respective limits. However, several constituents with Secondary Maximum Contaminant Levels (sMCLs) exceed their Recommended Levels. These constituents include iron, manganese, total dissolved solids (TDS), color, and conductivity.

Table 1-1 Estimated SMRCUP Raw Water Quality for Key Constituents

Parameter	Units	Regulatory Limit	Water quality		
			Min	Avg	Max
General water quality parameters					
Alkalinity as $CaCO_3$	mg/L	--	173	201	223
Calcium	mg/L	--	80	89	94
Magnesium	mg/L	--	31	37	68
pH	--	--	7.1	7.3	7.8
Potassium	mg/L	--	2.5	3.6	5.6
Silica	mg/L	--	26.8	26.8	26.8
Sodium	mg/L	--	95	115	132
Total Organic Carbon (TOC)	mg/L	--	ND	1.8	3.4
Constituents with Primary Maximum Contaminant Levels					
Aluminum	µg/L	1000	ND	ND	ND
Barium	µg/L	1000	ND	59	140
Fluoride	mg/L	2	0.1	0.4	0.7
Nitrate as NO_3	mg/L	45	ND	1.6	4
Constituents with Secondary Maximum Contaminant Levels					
Aluminum	µg/L	200	ND	ND	ND
Chloride	mg/L	250 Recommended 500 Upper	145	161	173
Color - Apparent	color units	15	ND	5	18
Conductivity (EC)	µS/cm	900 Recommended 1600 Upper	1030	1226	1317
Iron	µg/L	300	11	100	317
Manganese	µg/L	50	199	287	494
Odor	TON	3	ND	0.2	1.5
Sulfate	mg/L	250 Recommended 500 Upper	63	184	208
Total Dissolved Solids (TDS)	mg/L	500 Recommended 1000 Upper	690	743	816
Turbidity	NTU	5	0.06	0.73	2.6
Constituents with Notification Levels					
Boron	µg/L	1000	41	135	191

In order to determine the necessity of iron and manganese (IM) and reverse osmosis (RO) treatment, and to subsequently design these processes, an assumed raw water quality is required (referred to as design water quality). An abbreviated design summary for key constituents that can determine the necessity of IM and RO treatment is shown in Table 1-2.

The evaluation of the available raw water quality data shows that sufficient information is available for the evaluation and design of treatment processes for the SMRCUP with the following exceptions, where additional sampling, testing, and analysis is recommend:

- Strontium sampling and additional silica sampling;
- Disinfection By-Product formation testing; and
- Integrating 2008 to 2010 water quality data into raw water quality summary.

The additional sampling, testing and analysis is not expected to delay the project.

Table 1-2 Design Water Quality for IM and RO Processes

Parameter	Units	Design water quality
IM Process		
Iron	µg/L	10 min 400 max
Manganese	µg/L	500
RO Process		
Chloride	mg/L	165
Total Dissolved Solids (TDS)	mg/L	750

TM 2 - Water Quality Goals for the Fallbrook Public Utility District Santa Margarita River Conjunctive Use Project Facilities, proposes water quality production goals for the SMRCUP and provides a discussion of treatment processes that may be required to reach those goals.

The recommended goals are summarized in Table 1-3. These goals were developed based on consideration of the uses of the water (agricultural, potable consumption); the context of providing two major water sources in one distribution system (the SMRCUP water and imported water); the impact on recycled water quality; and past experience with waters from the same source (the south Marine Corps Base Camp Pendleton system). The reasoning behind the goals and detail of the goals is discussed in the body of the TM. The goals which have the most impact on treatment are those for iron, manganese and chloride.

Table 1-3 Summary of Recommended Water Quality Goals for the SMRUP[1]

Parameters	Units	Goals (descriptive)	Goals (quantitative)	Addresses
Iron	µg/L	Match existing supply	< 100	Aesthetics
Manganese	µg/L	Match existing supply	< 20	Aesthetics
Chloride	mg/L	Match existing supply	< 100 3-month avg (max) ≤ 87 long-term ≤ 87 Apr-Sept, when possible	Avocados & agriculture
TDS	mg/L	Meet accepted standard & match existing supply	≤ 483	Aesthetics
EC	µS/cm	Meet accepted standard & match existing supply	≤ 819	Aesthetics
THMs	µg/L	Conservative target	< 80% of pMCL	Regulation
HAAs	µg/L	Conservative target	< 80% of pMCL	Regulation
LSI	--	Match existing supply	0.37 (0.1-1.0)	Corrosion
CCPP	mg/L as $CaCO_3$	Match existing supply	4.6 (1.0-10)	Corrosion
Calcium hardness	mg/L as $CaCO_3$	Match existing supply	≤ 133	Scale formation

[1] Water quality goals are averages unless otherwise indicated

The preliminary list of required treatment technologies to meet these goals is as follows:

- Iron and manganese treatment with a backwash recovery system,
- Partial reverse osmosis (RO) treatment,
- Primary disinfection (*e.g.*, with free chlorine),
- Secondary disinfection with chloramines,
- Product water pH adjustment (*e.g.*, through caustic addition), and
- Facilities for adding orthophosphate for copper corrosion control.

With the above treatment technologies, it is expected that the SMRCUP can provide a safe, reliable, and agriculturally productive water supply that meets all regulatory limits, recommended consumer acceptance levels, and essentially maintains or bests the quality of the imported water quality with respect to agricultural uses.

TM 3- Evaluation and Feasibility of Processes to Achieve Recommended Water Quality Goals, defines the overall project based on TM 1, TM 2 and TM 4 and explains the reasoning behind the difference in the current project and that presented in the previously prepared USBR Feasibility Design Report, and the draft EIS/EIR. The major difference being the hydraulic modeling results showing that relative minor modifications to the District's distribution system eliminates the need for the two separate, previously proposed pipelines: one from the SMCUP plant to the Gheen reservoir site, and a second from the Gheen site to the Red Mountain Reservoir site. The elimination of the pipeline focuses attention on SMCUP treatment process to match the water quality within the District's distribution system.

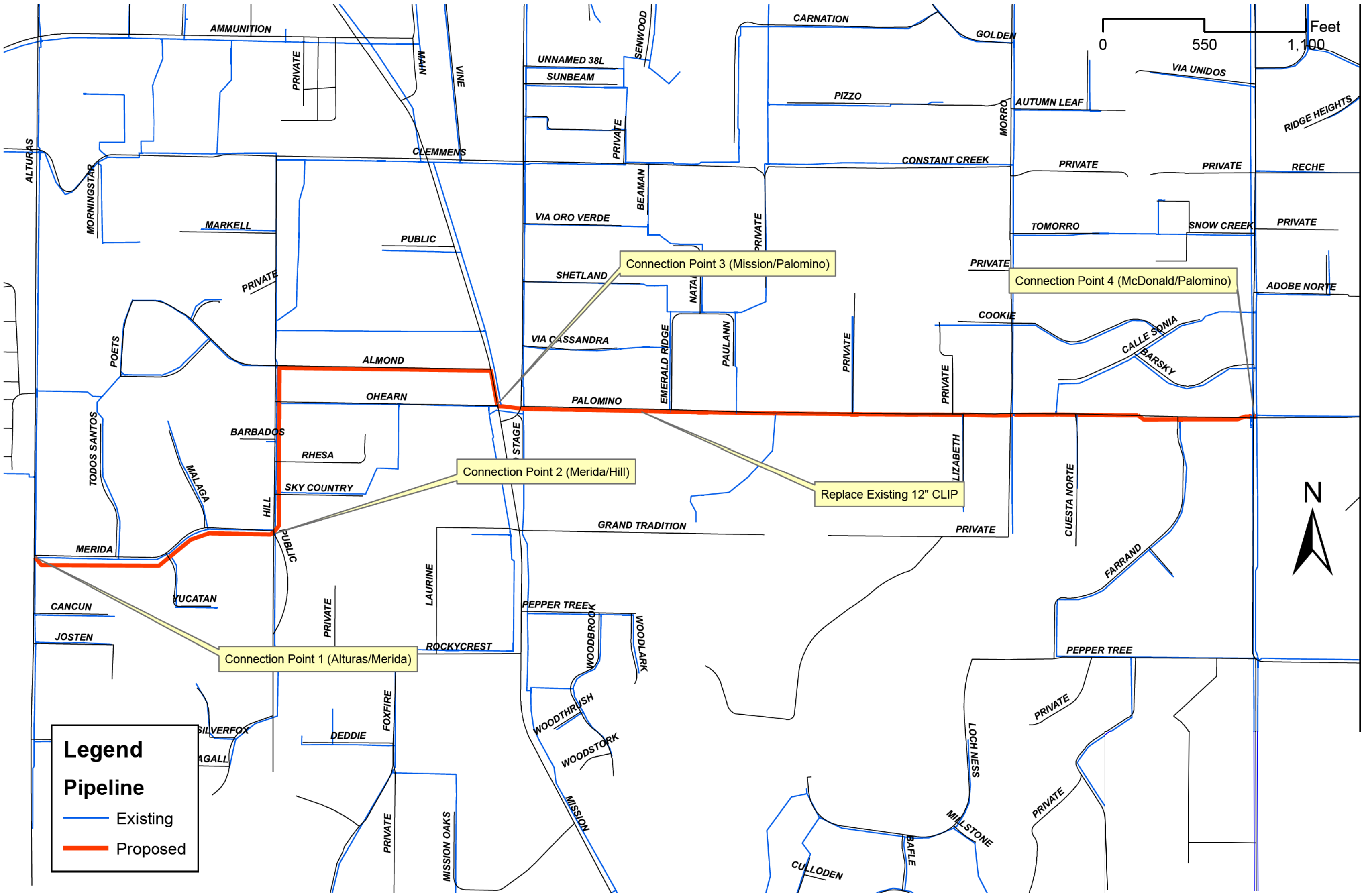
TM 4 - Water Distribution System Hydraulic Modeling, presents the results of an InfoWatewaterdistribution system hydraulic model prepared for the District. The model considers well water supplied from the CPEN, flowing through the proposed groundwater treatment facility (SMCUP plant) and pumped into the distribution system. Water quantities supplied are based upon monthly deliveries entitled to the District depending on Santa Margarita River flow of the previous year.

The water model was analyzed for May demand conditions, which represent the maximum potential delivery from CPEN of 7.8 million gallons per day (MGD) to the District. The model was used to determine if the distribution system could accept the maximum water production of the plant into the Gheen pressure zone, and to determine any pipeline improvements that may be necessary. The model was also used to determine potential improvements at the District's Gheen Reservoir site including: 1.) additional storage, 2.) a pump station to pump from the Gheen zone into the Red Mountain zone in the event that plant production exceeds the Gheen zone demands, and 3.) pipeline improvements to the adjacent Red Mountain zone.

The model was also used to determine the maximum amount of flow that the San Diego County Water Authority (SDCWA) could supply to CPEN in the event of a local extended drought situation through the District's system.

Based on input from the District, and the hydraulic evaluation, the recommended improvements and findings include the following:

- Gheen zone pipeline improvements as shown in Figure 1-1, which includes replacement and additions of nearly 8,500 feet of 24-inch diameter pipeline from the SMCUP plant site to McDonald Road.
- Red Mountain zone improvements near the Gheen reservoir site as shown in Figure 1-2, which includes about 2,000 feet of new 24-inch pipeline from the Gheen Reservoir site north to the Kauffman Pressure Reducing Valve (PRV), and upsizing of about 800 feet of the 12-inch main from the Gheen Reservoir site south to Gumtree PRV with a 24-inch main.
- A new pump station at the Gheen reservoir site to produce a total dynamic head (TDH) of 170 feet at a flow rate of 4 MGD, and a TDH of 202 feet at a flow rate of 8 MGD, requiring 200 and 400 horsepower respectively, as is shown in Figure 1.2.
- A new 4 million gallon (MG) reservoir of additional storage at the Gheen reservoir site.
- A product water SMCUP pump station to produce a TDH of 375 feet at a flow rate of 7.8 MGD requiring 2,500 horsepower.
- Facilities on the plant site to control return flows to CPEN, which, while limiting customer pressure reduction to 20 psi, could provide a flowrate of 7.3 MGD.



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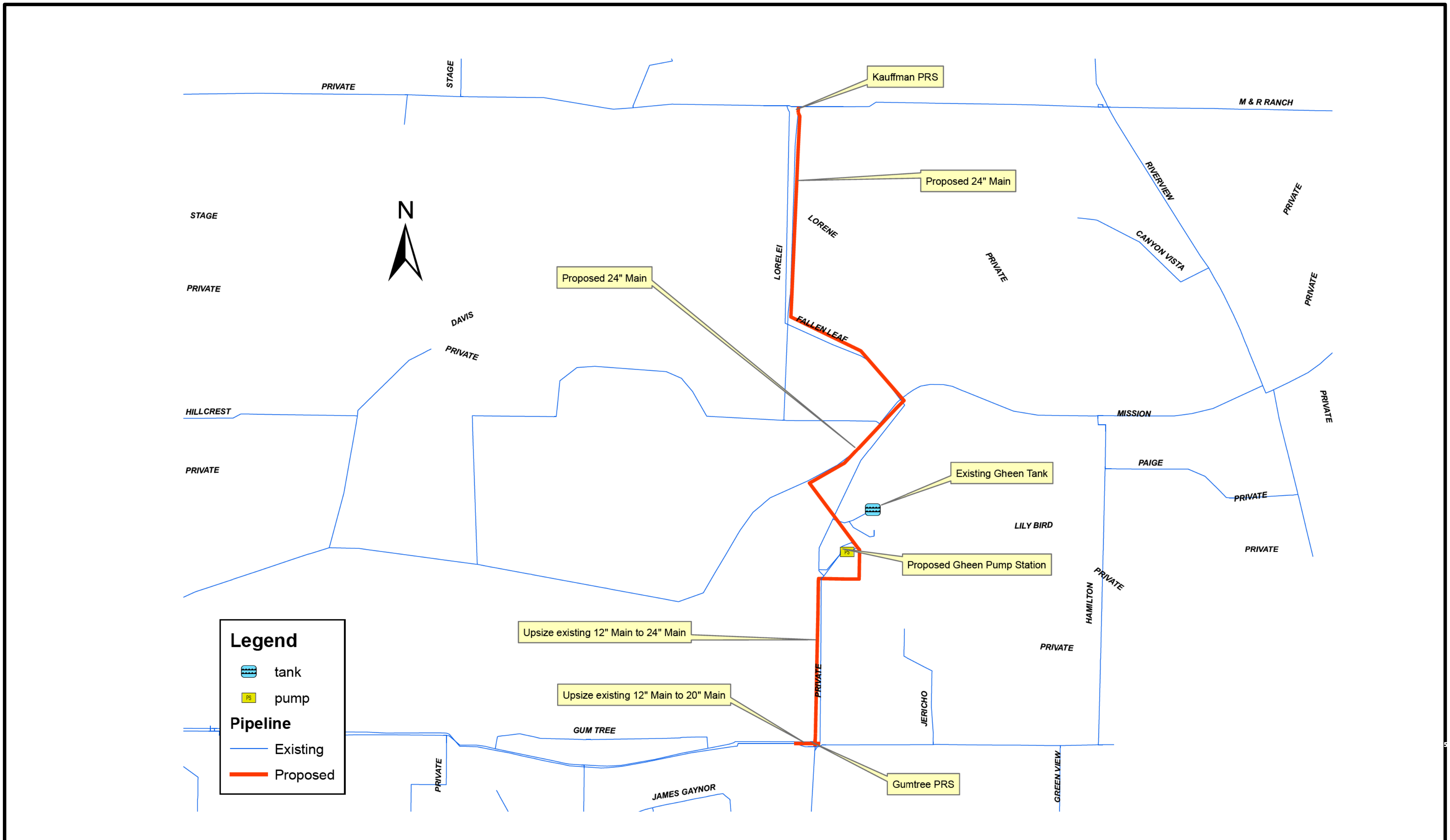
GHEEN ZONE IMPROVEMENTS

FIGURE
1-1



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RED MOUNTAIN ZONE IMPROVEMENTS

FIGURE 1-2

2.0 PURPOSE AND CONTENT OF THE PRELIMINARY DESIGN REPORT (PDR)

With the quality of the ground water being received from CPEN determined in TM 1, the water quality goals of the plant established in TM 2, plant process identified in TM 3, and the water distribution system modeling complete in TM 4, the purpose of the preliminary design report is to present the development of further engineering design investigations and alternative analysis associated with the project. Figure 2-1 on the next page depicts the SMCUP elements including the plant, distribution system, and Gheen reservoir site improvements. The information provided within the PDR includes development of design criteria, basis of the design, layout of the plant and Gheen sites, mechanical, structural, architectural, and electrical layout for each site, selecting specific types and sizes of the major pieces of equipment, and pipeline and yard piping alignments all culminating in the production of 30-percent complete design drawings found in Appendix A. A list of anticipated specifications to be developed during final design is presented in Appendix I.

The PDR provides the information necessary to proceed to final design development.

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OVERALL PROJECT PLAN

FIGURE
2-1

3.0 WATER TREATEMENT PLANT PROCESS FLOW

The process flow diagram follows closely with that of TM-3, and is shown on Drawing G-6 and G-7 of the 30% design drawings in Appendix A. An overview of equipment capacity and purpose are show in the Table 3-1 below.

Table 3-1 Summary of Equipment Sizes and Purpose

Plant Area	Equipment	Capacity	Purpose
Area 100	Flow Control Facility	7.2 mgd	Facilitates delivering water to CPEN under severe drought conditions
Area 200	Equalization (EQ) Tank	133,000 gallons	1. Allows for fluctuations in flow from CPEN. 2. Provides storage to assist with controlled startup and shutdown of the plant.
Area 200	IM Vessels	5 IM vessels, 12 foot in diameter by 30 feet long	Provides iron and manganese removal treatment.
Area 200	IM Vessel Back Wash Pumps	2 - 1,500 gpm pumps	Provides backwash of the IM vessels.
Area 300	RO Feed Tank	160,000 gallons	1. Proves additional volume and time within the process stream for dechlorination of the IM treated water to protect the downstream RO membranes from oxidation. 2. Provides washwater storage volume for backwashing the IM media.
Area 300	RO Feed Pumps	1 - 500 - gpm pump 2 – 1,200 – gpm pumps	Provides discharge of 40 psi to push the flow through the cartridge filters and on into the suction of the high-pressure RO pumps.
Area 300	IM Treated Water/RO By-Pass Flow-control valve (FCV)	6-inch Butterfly Valve 8-inch Butterfly Valve 14-inch Butterfly Valve	Controls the flowrate by-passing the RO system for downstream blending.
Area 400	RO Cartridge Filters	3 - Cartridge Filters	Fulfills RO pretreatment warranty requirement.
Area 400	RO high-pressure pumps	3 - 1,020 gpm pumps	Drives the flow through the RO membranes.
Area 400	RO membrane Trains	3 - 0.93 MGD trains	Reduces TDS and chloride

Plant Area	Equipment	Capacity	Purpose
Area 500	Clearwell	119,000 gallons	Provides detention time and baffling to assist with disinfection CT requirements.
Area 500	Product Water Pumps	4 – 1,400 gpm pumps	Pump product water from the clearwell into the Gheen pressure zone and distribution system
Area 700	Waste Washwater (WWW) Tank	186,000 gallon	Holds two IM vessel back wash volumes. Provides sludge settling time.
Area 700	WWW Sludge Pumps	1 - 35 gpm pumps	Pushes the WWW sludge to the drying beds.
Area 700	Treated WWW Recycle Pumps	1 - 250 gpm pumps 1 - 275 gpm pumps	Recycles the treated (decanted) WWW back to the front of the plant.

4.0 PLANT HYDRAULICS AND CONTROL

The hydraulic profile of the plant is shown on is Sheet G- 8 of the 30% design in Appendix A.
An overview of the plant hydraulic level control and flow control are provided below, shown in outline form. Refer to the P&IDs in the 30% drawings, found in Appendix A, as referenced.

4.1 Area 100 Ground Water Supply and CPEN Return

Under normal conditions ground water is provided to the District from CPEN by a pump station designed by the CPEN engineering consultant. Referring to Drawing 100I-1, the flow-control valve (FCV) is closed and the control valve (CV) is normally open. This function will be coordinated with CPEN's engineering consultant during final design.

Under return flow conditions the FCV is modulated based on a FPUD/CPEN agreed upon flow set point and the flow element/flow-indicator transmitter (FE/FIT) meter signal. The CV will be in closed position when flow is returned to CPEN.

4.2 Area 200 Equalization (EQ) Tank and IM Treatment

Refer to 200I -1 and note the following:

1. The FCV control valves on the discharge of each IM vessel control the following:
    a. Level in the EQ Tank based on a level set point and feedback from the level sensor by means of the level element/level-indicator transmitter (LE/LIT) signal. Compound level and flow setpoint control is used to stabilize both level and flowrate.
    b. Even flow split between the IM vessels in service based on the signals from respective flow meters, FE/FITs.
2. The motorized CVs open and close based on the programmed back washing sequence.
3. The IM backwash pumps are started manually or automatically based on either of the following:
    a. The IM vessel in-service time set point is has been reached and the RO Feed Tank has sufficient wash water volume to complete the wash cycle as indicated by the High level reading in the tank.
    b. The differential pressure set point between the pressure indicator transmitters (PITs) across the vessels is met and the RO Feed Tank has sufficient wash water volume to complete the wash cycle as indicated by the High level reading in the tank.
4. The IM back wash pumps are inactivated automatically when:
    a. The low level set point in the RO Feed Tank is reached.
    b. The high-high level in the Waste Wash Water Tank is reached.
    c. The backwash sequence is concluded.

4.3 Area 300 RO Feed Tank and IM Treated Water/RO By-Pass

Refer to 300I -1 and note the following:

1. The FCV in the IM treated water/RO by-pass line performs as follows:
    a. Modulates to maintain an RO Feed Tank high level based on the level set point and corresponding, LE/LIT signal, to maintain backwash water reserve.
    b. Adjusts the RO Feed Tank fill rate based on a set point percentage (10%) of the sum of the flow from CPEN, FE/FIT on 100I-1, and recycle flow, FE/FIT on 700I- 1.
    c. Closes at an increased rate when the low level set point in the RO Feed Tank is reached. This set point represents level at which the backwash volume has been used.
    d. Modulation of the FCV affects the flowrate through the FE/FIT, which in-turn adjusts the flow through the RO treatment train based on a set point flow rate split ratio (*e.g.*, 50%). The split on the RO system is maintained by adjusting the speed of the High-Pressure RO pumps via associated variable frequency drives (VFDs) and flow meters, see 400I-2 of the 30% design drawings found in Appendix A.
2. The RO Booster Feed Pumps are constant speed and are started and stopped manually depending on flows being received by CPEN.

4.4 Area 500 Clearwell and Product Water Pump Station

Refer to 500I -1 and note the following:

1. The motorized CV upstream of the clearwell tank closes upon a high-high level in the clearwell to prevent overflow of the tank.
2. The product water pumps will not start if the upstream PE/PIT does not meet a set suction pressure setting.
3. The product water pumps will not continue to run if the discharge pressure, as registered by the downstream PE/PIT, is higher than a set value after a set period of time (2 minutes)
4. When the pumps are started the discharge CV opens after a set time period (30 seconds).
5. The level in the clearwell is maintained to a set point by controlling the speed of the product water pumps by means of VFD drives.

4.5 Area 700 IM Waste Washwater Tank

Refer to 700I -1 and note the following:

1. The CV upstream of the waste wash water recovery tank closes upon a high-high level being reached based on the signal from the LE/LIT
2. The waste wash water sludge pump is constant speed.
3. The waste wash water reclaim pumps have VFDs.
4. The waste wash water reclaim and sludge pumps will not start if the upstream PE/PIT does not meet a set suction pressure setting.
5. The waste wash water reclaim pumps will stop based on the following:
    a. Set point turbidity range is not met after a set time period (*e.g.*, 20 minutes).
    b. Low level in the waste wash water tank is reached.
    c. High-high level in equalization tank is exceeded.
    d. High discharge pressure

6. The reclaim pumps are started automatically based on settling time setpoint.
7. WWW Sludge Pump and the WWW Decant Pumps are started and stopped manually, or on programmed timers. They will stop automatically based on exceeding a set high discharge pressure.

Calculations for hydraulic losses and pump head requirements are found in TM-4.

Hydraulic basis of pump and valve selection for the plant and Gheen site are provided under specific sub headings in Sections 5.0 and 7.0, respectively.

5.0 WATER TREATMENT PLANT PREDESIGN

Ground water received from CPEN treated at the water treatment plant and pumped into the District's distribution system. The design criteria and preliminary design of major elements and equipment for the water treatment plant are provided below.

5.1 Site and Yard Piping

The plant layout as shown on the Site Plan and Yard Piping, Drawing C-1 of the 30% design drawings found in Appendix A. and was based on the following considerations:

- Public Feedback
- Hydraulics
- Access to pumps, valves, tanks, vessel media exchange, and chemical deliveries
- Storm water
- Proximity to exist sludge drying beds
- Parking
- Yard piping configuration and process/fire loop
- Security
- District Feedback

A community meeting was held on April 16, 2015, where FPUD received feedback indicating a preference for the plant to be located at the lower elevations of the property as opposed to the higher elevation portion of the District's property located to the northeast of current site. See Drawing C-1.

While the majority of facilities are at lower elevations to assist with plant hydraulics it was necessary for the Equalization Tank to be placed at a higher elevation on the property. This minimizes the need for an additional pumps station and minimizes related energy costs. The Waste Wash Water Recovery Tank is above grade to reduce potential hard rock excavation and reduce cost.

To accommodate access to major pieces of equipment, that may need to be moved by means of a crane, the RO Booster pumps, IM Backwash pumps, and the Product Water pumps are located adjacent to the access road around the plant. The IM vessels themselves also being adjacent to the access road assists with the handling and procedures necessary for periodic IM media replacement. The access road provides complete circulation around the plant with a 25 foot minimum road width meeting fire truck and chemical truck turning radius requirements.

The site layout requires the demolition of one of the existing drying beds on the site to provide additional area for the plant, see Drawing D-1.

Parking is provided next to the plant control room and within convenient walking distance to the RO and chemical facilities.

The yard piping was laid out giving consideration to minimizing lengths of piping that may be stagnant during normal operations of the plant, reducing the potential for water age issues. The yard piping, where possible, utilizes multiple pipelines within a single trench to reduce overall costs. The yard piping includes a plant process water system/fire service loop to facilitate housekeeping and maintenance related needs, and fire protection requirements. Pipe design criteria will follow that provide in the Section 6.1 entitled Design Standards and Criteria.

Site security will include new fencing, gate and security camera surveillance.

5.2 Hydrology and Drainage Design

5.2.1 Existing Drainage Conditions

The proposed water treatment plant (WTP) site consists of moderately (5 to 10 percent) to steeply (greater than 10 percent) sloping terrain with elevations ranging from 652 at the existing condition runoff concentration point (Node 4) located at the existing asphalt storage area to 710 at the top of the hill. The existing condition drainage boundary is shown in Figure 5-1.

Drainage across the site is by sheet flow. The drainage area that is tributary to the runoff concentration point is approximately 3.63 acres. The undeveloped portion of the site has sparse and poor quality grass/brush coverage. The soils at the site are assumed to be Type D.

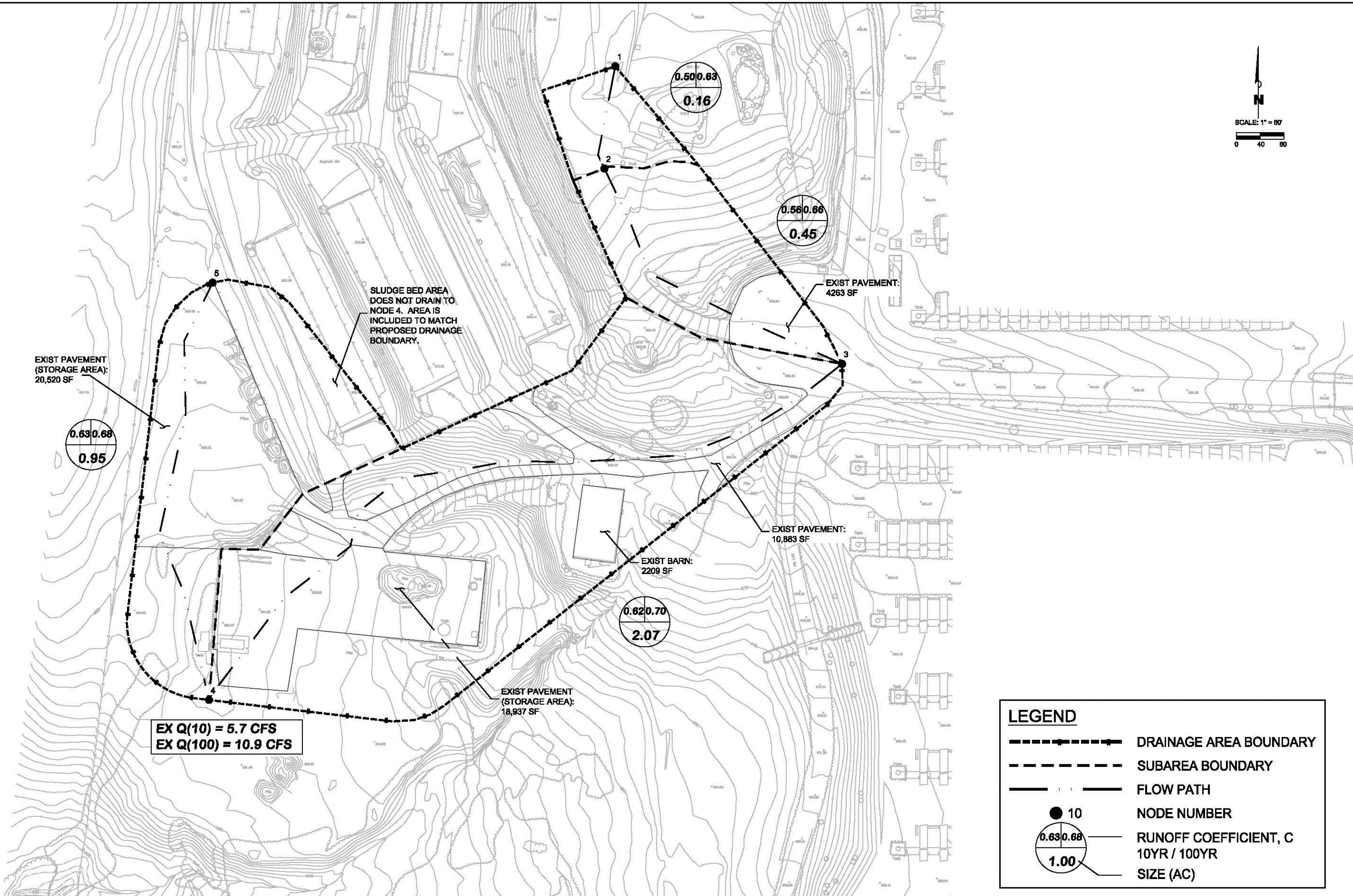
The existing improvements consist of the existing asphalt concrete roadway and storage pads, and a barn. The existing impervious area totals 56,812 square feet, or approximately 36 percent of the 3.63-acre drainage area.

5.2.2 Proposed Drainage Conditions

The proposed condition drainage area boundary is the same as the existing condition boundary, or 3.63 acres. Impervious improvements will consist of new tanks, process vessels, WTP building and access road. The proposed impervious area totals approximately 68,965 sf or 43.6 percent of the 3.63-acre drainage area. The proposed condition drainage boundary is shown in Figure 5-2. The site is divided into two general areas: upper and lower.

<u>Upper:</u>
Proposed improvements will include curb and gutter, asphalt concrete paving, and the equalization tank above approximate elevation 660 feet. Runoff from this area will be intercepted by the proposed curb and gutter and conveyed by the proposed roadway to the existing runoff concentration point at Node 5.

<u>Lower:</u>
The proposed WTP and perimeter access road will be constructed in the lower portion of the site, below approximate elevation 660 feet. The WTP pad will be graded and mostly surfaced with crushed rock with the exception of paving for equipment/tank pads, access road, and concrete walks and delivery areas adjacent to the WTP building. Runoff from the WTP pad will flow overland and runoff from the proposed access road will be conveyed by curb and gutter to the existing runoff concentration point at Node 5. A curb cut and concrete swale is proposed to convey the runoff into a detention basin. The detention basin is intended to be a dual purpose basin to reduce the proposed condition peak runoff rate to the existing condition runoff rate and to provide treatment of stormwater runoff prior to discharging to the existing condition concentration point.



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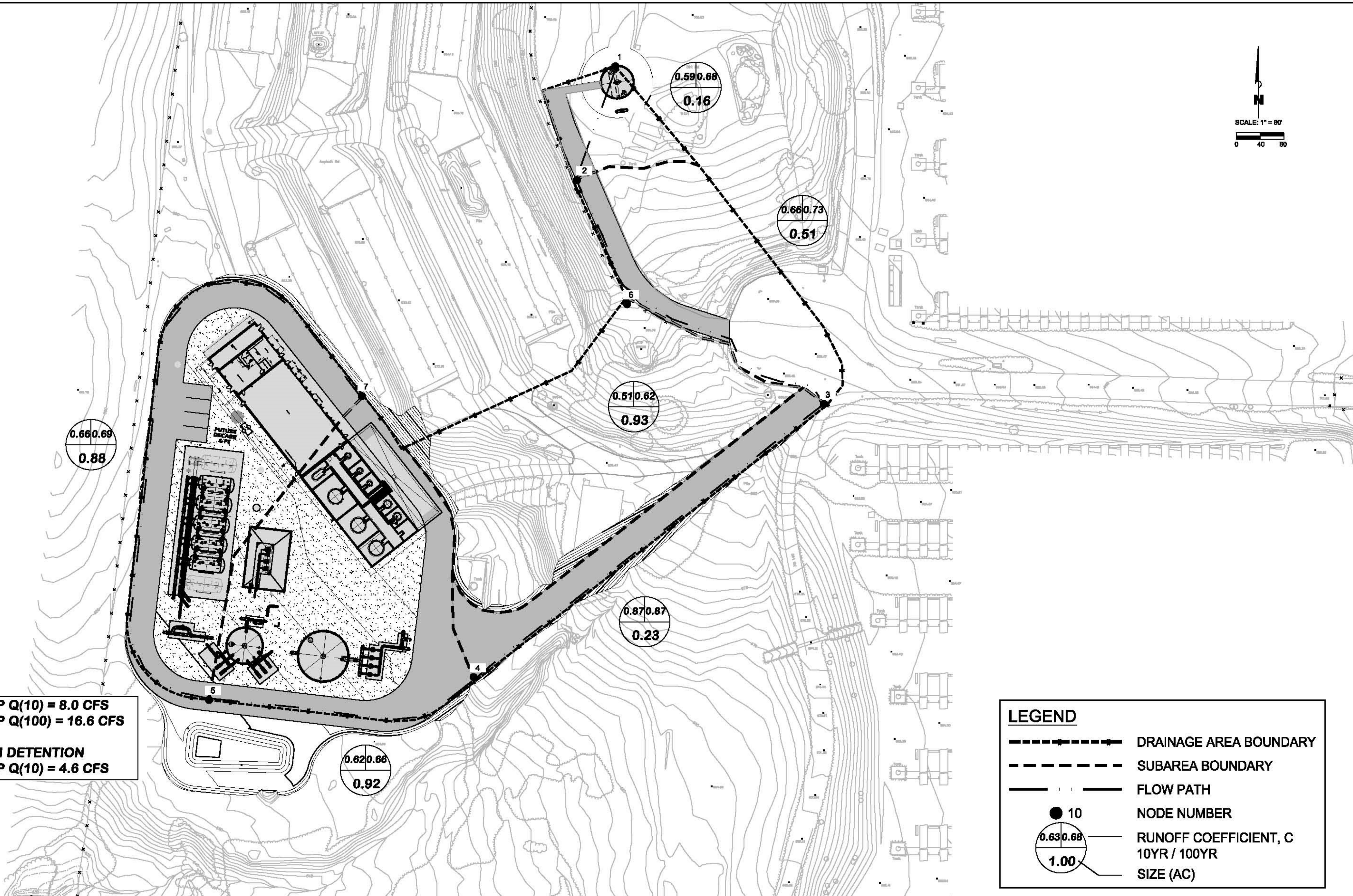
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

HYDROLOGY MAP - EXISTING CONDITION

FIGURE 5-1



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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

HYDROLOGY MAP - PROPOSED CONDITION

FIGURE 5-2

5.2.3 Rational Method Hydrology

Hydrology calculations were performed using the Civil3D computer program and the Modified Rational Method described in the San Diego County Hydrology Manual. The Rational Method formula estimates the peak rate of runoff at any location in a watershed as a function of the drainage area (A), runoff coefficient (C), and rainfall intensity (I) for a duration equal to the time of concentration (Tc), which is the time required for water to flow from the most remote point of the basin to the location being analyzed. The rational method formula is expressed as follows:

$Q = C\,I\,A$ Where:

Q = peak discharge, in cubic feet per second (cfs)
C = runoff coefficient, proportion of the rainfall that runs off the surface (no units)
I = average rainfall intensity for a duration equal to the time of concentration (Tc) for the area, in inches per hour (Note: If the computed Tc is less than 5 minutes, use 5 minutes for computing the peak discharge)
A = drainage area contributing to the design location, in acres

The methodology for Rational Method calculations is described in Appendix G. A 6-hour storm duration is used for design and is consistent with the guidelines of San Diego County. Also provided in this appendix are charts and tables used in the selection of the hydrologic parameters including runoff coefficients, rainfall depth, rainfall intensity and velocity and travel time nomographs. These are described further herein.

5.2.4 Runoff Coefficients

The runoff coefficients are selected in accordance with guidelines from the Caltrans Highway Design Manual. For runoff detention calculations, the runoff coefficients listed in the Caltrans Highway Design Manual, Chapter 810 – Hydrology, were used instead of those in the San Diego County Hydrology Manual because the Caltrans methodology provides a more accurate characterization of undeveloped, or natural ground, runoff coefficients based on relief, soil infiltration, vegetal cover, and surface storage.

One consideration for the development of subarea boundaries is the division of cover type, whether pervious or impervious. In some cases, a particular subarea may have combined pervious or impervious areas, in which case a weighted runoff coefficient is determined in accordance with the following equation:

$C = 0.9*(\%Impervious) + Cp*(1 - \%Impervious)$
where:
Cp = pervious area runoff coefficient corresponding to soil type.

A listing of weighted runoff coefficients is provided in Appendix G.

5.2.5 Summary of Peak Discharge

A summary of the estimated peak runoff rates for the existing and proposed conditions are shown in the following table:

Table 5-1 Hydrology Summary

Condition	Area (ac.)	Q_{100} (cfs)	Q_{10} (cfs)
Proposed – Node 5	3.63	16.6	8.0
Existing – Node 4	3.63	10.9	5.7
Difference:	- -	5.7	2.3

5.2.6 Detention Routing

In order to mitigate the increase in runoff for the 10-year storm event, a detention basin is proposed along the south side of the treatment plant site. All runoff from the site will be routed into a detention basin to reduce the total peak flow leaving the site.

Table 5-2 Hydrology Summary

Condition	Area (ac.)	Q_{10} (cfs)
Proposed with Detention – Node 5	3.63	4.6
Existing – Node 4	3.63	5.7
Difference:	- -	-1.1

A comparison with the existing condition shows that the detention basin reduces flows to less than existing conditions. The detention basin also serves as a water quality treatment facility, which is discussed in the next section.

5.2.7 Water Quality Treatment

The requirements of the reissued National Pollutant Discharge Elimination System (NPDES) Permit for Discharges from the Municipal Separate Storm Sewer Systems (MS4), Order No. R9-2013-0001, pertaining to the watersheds within the jurisdiction of the County of San Diego are used herein as a guideline in developing post-construction BMPs to address water quality concerns. Although the District is not a co-permittee to Order No. R9-2013-0001, this approach satisfies the District's duty to mitigate potential adverse impacts to health and the environment as required by the Order and is consistent with approaches that are in effect by the local jurisdiction to reduce the discharge of pollutants in urban runoff to the maximum extent practicable.

According to Order No. R9-2013-0001, the SMCUP project is categorized as a Priority Development Project (based on project size and impervious area) and is required to design treatment control BMPs to retain (i.e. intercept, store, infiltrate, etc.) onsite the pollutants contained in the volume of runoff produced from a 24-hour, 85th percentile storm event. Where retention is not feasible due to site and soil constraints, detention is allowed. The 24-hour, 85th percentile storm event is determined from the County of San Diego's 85th Percentile Precipitation Isopluvial Map.

The proposed basin will provide water quality enhancement via filtration through sand and gravel, attenuation of peak runoff, and a means for perpetuating the existing drainage patterns. It may also function to capture treatment process tank overflows although this is not a primary design consideration. The design criteria for the basin include:

Water Quality Criteria:

1. Treat the runoff from the 85th percentile, 24-hour storm event.
2. Size the detention basin bottom at a minimum of three-percent of the total impervious area.
3. Size the filter bed to allow for a drawdown period between 24 and 72 hours to provide treatment and to reduce the potential for vector breeding as a result of standing water.

Peak Discharge Criteria:

1. Detain the proposed 10-year, 6-hour storm runoff to match the 10-year existing condition flow rate, or less.
2. Concentrate the runoff from areas to receive improvements for more efficient treatment.
3. Preserve existing drainage patterns and flow rates.
4. In rare events, capture overflows from water treatment plant facilities and release the flows at a controlled rate.

Applying these criteria, the following objectives were established for the basin design:

Side Slopes:	3:1
Minimum Bottom area:	2,069 sf
Minimum Water Quality Volume:	5,805 cf
Minimum Freeboard:	3 inches
Water Quality Discharge Outlets:	4-inch diameter perforated PVC pipe(s)
Principal Discharge Outlet:	Double grated inlet (San Diego Regional Standard, Type G-2) with grate elevation above the water quality volume elevation
Emergency Overflow:	100-year, 6-hour storm runoff
Weir flow height:	6 inches
Weir length:	15 feet

Based on the proposed basin configuration, a basin depth of 3.2 feet (relative to the invert elevation of the subdrain system), or a ponding depth of 8 inches relative to the basin floor elevation, will be required for water quality treatment. The basin bottom section will consists of a sand media filter consisting of a layer of sand over a layer of Class 2 permeable base with a perforated PVC pipe subdrain. The sand media and perforated PVC pipe subdrain will allow for at least a 24-hour drawdown period. The principal outlet will be designed to safely pass up to the 100-year storm runoff or the overflows from the treatment process tanks.

5.3 Area 100 – CPEN Reverse Flow Control Facility (FCF)

The CPEN Reverse Flow Control Facility (FCF) is shown on the site plan, Drawing C-1 and 100M-1 of the 30% design drawings found in Appendix A. Under normal conditions ground water is provided to the District from CPEN by a pump station designed by the CPEN engineering consultant. Under conditions of drought water from SDCWA can be wheeled through the FPUD distribution system to CPEN. Under these conditions the FCV is placed into service and modulates flow based on FPUD/CPEN agreed upon flow set point (Refer to Section 4.0). While the design of the receiving facilities on CPEN are not defined at this time it is anticipated the terminal elevation at CPEN will match that of the (MCBCP) IM-24 desalter of approximately 130 feet. Water will be coming from SDCWA through the FPUD Gheen pressure zone. The current design utilizes a plunger valve. Hydraulic criteria for the valve is shown in the following table.

Table 5-3 CPEN Reverse Flow Control Valve Hydraulic Criteria

Hydraulic Element	HGL or Pressure
Gheen Zone HGL	1020
CPEN Estimated Terminal HGL	300
FCV Elevation	656
FCV Upstream HGL at Zero Flow	728
FCV Downstream HGL at Zero Flow	ATM
FCV Upstream Pressure (psig) at 7.3 mgd	140
FCV Downstream Pressure (psig) at 7.3 mgd	0 (ATM)

Note: Dynamic losses (approximately 100 feet) based on assumed pipe diameter of 24 inches and downstream length of 38,000 feet.

Actual sizing of the plunger valve will be performed during final design and when the CPEN facilities are defined by CPEN's design consultant. The HGL of the CPEN is approximated using the elevation of the (MCBCP) IM-24 site. Downstream control of the flow through the FCF may be necessary to provide some back pressure for the plunger valve to avoid discharging to atmosphere pressure. Piping design criteria matches that found in Section 6. The internal pressure of the pipeline on the plant site will conform a design pressure of 300 psig in compliance with Section 15076 of the FPUD Standard Specifications. Surge evaluation and cavitation analysis will occur as part of the final design process.

5.4 Area 200 – Iron and Manganese Treatment

The goal of the iron and manganese (IM) treatment system is to reduce iron and manganese concentrations to levels that meet aesthetic water quality goals and that prevent iron- and manganese-related fouling of the downstream reverse osmosis (RO) membranes (see Technical Memorandum 2 in Appendix C for water quality goals). Granular media pressure filtration with continuous chlorination application upstream will be used for IM removal. The IM system will also include supporting backwash, waste washwater, sludge handling, and chemical facilities. The design criteria for the IM system are described below.

An IM system Original Equipment Manufacturer (OEM) will provide the pressure vessels, facepiping, vessel valving, air scour system, differential pressure gauges and panel (with pressure switch), backwash flow rate panel, a local control panel and internals, and internals, including filter media, support media, underdrain, upperdrain, nozzles, and interior finish paint. The OEM will also provide programming of the IM system controls, and will be responsible for the effluent water quality.[1] Elements of the control system are introduced in the text below; further details are shown in the Process and Instrumentation Diagrams (P&IDs).

5.4.1 Equalization Tank

To account for minor fluctuations in flow rates of ground water received from CPEN an equalization tank is provided. The tank will provide 10 minutes of buffering capacity before overflow in case the plant

[1] Several IM OEMs were consulted in the development of the design criteria presented in this preliminary design report, including TonkaWater, WesTech, and Hungerford & Terry.

were to experience an emergency shutdown while receiving 7.8 mgd from CPEN. In a scenario where CPEN flow stops suddenly from 7.8 mgd, there is 4 feet or 5.5 minutes of buffering. However the control system will reduce the flow rate through the IM automatically to try and maintain the set point level in the EQ tank slowly bringing the flow to a stop. Both the IM and RO process can respond quickly to reduced flows. Design criteria for the tank is provided as follows.

- Type of Tank: Welded Steel (AWWA D-100)
- Storage Capacity: 0.14 MG
- Diameter: 27 feet
- High Water Level: 32 feet
- Floor Elevation: 710 feet
- Free Board: 2.5 feet
- Roof: column-supported cone with radius knuckle
- Total Tank Height: 34.5 feet

The tank is shown on the site plan, Drawing C-1 and Drawing 200M-1 of the 30% design drawings in Appendix A. Dimensions are subject to change during final design.

The proposed tank will be designed according to the provisions of ASCE 7. Key parameters for wind and seismic design loads are as follows:

General Parameters

- Site Class: C

Wind Design Load

- Wind Load Risk Category IV
- Wind Speed: 115 miles per hour
- Exposure: C

Seismic Design Load

- 0.2-second period, mapped spectral accel., S_S: 1.223 g
- 1-second period, mapped spectral accel., S_1: 0.471g
- Short-period site coefficient, F_a: 1.0
- Long-period site coefficient, F_v: 1.329
- 0.2-second period, Design Earthquake spectral response accel., S_{DS}: 0.815g
- 1-second period, Design Earthquake spectral response accel., S_{D1}: 0.418g
- Earthquake Importance Factor, I_e: 1.25

Tank Design

Steel tank structural design criteria consists of the following:

- Design per current AWWA D100 standard
- Roof design live load: 20 pounds per square foot (reducible)
- Tank shall be mechanically anchored to the foundation
- Tank shall be classified as Seismic Use Group (SUG) II
- Use Ri = 2.5 and Rc = 1.5 for base shear, overturning moment and hoop shell tension design
- Checking longitudinal tank shell compression stress (wall buckling)
- Freeboard will be based on AWWA D100 requirements. 2.6 feet of freeboard is estimated for

preliminary design based on the design of similar steel tanks in California per the current D100 standard. An alternative design procedure may consist of a lower tank roof (with less freeboard) which is structurally reinforced to withstand, but not prevent, damage from tank sloshing. This alternative approach is assumed to be similar in cost to a taller tank, although it is not yet common practice for steel tanks constructed per current AWWA code in California.

5.4.2 Pressure vessels

IM treatment technologies can include various combinations of adsorptive, oxidative, and filter processes to remove iron and manganese, including chemical oxidation with and without adsorption site catalysts, biological oxidation, granular media filtration, membrane filtration, and reverse osmosis. The most common technology is granular media filtration with a chemical oxidant carried through the filters. These filters are typically operated under pressure for relatively small systems treating groundwater, like the Fallbrook Public Utility District (FPUD). Pressure vessels will be used for this project and their design criteria are shown in Table 5-4.

Table 5-4 Pressure Vessel Design Criteria

Parameter	Units	Value
Number of pressure vessels	#	5
Pressure vessel configuration	na	Horizontal
Active surface area per vessel, minimum[1]	ft^2	360
Vessel diameter[2]	ft	12
Vessel overall length[2]	ft	33
Number of cells per vessel	#	2
Underdrain configuration	na	Common underdrain
Working pressure[3]	psi	100
Hydrostatic test pressure	psi	130
Construction	na	ASCE code stamped
Face-piping configuration	na	End-face piping
Nominal filtration rate[4]	gpm/ft^2	3.0
Nominal filter flow rate[4]	gpm	1,083
Backwashing filtration rate[5]	gpm/ft^2	3.8
Backwashing filter flow rate[5]	gpm	1,354

[1] Active surface area is the average filter surface area of the GreensandPlus media over the depth of the media
[2] Estimated dimensions based on preliminary discussions with IM OEMs
[3] Design pressure is approximately 30 psi
[4] All filters online, excluding estimated recycle flow of 0.78 MGD, calculated with minimum filter area per vessel (recycling would increase the filtration and filter flow rate to 3.3 gpm/ft^2 and 1,192 gpm, respectively)
[5] One filter backwashing (*i.e.*, one filter offline), excluding estimated recycle flow of 0.78 MGD, calculated with minimum filter area per vessel (recycling would increase the filtration and filter flow rate to 4.1 gpm/ft^2 and 1,490 gpm, respectively)

The number of vessels and minimum filter surface area were selected to achieve target filtration rates based on experience with other systems. The number of cells was selected to keep the filtration rate above 2 gpm/ft^2 at the minimum flow, where 2 gpm/ft^2 is recommended to avoid channeling (short-circuiting). Two cells per vessel will keep the minimum filtration rate above 2 gpm/ft^2 for all minimum flow deliveries guaranteed by MCBCP. MCBCP may provide flows that are not currently a part of the guaranteed minimum flow schedule, and a range of these flows (0.79 to 1.01 MGD) will lead to a filtration rate outside of 2 to 3 gpm/ft^2, even with two cells. To compensate, the number of online cells may have to be decreased when receiving these flows to avoid channeling. Decreasing the number of online cells does increase the filtration rate; however, the increase is somewhat marginal (resulting in filtration rates of 4 gpm/ft^2 or less) and several cells are available to bring online when the online cell reaches terminal headloss at these higher filtration rates (nine cells would be on standby when one is online).

The working pressure is recommended to provide a minimum wall thickness of 3/8 in, which provides a rigid shell and protection against negative pressures.

Vessels will be constructed to ASME Section VIII and include ASME stamp.

5.4.3 Filter Media

Several filter media alternatives are available for IM treatment with chemical oxidation, including oxide-coated filter media and manganese dioxide media (pyrolusite). Oxide-coated media and pyrolusite are reactive media, which facilitate the removal of dissolved manganese through surface-level adsorption reactions between the reduced manganese and the oxidized manganese oxide surface. Pyrolusite has a high specific gravity (approximately 4), which requires large backwash flow to fluidize the media compared to less dense oxide-coated media (*e.g.*, sand). Due to the greater backwash requirements, some IM system OEMs are moving away from pyrolusite and toward oxide-coated filter media.

Several IM system OEMs provide proprietary oxide-coated media for use in their pressure vessels. Invsersand Company offers an oxide-coated media, GreensandPlus, which is available to install in pressure vessels supplied by others. GreensandPlus will be used for this project due to the flexibility that it affords with selecting the OEM. The design criteria for the GreensandPlus, the anthracite cap, and the gravel support are shown in Table 5-5.

Table 5-5 Filter Media Design Criteria

Parameter	Units	Value
Anthracite (top layer)		
Depth	in.	12
Effective size (d_{10})	mm	0.60 to 0.80
Specific gravity	na	1.55 to 1.65
Uniformity coefficient		< 1.6
GreensandPlus[1] (middle layer)		
Depth	in.	24
Effective size (d_{10})	mm	0.30 – 0.35
Specific gravity	na	2.60 – 2.70
Uniformity coefficient		< 1.6
Torpedo sand (bottom layer)[2]		
Depth	in.	3
Effective size (d_{10})	mm	0.80 – 1.20
Specific gravity	na	2.60 – 2.70
Uniformity coefficient		< 1.6
Gravel support[2]		
Upper third depth	in.	4
Upper third size	in. x in.	1/4 x 1/8

Parameter	Units	Value
Middle third depth	in.	4
Middle third size	in. x in.	1/2 x 1/4
Bottom third depth	in.	4
Bottom third size	in. x in.	3/4 x 1/2

[1] Inversand Company

[2] Example support media design criteria (TonkaWater) - support media design is dependent on underdrain design, which can vary between IM system suppliers

5.4.4 Flow Control

The pressure vessels will be controlled with effluent modulating flow control valves and flow meters on each vessel. This flow control scheme enables equal filtration rates between the filters. An alternative flow control scheme that will not be employed is declining filtration. In a declining filtration flow control scheme all filters have the same head. If the filters are allowed to reach terminal headloss, all filters would require backwashing simultaneously, which would require large washwater storage and waste washwater facilities. An additional alternative would be to control the flow through each cell; however, vessel-flow control achieves the same result, if the whole vessel, instead of individual cells, is backwashed. Details of the flow control system are shown in the Process and Instrumentation Diagrams (P&IDs), Drawing 200I-1. Physical layout of these valves are shown on Drawings 200M- 1 and 200M- 2 of the 30% design drawings in Appendix A.

The effluent valves of all vessels (two valves per vessel), that are on-line at a given time, must work in unison to control the set point water level in the Equalization Tank. The control system automatically varies the flowrate set point to maintain the EQ Tank level set point. There will be high and low flowrate limits/alarms for the vessels. The level in the EQ tank and the downstream RO Feed tank vary in water surface elevation, and head loss across the media bed also varies. It is important that the effluent valves are selected for type and size to cover the hydraulic range of the expected operation. Table 5-6 summarizes the minimum and maximum operating of the two tanks.

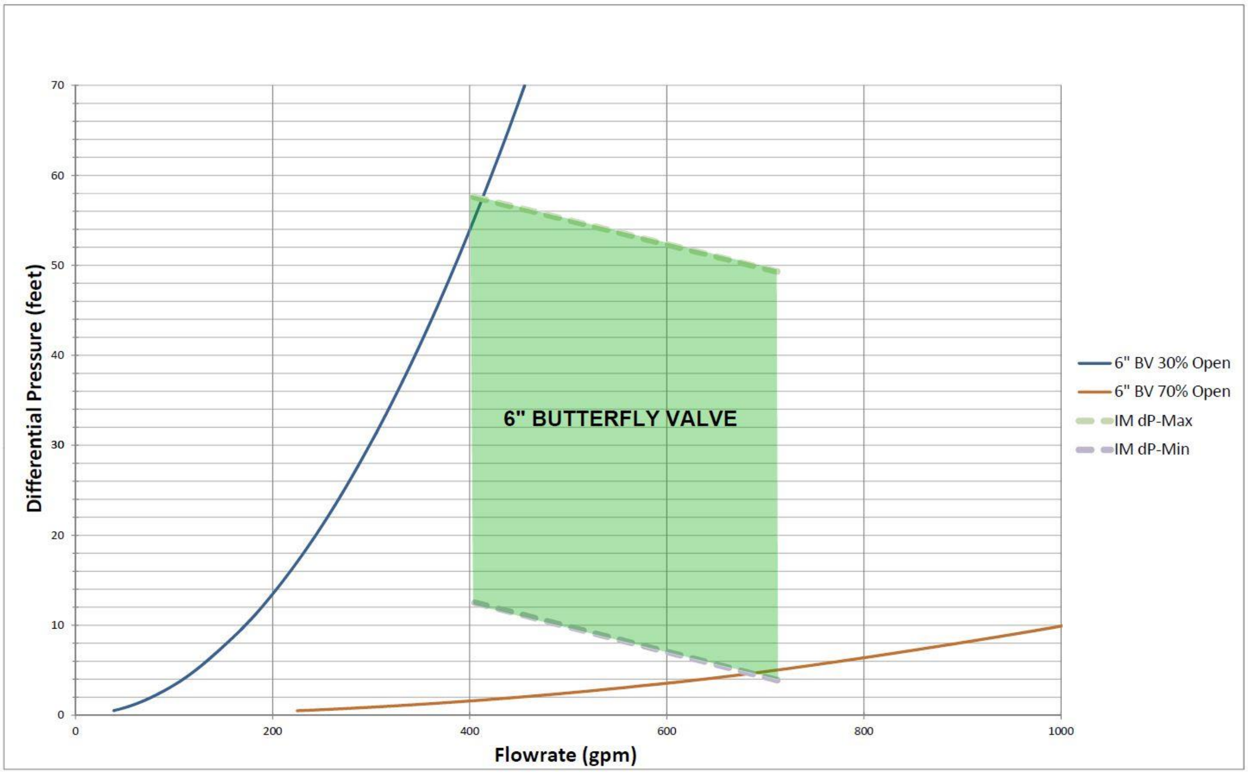
Table 5-6 Summary of Upstream and Downstream Conditions

Tanks	Base	Water Heights		HGL		Static Head	
	Elevation	Max	Min	Max	Min	Max	Min
EQ	710	25	17.5	735	727.5	**62**	**38.5**
RO Feed	657	32	16	689	673		

Losses across the media range between 2.5 feet and 21 feet.

The rangeability graphic shown in Figure 5- 3 presents the highest and lowest differential head across the valve (including filter and piping loses) as a function of flowrate by the dashed lines. The shaded area encompasses the differential pressure across the valve and the limits of flow, 360 gpm (minimum) and 745 gpm (maximum). The corresponding valve positions between 20 and 80 percent, the blue and brown lines respectively, shows the entire shaded area is covered within these acceptable position limits for a butterfly valve.

Figure 5-3 IM Vessels Effluent Control Valve Range



It is concluded that the use of 6-inch diameter butterfly valves to control vessel effluent are the correct choice for this application.

5.4.5 Oxidation System

Sodium hypochlorite will be dosed upstream of the filters and downstream of the EQ tank at sufficiently high concentrations to carry a residual through the filters. An alternative dosing point will be provided upstream of the EQ tank. Sodium hypochlorite can be effective at oxidizing iron in the bulk water where it forms precipitates that are removed on the filter media. The effectiveness of iron oxidation is a function of the natural organic matter present in the groundwater and complexation between the reduced iron and natural organic matter (NOM). Successful experience with chlorine oxidation at the Marine Corps Base Camp Pendleton (MCBCP) IM-24 plant shows that chlorine can effectively oxidize iron in this water.

Manganese, on the other hand, is not typically oxidized by chlorine in the bulk water; rather, manganese typically first adsorbs to the oxide-coated filter media, which subsequently catalyzes its oxidation by free chlorine. The byproduct of this reaction is a precipitant, with a new surface site for additional dissolved manganese adsorption. Stronger oxidants, such as permanganate, ozone, and chlorine dioxide, oxidize manganese in the bulk water, potentially forming colloidal manganese particles, which can be hard to remove through filtration. Permanganate, in particular, can contribute to fouling of downstream RO systems, as dissolved manganese itself is a byproduct of quenching residual permanganate (typically a oxidant residual is carried through the filters; quenching a permanganate residual results in dissolved manganese).

In addition to dosing sodium hypochlorite upstream of the filters, it will also be used for primary disinfection downstream of the RO blend point, regeneration of the IM vessels, and for removing sodium bisulfite from the backwash water. The oxidant feed system is described in this section, whereas the disinfection, regeneration, and backwash chemical feed systems are described later in the report. One storage facility will be used to store the common sodium hypochlorite neat solution that will supply all of the sodium hypochlorite chemical feed systems; the storage facility is described in this section.

Sodium hypochlorite solutions can degrade rapidly compared to many other chemicals typically used in water treatment. The degradation is largely a function of temperature, solution concentration, the concentration of trace metals that can catalyze the degradation, and the pH of the solution. Degradation leads to a loss of strength, which can render a chemical unusable for a given chemical metering system. Degradation also leads to the production of chlorate and perchlorate, compounds with health-advisory regulated levels, respectively (chlorate has a Notification level 0.8 mg/L and perchlorate Maximum Contaminant Level 0.006 mg/L). The two principle strategies for slowing degradation are (1) minimizing temperature (storing the neat solution out of direct sunlight) and (2) diluting the neat solution to a lower solution concentration. Regardless of the degradation rate, the delivery schedule and volume should be managed to only allow for acceptable levels of chemical degradation. Without dilution, small deliveries will likely be required during low flow conditions to ensure that the chemical can be used prior to excessive degradation. FPUD already successfully manages sodium hypochlorite deliveries at the Red Mountain treatment facility.

The residual oxidant concentration in the IM effluent will be used to control the oxidant dose, which requires a low coefficient of variation (less than 5%) in the residual concentration at the IM effluent analyzer. The piping between the dosing point and the residual analyzer should afford sufficient blending (greater than 160 pipe diameters), such that rapid mixing after injection is not required. The design criteria for the oxidant feed and sodium hypochlorite storage facilities are shown in Table 5-7.

Table 5-7 Oxidant and Sodium Hypochlorite Storage Design Criteria

Parameter	Units	Value
Oxidant chemical	na	Sodium hypochlorite
Typical dose, estimated	mg/L as Cl_2	5 to 6
High oxidant chemical metering pumps	Duty+standby	1+1
High oxidant feed pump capacity[1]	gph	31.3
High oxidant feed pump turndown, min[1]	na	10:1
Low oxidant chemical metering pumps	Duty+standby	1+1
Low oxidant feed pump capacity[1]	gph	3.5
Low oxidant feed pump turndown, min[1]	na	10:1
Sodium hypochlorite storage volume[2]	gal	7,500
Neat sodium hypochlorite strength, assumed	%	12.5

[1] Allows for the dosing of 2.0 to 7.5 mg/L as Cl_2 over the flow range of 0.6 to 8.58 MGD with a sodium hypochlorite degradation of at least 10% (90% of neat strength), which corresponds to about 15 days at 25 degrees Celsius

[2] Provides approximately 15 days of storage at typical doses

5.4.6 Quenching System

A quenching system will be included on the RO sidestream line, upstream of the RO break tank. This system will include measurement of the IM effluent chlorine residual, application of a quenching chemical (sodium bisulfite), power mixing, and final measurement of chlorine residual and oxidation-reduction potential (ORP) for verification, trim, and diversion. The design criteria for the quenching system are shown in Table 5-8.

Table 5-8 Quenching System Design Criteria

Parameter	Units	Value
Quenching chemical	na	Sodium bisulfite
Typical dose, estimated	mg/L	2.9
High quench chemical metering pumps	Duty+standby	1+1
High quench pump capacity[1]	gph	2.8
High quench pump turndown, min[1]	na	10:1
Low quench chemical metering pumps	Duty+standby	1+1
Low quench pump capacity[1]	gph	0.28
Low quench pump turndown, min[1]	na	10:1
Quench chemical storage volume[2]	gal	1,000
Quench chemical strength, assumed	%	38%

[1] Assuming a chlorine residual of between 0.35 and 3.0 mg/L as Cl_2, with a minimum and maximum safety buffer of 0.5 and 4.4 mg/L SBS, respectively, and flow ranges between 0.34 and 3.95 MGD

[2] Storage of approximately 15 days at design flow

5.4.7 Backwash System

The backwash will consist of multiple steps, including an air and low-rate water wash and a high-rate water-only wash (the air sour system is described in the following section). Backwash water will be supplied from the RO break tank and it will be chlorinated to remove residual sodium bisulfite prior to backwashing.

The backwash supply will be sized to backwash a whole filter vessel (both cells at the same time). Valving within the vessel face-piping will allow individual cells to be backwashed, when desired; however, the cell not being backwashed will have to remain idle and will not be able to filter while the other cell is backwashing. The backwash system will be sized to fluidize the media, which will allow for restratification of the dual media after intermixing during the combined air scour and low rate wash water step. The design wash water volume is 72,000 gallons per vessel, which is similar to other treatment facilities considering the size of filters.

The vessels will include underdrains with nozzles that distribute the backwash water evenly over the area of the filter. A waste wash water collection device will be included in the vessels to collect the waste washwater, which will drain to the reclaim tank (this device also distributes feed flow during filtration). A baffled trough waste wash water collection device will not be required, although they are acceptable. A baffled trough allows for minimal media loss during a continuously overflowing air and wash water backwash step, which may improve backwashes, but which should not be necessary for this water. Instead, a brief air and water wash should provide sufficient removal of particulates[2]. The design criteria of the backwash system are summarized in Table 5-9.

[2] For example, the air and water wash may be proceeded by a drain step to sufficiently drop the water level below the waste wash water collection device so that a combined air and water wash can be conducted without overflowing the waste wash water collection device and loosing media.

Table 5-9 IM Vessel Backwash System Design Criteria

Parameter	Units	Value
Backwash rate, high-rate[1]	gpm/ft^2	15
Backwash rate, low-rate	gpm/ft^2	3
Backwash flowrate, high-rate, one vessel[1]	gpm	5,670
Backwash flowrate, low-rate, one vessel[1]	gpm	1,134
Backwash flowrate, high-rate, one cell[1]	gpm	2,835
Backwash flowrate, low-rate, one cell[1]	gpm	567
Backwash volume[2]	gal	72,000
Backwash freeboard, min[3]	% of filter media depth	50
BW chlorination chemical	na	Sodium hypochlorite
Typical dose, estimated	mg/L as Cl_2	5
Chlorine BW chemical metering pumps	Duty+standby	1+1
Chlorine BW pump capacity[4]	gph	12.6
Chlorine BW pump turndown, min[4]	na	10:1
Chlorine BW chemical storage volume	gal	Same as oxidant feed
Chlorine BW chemical strength, assumed	%	Same as oxidant feed

[1] Based on minimum active surface area design criteria with a safety factor of 5% to tolerate deviations in surface area among OEMs; high-rate achieves bed expansion of 40%, assuming 25 degrees Celsius (Inversand Company);

[2] Estimated wash water volume to backwash one vessel

[3] Percent of sand and anthracite depth, where freeboard is distance from the top of the media to the waste wash water collection device opening(s)

[4] Target residual of 2 mg/L as Cl_2, after quenching bisulfite residual (up to 4.4 mg/L), and allowing for a neat sodium hypochlorite solution decay of at least 10% for backwash rates ranging from 3 to 15 gpm/ft^2 while backwashing both cells at a time and one cell at a time

5.4.8 Air Scour System

Air sour will be included in the backwash sequence. Air scour increases the efficiency of backwashes and they have become standard in filter design. The air scour system will include a blower and air distribution grids inside of the filter cells. The design criteria for the air sour system are summarized in Table 5-10.

Table 5-10 Air Scour System Design Criteria

Parameter	Units	Value
Air rate	scfm/ft^2	3
Pressure at air rate	psi	5

5.4.9 Regeneration System

Facilities will be included for infrequent regeneration of the filter media's oxide coating. The facilities will include a chemical metering pump to dose approximately 1,000 mg/L of chlorine into the backwash line, an equalization tank to allow for rapid drainage of the regenerate waste after regeneration, and a regenerate quenching pump to quench regenerate before pumping to the sewer. Regeneration requires draining the pressure vessels, filling them with chlorinated backwash supply water (chlorinated to 1,000 mg/L), soaking the media for at least four hours (preferably overnight), draining the solution to the regenerate equalization tank, adding quenching chemical to the regenerate while the regenerate is draining into the equalization tank to take advantage of mixing, rinsing the media prior to placing the vessel back into service, and pumping the quenched regenerate from the regenerate equalization tank to the sewer. The regeneration system will draw from the same neat sodium hypochlorite solution that is used for oxidation upstream of the filters and disinfection. The regenerate quenching system will draw from the same sodium bisulfite solution that is used to quench the reverse osmosis sidestream prior to the reverse osmosis feed tank. The design criteria for these facilities are shown in Table 5-11.

Table 5-11 Regeneration System Design Criteria

Parameter	Units	Value
Regeneration chemical	na	Sodium hypochlorite
Typical dose, estimated	mg/L as Cl_2	1,000
Regeneration chemical metering pumps	Duty+spare	1+1
Regeneration chemical pump capacity[1, 2]	gph	225
Regeneration chemical pump turndown, min[1, 2]	na	5:1
Regeneration chemical storage volume	gal	Same as oxidant feed
Regeneration chemical strength, assumed	%	Same as oxidant feed
Regenerate equalization tank volume[3]	gal	14,000
Regenerate quenching chemical	na	Sodium bisulfite
Typical dose, estimated	mg/L	1,500
Regenerate quenching chemical metering pumps	Duty+spare	1+1
Regenerate quenching pump capacity[4]	gph	612
Regenerate quenching pump turndown, min[4]	na	10:1
Regenerate quenching chemical storage volume	gal	Same as Quenching System
Regeneration quenching chemical strength, assumed	%	Same as Quenching System

[1] Doses of approximately 250 to 1,250 mg/L as Cl_2 at fill rate of 425 gpm at a neat solution decay of 10%
[2] Based on fill flow of 425 gpm (fill time of approximately 20 minutes)
[3] Estimated volume required to submerge media of 14,000 gallons
[4] Allows for volumetric dose of 183 to 1,834 mg/L (to quench 125 to 1,250 mg/L as Cl_2) with an assumed pump time of 5 minutes and an assumed regenerate waste volume of 14,000 gallons

5.5 Area 300 - RO Feed Tank, IM Backwash Pumps, RO Feed Pumps & By-Pass

The RO feed tank provides 80,000 gallons of buffering volume to assure dechlorination of the IM water prior to the RO. In addition it stores enough wash water to backwash one IM vessel, 80,000 gallons. The control system reduces production to fill the tank after backwashes in preparation for future backwashes. The fill rate is limited to minimize fluctuations in the RO permeate to 10%. The RO feed pumps and the backwash pumps take suction off the tank. The RO by-pass connects just upstream of the RO tank. See the site plan and Drawing 300M-1 of the 30% design drawings found in Appendix A.

5.5.1 RO Feed Tank

The tank is shown on drawing 300M-1 in Appendix A. The design criteria for the tank is provided below:

- Type of Tank: Welded Steel (AWWA D-100)
- Storage Capacity: 0.160 MG
- Diameter: 30 feet
- High Water Level: 32 feet
- Floor Elevation: 657 feet

- Free Board: 3 feet
- Roof: column-supported cone with radius knuckle
- Total Tank Height: 36 feet

The tank is shown on the site plan, C-6 and 300M-1 of the 30% design drawings in Appendix A.

The proposed tank will be designed according to the provisions of ASCE 7. Key parameters for wind and seismic design loads are as follows:

General Parameters

- Site Class: C

Wind Design Load

- Wind Load Risk Category IV
- Wind Speed: 115 miles per hour
- Exposure: C

Seismic Design Load

- 0.2-second period, mapped spectral accel., S_S: 1.223 g
- 1-second period, mapped spectral accel., S_1: 0.471g
- Short-period site coefficient, F_a: 1.0
- Long-period site coefficient, F_v: 1.329
- 0.2-second period, Design Earthquake spectral response accel., S_{DS}: 0.815g
- 1-second period, Design Earthquake spectral response accel., S_{D1}: 0.418g
- Earthquake Importance Factor, I_e: 1.25

Steel Tank

Steel tank structural design criteria consists of the following:

- Design per current AWWA D100 standard
- Roof design live load: 20 pounds per square foot (reducible)
- Tank shall be mechanically anchored to the foundation
- Tank shall be classified as Seismic Use Group (SUG) II
- Use Ri = 2.5 and Rc = 1.5 for base shear, overturning moment and hoop shell tension design
- Checking longitudinal tank shell compression stress (wall buckling)
  Freeboard will be based on AWWA D100 requirements. 3.0 feet of freeboard is estimated for preliminary design based on the design of similar steel tanks in California per the current D100 standard. An alternative design procedure may consist of a lower tank roof (with less freeboard) which is structurally reinforced to withstand, but not prevent, damage from tank sloshing. This alternative approach is assumed to be similar in cost to a taller tank, although it is not yet common practice for steel tanks constructed per current AWWA code in California.

5.5.2 IM Backwash Pumps

The IM backwash pumps take suction off the RO feed tank and supply the IM vessels with wash water. See the 30% design drawings, 300M-2, in Appendix A.

IM Backwash Pumping Operating Head Conditions

IM manufactures require 10 to 17 psig at the entrance to the backwash nozzles on the vessels. The face piping of the IM vessels is shown 200M-1 and 200M-2. The backwash pumps therefore have to account for the varying head levels in the upstream RO feed tank as well as the varying flowrates associated with the backwash sequence. A summary of upstream and downstream head conditions is shown in Table 5-12.

Table 5-12 Summary of Backwash Pump Upstream and Downstream Conditions

Location	Base	Water Heights		HGL		Static Head	
	Elevation	Max	Min	Max	Min	Max	Min
RO Tank	657	32	16	689	673	26	10
Nozzle	659	-	-	699[1]	699[1]		

Note:

1. Varies per IM vendor. 682 to 699 feet.
2. All values are in feet.

IM Backwash Pump Type and Configuration

The preliminary layout of the backwash pumps are shown 200M-1 of the 30% drawings found in Appendix A. The proposed pump layout consists of two horizontal end-suction pumps of the same capacity with VFD drives. This configuration was chosen based on the following:

- The suction piping for the horizontal above grade and thus much simpler than vertical turbine pumps (VTP) in this application.
- Since the RO feed tank has a high operating head, suction pressure provided to the pumps does not warrant considering vertical turbine pumps.
- Two pumps are necessary to cover the range hydraulic range. See Figure 5-4
- Two pumps of the same size minimize storing additional spare parts.
- Two pumps provide a degree of redundancy if one pump fails especially in a condition when the RO feed tank water level is 75% or higher.
- VFD drives make the transitions in backwash flowrates smooth allowing for a higher degree of electrical efficient than if a constant speed pump were to be use with a pump control valve.

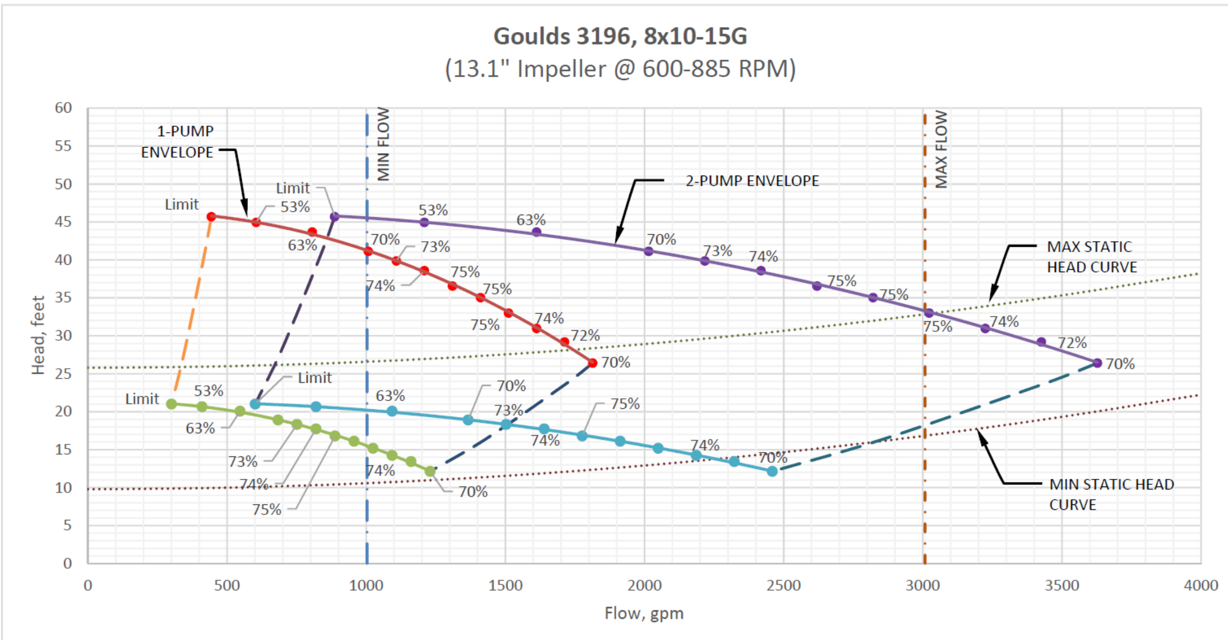
IM Backwash Pump Selection and Performance

Goulds single-stage pump with a 20-horsepower (HP) motor meets the criteria. Pump efficiency is about 75 percent at full speed (885 rpm) and a design flow of 1500 gpm (per pump).

Figure 5-4 below shows the envelope of one pump operating, and a second operating envelope with two pumps in parallel at various speeds. In combination the expected range of flows and heads are well accommodated. For the operating conditions within the anticipated range of flows, the pump efficiencies are good (above 60 percent).

The figure indicates that with VFD drives the pumps will cover all except the lowest flows when the RO feed tank is at higher elevations but this should not be of any consequence. The transition from one pump to two pumps should occur at about 1100 gpm.

Figure 5-4 IM Backwash Pump System and VFD Operating Envelopes



Pumps of similar configuration are available from numerous manufacturers, and the specifications will require that the pumps meet the material and performance objectives for the project (See Appendix P1 for pump data).

IM Backwash Pump Suction and Discharge Piping

The pump station suction and discharge piping are sized using the standards set forth by the Hydraulics Institute (HI). Table 5-13 summarizes the recommended pipe sizes based on hydraulic design parameters.

Table 5-13 IM Backwash Pump Suction and Discharge Pipe Sizing

Item	DIA, in	V, fps	Q, gpm	HI Recommendation for Horizontal Pumps
Pump Suction	16	2.4	1500	8 fps max
Pump Discharge	12	4.3	1500	-

In addition to these requirements, HI indicates that there shall be no flow disturbing fittings closer than five pipe diameters from the pump.

5.5.3 RO Feed Pumps

The RO feed pumps take suction off the RO feed tank and push IM treated water through the RO cartridge filters and on to the suction side of the high pressure RO pumps.

RO Feed Pump Operating Head Conditions

To push IM treated water through the cartridge filters and on to the high pressure RO pumps requires about 40 psig at the discharge of the pump. See Drawing 300M-1 of the 30% design drawings in Appendix A for the physical layout. RO feed pumps have to account for the varying water levels in the upstream RO feed tank. The plant control system determines the number feed pumps that are on-line at a given time based on flow rates through the RO system. Flow rates through the RO trains are modulated by the VFD driven RO high pressures pumps.
A summary of upstream and downstream head conditions is shown in Table 5-14.

Table 5-14 Summary of RO Feed Pump Upstream and Downstream Conditions

<table>
<tr><th rowspan="2">Tanks</th><th>Base</th><th colspan="2">Water Heights</th><th colspan="2">HGL</th><th colspan="2">Static Head</th></tr>
<tr><th>Elevation</th><th>Max</th><th>Min</th><th>Max</th><th>Min</th><th>Max</th><th>Min</th></tr>
<tr><td>RO Feed</td><td>657</td><td>32</td><td>16</td><td>689</td><td>673</td><td rowspan="2">81</td><td rowspan="2">65</td></tr>
<tr><td>Pumps Discharge Pressure Range</td><td>657</td><td>-</td><td>-</td><td>754</td><td>754</td></tr>
</table>

Note: all values are in feet.

RO Feed Pump Type and Configuration

The preliminary layout of the RO feed pumps are shown on Drawing 300M-1 of the 30% drawings found in Appendix A. The proposed pump layout consists of three horizontal end-suction pumps, two of the same size and one smaller pump to facilitate the minimum conditions of the plant. Each pump is constant speed. This configuration was chosen based on the following:

- The suction piping for the horizontal is above grade and thus much simpler than vertical turbine pumps (VTP) in this application.
- Since the RO feed tank has a normal high operating level, suction pressure provided to the pumps does not warrant considering vertical turbine pumps.
- Three pumps are necessary to cover the range hydraulic range. See Figure 5-5.
- For conditions of minimum flows the one smaller pump is required. This smaller pump suction draws from a sump in the tank that facilitates draining the tank when the plant is being taken off line for an extended period.
- Two same-size pumps provide a degree of redundancy if one pump fails.

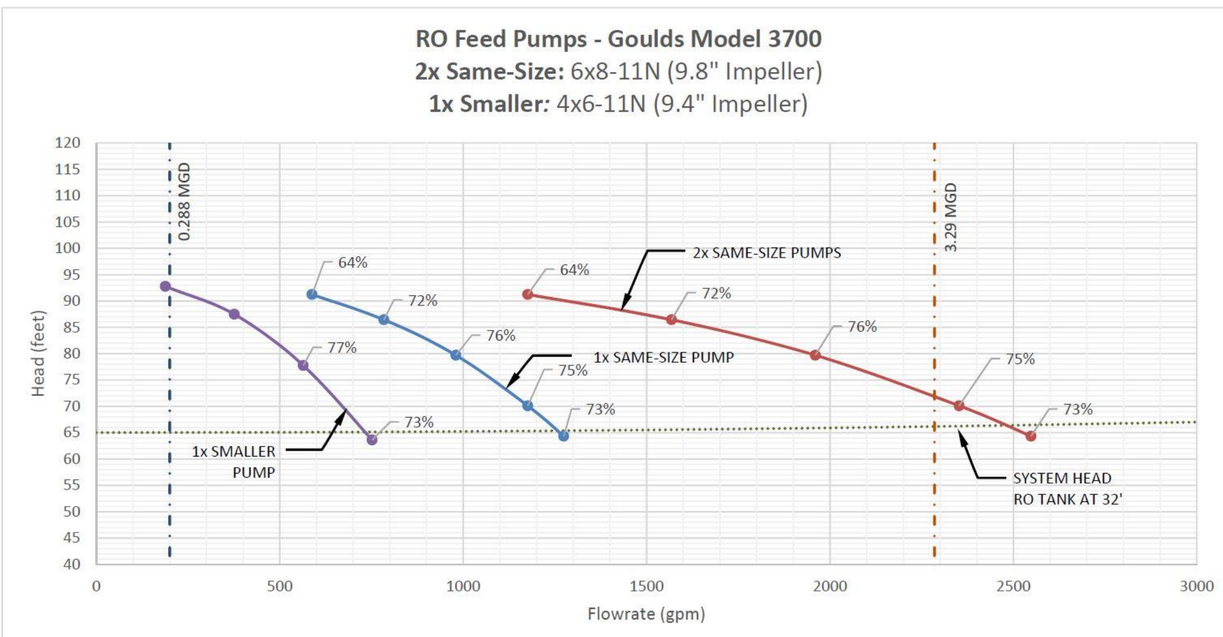
RO Feed Pump Selection and Performance

For the two same-size pumps (6x8-11N), Goulds single-stage pump with a 40-horsepower (HP) motor meets the criteria. Pump efficiency is about 75 percent at the design flow of 1140 gpm (half of 3.29 MGD per pump).

For the smaller pump (4x6-11N), Goulds single-stage pump with a 20-horsepower (HP) motor meets the criteria. Pump efficiency varies from 53 to 73 percent at the minimum flow conditions.

Figure 5-5 below shows the operating head of one pump operating, and a second parallel pump operating. The smaller pump meets the low flow conditions. In combination the expected range of flows and heads is well accommodated. For the operating conditions within the anticipated range of flows, the pump efficiencies are good (above 64 percent for flows greater than 500 gpm). Pressure at the discharge will vary between 38 psig and 55 psig depending on flow and RO Feed Tank water level. Transition from the small pump to one larger pump at about 650 gpm, and from larger pump to two larger pumps at about 1150 gpm.

Figure 5-5 RO Feed Pump Curves



Pumps of similar configuration are available from numerous manufacturers, and the specifications will require that the pumps meet the material and performance objectives for the project.

RO Feed Pump Suction and Discharge Piping

The pump station suction and discharge piping are sized using the standards set forth by the Hydraulics Institute (HI). Tables 5-15 summarizes the recommended pipe sizes based on hydraulic design parameters.

Table 5-15 RO Feed Pump Suction and Discharge Pipe Sizing

Item	DIA, in	V, fps	Q, gpm	HI Recommendation for Horizontal Pumps
Two Same-Size Pumps				
Pump Suction	12	3.2	1140	8 fps max
Pump Discharge	10	4.7	1140	-
Smaller Pump				
Pump Suction	8	4.8	750	8 fps max
Pump Discharge	8	4.8	750	-

In addition to these requirements, HI indicates that there shall be no flow disturbing fittings closer than five pipe diameters from the pump.

5.5.4 RO Bypass

A portion of the IM treated water by-passes around the RO treatment system and is blended with the RO permeate to meet the targeted product water chemistry. The RO bypass connection is just upstream of the RO feed tank, see Drawing 300M-1 of the 30% design drawings found in Appendix A. The by-pass flows by gravity and first enters a magnetic flow meter and continues through a flow control valve before connecting to the RO permeate piping just upstream of the clearwell. The sizing of the by-pass piping and the size and type of flow control valves is critical for proper operation of the plant.

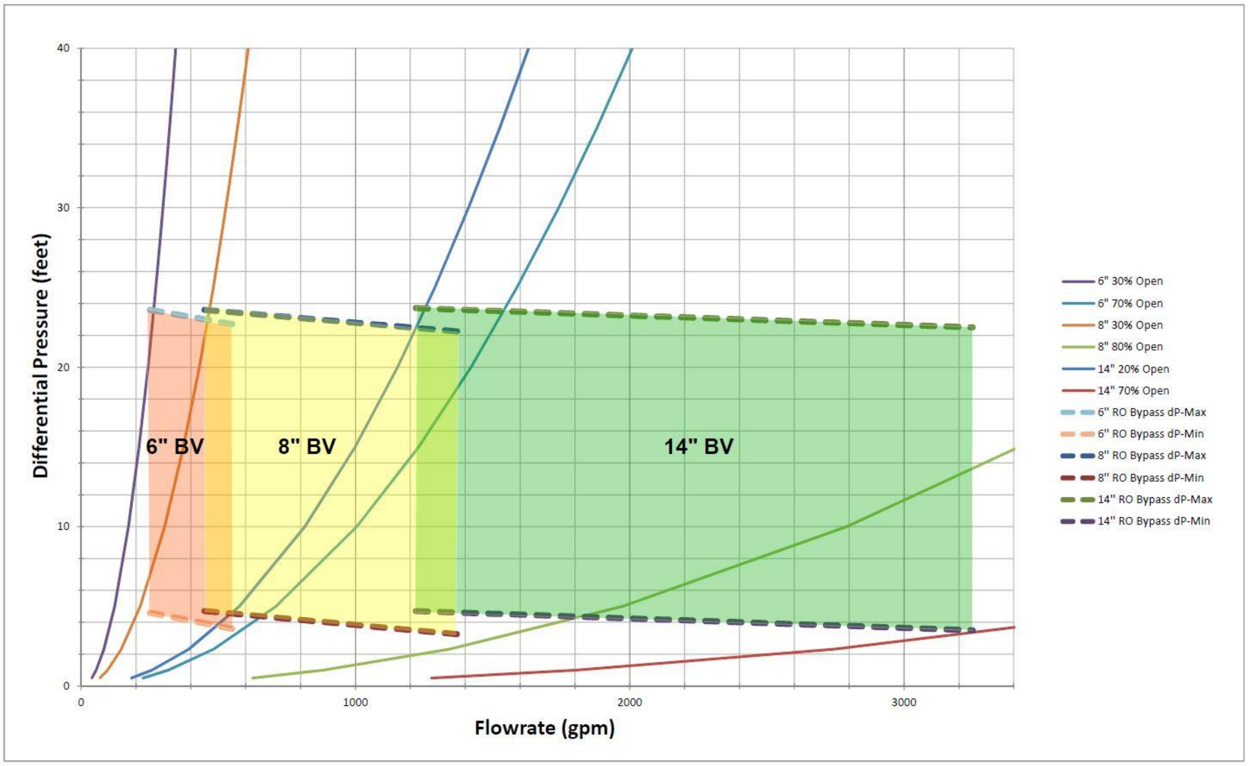
Hydraulic criteria for the flow control valve is shown below:

Table 5-16 Summary of RO Bypass Valve Upstream and Downstream Conditions for RO Bypass Valve

<table>
<tr><th rowspan="2">Tanks</th><th rowspan="2">Base Elevation</th><th colspan="2">Water Heights</th><th colspan="2">HGL</th><th colspan="2">Static Head</th></tr>
<tr><th>Max</th><th>Min</th><th>Max</th><th>Min</th><th>Max</th><th>Min</th></tr>
<tr><td>RO Feed</td><td>657</td><td>32</td><td>16</td><td>689</td><td>673</td><td rowspan="2">24</td><td rowspan="2">5</td></tr>
<tr><td>CW Tank</td><td>658</td><td>10</td><td>7</td><td>668</td><td>665</td></tr>
</table>

The valve rangeability graphic shown in Figure 5- 6 presents the highest and lowest differential head across the valves (including piping loses) as a function of flowrate as indicated by the dashed lines. The corresponding valve position between 20 and 80 percent open for the three parallel butterfly valves, is indicated in the legend.

Figure 5-6 RO Bypass Control Valve Range and Sizing



Several scenarios were investigated to determine the most practical flow control valve for the RO Bypass flow. A single valve larger than 6 inches would not have sufficient turn down to be capable of controlling the low flow rates. Butterfly, cone, eccentric plug, full port ball and v-port ball valves were investigated to determine applicability valve types.

We conclude that three butterfly valves in parallel provides both good control and value. One valve will be in operation at a time. The 6 inch valve will operate as flow set points between 200 gpm and up to and including 500 gpm. The 8 inch valve will operate as flow set points over 500 gpm and up to and including 1300 gpm. The 14 inch valve will operate as flow set points over 1300 gpm and up to 3300 gpm.

5.6 Area 400 – RO Treatment System

5.6.1 RO Building Layout and Architecture

The process building will house components of the RO treatment systems along with additional services. The process equipment area will be designated as NEMA 4X and segregated from the other building areas. Equipment in the process area will include the cartridge filters, injection piping from the sulfuric acid and threshold inhibitor addition systems, RO high pressure feed pumps, the RO membrane trains, and the RO cleaning system. Process piping between the cartridge filters, cleaning system, and membrane trains will be routed in utility trenches covered by aluminum bar type grating with banded opening for pipe penetrations. All motor actuated valves, instruments and injectors will be installed on portions of the piping systems outside the trenches. Certain manual valves at the RO trains will be installed beneath the grating. These will be fitted with 2-inch square nut operators accessed by dedicated banded openings in the trench grating and operated with a T-handle wrench. See Drawing 400M-1 of the 30% design drawings in Appendix A.

Architecture for the RO building will match that of other District water facilities. See Drawings 400A-1 and 400A-2 of the 30% design drawings in Appendix A.

Control Room

The control room will house desks and workstations associated with the facility SCADA system. It will also include a small conference table and chairs. The main plant PLC cabinet will also be installed in the control room.

Storage Room

A storage room will be provided to house spare equipment and maintenance materials for the facility. It will be fitted with rollup and personnel access doors and include a caged area with shelves to hold the spare components. A small sample sink, counter and cabinet will be provided to allow on-site sample analysis as well as organize samples for offsite analysis. Floor space will be allocated for larger spare equipment items, such as a boxed spare RO CIP pump and motor.

Restroom

A single unisex restroom will be provided.

5.6.2 Access Requirements

Access is required to pumps, cartridge filters, the RO membrane trains and the RO cleaning system. In general, rollup doors will be provided to allow removal of RO pressure vessels and access to the CIP system. CIP chemicals will be provided in bags or drums and brought into the RO process building when a cleaning is scheduled. A hose and eductor system will be employed to transfer chemicals into the CIP tank for solution makeup.

Access will be provided around the cartridge filters to allow change out of the filter elements. The RO elements inside the pressure vessels will be accessed from the operating floor/grating at the ends of the trains. The grating will not be traffic rated, so the vessel columns will be kept low (less than 6-ft to the centerline of the top pressure vessel in each train). Space for loading and unloading membrane elements will be provided at each end of the trains.

The inter-stage booster pumps on the RO trains will be serviceable in place, along with the CIP pump and motorized valve actuators. The RO high pressure feed pumps will be vertical turbine can type pumps. These will be accessed by exterior crane through removable skylights above each pump.

5.6.3 RO Cartridge Filters

The cartridge filters are provided for pretreatment ahead of the RO membrane trains providing removal of particulate matter and suspended solids. These particulates if left untreated can lead to plugging of the feed/concentrate channels in the spiral wound membrane elements, increasing differential pressure and shortening membrane life. The filters also provide for supplemental mixing of the pretreatment chemicals.

Each filter includes an ASME-rated pressure vessel and disposable cartridge filter elements. The vessels are compatible with several types of filter cartridges, but we recommend the string wound type for this project. Wound filters are the lowest cost alternative and should provide acceptable service life given the upstream treatment provided by the IM filters. This type of filter is also immune to gross breakthrough or breach of the material. An initial retention rating of 5 microns is recommended. The filters are available with ratings between 1 and 20 microns. Alternative rated cartridges could be employed in successive change outs if conditions warrant. A lower retention rating can remove additional fine solids at the expense of service life. Clean filters usually experience an initial pressure drop of around 5 psi and require replacement once they reach 15 psi. Design criteria for the cartridge filters are provided in Table 5-17: Cartridge Filter Design Criteria.

Table 5-17 Cartridge Filter Design Criteria

Parameter	Units	Value
Number of Cartridge Filters	--	3
Operating Configuration	%	3 x 50
Vessel Orientation	--	Horizontal
Vessel Design Capacity	gpm	1,150
Vessel Inlet and Outlet Connections	inches	10
Vessel Pressure Rating	psig	150
Vessel Materials of Construction	--	Type 316 stainless steel
Number of Filter Elements per Vessel	--	103
Filter Element Diameter and Length	inches	2.5 x 40
Filter Element Materials	--	Polypropylene
Filter Element Retention Rating	microns	5

5.6.4 RO SYSTEM Alternatives and Selection

The RO system provides for demineralization of the feed supply, producing a low salinity product or permeate stream and a high salinity brine or concentrate stream. For this project it will remove all dissolved constituents of concern in the treated water along with chloride—the constituent which controls the final product water quality. Permeate from the RO system is essentially “over desalted” and can be blended back with pretreated feed water that bypasses the system to meet final product water goals—in this case a chloride target of 100 mg/L.

One of the bigger challenges in the design of the RO system for this project is the large flow range that needs to be covered from CPEN deliveries up to 8.0 mgd and down to 0.6 mgd. Typical RO membranes have the ability to adjust flow by ± 30 percent; a range insufficient to alone cover the more than 10:1 turndown ratio required.

5.6.5 RO Membrane Trains

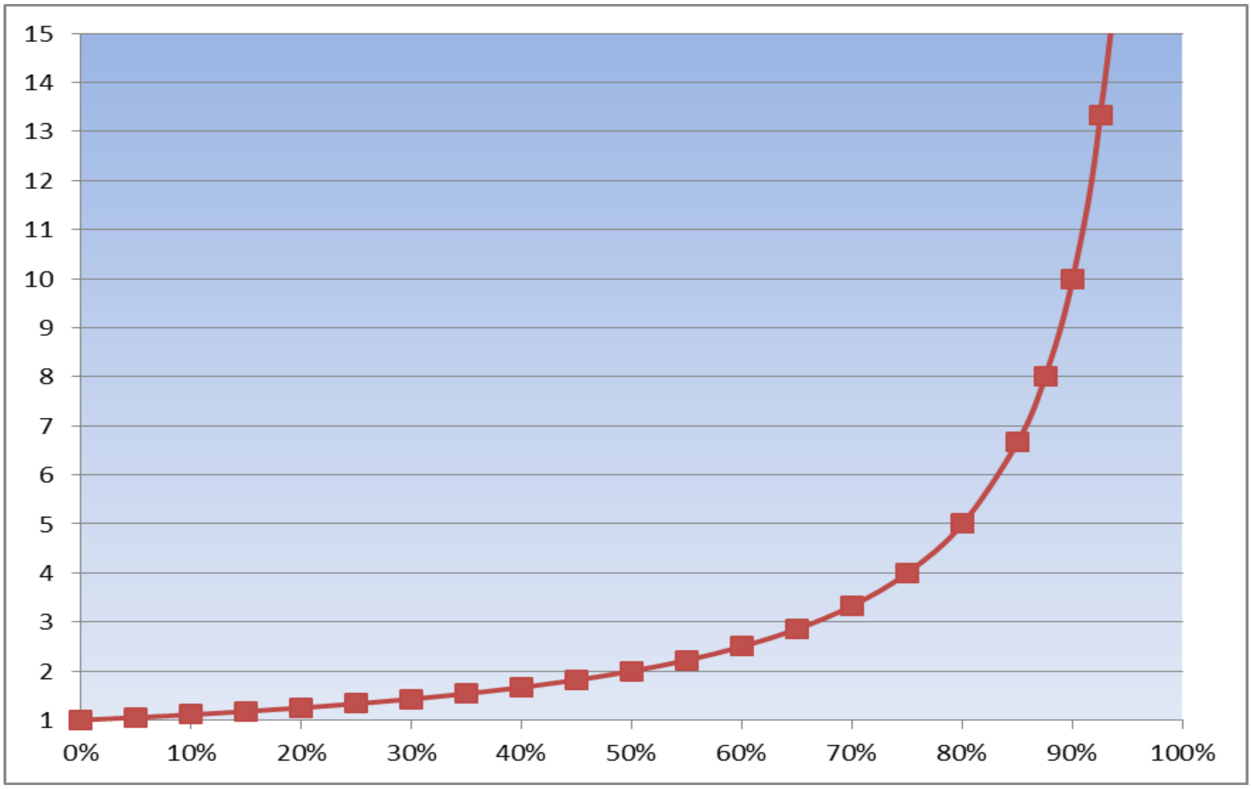
The RO system will have a design raw water treatment capacity from 0.37 – 3.29 mgd. At the lowest flow it will produce excess permeate than required to meet the target finished water chloride goal; and at the highest range slightly less than required to blend with the full 8.0 mgd plant flow to the chloride goal. These are considered acceptable tradeoffs which allow the system to be configured with three, identical independent RO membrane trains. A redundant RO train is not recommended as systems can typically achieve a greater than 90 percent on line factor which is considered sufficient for this project. In this case, having three identical trains is a benefit as it allows the maintenance of two thirds of the RO system treatment capacity with any single train out of service.

For the RO membranes, we recommend a high rejection low pressure polyamide composite type. The high rejection characteristic insures that permeate water produced will have the lowest chloride value, decreasing the required capacity of RO treatment and lowering the system cost. Low pressure operation is desirable from an energy perspective and can be achieved by a current class of low pressure, high rejection membranes available from several manufacturers.

For an RO system, key design parameters are flux and recovery. Flux is effectively the loading rate on the membranes expressed as gpd/ft^2 or gfd. Higher flux designs produce better quality water and a reduced membrane area requirement, but can result in higher energy operation and increased fouling. Conversely, lower fluxes can sacrifice salt rejection somewhat but allow for lower pressure operation and extended membrane life. For typical groundwaters, a membrane flux up to 18 gfd average is achievable. For this project, modeling revealed that the energy conserved by an average design flux of 12 gfd provided enough savings in energy to offset the increased capital expense of the additional membrane. The difference in product water quality is not a factor in this case, as an acceptably low chloride concentration can be produced at either design point. Further, designing the nominal, average system at a flux of 12 gfd provides headroom to expand an individual train's flow by 34 percent and not exceed recommended operating flux of any element in the train. This flow expansion allows the three RO trains proposed to cover the full range of system flows from minimum to maximum without gaps.

In terms of recovery, maximizing recovery increases the amount of permeate extracted from each gallon of feed water. Higher recoveries therefore conserve the raw water supply resource while at the same time minimizing the amount of residual concentrate for disposal. Recovery is limited however by the concentration of sparingly soluble salts in brine stream. As water is transported across the RO membrane, residual dissolved constituents are left behind in a decreasing volume of water. This concentration factor is directly tied to the system recovery and increases exponentially with increasing recovery as shown in Figure 5-7: Concentration Factor vs RO Recovery.

Figure 5-7 Concentration Factor vs RO Recovery



So at a recovery of 70 percent dissolved constituents are concentrate by a factor of 3.33; but at 80 percent this cycles up to a factor of 5.0. For the CPEN source supply, the main compounds of concern are calcium carbonate and silica. Calcium carbonate scaling can be addressed through acid addition to control pH along with application of a threshold inhibitor compound which prevents the genesis of crystals at levels above theoretical saturation limits. Silica scales are more problematic and must be controlled through the addition of inhibitors along with design recoveries that maintain the concentrate concentration at 180 mg/L or less. For this project, a design recovery of 85 percent maximum is proposed.

Conventional spiral wound membrane elements come in standard diameters of 2.5, 4.0, 8.0, and 16.0 inch diameter; and normally 40-in in length. The standard diameter for municipal systems of this size is 8-inch. 16-inch membranes while space efficient result in higher initial cost along with handling issues (8-in elements can be lifted by a single person while 16-in elements require slings and special lifting devices). They have their place where space constraints trump other considerations, but for this facility we find the 8-in elements to be optimum. Most 8-in elements over the last 10 years or so have had 400 square feet of membrane area. In the last few years, several manufacturers have come out with 440 square feet elements. Use of the higher area elements reduce the number of discrete membrane elements required and can reduce system footprint and cost. For this project we propose using the 440 square feet elements.

To achieve the target average flux in the system, multiple elements must be combined in pressure vessels. The elements are loaded in series. Most commercial pressure vessels can accommodate up to eight 40-in elements. For this project, we are proposing a design based on seven elements per pressure vessel. The recovery that can be achieved by a seven element column of membranes is between 40 – 60 percent. Higher recoveries are achieved by what is known as "brine staging". The brine exiting the first seven element column of membranes is collected and routed to a second group of pressure vessels. For this system we are proposing a 3-stage design. As permeate is extracted in a given stage, the amount of residual feed water is reduced. Therefore, the residual concentrate from all of the vessels in a given stage is typically combined and sent to a reduced number of vessels in the succeeding stage. This insures that minimum element flow requirements are maintained as the volume of feed/concentrate is reduced through the system. The pressure vessel array for the project has been selected as 15:7:3-that equates to fifteen vessels in the first stage, seven vessels in the second stage, and three vessels in the third stage. In addition to the membrane elements and pressure vessels, each train is fitted with a feed pump that provides the driving pressure to effect the process and concentrate control valve that controls the brine flow leaving the train and thus the recovery. Design criteria for the membrane trains are provided in Table 5-18: RO Membrane Train Design Criteria. Additional features of the system design are discussed below.

Table 5-18 RO Membrane Train Design Criteria

Parameter	Units	Value
Number of RO Trains	--	3
Operating Configuration	%	3 x 33
Design Capacity, Each Train (Permeate) <u>3-Stage Mode</u> Average Maximum Minimum <u>2-Stage Mode</u> <u>Average</u> <u>Maximum</u> <u>Minimum</u>	mgd	 0.93 1.25 0.0.63 0.410 0.545 0.30
Design Recovery Maximum Minimum	%	 85.0 82.5
Design Flux Average Maximum Minimum	gfd	 12.1 17.7 8.1
Number of Pressure Vessels per Train	--	25
Pressure Vessel Configuration	--	15:7:3
Number of Elements per Pressure Vessel	--	7
Element Area	ft^2	440
Number of Elements per Train	--	175
Number of Feed Pumps per Train	--	1
Pump Type	--	Vertical Turbine Can

Parameter	Units	Value
Pump Capacity	gpm	255 – 1,020
Pump Design Head	feet	85 - 345
Pump Materials of Construction	--	Type 316 Stainless Steel
Pump Motor Size	hp	125
Pump Drive System	--	Variable Speed
Number of Concentrate Control Valves per Train	--	1
Valve Type	--	Cage Guided Globe
Valve Flow Range	gpm	38 – 153
Valve Rated Pressure Drop	psi	35 – 101
Maximum Valve Coefficient	C_v	75
Valve Materials of Construction	--	Type 316 Stainless Steel
Valve Size	inches	2

5.6.6 Energy Recovery

There are several energy recovery devices available in the market at this time. Isobaric devices operate at the highest efficiency but require balanced, matching flows on either side of the exchanger. In staged brackish water systems, the brine flow containing the energy to be recovered is often considerably less than 50 percent of the feed water making it a poor application for isobaric energy recovery. Such devices are most often applied to seawater RO systems that operate at recoveries of 50 percent or less. In brackish systems, pressure exchangers are more common, through which energy from a high pressure, low flow stream is transferred to a higher flow stream to increase its pressure. Such devices usually find application as an inter-stage device where the concentrate stream from a given stage is used to boost its incoming feed pressure.

Modelling for this project has shown we need around 50 psi of boost pressure into the final stage pressure vessels. This amount of boost would not be available through a pressure exchanger. There are some new motor assisted pressure exchangers on the market at this point. Operating experience is however limited and not without risk at this time. With the relatively low capacity of trains for this facility, a motor driven boost pump of 15 hp would work well and is what we recommend.

Table 5-19 Inter-Stage Boost Pump Design Criteria

Parameter	Units	Value
Number of Pumps per Train	--	1
Pump Type	--	Vertical Centrifugal
Pump Capacity	gpm	100 – 210
Pump Design Head	feet	115
Pump Materials of Construction	--	Type 316 Stainless Steel
Pump Motor Size	hp	15
Pump Drive System	--	Variable Speed

5.6.7 Piping Configuration

Each RO train will have the following connections:

1. Feed inlet
2. Permeate outlet
3. Concentrate outlet
4. Cleaning feed
5. Cleaning return
6. Permeate cleaning return

Common headers will interconnect each train to the given service, with the exception of the feed inlet which will be dedicated line from each feed pump to the respective train. The headers will be routed through the utility trenches to keep the operating floor around the trains free of interference.

On the trains themselves, permeate and concentrate headers will be routed on top or alongside the trains above grade. This will permit flow meters, automated valves, and other instruments to be accessible from the operating floor and not susceptible to flooding in the trenches. Vessel feed and concentrate connections will be port-to-port, employing large 3-inch diameter outlet ports on each vessel interconnected with stainless steel grooved couplings, as shown in Figure 5-8.

Figure 5-8 Vessel Feed/Concentrate Connections

5.6.8 Clean-In-Place System

RO membranes require periodic cleaning to maintain permeability and salt rejection characteristics. For a system of this size an in-place cleaning system is typical, wherein the membranes are cleaned within the pressure vessels themselves by circulating cleaning solutions through them. Typical components include a cleaning solution makeup tank equipped with an immersion heater, a circulation pump, cleaning chemical dosing system, cartridge filter, instrumentation, and connecting piping and valves.

RO cleaning chemicals are typically not stored continuously on site but rather ordered when a cleaning is warranted. Typical criteria include a 15 -20 percent loss in permeability, a 15-20 percent increase in salt passage, or 15-20 percent increase in differential pressure across the membranes. The system will be configured to allow cleaning of each stage individually through permanently connected pipe manifolds and valves. The incidence of cleaning on a groundwater RO system of this type is typically low, often a single time per year. Owing to this we propose a simple, manually operated cleaning system as opposed to an automated system. Automated systems have increased complexity and lack the flexibility of a manual system. They can be useful where the frequency of cleaning is high.

For mineral scales low pH cleaners are typically employed, such as citric acid at a 2 percent concentration. For silica, custom cleaning agents are available from vendors in both low and high pH forms. Close monitoring of system operating performance can often identify the nature of a foulant and inform the selection of an appropriate cleaner. If there is not enough information, destructive autopsy of a single representative element from the train can be conducted to help identify the foulants. To allow flexibility in form (dry and liquid) and type of cleaners used for the system, we propose providing an eductor and hose system to load chemicals into the tank. Numerous other utilities have had success with this approach which allows the eductor to draw in chemical from any receptacle.

Design criteria for the RO clean-in-place (CIP) system are provided in Table 5-20.

Table 5-20 RO CIP System Design Criteria

Parameter	Units	Value
No. of Tanks	--	1
Tank Type	--	Vertical, Cylindrical
Tank Materials	--	FRP
Tank Capacity	gal	3,375
No. of Heaters	--	1
Heater Type	--	Flanged Immersion
Heater Materials	--	Stainless Steel/Incoloy
Heater Size	kW	100
Number of Pumps	--	1
Pump Type	--	Horizontal Centrifugal
Pump Capacity	gpm	120 – 600
Pump Design Head	feet	140
Pump Materials of Construction	--	Type 316 Stainless Steel
Pump Motor Size	hp	40
Pump Drive System	--	Variable Speed
Number of Cartridge Filters	--	1
Vessel Orientation	--	Horizontal
Vessel Design Capacity	gpm	600
Vessel Inlet and Outlet Connections	inches	8
Vessel Pressure Rating	psig	150
Vessel Materials of Construction	--	Type 316 stainless steel
Number of Filter Elements per Vessel	--	52
Filter Element Diameter and Length	inches	2.5 x 40
Filter Element Materials	--	Polypropylene
Filter Element Retention Rating	microns	5

5.6.9 Residuals

Residual streams associated with the RO system include the RO concentrate stream from each train along with cleaning system residuals. RO concentrate waste flows will be present whenever the system is operating and for a short period following shut down when the trains are flushed with raw water. Cleaning residuals will be limited to the specific cleaning events and will consist of both drain down of waste cleaning solutions (adjusted to a neutral pH as required) along with post flush of the membranes to remove any residual solution from the membranes and pressure vessels.

The RO concentrate will flow under pressure from the RO trains to the existing effluent control structure and enter through an air gap. Cleaning residuals will most likely be discharged to the wastewater treatment plant. A certain amount of the CIP waste solution can be pumped out of the tank; but a portion will need to drain by gravity.

Each train will also be equipped with a permeate dump valve to protect against over-pressurization of the train permeate and allow discharge of off-spec permeate during post-operation and cleaning flushes. This stream can either be allowed to drain directly to the pipe trench for gravity drain out or piped to a suitable receiving system.

5.6.10 Special Features

The wide turndown range required of the RO trains will be accomplished by blocking off the first stage vessels and operating the trains during low flows as a 7:3 two stage array. The achievable minimum flow will be dictated by the minimum continuous flow of the RO high pressure feed pumps. A final selection is still being investigated, but initial indications are that a flow as low as 255 gpm may be achievable. Manual valves with position switches will be used to configure the trains for either 2- or 3-stage operation. Depending on the length of the 2-stage operation, the first stage membranes can either be periodically flushed using the CIP system or stored in a 2 percent solution of sodium bisulfite.

In addition to the low flow configuration, the trains will also be equipped with individual permeate flow monitoring of all of the individual stages. This is particularly important for systems concerned about silica scaling as we are here. The onset of silica scale formation is typically first evidenced a drop in the flow of permeate in the final stage, where silica concentrations are highest. By monitoring the flows real time the onset of scale formation can be identified early and the membranes cleaned before it has a chance to take root. Once established, silica scales are difficult to remove and tend to recur at increasing frequency.

5.6.11 Future Reliability/Expansion

The building layout is structured to allow the addition of one more cartridge filter and RO membrane train to either increase system redundancy or accommodate an expanded facility flow.

5.6.12 Pretreatment Chemical Feed Systems

As discussed regarding RO system recovery optimization, pretreatment chemicals are used to keep potential scalants in check. Sulfuric acid will be used to lower the feed water pH while the threshold inhibitor will be used help control the formation of scales. Each system is discussed separately below.

5.6.13 Sulfuric Acid System

Sulfuric acid is the preferred mineral acid for RO systems as it does not fume the way concentrated hydrochloric acid does. Rather, it tends to draw moisture from the air and requires a desiccant on the storage tank air draw. Modelling based on the design water quality shows a target pH of 6.9 into the RO system. This will require a dose of roughly 40 mg/L of acid in proportion to the RO feed water flow. The rate of dosing will primarily be flow paced with a pH trim to help control the system to a target pH set point. Proper operation of the sulfuric acid system will be monitored by downstream pH analyzers with alarm functionality to catch any over or under-dosing.

The acid dosing system itself will include a storage tank, metering pumps, piping, valves and chemical injector. A horizontal lined steel storage tank is recommended to help guard against corrosion. The design storage duration is 15 days at the average plant operating capacity. Metering pumps will be hydraulic diaphragm type driven by small chassis mount VFDs. Each pump will be provided with its own drive panel. Sulfuric acid can generate a large amount of heat from back-mixing with water, which can occur at the injection point. We recommend the use of welded Alloy 20 piping for the injection piping to both increase its strength and guard against temperature effects. For low pressure piping we propose using butt fused PVDF. The chemical injector will be of Alloy 20 construction, fitted with a check valve and installed through a wet-tap installation that will permit extraction of injector without draining the process pipeline. Design criteria for components of the sulfuric acid system are provided in Table 5-21.

Table 5-21 Sulfuric Acid System Design Criteria

Parameter	Units	Value
Sulfuric Acid Concentration	%	93
Sulfuric Acid Specific Gravity	--	1.83
Sulfuric Acid Dose	mg/L	40
No. of Tanks	--	1
Tank Type	--	Horizontal, Cylindrical
Tank Materials	--	Phenolic Lined Steel
Tank Capacity	gal	1,000
No. of Pumps	--	2
Operating Configuration	%	2 x 100
Pump Type	--	Hydraulic Diaphragm
Pump Capacity	gph	3.6
Pump Materials of Construction	--	Alloy 20/PTFE
Pump Motor Size	hp	0.5
Pump Drive System	--	AC Variable Speed

5.6.14 Threshold Inhibitor Addition System

Threshold inhibitors are proprietary compounds developed by chemical vendors and designed to impede the formation of crystals which can plate the membrane surface. A target dose of 1.0 to 3.0 mg/L is recommended as the basis of design and can accommodate a wide range of candidate inhibitors. In the case of threshold inhibitor, there is as yet no reliable analytical measurement to detect its concentration in the RO system feed water. Its dose is therefore strictly flow paced. To insure that it is being applied correctly, a flow meter will be provided on the injection line for the purpose of monitoring flow and activating alarms. Given the potential low facility flows and low dose rate, at times the flow of 100 percent (neat) inhibitor could drop as low as 0.06 gph. Monitoring a flow this low would be difficult; so instead, the system will be designed to allow dilution of raw inhibitor at a rate up to 10:1. This will serve to maintain the flow of threshold inhibitor in the injection line in a range that can be accurately monitored. The dilution source will be RO permeate and added directly to the threshold inhibitor storage tank at the time of raw inhibitor delivery.

Piping materials consist of Type 316 stainless steel for injection piping and butt fused polypropylene for low pressure piping. The stainless steel injection piping is structurally robust and guards against breakage. The acid system will include a storage tank, metering pumps, and injector. We propose using a fixed in place storage tank which allow for the periodic dilution of inhibitor with RO permeate as needed. Design criteria for components of the system are provided in Table 5-22.

Table 5-22 Threshold Inhibitor System Design Criteria

Parameter	Units	Value
Threshold Inhibitor Concentration	%	10 - 100
Threshold Inhibitor Specific Gravity	--	1.00 – 1.05
Threshold Inhibitor Dose	mg/L	3
No. of Tanks	--	1
Tank Type	--	Vertical, Cylindrical
Tank Materials	--	FRP
Tank Capacity	gal	565
No. of Pumps	--	2
Operating Configuration	%	2 x 100
Pump Type	--	Hydraulic Diaphragm
Pump Capacity	gph	1.0
Pump Materials of Construction	--	316 Stainless/PTFE
Pump Motor Size	hp	0.5
Pump Drive System	--	AC Variable Speed

5.7 Area 500 – Disinfection, Stabilization, Clearwell, and Product Water Pumping

After the ground water is treated and blended it undergoes disinfection and stabilization. Part of this process occurs in the clearwell before the product water pumps boost the pressure to match the District's distribution system, specifically the Gheen pressure zone. The associated design criteria for the processes and equipment is provided in the following paragraphs.

5.7.1 Disinfection

The disinfection system is divided into two major categories: primary disinfection for virus removal and secondary disinfection to maintain a biostatic in the distribution system. Primary disinfection will be conducted in a clearwell with free chlorine. The contact time in the clearwell and the chlorine residual at the outlet of the clearwell have been selected to achieve 4 logs of virus inactivation, according to the Environmental Protection Agency (EPA) CT tables[3]. Sodium hypochlorite will be drawn from the same sodium hypochlorite storage system that is used for oxidation addition upstream of the IM vessels, backwash chlorination and regeneration. Rapid mixing will be provided after application of sodium hydroxide to ensure adequate blending prior to flow line (streamline) separation in the clearwell.

Secondary disinfection will be accomplished with chloramines because they match the secondary disinfectant used by the San Diego Country Water Authority (SDCWA) and FPUD at the Red Mountain Water Treatment Plant (WTP). Chloramines have the further benefits in that they are more stable than free chlorine (they degrade more slowly), and that they form fewer trihalomethanes (THMs) and haloacetic acids (HAAs). Chloramines will be formed by the addition of ammonia (ammonium hydroxide) to the clearwell effluent, which will react with the residual free chlorine to form chloramines. An effluent clearwell free chlorine analyzer will be used to control the chlorine dose, based on maintaining a conservative residual setpoint. In addition to trimming the chlorine dose, the effluent clearwell chlorine analyzer will be used for compliance monitoring and to control the ammonia dose, based on feed-forward control and flow-pacing. An optional influent analyzer is included to monitor the dosed concentration and chlorine decay through the clearwell. The design criteria for these systems are shown in Table 5-23.

[3] Assuming 15 degrees Celsius, or greater, a pH in the range of 6 to 9, a T_{10}/T baffling efficiency of 0.3, a safety factor of 20%, a free chlorine residual of 1 mg/L, and a flow of 7.8 MGD. A tracer study will likely be necessary to validate the baffling factor at start-up.

Table 5-23 Disinfection System Design Criteria

Parameter	Units	Value
Disinfectant chemical	na	Sodium hypochlorite
Typical dose, estimated	mg/L as Cl_2	2.5
High disinfectant chemical metering pumps	Duty+standby	1+1
High disinfectant pump capacity[1]	gph	11.3
High disinfectant pump turndown, min[1]	Maximum flow: minimum flow	10:1
Low disinfectant chemical metering pumps	Duty+standby	1+1
Low disinfectant pump capacity[1]	gph	1.2
Low disinfectant pump turndown, min[1]	Maximum flow: minimum flow	10:1
Disinfectant chemical storage volume	gal	7500
Disinfectant chemical strength, assumed	%	12.5
Clearwell volume for CT, minimum	gal	90,000
Ammonia chemical	na	Ammonium hydroxide
Typical dose, estimated	mg/L	0.5
High ammonia chemical metering pumps	Duty+standby	1+1
High ammonia pump capacity[2]	gph	1.2
High ammonia metering pump turndown, min[2]	Maximum flow: minimum flow	10:1
Low ammonia chemical metering pumps	Duty+standby	1+1
Low ammonia pump capacity[2]	gph	0.12
Low ammonia metering pump turndown, min[2]	Maximum flow: minimum flow	10:1
Ammonia chemical storage volume[3]	gal	500
Ammonia chemical strength, assumed	% as NH_3	29%

[1] Dose of 1 to 4.5 mg/L as Cl_2 for flow ranges between 0.40 and 7.8 MGD with a neat sodium hypochlorite solution decay of 10%
[2] Doses of 0.2 to 1.0 mg/L (chlorine to ammonia weight ratio of 5:1 for chlorine residuals of 0.8 to 4 mg/L as Cl_2) for flows ranging from 0.40 to 7.8 MGD
[3] Estimated storage time of 17 days at design flow

Space for a booster chlorine dose point will be reserved, in case it is necessary to decouple the disinfection process from the maintaining a distribution system chlorine residual. For example, decoupling would allow for a low clearwell effluent free chlorine residual (*e.g.*, 0.2 to 1 mg/L as Cl_2, depending on flow) with a higher chloramine distribution system residual (*e.g.*, 2 to 3 mg/L as Cl_2).

5.7.2 Stabilization

The product water will be stabilized prior to entering the distribution system. Stabilization is required to minimize corrosion of the distribution piping and household plumbing, given the corrosivity of the product water, which is a blend of RO permeate and highly carbonated groundwater. Stabilization will be achieved with caustic (sodium hydroxide) and orthophosphate addition. Liquid lime was considered as alternative to caustic; however, caustic was chosen because liquid lime is relatively new and lacks an extensive track record. A degasifier was also considered to reduce caustic requirements; however, caustic was found to be a more cost effective alternative on a net present worth basis (see Appendix H for details of comparison).[4]

Caustic is added downstream of the clearwell due to higher rates of disinfection at lower pH values, as well as lower rates of trihalomethane (THM) formation. The caustic dose will be controlled by downstream pH measurement, with power id mixing in between the dose point and the analyzer sample

[4] Space will be reserved on site so that a degasifier can be added at a later date, if desired.

location to achieve a low coefficient of variation (*e.g.*, 5%). Orthophosphate addition will be flow paced, with the dose set by the operator. The design criteria for the stabilization system are shown in Table 5-24.

Table 5-24 Stabilization System Design Criteria

Parameter	Units	Value
Alkali chemical	na	Sodium hydroxide
Typical dose, estimated	mg/L	22
High alkali metering pumps	Duty+standby	1+1
High alkali metering pump capacity[1]	gph	43.0
High alkali pump turndown, min[1]	Maximum flow: minimum flow	10:1
Low alkali metering pumps	Duty+standby	1+1
Low alkali metering pump capacity[1]	gph	5.2
Low alkali pump turndown, min[1]	Maximum flow: minimum flow	10:1
Alkali chemical storage volume[2]	gal	9,000
Alkali chemical strength, assumed	%	25%
Phosphate chemical	na	Phosphoric acid
Typical dose, estimated	mg/L	3
High phosphate metering pumps	Duty+standby	1+1
High phosphate pump capacity[3]	gph	1.1
High phosphate pump turndown, min[3]	Maximum flow: minimum flow	10:1
Low phosphate metering pumps	Duty+standby	1+1
Low phosphate pump capacity[3]	gph	0.12
Low phosphate pump turndown, min[3]	Maximum flow: minimum flow	10:1
Phosphate chemical storage volume[4]	gal	500
Phosphate chemical strength, assumed	%	85%

[1] Doses of 9 to 38 mg/L (based on RO bypass ratios of 40 to 62%, as product, for a range of influent water qualities, targeting a positive Langelier Saturation Index and a Calcium Carbonate Precipitation Potential of 3 to 5 mg/L as $CaCO_3$) for flows ranging from 0.40 to 7.8 MGD

[2] Typical storage time estimated at 15 days for design flow

[3] Doses of 1 to 5 mg/L for flows ranging from 0.40 to 7.8 MGD

[4] Storage duration of approximately 30 days at typical dose and design flow

5.7.3 Clearwell

The clearwell is shown on the site plan and Drawing 500M-1 of the 30% design drawings in Appendix A.

The sizing of the clearwell considered buffering time in addition to disinfection CT. In the event of the IM and RO process suffering an emergency shutdown and assuming only 76,000 gallons in the clearwell there would be 5 minutes of buffering capacity. The critical case however is when the product water pumps suddenly stop. A 90,000 gallon tank, covering CT requirements, would likely provide only 10,000 gallon, or 2 minutes of buffering. The tank is currently sized at 116,000 gallons which provides 7 minutes of buffering at full capacity. On high-high clearwell level indication the IM and RO processes will be shut-down, and the RO by-pass valve closed which takes very little time.

The tank will be baffled to assist with providing additional assurance for meeting disinfection requirements.

Design criteria for the tank is provided as follows.

- Type of Tank: Welded Steel (AWWA D-100)
- Storage Capacity: 0.12 MG
- Diameter: 45 feet
- High Water Level: 10 feet
- Floor Elevation: 658 feet
- Free Board: 3.0 feet
- Roof: column-supported cone with radius knuckle
- Total Tank Height: 13.0 feet

The tank is shown on the site plan, Drawing C-1 and Drawing 500M-1 and 500M-2of the 30% design drawings in Appendix A.

The proposed tank will be designed according to the provisions of ASCE 7. Key parameters for wind and seismic design loads are as follows:

General Parameters

- Site Class: C

Wind Design Load

- Wind Load Risk Category IV
- Wind Speed: 115 miles per hour
- Exposure: C

Seismic Design Load

- 0.2-second period, mapped spectral accel., S_S: 1.223 g
- 1-second period, mapped spectral accel., S_1: 0.471g
- Short-period site coefficient, F_a: 1.0
- Long-period site coefficient, F_v: 1.329
- 0.2-second period, Design Earthquake spectral response accel., S_{DS}: 0.815g
- 1-second period, Design Earthquake spectral response accel., S_{D1}: 0.418g
- Earthquake Importance Factor, I_e: 1.25

Tank Design

Steel tank structural design criteria consists of the following:

- Design per current AWWA D100 standard
- Roof design live load: 20 pounds per square foot (reducible)
- Tank shall be mechanically anchored to the foundation
- Tank shall be classified as Seismic Use Group (SUG) II
- Use Ri = 2.5 and Rc = 1.5 for base shear, overturning moment and hoop shell tension design
- Checking longitudinal tank shell compression stress (wall buckling)

- Freeboard will be based on AWWA D100 requirements. 3.0 feet of freeboard is estimated for preliminary design based on the design of similar steel tanks in California per the current D100 standard. An alternative design procedure may consist of a lower tank roof (with less freeboard) which is structurally reinforced to withstand, but not prevent, damage from tank sloshing. This alternative approach is assumed to be similar in cost to a taller tank, although it is not yet common practice for steel tanks constructed per current AWWA code in California.

5.7.4 Product Water Pump Station

The product water pumps take suction of the clearwell and supply the Gheen distribution zone.

Product Water Pumping Operating Head Conditions

The product water pump are controlled off the clearwell level and maintain a set point water surface elevation. The discharge varies with the water surface elevation in the Gheen reservoir, Gheen zone demand and the production rate off the plant. A summary of upstream and downstream head conditions is shown in Table 5-25.

Table 5-25 Summary of Product Water Pump Upstream and Downstream Conditions

Tanks	Base	Operating Water Levels		HGL		Static Head	
	Elevation	Max	Min	Max	Min	Max	Min
Clearwell	658	10	7	668	665	364	346
Gheen Reservoir	998	31	16	1029	1014		

Note: all values are in feet.

Product Water Pump Type and Configuration

The preliminary layout of the product water pumps are shown 500M-1 of the 30% drawings found in Appendix A. The proposed pump station consists of four can-mounted, vertical turbines pumps of the same capacity with VFD drives. This configuration was chosen based on the following:

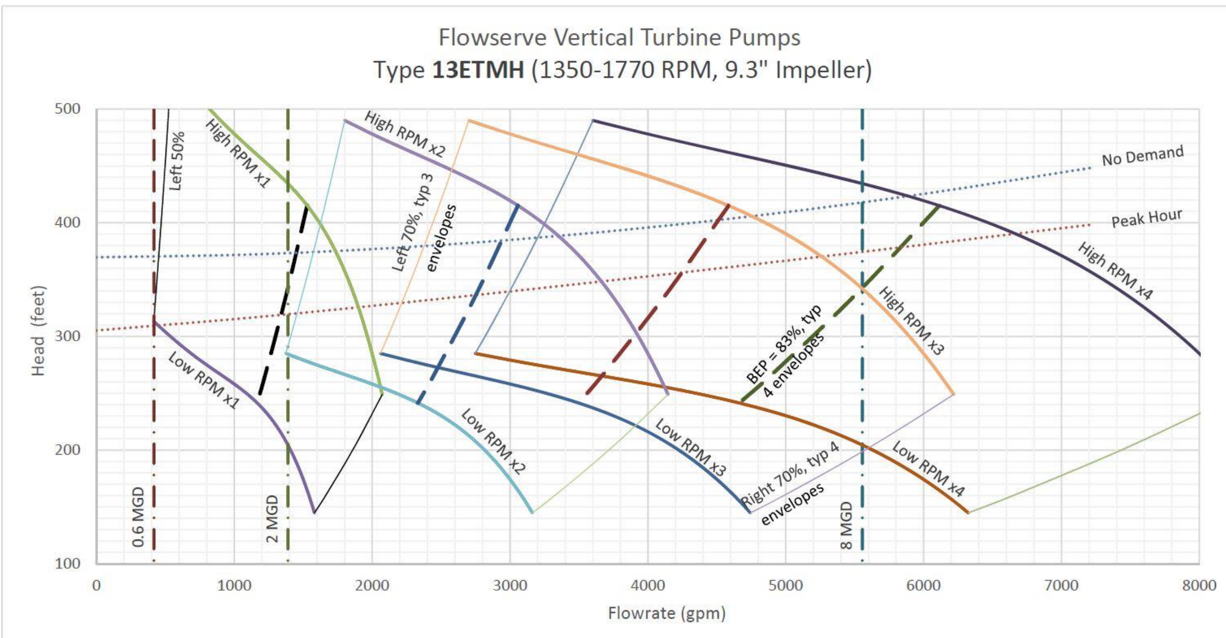
- Vertical turbine pumps (VTP) have a smaller footprint of similarly capacity horizontal pump/motor combinations, thus reducing the size and construction costs of the pump station. This is especially the case with multistage pumps as required for this application.
- Vertical turbine pumps maintain better suction when connected to above ground tanks than grade mounted horizontal pumps. The VTP's extend below grade which effectively increases the suction pressure to the pumps and will assist in quickly draining the clearwell in preparation for periods when the plant may offline for extended periods of time.
- Four pumps of the same size minimize storing additional spare parts for the pumps and associated suction and discharge piping.
- VFD drives minimize water level fluctuations in the clearwell and assist in maintaining smooth ramp-ups and ramp-downs associated with transitions when adding or removing pumps to meet production flow conditions.

Product Water Pump Selection and Performance

Flowserve five-stage pump with a 250-horsepower (HP) motor meets the criteria. Pump efficiency is about 80 percent at full speed (1770 rpm) and a design flow of 2 MGD (per pump).

Figure 5-9 below shows the operating VFD envelopes for one, two, three and four pumps operating in parallel. For the operating conditions within the anticipated range of flows, the pump efficiencies are good (above 70 percent for most flows greater than 2 MGD). The pumps will cover all anticipated production rates. Transition from on pump to two will occur 1500 gpm, two to three pumps in operation at about 3200 gpm, and three to four pumps in operation at about 4500 gpm.

Figure 5-9 Product Water Pump System Curve and VFD Operating Envelopes



Note: that High RPM = 1770, Low RPM = 1350.

Pumps of similar configuration are available from numerous manufacturers, and the specifications will require that the pumps meet the material and performance objectives for the project

Product Water Pump Suction and Discharge Piping

The pump station suction and discharge piping are sized using the standards set forth by the Hydraulics Institute (HI). Table 5-26 summarizes the recommended pipe sizes based on hydraulic design parameters.

Table 5-26 Product Water Pump Suction and Discharge Pipe Sizing

Item	DIA, in	V, fps	Q, gpm	HI Recommendation for Vertical Turbine Pumps
Suction Header	24	4.0	5600	8 fps max
Pump Suction	12	4.0	1400	4 fps max
Pump Discharge	10	5.7	1400	-

In addition to these requirements, HI indicates that the length of the suction piping upstream of the pump must be at least five pipe diameters.

5.8 Area 600 – Chemical Facilities

The chemical facilities are show on the site plan and on drawing 600M-1 of the 30% design drawings in Appendix A. The facility includes chemical truck unloading, depressed chemical containment and chemical trenches. Trenches are covered with FRP grating. Operator access to the facility is from the RO building on the northwest, with the trench grating matching the grade of the RO building floor. The grated trench continues the length of the facility and exits on the southeast end of the facility. Chemical storage and metering pump criteria and indicated elsewhere within this document. A list of chemicals stored, containment capacity, and reference to paragraphs where additional criteria can be found is shown in Table 5-27. The facility will be designed in compliance with the IBC and fire codes.

Table 5-27 Chemical Criteria References and Containment Capacities

Chemical	Chemical Storage Volume	Containment Capacity	Reference Paragraphs
Sodium Hypochlorite 12.5%	7,500 gal	8,000 gal	5.4.5 Oxidation System, 5.7.1 Disinfection
Sulfuric Acid 93%	1000 gal	5,500 gal	5.6.12 Pretreatment Chemical Feed System
Threshold Inhibitor 100%	565 gal	1,420 gal	5.6.12 Pretreatment Chemical Feed System
Ammonium Hydroxide 29%	500 gal	1,430 gal	5.7.1 Disinfection
Sodium Hydroxide 25%	7,500 gal	9,150 gal	5.7.2 Stabilization
Phosphoric Acid 85%	500 gal	1,420 gal	5.7.2 Stabilization
Ferric Chloride 37%	500 gal	1,420 gal	5.4.6 Quenching System 5.9 Area 700 - Waste Backwash Recovery and Drying Beds
Sodium Bisulfite 38%	1,000 gal	1,430 gal	5.10 Plant Shutdown, Mothballing, and Startup Design Features
Small Spare Area	TBD	1,430 gal	5.8 Chemical Facilities
Larger Spare Area	TBD	6,200 gal	5.8 Chemical Facilities

The facility will be covered with a steel canopy extending several feet beyond the perimeter of the base footprint. A skirt extending vertically 9 feet from the roof down the sides will assist in keeping rainwater out of the facility. The canopy will be equipped with gutters and downspouts.

Metering pumps will be peristaltic type unless otherwise noted mounted above sinks to facilitate periodic hose maintenance. There are two entrance/exit location for each separate containment area. Chemical safety data sheets for the chemicals used are provided in Appendix J, Chemical Safety Data Sheets.

The ammonia hydroxide will need the full California Accidental Release Prevention (CalARP), Program level 2 which includes a process safety review, offsite consequence analysis and plenty of procedural documents submitted to the County.

5.9 Area 700 – Waste Backwash Water Recovery and Drying Beds

The waste washwater recovery tank and drying beds are shown on the site plan of the 30% design drawing in Appendix A. The waste backwash water from the IM vessels will flow by gravity to a below grade reclaim tank and result in recovering essentially all of the water and returning it to the front of the plant (the washwater recovery system increases the IM treatment system recovery from estimated 96% to estimated 99.98%). In addition to increasing recovery, the waste backwash water recovery system also reduces the loading of waste backwash water on the WWTP (*e.g.*, manganese loading). Sludge will be pumped to the drying beds.

As the waste washwater flows to the waste washwater (WWW) recovery tank, ferric chloride will be injected to improve settling of the solids[5]. Ferric chloride is included because experience with similar waters that are low in iron but high in manganese have shown poor settling without the addition of ferric chloride. After ferric chloride addition, the waste washwater will be allowed to gravity thicken in the WWW recovery tank. Gravity thickening results in the separation of particles in the backwash waste water, with particle concentrations reduced in the supernatant and particle concentrations increased in the sludge, due to the downward movement of large particles by the force of gravity. Gravity thickening effectiveness increases with increasing time (settling time). The shortest settling time occur at the design flow, which is when the filter backwash frequency is the greatest. Longer settling times can be achieved at lower flows. The WWW recovery system was sized for the most challenging condition: design flow.

After gravity thickening, the supernatant will be pumped back to the equalization (EQ) tank at a target recycle rate of 10% (*i.e.*, during recycling, 10% of the total flow to the filters will be from reclaimed backwash waste water and 90% of the flow will be from MCBCP). A recycle rate of 10% was selected to minimize the impact of the reclaim water quality on filter performance. The recycle rate, and thus the time period when recycling is occurring (recycling time), will vary with the plant flow rate in order to meet the target recycle rate (*e.g.*, the recycle time will be shortest at design flow). After recycling, the WWW recovery tank will be ready to receive draindown and waste backwash water from a backwashing filter. When the WWW recovery tank has received the last of the backwash waste flows, gravity thickening can begin again, and the solids separation process is repeated. The settling time is constrained by the recycling time and the time when the WWW recovery tank receives backwash water; thus, given that the recycling time is fixed, the time when the WWW recovery tank receives backwash water should be kept to a minimum.

During gravity thickening, particles accumulate at the bottom of the WWW recovery tank. These particles will thicken to form a sludge, which will be periodically pumped to drying beds for further

[5] A minimum of 20 pipe diameters is required between the injection point and the Reclaim Tank to ensure sufficient mixing

thickening. The WWW recovery tank will include at least 2 ft of dedicated volume for sludge accumulation. The WWW recovery tank and supporting system design criteria are shown in Table 5-28. Design criteria for the system elements follow.

Table 5-28 Waste Backwash Water Reclaim System Design Criteria

Parameter	Units	Value
Reclaim tanks[1]	#	1
Active reclaim tank volume[2]	gal	145,000
Coagulant chemical	na	Ferric chloride
Typical dose, estimated	mg/L	30
Coagulant metering pumps	Duty+standby	1+1
Coagulant metering pump capacity[2]	gph	64.8
Coagulant pump turndown, min[3]	Maximum flow: minimum flow	10:1
Coagulant chemical storage volume[4]	gal	500
Coagulant chemical strength, assumed	%	37
Reclaim pumps	Duty	3
Reclaim pump capacity[5]	gpm	42 to 542
Sludge pumps	Duty	1
Sludge pump capacity	gpm	32

[1] Affords approximately 186 minutes of settling time and 133 minutes of reclaim time, with 24 minutes to receive backwash water, at design flow and estimated backwash interval of 5.6 hours (based on estimated filter run times of 28 hours).
[2] Active volume is volume that can be reclaimed by the reclaim pump (it does not include the dedicated sludge volume); active volume includes storage for two backwashes (at 72,000 gallons per backwash).
[3] Provides doses of 30 to 60 mg/L for backwash rates ranging from 3 to 15 gpm/ft^2
[4] Estimated storage duration of approximately 20 days at design flow
[5] With variable speed drive

5.9.1 Waste Washwater Recovery Tank

The waste washwater recovery (WWW) tank is shown on 700M-1 in the 30% design drawings found in Appendix A. This is a cast-in-place concrete tank with a hopper bottom. The hopper bottom facilitates sludge collection and reduces cost by not having vertical walls in excess of 15 feet deep. Initial geotechnical information (See Appendix F) indicates that at about 15 feet deep across hard material is present. Construction of the tank as currently configured slightly exceeds this depth. If rock is present at the depth of the current design there is not much rock excavation that general structural design criteria will have to be performed to accommodate the current design. We will consider further investigative methods or make dimensional adjustments during final design. Refinements to the wash water recovery system will occur as part of the design development process.

5.9.2 Washwater Recovery Pumps

The washwater recovery pumps take suction off the WWW recovery tank and pump to the front of the plant. The wash water recovery pumps are shown on Drawing 700M-1 of the 30% design drawing in Appendix A.

Washwater Recovery Pumping Operating Head Conditions

The washwater recovery pumps feed the supernatant back to the front of the plant. They are manually initiated and operated based on settling time following a back wash of the IM vessel and operation experience. The pump will be manually shutdown or automatically by low level control. Suction pressure depends on the level in the WWW Tank. The discharge pressure varies depending on the level in the Equalization Tank. A summary of upstream and downstream head conditions is shown in Table 5-29.

Table 5-29– Summary of Washwater Recovery Pump Upstream and Downstream Conditions

Tanks	Base Elevation	Water Heights		HGL		Static Head	
		Max	Min	Max	Min	Max	Min
WWW	633.3	21.5	8.2	654.8	641.5	94	73
EQ	710	25	17.5	735	727.5		

Note: all values are in feet.

Washwater Recovery Pump Type and Configuration

The preliminary layout of the washwater recovery pumps is shown on drawing 700M-1 of the 30% drawings found in Appendix A. The proposed pump station consists of three vertical turbines pumps, two of the same capacity and one of smaller capacity to meet minimum flow conditions, all with VFD drives. This configuration was chosen based on the following:

- Vertical turbine pumps (VTP) have a smaller footprint of similarly capacity horizontal pump/motor combinations.
- Vertical turbine pumps maintain better suction when connected to above ground tanks than grade mounted self-priming horizontal pumps. The VTP’s extend below grade which effectively increases the suction pressure to the pumps.
- Two pumps of the same size minimize storing additional spare parts for the pumps and associated suction and discharge piping.
- VFD drives minimize flow fluctuations in the water entering the plant contribute to overall smooth operations.

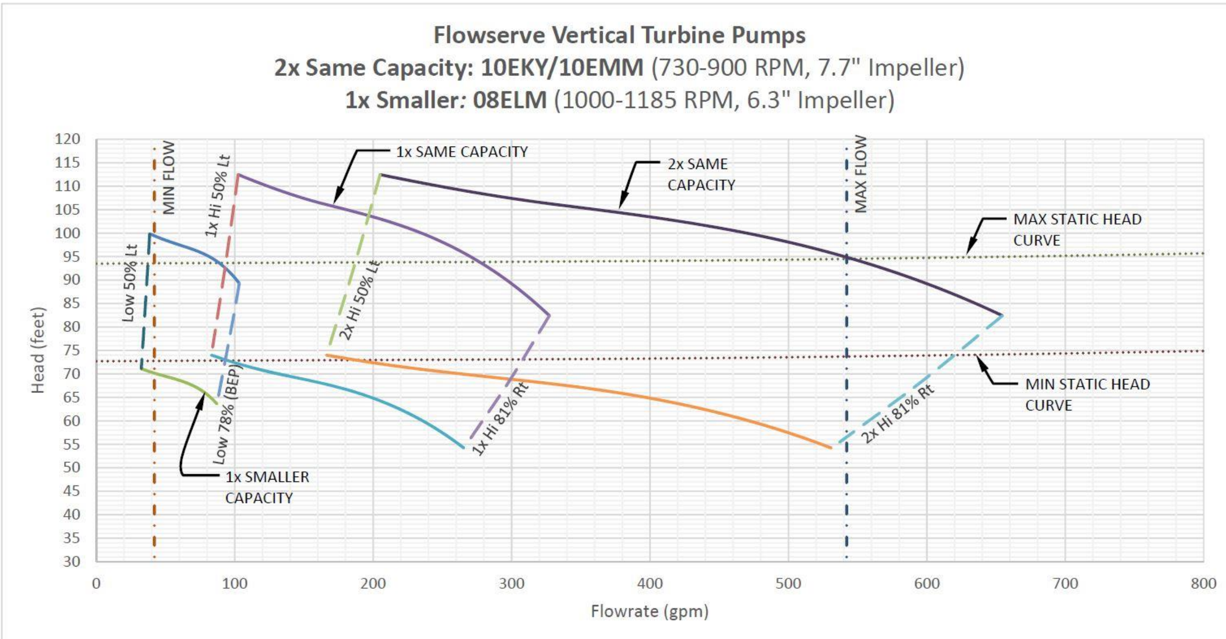
Washwater Recovery Pump Selection and Performance

For the two same capacity pumps, Flowserve eight-stage pump with a 10-horsepower (HP) motor meets the criteria. Pump efficiency is about 82 percent at high speed (890 rpm) and a design flow of 270 gpm (per pump).

For the smaller capacity pump, Flowserve six-stage pump with a 3-horsepower (HP) motor meets the criteria. Pump efficiency is about 72 percent at high speed (1185 rpm) and a design flow of 90 gpm (per pump).

Figure 5-10 below shows the operating envelopes for the one smaller pump alone and the other two pumps, one alone and two in parallel. For the operating conditions within the anticipated range of flows, the pump efficiencies are good (above 50 percent).
Figure 5-10 also indicates that with VFD drives the pumps will cover all excepted production rates.

Figure 5-10 Waste Washwater Recovery Pump System and VFD Operating Envelopes



Pumps of similar configuration are available from numerous manufacturers, and the specifications will require that the pumps meet the material and performance objectives for the project (See Appendix P4 for pump data).

Washwater Recovery Discharge Piping

Pipe sizes and hydraulic parameters are summarized below.

Discharge – *Same Capacity Pumps*
- Diameter: 6 inches
- Velocity: 3.1 feet per second
- Flow: 270 gallons per minute

Discharge – *Smaller Pumps*
- Diameter: 4 inches
- Velocity: 2.6 feet per second
- Flow: 100 gallons per minute

In addition to these requirements, HI indicates that the VTPs suspended in an open tank or from a pier are to be separated by five times the maximum cross-sectional dimension of any obstructions to the intake flow path. Also they are to be set at five inlet bell outside diameters above and sludge material that is not captured by suction flow.

5.9.3 Sludge Pump

The sludge pump takes suction off the waste washwater recovery tank and pumps to one of two drying beds. The sludge pump is shown on 700M-1.

Sludge Pumping Operating Head Conditions

The sludge pump is manually controlled and operated based on sludge measurements and operation experience. The pump will be manually shutdown or automatically by low level control. Suction pressure depends on the level in the waste washwater recovery tank. The discharge pressure varies depending on which drying bed is receiving sludge. A summary of upstream and downstream head conditions is shown in Table 5-30.

Table 5-30 – Summary of Sludge Pump Upstream and Downstream Conditions

Tanks	Base Elevation	Water Heights		HGL		Static Head	
		Max	Min	Max	Min	Max	Min
WWW	633.3	21.5	8.2	654.8	641.5	44	19
Drying Bed 1 (DB-1)	683.5	1.5	0.5	685	684		
Drying Bed 2 (DB-2)	673.5	1.5	0.5	675	674		

Note: all values are in feet.

Sludge Pump Type and Configuration

The preliminary layout of the sludge pump is shown on drawing 700M-1 of the 30% drawings found in Appendix A. A single constant speed submersible pump is employed for this service. A submersible pump was chosen based on the following:

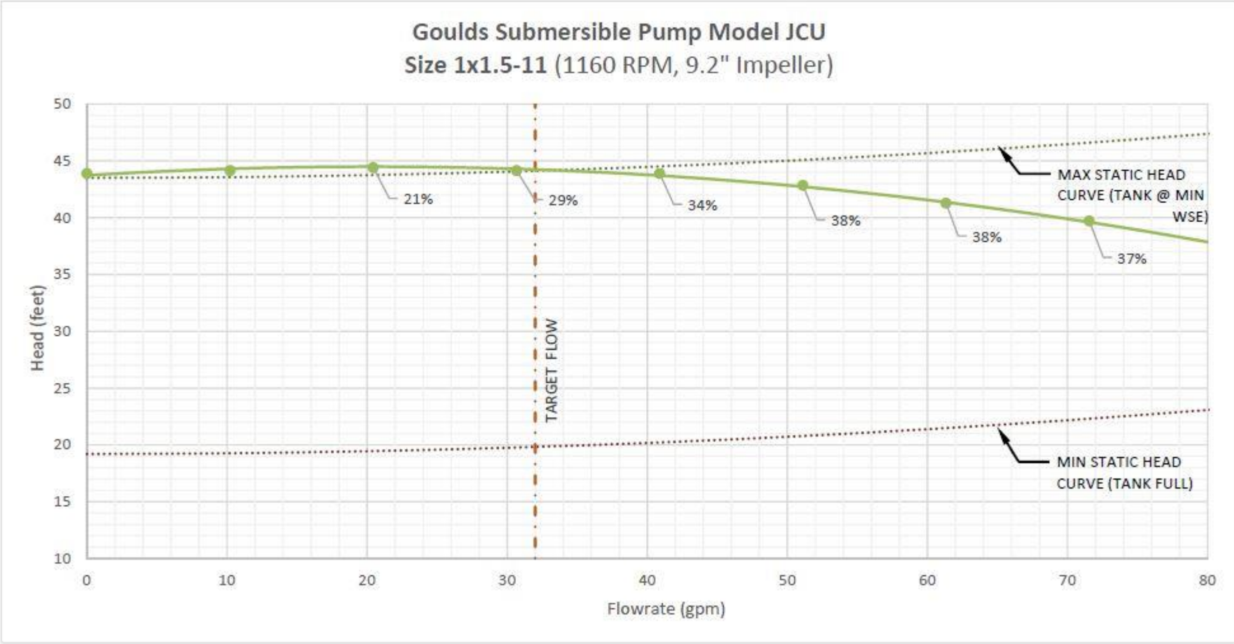
- Small footprint.
- Ease of removal.
- Specifically designed for sludge.

Sludge Pump Selection and Performance

Goulds single-stage pump with a 2-horsepower (HP) motor meets the criteria. Pump efficiency is about 29 percent at rated speed (1160 rpm) and a design flow of 32 gpm.

Figure 5-11 below shows that the target is met when pumping to the upper Drying Bed 1 with good pumping efficiencies (about 30%). The figure also shows that when pumping to the lower Bed 2, the pump will run off the end of the curve. During final design, this condition will be evaluated to impose a restriction in the discharge piping so that minimum target flows can be met while maintaining maximum flows that remain on the pump curve.

Figure 5-11 Washwater Sludge Pump Curve



Pumps of similar configuration are available from numerous manufacturers, and the specifications will require that the pumps meet the material and performance objectives for the project (See Appendix P5 for pump data).

Sludge Pump Suction and Discharge Piping

Sludge pump pipe sizes and hydraulic parameters are summarized below.

- Diameter: 2 inches
- Velocity: 3.3 feet per second
- Flow: 32 gallons per minute

5.9.4 Sludge Drying Bed System

Sludge from the reclaim system will be sent to rehabilitated sludge drying beds for dewatering. These beds previously served the Fallbrook Public Utility District (FPUD) Wastewater Treatment Plant (WWTP), but are no longer needed by the WWTP. The drying beds have a center sand channel, which used to drain water from the sludge to the WWTP. The liner that separates the sand from the soil has been subject to damage from animals and may cause flooding of nearby low-lying areas. The rehabilitated beds will include removing the center channel extending the concrete floor slab over this area. See 700M-2 of the 30% design drawings in Appendix A. The modifications include the ability to decant the drying beds to the sewer and also to discharge the sludge from the waste washwater reclamation tank to the sewer if the beds become overwhelmed. Decanting will be accomplished through an adjustable overflow (*e.g.*, stop logs). The estimated drying time is one to eight weeks, depending on the time of the year[6]. The beds are best operated at the same time, to maximize evaporative surface area, with isolation

[6] Estimate based on guaranteed minimum delivered flows from MCBCP

occurring only for drying and sludge removal. The estimated clean out interval is once a year per bed. The design criteria for the rehabilitation of the beds are shown in Table 5-31.

Table 5-31 Sludge Drying Bed Design Criteria

Parameter	Units	Value
Number of drying beds	#	2
Number of independent channels per drying bed	#	2
Drying bed length	ft	175
Channel width	ft	20
Drying bed depth	ft	1.5

5.10 Project Structural Design

The general structural design criteria for the project is provided under this section. The intent of the criteria is to ensure all structural buildings and facilities meet structural code requirements (code level forces) for life safety.

Applicable Codes, Standards, and References

The design codes, standards, and references in Table 5- 32 are applicable for the evaluation of structures for the Project.

Table 5- 32 Applicable Structural Codes and Standards

Code/Standard	Application and Project Impact
California Building Code (CBC), 2013 Edition	Specifies minimum structural design loads and design requirements for new facilities constructed in California. This code refers to International Building Code (IBC) 2013 for many criteria, which contains more specific details.
American Society of Civil Engineers (ASCE) Standard No. 7-10, "Minimum Design Loads for Buildings and Other Structures."	Specifies minimum structural design loads and design requirements for new facilities.
ACI 318-11 "Building Code Requirements for Reinforced Concrete."	Specifies generic minimum design criteria for reinforced concrete structures.
ACI 350-06. "Code Requirements for Environmental Engineering Concrete Structures."	Contains minimum design criteria for environmental and liquid retaining concrete structures to provide concrete crack and leakage control measures.

Geotechnical Criteria

Findings and recommendations from the geotechnical investigations (See Appendix F) are used to form the basis for the structural design criteria of the Santa Margarita Conjunctive Use structure. Below grade structures are evaluated to resist the lateral earth pressures determined based on the soil analysis. Additional geotechnical work will be performed and consideration given to pumping to a raised tank to avoid bedrock. Also note from work on WRP site, in additional to bedrock there were very large boulders spread across the site above bedrock.

Seismic Design

Seismic design utilizes the peak ground acceleration at the site and the probability of exceedance as provided in the geotechnical investigation (See Appendix F).

Design Loads

The following definitions of loads are used for design of structures:

D	Dead Load (material weights and fixed equipment)
E	Earthquake (seismic) Load
E_m	Estimated Maximum Earthquake Force (ASCE 7-10 Section 12.4.3)
f1	Coefficient defined in 2013 CBC Section 1605.2
H	Lateral Pressure of Soil and Water in Soil Loads
L	Live Load (except roof live load)
L_r	Roof Live Load
W	Wind Load

The design loads for dead (D), live (L), fluid (F), wind (W), and earthquake /seismic (E) loads are included as Table 5-33. The load combinations used for reinforced concrete, steel, and masonry structural design are included as Table 5-34.

Acceptance Criteria

The acceptance criteria for ensuring that structural designs meet the CBC and IBC design requirements are summarized in Table 5-33.

Table 5-33 Structural Design Loads

Design Load	Value
Dead Load (D)	
Structure Weight	
Concrete	150 pound per cubic feet (pcf)
Steel	490 pcf
Aluminum	165 pcf
Equipment	Actual weight per vendor
Live Loads (L)	
Roof	20 psf minimum
Fluid Loads (F)	
Hydrostatic Loads	Water density = 62.4 pcf
Wind Loads (W)	
Basic Wind Speed	115 miles per hour (mph)
Exposure	C
Wind Loads Factor	ASCE 7-10 Section 6.5.11
Earthquake (Seismic) Loads (E)	
Seismic Coefficients	
Risk Category	IV
Site Class	D

Design Load	Value
Site Coefficient (F_a)	1.0
Site Coefficient (F_y)	1.0
Site Coefficients SMs and SDs	SMs=1.210 and SDs=0.807
Site Coefficients SM1 and SD1	SM1=0.704 and SD1=0.470
Importance Factors	
Structures	I=1.25
Equipment	I_p=1.5
Response Modification Coefficient (R)	
Structures	ASCE 7-10 Table 12.2-1
Mechanical & Electrical Components	ASCE 7-10 Table 13.6-1
Non-Building Structures	ASCE 7-10 Table 15.4-2

Table 5-34 Structural Load Combinations

Loading Combination	Reference
Reinforced Concrete Strength Design (SD) Method	
U=1.4D	CBC Section 1605.2, EQN: 16.1
U=1.2D+1.6 (L+H)+0.5 Lr	CBC Section 1605.2, EQN: 16.2
U=1.2D+1.6Lr+1.6H+ f_1L+0.5w	CBC Section 1605.2, EQN: 16.3
U=1.2D+1.0W+ f_1L+1.6H+0.5Lr	CBC Section 1605.2, EQN: 16.4
U=1.2D+1.0E+f_1L+1.6H	CBC Section 1605.2, EQN: 16-5
U=0.9D +1.0W+1.6H	CBC Section 1605.2, EQN: 16-6
U=0.9D+1.0E+1.6H	CBC Section 1605.2, EQN: 16-7

Design Methods

The Ultimate Stress Design (USD) method would be used for design of reinforced concrete structures including walls, slabs, beams, columns and foundations. Concrete liquid containing structures must use 1.3 durability factor in accordance with ACI 350. The ASD method would be used for the design of steel and masonry structures. The foundations for all structures would use the actual unfactored loads and the ASD method for sizing footings, slab on grade, and concrete mat foundations.

Deflection Criteria

The maximum allowable deflection for elevated slabs and beams would be as follows:

Live Load (L) only	L/360
Total Load (D+L)	L/240
Concrete Roof (L)	L/240
Concrete Roof Deck (D+L)	L/180

Material Properties

The materials considered for structural design with respective properties are indicated in Table 5-35.

Table 5-35 Structural Material Properties

Material	Reference
Reinforced Concrete	
Shotcrete	4,000 psi
Compressive Strength	$f^{1}c$=4000 psi
Reinforcing Steel	ASTM A615, Grade 60
Carbon Fiber Composite	
Tensile Strength	121,000 psi
Tensile Modulus	$11.9x10^{6}$ psi
Flexural Strength	15,200 psi
Flexural Modulus	384,200 psi
Epoxy for Crack Repairs	
Compressive Strength	10,000 psi
Compressive Modulus	200,000 psi
Tensile Strength, 7 days	7,000 psi
Bond Strength, 2 days	2,000 psi
Flexural Strength, 14 days	14,000 psi

Allowable Loads

For concrete USD, the factored design loads would cause bending moment, shear and axial loads in membranes which must be less than or equal to the strength reduction factor (Φ) times the member capabilities, as determined per Chapter 9.3 of ASCE 7-10.

For loading combinations including wind (W) or earthquake (E) design loads, the allowable could be increased by 33 percent to account for the short-term duration of these loads as allowed in 2013 CBC.

Foundation Design Criteria

Foundation design would be acceptable provided it meets the entire acceptance criteria specified in Table 5-36.

Table 5-36 Acceptance Criteria for Structural Designs

Criterion		Value
Maximum allowable soil pressure	Normal D,L,F,H loading for slab/mat foundation combinations	2,500 psf
	Wind or Seismic loading combinations only	3,333 psf
Minimum factor of safety for normal (D,L,F,H) loading against buoyancy uplift, sliding, and overturning		1.5
Loading combinations for earthquake (E) or wind (W)	Sliding	E - 1.1; W-1.5
	Overturning	E -1.1; W-1.5
Sliding resistance; soil against concrete friction coefficient		0.35
No net uplift is allowed on any portion of the foundation.		

Special Inspection

Special inspections would be provided by Contractor and Construction Manager in accordance with CBC Chapter 17 for the following constructions:

- Cast-in-place concrete, except concrete with a compressive strength (f'c) of less than 2,500 psi or site-work concrete.
- Placement of concrete reinforcing steel.
- Earthwork including excavations, backfill compaction and grading.
- Where required by the respective International code Council Evaluation Service (ICC-ES) evaluation report, special inspection would be required for mechanical couplers, expansion anchors, and adhesive anchors. Expansion anchor and adhesive anchors would be ICC-ES approved and would be designed based on ICC-ES allowable loads.

  Concrete masonry structures, with the assumption that full stresses were used in the design.

5.11 Project Electrical and Controls Design

The design approach for the electrical and controls at SMCUP plan is provided below.

Electric Service

The WTP will have an SDG&E service separate from the adjacent WWTP. There is an existing SDG&E service that feeds a storage building next to the new WTP site that can be utilized for power. SDG&E will provide a service order to be used by the Contractor to implement the new service. A new 480 volt, 3-phase service meter switchboard with surge suppression will be installed next to the RO Building in a NEMA 3R enclosure. The service will be rated for 3,000A. Included with the meter switchboard will be a Manual Transfer Switch with lugs for connecting a portable emergency generator. The site fence must have a SDG&E padlock to allow meter reading access. The 3,000 amp switchboard will have a load of approximately 2,200 amps with all loads running.

Motor Control Center (MCC)

The MCC will be located in the RO Building Electrical Room. The MCC will power the RO system and associate pumps. It will also include product water pumps (motor starters, VFD's, circuit breakers), and its ancillary equipment (chemicals, CIP, etc.). There will be an active harmonic filters to mitigate VFD generated harmonics and meet IEEE 519. It will also contain a 120/240 volt panelboard for site lights, controls, fans, etc. and be equipped with a Power Monitor system.

Controls

The Plant will be equipped with a Main PLC Panel (CP-1). This will be the panel that supplies information to the SCADA system for operators to control and monitor the plant's operation onsite and remotely. The RO system will be equipped with its own Control Panel that will monitor and control the RO system and it ancillary systems. This PLC will be provided by the RO supplier. The Control Panels will be connected together with an Ethernet network. The Operator Workstations and the SCADA server will also be on this network. The Plant SCADA will communicate with the District SCADA Central. The Gheen Reservoir site will communicate by the District's radio network. SCADA software, PLC's and radios will be based on District standards.

5.12 Future Plant Expansion

Space will be left on the plant site for several additional IM and RO components for the contingency that the base flow to the plant increases and or that additional treatment provisions are needed (the maximum flow is not expected to increase). Space will be reserved for the following:

1. IM reaction tank preceding the current IM vessels, of the same size as the IM vessels,
2. Sixth IM vessel to allow for lower filtration rates while backwashing at the maximum flow,
3. High-rate clarifier backwash recovery system, related flow equalization tank and pump.
4. Fourth RO train. Space within the currently designed RO building is available.
5. Decarbonator to reduced long term caustic usage costs.

5.13 Plant Shutdown, Mothballing, and Startup Design Features

Since the SMCUP plant will be shut down and started up once a year or even possibly mothballed for a period of several years, special features within the design will assist the District with preparing for these events and executing related procedures. Below are some initial items and features that have been or will be considered in the final design.

5.13.1 Steel and Concrete Tanks

During period of extend shut down the tanks will be drained and left empty. Inspection prior to start up will be performed. To assist with these efforts the design will:

- Utilize floor sumps or bottom penetrations outlet piping to minimize standing water in the tank, providing more water processed prior to opening the tank for shutdown.
- Utilize enlarged, 30 or 36 inch diameter, manholes to facilitate tank entrance and provide manhole davit supports.
- Provide two manhole entrances per tank.
- Include enlarged ventilation openings to facilitate ventilation considering permanent forced ventilation to minimize labor and time during the shutdown process.
- Provide external drains or blow-offs to facilitate drainage to the sewer to minimize surface drainage or the use of vacuum trucks.
- Provide provisions for draining the EQ tank through the outlet piping including a downstream blow-off to drain to stormwater basin.

5.13.2 Pumps and Piping

Strategically locate drains and flushing connections. Configure plant process water system layout to facilitate temporary connections to flushing points. Provide sewer drains adjacent to pipe and pump drains. Specifically provide:

- A valve to by-pass the equalization tank which will facilitate flushing of the inlet and outlet lines before placing the tank in service.

- Provide for a connection from the RO feed pumps to the RO by-pass line to assist with lowing the level in the RO feed tank in preparation for long period shutdowns.

5.13.3 IM Vessels

The IM vessels have specific procedures to be followed in preparation for long period shutdown. To assist with these efforts the design will:

- Provide for gravity drainage. .
- Utilize enlarged and easy to open manholes to facilitate vessel entrance and sanitizing.
- Provide four manhole entrances per vessel (two per cell) with permanent ladder or platform access.
- Provide filter-to-waste facilitate vessel performance evaluations as part of the startup procedure.
- Include local provisions for sanitizing the filter media by applying 10 gallons of 15% Sodium Hypochlorite for every 100 cubic feet of media.
- Consider internal sanitation piping.
- Include local provisions for reconditioning the media.

5.13.4 RO Facility

The RO membranes have to be protected for long period shutdowns. To assist with these efforts the design will:

- Provide for gravity drainage flowing to the sewer to minimize drainage to the surrounding area including RO vessels and CIP system components.
- Provide features for creating a sodium bisulfite solution to be circulated through the RO membranes and isolation. The Sodium bisulfite solution for RO membrane element storage are diluted to a 2 percent solution in the CIP tank.

6.0 DISTRIBUTION SYSTEM UPGRADES

6.1 Design Standards and Criteria

The design of new pipelines will conform to District standards (i.e., FPUD Standard Specifications – Design Manual and Specifications), District preferences, and American Water Works Association (AWWA) guidelines and standards.

6.1.1 FPUD Standard Specifications

Pipeline design and materials will conform to the following District design criteria:

- Pipeline material shall be cement mortar lined and coated (CML&C) steel pipe.
- Cement mortar lining is a minimum of 3/8-inch thick and cement mortar coating is a minimum of ¾-inch thick for buried pipe per District Standard Specifications Section 15076 and AWWA C205).
- CML&C pipe shall be welded joints and shall conform to AWWA C200.
- Pipelines shall have design cover of 3 feet minimum to 3.5 feet maximum. Additional cover may be required at existing utility crossings.
- Air release valves and blow offs will be installed at high and low points in the pipeline profile, respectively.
- FPUD STD Drawings for distribution work.

6.1.2 American Water Works Standards

Pipeline design shall conform to the requirements of the California Water Works Standards, Title 22, California Code of Regulations, including separation distance from non-potable fluid pipelines, and the guidelines contained in the following AWWA manuals (as applicable):

- Manual M23, PVC Pipe –Design and Installation,
- Manual M11, Steel Pipe – A guide for Design and Installation,
- Manual M41, Ductile-Iron Pipe and Fittings, 3rd Ed.

6.1.3 Thickness Design of Steel Pipe

The design of steel pipe wall thickness will consider dead and live loads on the steel cylinder. Pipe deflection will be evaluated in accordance with AWWA Manual M11 with deflection criterion of approximately two percent to reduce the potential for cracking the cement mortar linings.

The design of steel pipe wall thickness will also consider transient pressures which will be evaluated during final design. The construction of surge control facilities is anticipated at the proposed Water Treatment Plant and at the Gheen Pump Station.

6.1.4 Isolation Valves

New valves will be installed at all branches at new tees or cross connections and where new pipelines will connect to existing tees or crosses. District standards for valve spacing are as follows:

- The maximum spacing between valves on distribution lines shall be 750 feet in residential areas and 500 feet in all other areas.
- The maximum spacing between valves on transmission lines (generally 16" and larger) shall be 1,000 feet.

Isolation valves on the new 24-inch transmission main are proposed at the following locations:

- Alturas Street / Merida Drive
- Merida Drive / S. Hill Avenue
- Almond Street
- S. Mission Road / Ohearn Road
- Palomino Road / Old Stage Road
- Palomino Road / Emerald Ridge Road
- Palomino Road / Colt Road
- Palomino Road / Morro Road
- Palomino Road / Farrand Road
- Palomino Road / McDonald Road

Valve types shall conform to the FPUD Approved Materials List and is dependent on the working pressure of the mainline as follows:

- Resilient Wedge gate valves will be used where static pressure is less than 150 psi. Valves 12 inches and smaller will conform to AWWA C509 or C515, and valves 14- through 24-inches will conform to AWWA C509. Coatings will consist of epoxy coating in accordance with AWWA C550.
- Class 250 resilient wedge gate valves will be used where static pressure is between 150 psi and 250 psi.
- Butterfly valves may be used on lines 18-inches or larger providing they conform to the San Diego Water Agencies Standards (WAS) approved materials list and testing procedures. Butterfly valves will conform to AWWA C504 and coatings will consist of epoxy coating in accordance with AWWA C550.

6.1.5 Pipe and Fittings

Pipe, fittings and protective coatings shall conform to the following standards:

- AWWA C110 – Ductile iron fittings for buried tees, crosses, bends and reducers with flanged or mechanical joint, depending on the site conditions for connections. Interior lining will be cement mortar lining with bituminous coating.
- AWWA C105 – 10 Polyethylene encasement for buried ductile-iron pipe and fittings
- AWWA C200 – Steel pipe for above-ground applications and inside pressure reducing stations.
- AWWA C205 – Cement-mortar lining and coating for steel water pipe.

- AWWA C207 – Steel pipe flanges, dimensions and pressure rating.
- AWWA C208 – Fabricated steel water pipe fittings, dimensions and pressure rating.
- AWWA C210 – Liquid epoxy lining and coating for steel water pipelines.

6.1.6 Thrust Restraint

For new steel pipe, welded joints are recommended for thrust restraint. At valves and fittings, thrust restraint will be provided by flanged connections or restrained joint fittings.

6.1.7 Pipeline Connections

Connections to existing pipelines are proposed with new couplings, flange adapters or cut-in tees with provision for thrust restraint on the newly installed pipe at the connection. Pipeline connections using tapping sleeves are not proposed.

6.1.8 Service Connections

Water service connections to pipelines that are larger than 16-inch diameter require special approval by the District. This is the case at several locations where space limitations exist or where consolidation of two separate pipelines of the same pressure zone is desired as follows:

- Private Drive south of Gheen Tank – replacement of an existing 12-inch pipeline with new 24-inch pipeline
- Palomino Road – replacement of an existing 12-inch pipeline with new 24-inch pipeline

6.2 Hydraulic Basis of Design

The hydraulic design of the pipelines will be based on the results of hydraulic modeling performed by IEC (see TM 4 in Appendix E). The hydraulic grade lines for the project area are the Gheen 1037 Zone and the Red Mountain 1137 Zone. Hydrostatic pipeline pressures are summarized in Table 6-1 along the pipeline alignments based on the estimated centerline of pipe elevations and the zone maximum HGLs.

Table 6-1 Pipeline Maximum Hydrostatic Pressure

Site	Max. HGL (ft.)	Ground Elev. (ft.)	Max. Static Pressure (psi)
WTP	1037	650	168
Alturas Rd.	1037	713	140
Merida Dr./ S. Hill Ave.	1037	699	146
Almond St.	1037	644	170
S. Mission Rd.	1037	635	174
Palomino Rd.	1037	639	172
Gumtree PRV	1037/1137	931	46/89
Gheen Tank Site	1037/1137	998	16/60
E. Mission Rd.	1137	972	71
Fallen Leaf Ln.	1137	906	99
Lorelei Ln.	1137	815	138

Pipeline sizing will conform to the District's velocity criteria of 5 feet/second for peak hour and 10 fps for maximum day plus fire flow as discussed in the aforementioned appendix.

6.3 Gheen Zone

6.3.1 Proposed Pipelines

New pipelines will consist of the following (refer to Figures 6-1 and 6-2 and the 30% drawings in Appendix A:

- Approximately 8,500 lf of new 24-inch cement mortar lined and coated (CML&C) steel pipeline from the proposed Water Treatment Plant to the intersection of Palomino Road and McDonald Road (Palomino Road corridor pipeline).
- Approximately 100 lf of CML&C steel pipeline upsizing (12-inch to 20-inch) in Gum Tree Lane.

The majority of the pipeline alignment is within public right-of-way. However, in Palomino Road from Emerald Ridge Road to Morro Road, the alignment is located within District easements.

Design and construction considerations for the new pipeline are summarized below and are discussed in greater detail in Chapter Section 9.0:

- The new 24-inch Palomino Corridor Pipeline will be constructed parallel to the existing distribution pipelines except along Palomino Road from S. Mission Road to McDonald Road. In this section of the alignment, the new 24-inch pipeline will replace the existing 12-inch distribution pipe. The existing water service connections will be transferred to the new 24-inch transmission main in accordance with District preference.
- The presence of numerous existing utilities (sewer, water, gas, and telecommunications) in Merida Drive, S. Hill Road, and Palomino Road will result in less than 10 feet of horizontal separation from non-potable fluid pipelines and are expected to require a variance to the California Water Works Standards. The variance request will be submitted to the California Division of Drinking Water upon concurrence of the pipeline alignments presented herein. Refer to the 30% design drawings in Appendix A.
- The new 24-inch pipeline will have points of connection to the existing distribution system as follows:
    - Existing 8-inch pipeline within Alturas Road
    - Existing 12-inch pipeline within S. Hill Avenue
    - Existing 12-inch pipeline within S. Mission Road
    - Existing 20-inch pipeline within McDonald Road.
- Permits for construction will be required from the County of San Diego (refer to Section 6.6).
- District easements exist along Palomino Road from Old Stage Road to Morro Road and are shown on the preliminary drawings.

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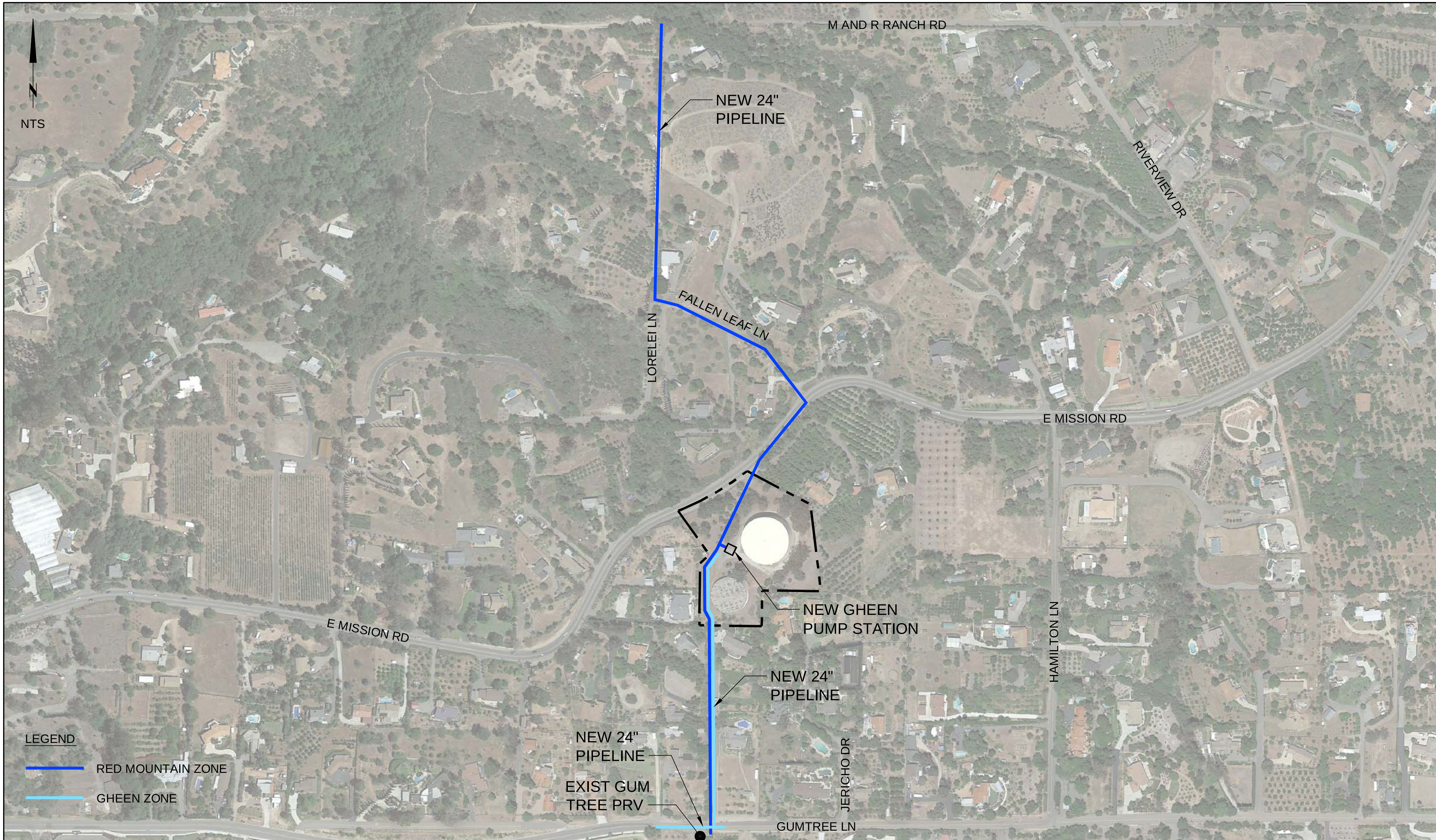
Fallbrook Public Utility District
Santa Margarita Conjunctive Use Project

FIGURE 6-1

PROPOSED GHEEN ZONE PIPELINE



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PROPOSED GHEEN AND RED MOUNTAIN ZONE IMPROVEMENTS

FIGURE
6-2

6.4 Red Mountain Zone

6.4.1 Proposed Pipelines

New pipelines will consist of the following (refer to Figure 6-2 and 30% design drawing found in Appendix A):

- Approximately 2,000 lf of new 24-inch pipeline along E. Mission Road, Fallen Leaf Lane, and Lorelei Lane. This pipeline will provide conveyance from the new Gheen Pump Station to the existing transmission main along M and R Ranch Road thereby providing the desired redundancy to the Red Mountain Zone.
- Approximately 700 lf of new 24-inch pipeline between the Gheen Tank site and Gum Tree Lane. The existing 12-inch pipeline will be replaced (consolidated) with the new 24-inch pipeline.

Design and construction considerations for the new pipeline include the following:

- The new pipeline will be constructed parallel to the existing distribution pipelines Permits for construction will be required from the County of San Diego (refer to Section 6.6).
- District easements are located on Fallen Leaf Lane and Lorelei Lane.

6.5 Right-of-Way and Easements

6.5.1 Existing Easements

Existing easements are identified along the pipeline corridors as follows:

- Private road easement – Palomino Road, from Emerald Ridge Road to Morro Road;
- Fallen Leaf Lane, north of East Mission Road – 30-foot wide District utility easement;
- Lorelei Lane – 20-foot District easement over the westerly properties and a 15-foot easement over the easterly properties except for a 250 foot section north of the intersection with Fallen Leaf Lane.

The proposed pipeline alignments outside of these areas are located within public right-of-way or District property.

6.5.2 Easement Requirements

The existing easements located at the following locations are assumed to allow for the construction of the proposed pipelines (to be confirmed):

- Fallen Leaf Lane, north of East Mission Road – confirm that the entirety of Fallen Leaf Lane lies within the existing easement;
- Lorelei Lane north of Fallen Leaf Lane – confirm that a new pipeline can be constructed within the existing easements.

New permanent easements may need to be acquired as follows:

- Palomino Road, generally from Emerald Ridge Road to Morro Road;
- Fallen Leaf Lane, north of existing utility easement
- Lorelei Lane, southerly 250 feet.

6.6 Agency Coordination and Permit Requirements

The project will require coordination with the San Diego County Department of Public Works and the North County Fire Protection District. The requirements for coordination and permit processing are described below.

6.6.1 County of San Diego, Department of Public Works

Both the Gheen Zone pipelines and Red Mountain Zone pipelines are located within unincorporated San Diego County. The sites are mostly under the purview of the Department of Public Works. The following permit will apply:

Excavation and Traffic Control Permits

The project is expected to require Excavation Permits and Traffic Control Permits for work within County right-of-way. These requirements will be defined in the contract documents as a requirement of the Contractor.

The County's "Pavement Cut Policy" limits trenching on new and newly resurfaced publicly maintain roads for a 3-year period following pavement treatment, defined as asphalt concrete surfacing, chip seals, or slurry seals. The project may be subject to this policy and restoration of pavements beyond the trench paving limits or with asphalt concrete overlays may be required. This determination will be made upon submittal of preliminary drawings to the County and, if applicable, a request for a waiver of the moratorium will be made. If a waiver is granted by the County, a betterment of the existing pavement may be required (i.e., pavement overlay or sealing) along portions of the pipe alignment.

6.6.2 Special Districts

North County Fire Protection District

The project will include a utility conflict check submittal upon development of the preliminary construction plans to identify any special requirements for NCFPD facilities that may be affected by the project. Typical requirements may include the installation or relocation of fire hydrants.

County of San Diego Parks

The County of San Diego Planning Department's website was reviewed for designated public access or equestrian trails adjacent to the proposed work sites (http://sdcounty.maps.arcgis.com/home/). South Mission Road and East Mission Road are designated trails and South Hill Avenue is a proposed trail based on County of San Diego Parks Regional Trails or County Park Trails maps. The project design will consider appropriate setbacks or design features for appurtenances and station access hatches or manholes that do not create obstructions in existing parkway areas.

6.6.3 San Diego Gas & Electric

The new pipelines are anticipated to cross or parallel existing SDG&E overhead distribution and transmission lines. In particular, pipeline construction along Palomino Road will be located in close proximity to the existing, parallel overhead electric line.
The requirements for setbacks from SDGE overhead electric utilities, or their easements, if any, is currently being investigated and will be confirmed at the onset of final design.

6.6.4 California Division of Drinking Water

Pipeline design will adhere to the minimum pipeline separation requirements of Title 22, California Code of Regulations, Division 4, Chapter 16, California Waterworks Standards which are regulated by the California Division of Drinking Water (formerly, Department of Public Health).

In areas where the minimum horizontal or vertical separation distances between potable and non-potable fluid pipelines stipulated in the regulations cannot be met, a variance will be requested. This will require submitting plans and a letter request with justification for the variance. Based on the preliminary pipeline drawings, a variance request is anticipated at the following locations:

- Alturas Road
- Merida Drive
- S Hill Avenue
- Palomino Road

6.7 Storm Water Compliance

6.7.1 Construction General Permit (State-wide)

Projects that have a disturbed exceeding one acre are subject to the Construction General Permit (CGP), Order No. 2012-0006-DWQ, NPDES No. CAS000002 and the preparation and filing of Permit Registration Documents (PRDs) via the State Waterboard's website. This pertains to traditional construction sites and linear underground/ overhead (LUP) projects. The PRDs consist of:

- Notice of Intent
- Risk Assessment
- Site Map
- Stormwater Pollution Prevention Plan (SWPPP)
- Annual Fee
- Certification

Exemptions exist for certain types of construction activity. For this project, the exemption criterion applies to maintenance projects which include the updating of existing facilities to comply with applicable codes, standards, and regulations regardless if such projects result in increased capacity (CGP Fact Sheet Section II,C.2.a). The portions of the project for which this exemption is deemed to apply are as follows:

- Alturas Road

- Merida Drive
- S Hill Avenue
- Palomino Road
- Fallen Leaf Ln
- Lorelai Ln
- East Mission Road

Portions of the project that are not subject to an exemption include the proposed Water Treatment Plant site (3.5 acres) and the proposed Gheen Pump Station (1.1 acres) and compliance with the CGP will be required for these areas.

Since portions of the proposed pipeline are not considered to be exempt from the CGP, the preparation of one or two SWPPPs may be considered for the project for the following reasons:

- The proposed Water Treatment Plant site may be subject to post-construction standards defined in Section XIII of the CGP. These generally pertain to the reduction of water quality impacts. The application for termination of coverage under the CGP requires that "final stabilization" of the site be achieved.
- A separate SWPPP for the pipeline segment will allow for the application for termination of coverage independently of the status of construction at the proposed Water Treatment Plant site or the status of the application for termination of coverage for the WTP site.
- A separate SWPPP for the pipeline segment is anticipated to require less monitoring and reporting during construction because it is considered a linear underground/overhead (LUP) project.
- If the potential for having more than one contractor for the entire project is anticipated, the risk associated with stormwater compliance at either the WTP site or the pipeline sites can be better managed by the District.

6.7.2 County of San Diego

The County's Stormwater Standards Manual will apply to construction activities and standard BMPs will be required. Minimum performance standards to control pollution from any operations falling under a County permit are:

- Installation and maintenance of BMPs to prevent construction pollutants from contacting storm water and with the intent of keeping products of erosion from moving off site into receiving waters.
- No discharges of pollutants (including sediment) from the site.

Every permittee is responsible and required to meet these performance standards and to certify that selected BMPs will be installed, monitored, maintained or revised as appropriate to ensure effectiveness. BMPs must be installed in accordance with industry recommended standards (e.g. Caltrans or California Stormwater BMP handbooks, etc). Storm water BMPs will be identified in the contract documents as a contractor responsibility.

7.0 GHEEN FACILITIES

7.1 Introduction

This section provides design criteria and recommendations for the design of the new Gheen pump station (PS) and Gheen storage tank.

The existing 6 MG reservoir at the site has recently undergone a major maintenance effort and is now in excellent condition. The old 1 MG Martin Reservoir reached the end of its useful life and has been out of service for an extended period. It will be demolished as part of this project (See Drawing D-2 of the 30% design drawings in Appendix A). As identified in distribution hydraulic study TM-4 addition storage capacity at the Gheen site is warranted. The recommendation is to provide for the maximum additional capacity that can fit on the site, 4 MG, be constructed.

Specific design criteria, equipment selection, and description of the preliminary design are presented for both the pump station and the new storage tank and presented on the pages following.

7.2 Gheen Facilities Pump Station

7.2.1 Pumping Rates & Operating Head Conditions

At certain times following a year of significant rain fall, when the SMCUP plant is in operation, the Gheen Reservoir tank will receive the differential between the Camp Pendleton Delivery and the Gheen Zone demand. This is the case even with no other water supply entering the Gheen zone from other zones or SDCWA connections. In February with a maximum 6.9 mgd plant production, less 1.5 mgd (0.52 minimum flow factor times the average 2.9 mgd) of Gheen zone demand, 5.4 MGD be pumped from the Gheen service area to the Red Mountain zone. With an additional allowance for reduced demand due to rain, flow to the Red Mountain zone could approach the capacity of the plant. The design of the pump station will accommodate a maximum of 8 MGD.

The system curves shown in Figure 8 of TM 4 have been reproduced in Figure 7-3 (below) as the upper and lower possible system curves. These two curves represent the upper and lower boundary of 6 curves that were analyzed as part of the hydraulic model (TM 4), and they are representative of dynamic losses for the following discharge pipeline configurations:

- North to Kauffman PRS
- South to Gumtree PRS
- Both North and South

Since the upper and lower possible curves are comprehensive, they provide a very broad range of static head conditions. For this reason, Figure 7-3 also shows upper and lower probable system curves that better fit the expected operating conditions of the system. These conditions are summarized in the following Table 7-1.

Table 7-1 Summary of Gheen Pump Station Probable HGL Operating Conditions

FPUD Zones	Base Elevation	Water Heights		HGL		Static Head	
		Max	Min	Max	Min	Max	Min
Gheen (Suction)	998	27	14	1025	1012	113	50
Red Mtn (Discharge)	1050	75	25	1125	1075		

Note: all values are in feet.

7.2.2 Pump Type and Configuration

Pump and driver selection considerations include the type and number of pumping units, the individual pump capacity (head and flow), multiple sizes of pumps, and operational flexibility to meet the water demands under the different operating conditions.

The preliminary layout of the new Gheen Pump Station is shown on M-1 of the 30% drawings. The proposed pump station consists of two can-mounted, vertical turbines pumps of the same capacity with VFD drives. This configuration was chosen based on the following:

- Vertical turbine pumps (VTP) have a smaller footprint of similarly capacity horizontal pump/motor combinations, thus reducing the size and construction costs of the pump station building.
- Vertical turbine pumps maintain better suction when connected to above ground tanks than grade mounted horizontal pumps. The VTP's extend below grade which effectively increases the suction pressure to the pumps.
- One 4 mgd pump satisfies the flow requirements under most conditions, but to meet the extended conditions, and with the added benefit of providing backup, a two pump configuration has been incorporated into the design.
- Two pumps of the same size minimize storing additional spare parts for the pumps and associated suction and discharge piping.
- VFD drives minimize water level fluctuations in the Gheen tank(s) and thus the varying service pressure customers in the Gheen zone would otherwise experience.

7.2.3 Pump Selection Criteria and Performance

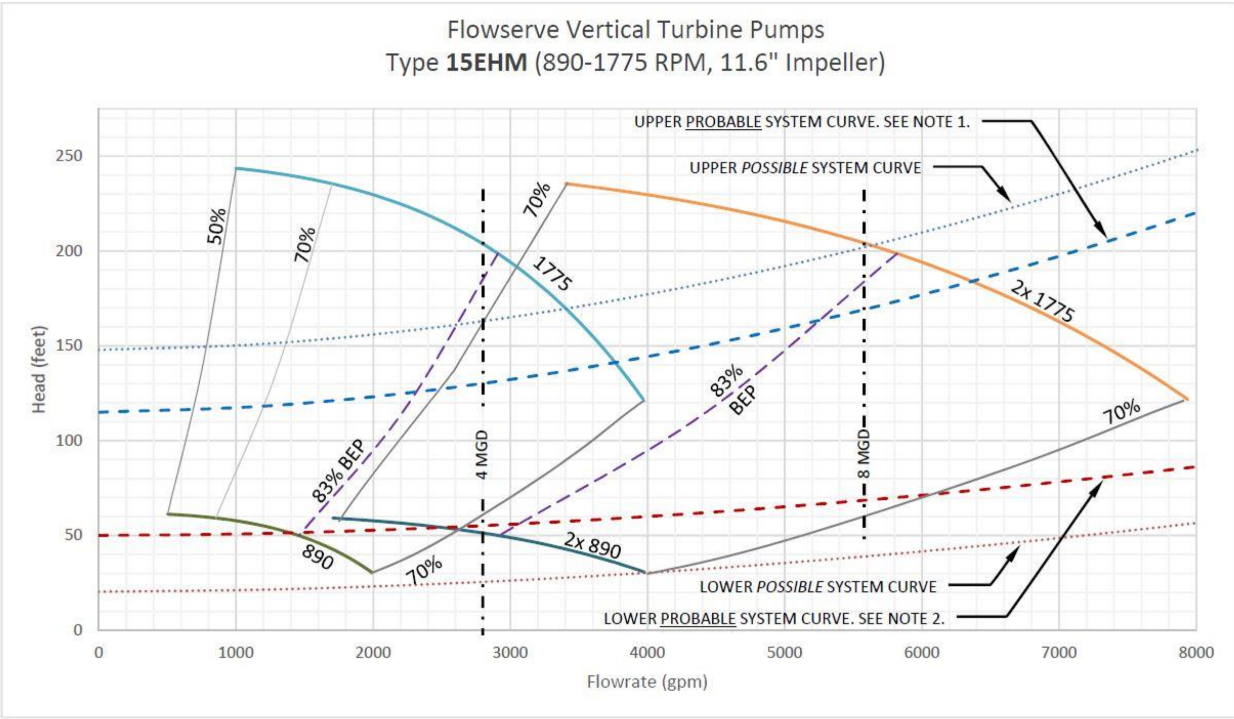
Based on considerations presented above, along with discussions with FPUD staff, two equally sized pumps each rated at 2800 gpm (4 mgd) for a total capacity of 5600 gpm (8 mgd) should be used. The range between the maximum pumping head-flow condition and the minimum pumping head-flow condition has been evaluated.

A Flowserve two-stage pump with a 200-horsepower (HP) motor meets the criteria. The length of the bowl assembly is estimated at 4 feet, and the length of the suction can is estimated at 12 feet (below the pump head mounting surface). Pump efficiency is about 83 percent at rated speed (1775 rpm) and a design flow of 2800 gpm (per pump).

Figure 7-3 below shows the operating envelope of one pump operating, and a second operating envelope with two pumps in parallel at various speeds. In combination the expected range of flows and heads is well accommodated. For the operating conditions within the anticipated range of flows, the pump efficiencies are good (above 70 percent).

Figure 7-3 also indicates that with VFD drives the pumps will cover all except the lowest flows. This means that the tank levels can be held constant at a given level set point equating to pressures to customers being constant over most of the flow range. When plant production exceeds demands by less than 1,000 gpm one pump should be operated at minimum speed of 890 rpm in an off-on mode, started and stopped based on levels in the tank(s). At low flows, with two Gheen tanks in operation, the water level change would be less than three inches per hour. If the control dead band were to be set at 1 foot the pump would only start once in 4 hours under these conditions.

Figure 7-3 Gheen Pump Station System Curves w/ VFD Operating Envelopes



Notes:

1. Upper Probable System Curve assummes Red Mountain is 3/4 full, and Gheen tanks are half full.
2. Lower Probable System Curve assumes Red Mountain is 1/4 full, and Gheen tanks are 7/8 full.

Pumps of similar configuration are available from numerous manufacturers, and the specifications will require that the pumps meet the material and performance objectives for the project.

7.2.4 Suction and Discharge Piping

The pump station suction and discharge piping are sized using the standards set forth by the Hydraulics Institute (HI). Table 7-2 summarizes the recommended pipe sizes based on hydraulic design parameters.

Table 7-2 Gheen Pumps Suction and Discharge Pipe Sizing

Item	DIA, in	V, fps	Q, gpm	H.I. Recommendation
Suction Header	20	5.7	5600	8 fps max
Pump Suction	20	2.8	2800	4 fps max
Pump Discharge - Option 1	10	11.4	2800	Sized per pump MFGR
Pump Discharge - Option 2	12	7.9	2800	

In addition to these requirements, HI indicates that the length of the suction piping upstream of the pump can be at least five pipe diameters.

Pump suction pressure is proposed to be monitored via a low pressure water probe installed on the suction header.

7.2.5 Pump Station Layout/Features and Flow Metering

Pump station site features include the following (See C-14 Gheen Site Plan and Yard Piping):

- Vehicle access around the pump station and existing storage tank
- Sheet flow drainage across pavement to existing storm drain
- Tree removal
- Grading

Pump station features include the following (See GFM-1 and 2, Gheen Pump Station Plan and Sections):

- Maintenance accessibility
- Separate Electric Room
- Glass window between electric Room and pump room
- Roll up and man door access
- Pump drains and floor sump

A 16” magnetic flow meter has been located inside the pump station building and measure the anticipated range of flows. Design was based on Sparling meter which only requires 3 pipe diameters up and downstream from the center of the meter, the pipe layout shown on the pump station layout (GFM-1) shall accommodate other products that may require additional upstream and downstream lengths.

7.3 Gheen Facilities 4MG Tank

7.3.1 Proposed Tank and Site Layout

The southern portion of the Gheen site is the most feasible location for the proposed tank see Drawing C-11 of the 30% drawings in Appendix A. Demolition of the Existing Old Martin Reservoir is required, in addition to the removal of approximately 45 trees. The earth removal required to level-out the site will be partially balanced with fill locations on site. Approximate grading quantities—fill, cut and net export—are summarized on C-14 of the 30% design drawings found in Appendix A.

Site features include the following (See C-14 Gheen Site Plan and Yard Piping):

- Vehicle access around the new storage tank
- Sheet flow drainage
- Tree removal
- Grading

7.3.2 Tank Design Criteria

The following criteria are based on conversations with FPUD, physical site constraints such as topography and disturbance area, the results of hydraulic modelling (TM 4 in Appendix E) and design assumptions based on past experience with similar projects.

- Type of Tank: Welded Steel (AWWA D-100)
- Storage Capacity: 4 MG
- Diameter: 130 feet
- High Water Level: 1038 feet
- Floor Elevation: 998 feet
- Free Board: 7 feet
- Roof: column-supported cone with radius knuckle
- Total Tank Height: 48 feet

The proposed tank will be designed according to the provisions of ASCE 7.

General Parameters

- Site Class: C

Wind Design Load

- Wind Load Risk Category IV
- Wind Speed: 115 miles per hour
- Exposure: C

Seismic Design Load

- 0.2-second period, mapped spectral accel., SS: 1.223 g
- 1-second period, mapped spectral accel., S1: 0.471g
- Short-period site coefficient, Fa: 1.0
- Long-period site coefficient, Fv: 1.329
- 0.2-second period, Design Earthquake spectral response accel., SDS: 0.815g
- 1-second period, Design Earthquake spectral response accel., SD1: 0.418g
- Earthquake Importance Factor, Ie: 1.25

Tank Design

Steel tank structural design criteria consists of the following:

- Design per current AWWA D100 standard
- Roof design live load: 20 pounds per square foot (reducible)
- Tank shall be mechanically anchored to the foundation
- Tank shall be classified as Seismic Use Group (SUG) II
- Use Ri = 2.5 and Rc = 1.5 for base shear, overturning moment and hoop shell tension design
- Checking longitudinal tank shell compression stress (wall buckling)

Freeboard will be based on AWWA D100 requirements. 5.0 feet of freeboard is estimated for preliminary design based on the design of similar steel tanks in California per the current D100 standard. An alternative design procedure may consist of a lower tank roof (with less freeboard) which is structurally reinforced to withstand, but not prevent, damage from tank sloshing. This alternative approach is assumed to be similar in cost to a taller tank, although it is not yet common practice for steel tanks constructed per current AWWA code in California.

7.4 Electrical and Controls Design

The design approach for the electrical and controls at SMCUP plan is provided below and on drawings E-4 and E-5 of the 30% design drawings found in Appendix A.

7.4.1 Electric Service

Gheen Reservoir has SDG&E service to the site for the existing District RTU and for a cellular tower. SDG&E will provide a service order to be used by the Contractor to implement the new service. A new 480 volt, 3-phase service transformer and meter switchboard with surge suppression will be installed on the site. The transformer will be located near the service pole. The Main Switchboard with meter will be located next to the Pump Station Building in a NEMA 3R enclosure. The service will be rated for 400A. Included with the meter switchboard will be a Manual Transfer Switch with lugs for connecting a portable emergency generator. The site fence must have a SDG&E padlock to allow meter reading access.

7.4.2 Motor Control Centers (MCC)

The project will have one MCC located in the Pump Station Electrical Room. This MCC will power the two 200HP pump's VFD's. It will also contain a 120/240 volt panelboard for site lights, controls, fans, etc. The MCC will also have an active harmonic filter to mitigate VFD generated harmonics and meet IEEE 519. The MCC will be equipped with a Power Monitor that will send a signal to the PLC.

7.4.3 Controls

The Pump Station will be equipped with a PLC Panel (CP-1). This will be the panel that supplies information to the SCADA system for operators to control and monitor the pump station's operation onsite and remotely. The control logic will be located in this PLC for automatic and remote manual control of the Pump Station. Local control will be done via and OIT mounted on CP-1's door. The Pump

Station PLC at Gheen Reservoir will communicate with the District SCADA Central and WTP via the Districts radio network. OIT, PLC and radio will be based on District standards.

8.0 PERMITTING

Key permitting elements of the project includes obtain approval from the Division of Drinking Water (DDW) and potential modifications to the District's National Point Discharge Elimination System (NPDES) permit. Commentary on these two elements follow.

8.1 Division of Drinking Water

The design team and FPUD met with the State Water Resources Control Board (SWRCB) Division of Drinking Water (DDW) on April 2, 2015 to introduce DDW to the project and to discuss the water quality goals and the preliminary design. DDW staff from both the Orange County district and the San Diego district participated as MCBCP falls under the purview of the Orange County district, whereas Fallbrook is located within the San Diego district. During the meeting, DDW staff expressed that they anticipate that the FPUD domestic water supply permit could be amended to include the SMRCUP water. The new wells on MCBCP would have to be regulated by the Orange County District. Staff expressed that the wheeled flow (where treated imported water would be transmitted through FPUD to MCBCP through the bi-directional pipeline that typically delivers groundwater from MCBCP to the treatment plant) may need to be disinfected. Staff also expressed some concern about the co-location of the treatment plant next to the WWTP, but given the distances and terrain separating the two facilities should mitigate these concerns. DDW staff will review any cross connections between the WTP and the WWTP. Lastly, new sampling sites may have to be developed for the Stage 2 Disinfectants Disinfection By-product Rule, as flows through the distribution system will change with this project.

8.2 National Point Discharge Elimination System (NPDES)

The RO concentrate stream of 0.495 MGD (design flow) will be discharged through the WWTP land outfall, which connects to the Oceanside Ocean Outfall (OO). The land outfall is subject to a National Point Discharge Elimination System (NPDES) permit, which would need to be amended to include this new source of waste water. The Regional Water Quality Control Board (RWQCB), San Diego Region (San Diego Water Board) should be notified of the new source, so that the permit can be amended to include the new facility and the new waste discharge.

The water quality of the new source, the RO concentrate, will differ from the WWTP secondary effluent. Initial modeling of available, albeit limited, data does not predict any NPDES exceedances when discharging the RO concentrate stream, although copper and beryllium approach the estimated limit. Any discharged secondary effluent would dilute copper and beryllium concentrations, pushing their values farther below the anticipated NPDES permit limits.

The RO concentrate will have higher salinity than the WWTP secondary effluent, due to the concentration of ions. This higher salinity may impact the initial dilution of the combined Oceanside OO waste waters; however, the impact on the initial dilution is expected to be minimal given the low flow of the RO concentrate compared to the other waste flows (Oceanside OO NPDES-rate capacity of 29.005 MGD) and the relatively dilute salinity of the stream (approximately 15% of ocean water salinity). Thus, it is expected that the initial minimum dilution of an amended NPDES permit will not be revised, or that if it is revised that the change would be negligible.

A preliminary evaluation of the RO concentrate stream suggests that copper and beryllium may approach limits in a modified NPDES permit (copper RO concentrate concentration estimated to be 37% of 6-month NPDES permit limit and 62% of daily maximum limit, and beryllium estimated to be 57% of daily maximum NPDES limit)[7]; however, any secondary effluent discharged from the WWTP would dilute these concentrations. Further, other waste streams in the Oceanside OO could also dilute these concentrations prior discharge to the ocean.

The above preliminary analysis is limited to constituents for which detectable data is available in the MCBCP feed water (which will be used to provide feed water to the SMRCUP in the future). Detectable data is not available for most California Ocean Plan (COP) water quality objectives (which are used to generate NPDES permits) and thus the relationship of many constituents in the RO concentrate stream to potential NPDES permit limits is unknown. The MCBCP RO concentrate stream may offer a rich source of data with respect to NPDES limits, as the water quality should be similar to the SMRCUP RO concentrate.

The NPDES-permitted FPUD dry weather land outfall flow is 2.7 MGD (May to October) with a wet weather flow of 3.6 MGD (November through April). At the design SMRCUP WTP flow, where the RO concentrate flow is 0.495 MGD, the secondary effluent discharged through the land outfall would have to be less than 2.205 MGD during dry weather and less than 3.105 MGD during wet weather as to not exceed the NPDES flow limit.

Meeting with CPEN and reviewing their P-113 (AWT) RO concentrate WQ, including ocean plan monitoring data and relevant RO process data, is recommended to better understand how the SMCUP RO concentrate will compare to the ocean plan water quality objectives and NPDES permit limits.

[7] Using the current initial dilution factor of 87 parts seawater to 1 parts waste water, assuming an RO rejection of 100%, and using average estimated raw water quality data for the RO feed for the 6-month analysis and estimated maximum raw water quality data for the RO feed for the daily maximum analysis (see TM 1 for estimated water quality data).

9.0 CONSTRUCTION CONSIDERATIONS

9.1 Raw Water Pipeline

Raw water will be delivered from the Marine Corps Base Camp Pendleton (MCBCP) well field to the proposed FPUD Water Treatment Plant via a new pipeline to be designed and constructed by MCBCP. The point of connection of the new MCBCP pipeline is contemplated at the south end of the proposed WTP near the proposed flow control facility. The final connection location and schedule for connection will require coordination with MCBCP.

9.2 Concentrate Discharge Connection at the WRP

Concentrate from the reverse osmosis treatment process will be conveyed via a new pipeline (6-inch to 8-inch estimated diameter) from the WTP RO Building and disposed of at the Water Reclamation Plant (WRP). The new pipeline has two possible points of connection: 1) overflow at the Chlorine Contact Tank or 2) overflow at the Applied Water Pump Station, see Drawing C-6 and C-7 of the 30% design drawings found in Appendix A. The existing overflows from these two locations connect to the existing Final Effluent Junction Structure which then discharges to the 30-inch Outfall. Connection at either of these locations is estimated to result in the least amount of disruption to WRP operations.

Alignment opportunities for the discharge pipeline consist of the east side or the west side of the reclaimed water storage basin:

- East side – the pipeline alignment would generally be situated in the paved, north-south trending access road. This alignment would have a high point (elevation 680 to 700) west of the solar field which will require greater pumping head (for the WTP elevation of +/- 650) and may require pavement restoration if the pipeline is constructed within the paved road section. There are other existing pipelines (sewer force main, reclaimed water pipeline) along this alignment.

- West side – the pipeline alignment would parallel the existing fence along the westerly property boundary of the Water Reclamation Plant, then continue to the west embankment of the reclaimed water and secondary effluent equalization basins. There is a 24-inch reclaimed water pipeline within this embankment. The topography of this alignment is generally downhill of the proposed WTP, requiring less head for pumping.

9.3 Waste Washwater Reclamation Tank and Product Water Pump Station

Initial geotechnical information (See Appendix F) indicates that at about 15 feet deep across hard material is present. Construction of the WWW Reclamation Tank as currently configured slightly exceeds this depth, and the Product Water Pump Station approach that depth. If rock is present at the depth of the current design there is not much rock excavation that will have to be performed to accommodate construction. We will consider further investigative methods and/or make dimensional adjustments during final design.

9.4 Potable Water Distribution System

9.4.1 Gheen Tank Site

The existing Gheen Zone pipelines at the Gheen Tank site are expected to require alignment modifications for the construction of the proposed Gheen Pump Station. This work will require isolation of the Gheen Tank and Zone pipelines. The Gum Tree PRS and Kaufman PRS are anticipated to supply the Gheen Zone demand during isolation of the Gheen Tank.

The Red Mountain Zone pipeline at the Gheen Tank site will be replaced as described below.

9.4.2 Red Mountain Zone Pipeline - south of Gheen Tank

Construction of a new 24-inch Red Mountain Zone pipeline from the proposed Gheen Pump Station to Gum Tree Lane will replace the existing 12-inch pipeline located within the existing private drive. The private drive serves four properties along this corridor and the water services will require temporary highlining during construction.

9.4.3 Red Mountain Zone Pipeline - Fallen Leaf Lane and Lorelei Lane

Construction of a new 24-inch Red Mountain Zone pipeline will replace an existing 6-inch pipeline within this corridor because of limited space for a new pipeline. The new 24-inch pipeline will parallel the existing 20-inch Gheen Zone pipeline. There are approximately five water services in Lorelei Lane that will require temporary highlining along this reach; four are connected to the Red Mountain Zone 6-inch pipeline and one is connected to the Gheen Zone pipeline.

9.4.4 New 24-Inch Pipeline - WTP to McDonald Road

From Alturas Road to S. Mission Road, the new 24-inch pipeline will parallel the existing distribution system pipelines. There will be new connections to the existing distribution system at Alturas Road and S. Hill Avenue associated with the construction of the new Gheen Zone pipeline. These may be accomplished with new pipe segments connecting the existing distribution pipelines to new valves at tees or crosses installed on the new 24-inch pipeline.

Along Palomino Road, from S. Mission Road to McDonald Road, the existing distribution pipeline will be replaced (consolidated) with a new 24-inch pipeline. In a few locations, the existing 12-inch water main will be abandoned in place because of the presence of dry utilities (telephone and natural gas) which have been constructed over the existing water main or in close proximity to it. A construction phasing plan will be developed during final design which will consider the locations of existing isolation valves and distribution system redundancy in order to identify temporary highlining requirements for the eastern portion of the Palomino Road corridor. The project will provide an opportunity to replace existing (old) distribution valve assemblies with new valve assemblies along this reach.

9.5 Traffic Considerations

Special consideration for traffic is warranted along segments of E. Mission Road (north of Gheen Tank) and S. Mission Road (between Almond Street and Palomino Road) where new pipeline construction will occur within prime arterial streets. The pipeline alignments will be designed to reduce traffic impacts as follows:

- E. Mission Road: existing 20-Inch Gheen Zone and 6-inch Red Mountain Zone pipelines are situated in the eastbound and westbound lanes, respectively. The new 24-inch Red Mountain Zone pipeline alignment design will strive to place the new pipe alignment such that only one lane of traffic is impacted. Because of high traffic volumes, night work should be considered to reduce traffic impacts and to allow for a more productive rate of construction at this location.

Work in Mission Road will be staged to allow for 1 lane of traffic to be open at all times. The use of flaggers will likely be needed to control the 2-way traffic;

- S. Mission Road: the new pipeline alignment will be designed as near to the east curb of S. Mission Road as possible, leaving the lane nearest the median open for traffic.

The remaining streets in which construction will occur consist predominantly of residential streets with available parallel routes that may serve as traffic detours.

10.0 PROJECT CONSTRUCTION COSTS

The construction cost of the project is based on the 30% design drawings found in Appendix A. It assumes the project will be constructed by June 2018 with the construction midpoint of June 2017.

Table 10-1 displays the construction costs, which include mobilization, overhead and profit and bonds. The construction contingency costs of 30% are allocated among the project features.

Table 10-1 Project Construction Costs[1, 2]

Project Element	Construction Costs
Fallbrook Water Treatment Plant (WTP)	$27,728,000
WTP Connect and Distribution Sys Improvements	$ 5,497,000
Gheen Pump Station and Red Mtn. Zone Improvement	$ 4,195,000
Total Construction Cost	**$37,420,000**
Optional Bid 4 MG Tank at the Gheen Site	$ 5,656,000
Optional Bid Red Mtn. Zone Pipeline N. of Gheen Site	$ 1,110,000
Subtotal Optional Bid Items	**$ 6,766,000**
Total Construction Costs w/ Bid Options (2015 Dollars)	**$44,186,000**
Total Project Cost with 3.0% Inflation to June 2017	**$46,877,000**

1. Costs have been rounded to the nearest thousand.
2 The construction period is estimated to be 2 years. Based on this construction schedule, costs have been calculated using the compound interest method to the midpoint of construction using an interest rate of 3.0 percent.

Detailed costs are provided in Appendix K. The cost presented is a Class 3 Association for the Advancement of Cost Estimating (AACE) estimate reflecting and accuracy range of +40% to -20%.

APPENDICES

APPENDICES CONTENT

APPENDIX A: 30% DESIGN DRAWINGS

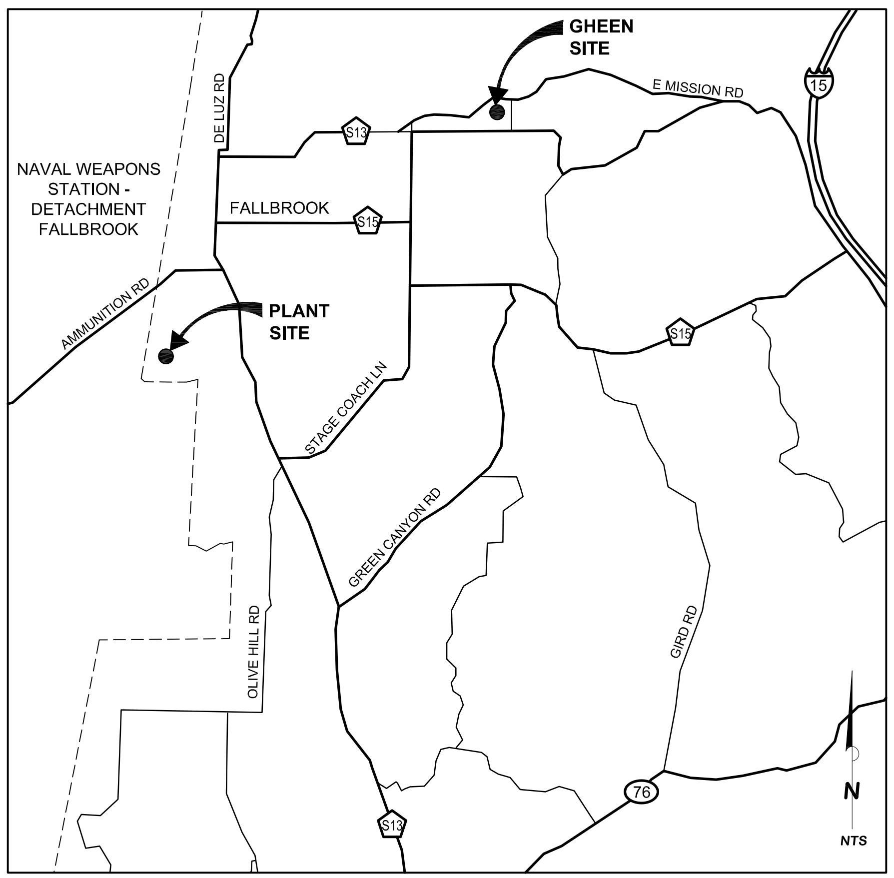
FALLBROOK PUBLIC UTILITY DISTRICT

FALLBROOK, CALIFORNIA

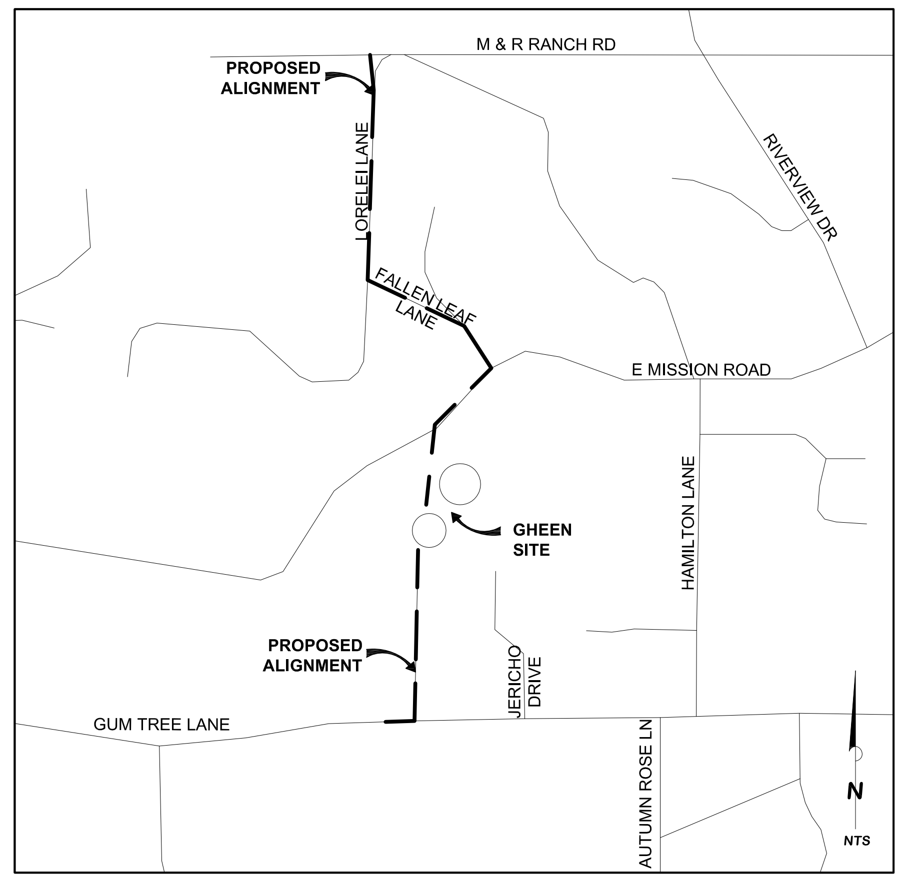
PLANS FOR THE CONSTRUCTION OF

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

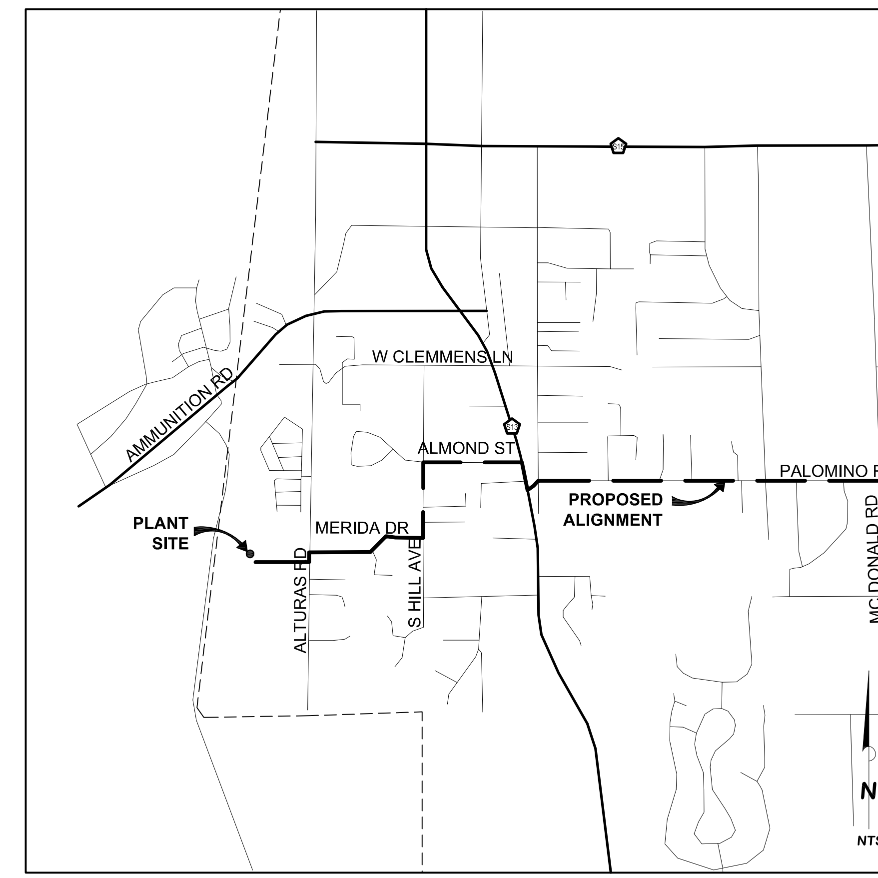
OCTOBER 2015



VICINITY MAP
NTS



LOCATION MAP
NTS



LOCATION MAP
NTS

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE NTS
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY TS
DRAWN BY TS
CHECKED BY RK

Infrastructure
ENGINEERING CORPORATION
14271 Danielson Street
Poway, California 92064
T 858.413.2400 F 858.413.2440
www.iecorporation.com

DATE

FPUD Fallbrook Public Utility District

990 E. MISSION RD
FALLBROOK, CA 92028

APPROVED BY:

JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER

DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

TITLE SHEET

DRAWING NO. G-1
SHEET NO. 1 OF XX
CLIENT JOB NO. 2744

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DRAWING INDEX

SHT NO.	DWG NO.	DESCRIPTION
		GENERAL
X	G-1	TITLE SHEET
X	G-2	DRAWING INDEX
X	G-3	LEGEND AND NOTES
X	G-4	GENERAL NOTES
X	G-5	ABBREVIATIONS
X	G-6	OVERALL FLOW DIAGRAM
X	G-7	PLANT PROCESS FLOW DIAGRAM
X	G-8	PLANT HYDRAULIC PROFILE
X	G-9	GHEEN HYDRAULIC PROFILE
		DEMOLITION
X	D-1	WTP SITE DEMOLITION PLAN
X	D-2	GHEEN FACILITY DEMOLITION PLAN
		CIVIL
X	C-1	WTP SITE PLAN
X	C-2	WTP YARD PIPING PLAN
X	C-3	WTP PIPING - ENLARGE PLAN 1
X	C-4	WTP PIPING - ENLARGE PLAN 2
X	C-5	WTP BRINE & SEWER PLAN 1
X	C-6	WTP BRINE & SEWER PLAN 2
X	C-7	BRINE LINE PROFILE - STA 100+00 TO STA 108+00
X	C-8	BRINE LINE PROFILE - STA 108+00 TO STA 117+11.21
X	C-9	WTP SEWER PROFILE - STA 140+00 TO STA 148+00
X	C-10	WTP SEWER PROFILE - STA 148+00 TO STA 152+43.37
X	C-11	WTP FM PROFILE - STA 120+00 TO STA 128+00
X	C-12	WTP FM PROFILE - STA 128+00 TO STA 134+24.10
X	C-13	DRYING BED MODIFICATIONS
X	C-14	GHEEN FACILITY AND YARD PIPING PLAN
		ARCHITECTURE
X	400A-1	RO BUILDING FLOOR PLAN
X	400A-2	RO BUILDING ELEVATIONS
X	GFA-1	GHEEN PUMP STATION PLANS
X	GFA-2	GHEEN PUMP STATION ELEVATIONS
		PIPELINE
X	P-1	PRODUCT WATER PLAN AND PROFILE - STA 10+00 TO STA 14+50
X	P-2	PRODUCT WATER PLAN AND PROFILE - STA 14+50 TO STA 19+38.13
X	P-3	PRODUCT WATER PLAN AND PROFILE - STA 20+00 TO STA 24+00
X	P-4	PRODUCT WATER PLAN AND PROFILE - STA 24+00 TO STA 28+00
X	P-5	PRODUCT WATER PLAN AND PROFILE - STA 28+00 TO STA 32+00
X	P-6	PRODUCT WATER PLAN AND PROFILE - STA 32+00 TO STA 36+00
X	P-7	PRODUCT WATER PLAN AND PROFILE - STA 36+00 TO STA 40+00
X	P-8	PRODUCT WATER PLAN AND PROFILE - STA 40+00 TO STA 44+00
X	P-9	PRODUCT WATER PLAN AND PROFILE - STA 44+00 TO STA 48+00
X	P-10	PRODUCT WATER PLAN AND PROFILE - STA 48+00 TO STA 52+00
X	P-11	PRODUCT WATER PLAN AND PROFILE - STA 52+00 TO STA 55+50
X	P-12	PRODUCT WATER PLAN AND PROFILE - STA 55+50 TO STA 60+00
X	P-13	PRODUCT WATER PLAN AND PROFILE - STA 60+00 TO STA 64+00
X	P-14	PRODUCT WATER PLAN AND PROFILE - STA 64+00 TO STA 68+00
X	P-15	PRODUCT WATER PLAN AND PROFILE - STA 68+00 TO STA 72+00
X	P-16	PRODUCT WATER PLAN AND PROFILE - STA 72+00 TO STA 76+00
X	P-17	PRODUCT WATER PLAN AND PROFILE - STA 76+00 TO STA 80+00
X	P-18	PRODUCT WATER PLAN AND PROFILE - STA 80+00 TO STA 84+00
X	P-19	PRODUCT WATER PLAN AND PROFILE - STA 84+00 TO STA 88+00
X	P-20	PRODUCT WATER PLAN AND PROFILE - STA 88+00 TO STA 92+00
X	P-21	PRODUCT WATER PLAN AND PROFILE - STA 92+00 TO STA 96+00
X	P-22	PRODUCT WATER PLAN AND PROFILE - STA 96+00 TO STA 99+59.29
X	P-23	PRODUCT WATER PLAN AND PROFILE - STA 100+00 TO STA 101+19.24 AND STA 200+00 TO STA 202+00
X	P-24	PRODUCT WATER PLAN AND PROFILE - STA 202+00 TO STA 206+83.96
X	P-25	PRODUCT WATER PLAN AND PROFILE - STA 300+00 TO STA 304+00
X	P-26	PRODUCT WATER PLAN AND PROFILE - STA 304+00 TO STA 308+00
X	P-27	PRODUCT WATER PLAN AND PROFILE - STA 308+00 TO STA 312+00
X	P-28	PRODUCT WATER PLAN AND PROFILE - STA 312+00 TO STA 316+00
X	P-29	PRODUCT WATER PLAN AND PROFILE - STA 316+00 TO STA 318+17.70
X	P-30	CONNECTION DETAILS
X	P-31	CONNECTION DETAILS

SHT NO.	DWG NO.	DESCRIPTION
		MECHANICAL
X	100M-1	AREA 100 - RETURN FCF - PLAN AND SECTIONS
X	100M-2	AREA 100 - RETURN FCF - SECTIONS
X	200M-1	AREA 200 - EQUALIZATION TANK - PLAN AND SECTION
X	200M-2	AREA 200 - EQUALIZATION TANK - SECTIONS
X	200M-3	AREA 200 - IRON AND MANGANESE FILTRATION - PLANT
X	200M-4	AREA 200 - IRON AND MANGANESE FILTRATION - SECTIONS
X	300M-1	AREA 300 - RO FEED TANK AND BOOSTER PS - PLAN AND SECTION
X	300M-2	AREA 300 - RO FEED TANK AND BOOSTER PS - SECTIONS
X	300M-3	AREA 300 - RO FEED TANK AND BOOSTER PS - SECTIONS
X	400M-1	AREA 400 - MECHANICAL - RO SYSTEM - PLAN
X	400M-2	AREA 400 - MECHANICAL - RO SYSTEM - SECTIONS
X	400M-3	AREA 400 - MECHANICAL - CARTRIDGE FILTERS - ENLARGED PLAN AND SECTION
X	400M-4	AREA 400 - MECHANICAL - RO TRAINS - ENLARGED PLAN
X	400M-5	AREA 400 - MECHANICAL - RO TRAINS - SECTIONS
X	400M-6	AREA 400 - MECHANICAL - RO TRAINS - ENLARGED PLAN
X	400M-7	AREA 400 - MECHANICAL - RO TRAINS - SECTIONS
X	400M-8	AREA 400 - MECHANICAL - RO TRAINS - SECTIONS
X	400M-9	AREA 400 - MECHANICAL - RO CIP SYSTEM - ENLARGED PLAN AND SECTION
X	500M-1	AREA 500 - CLEARWELL TANK AND PS - PLAN
X	500M-2	AREA 500 - CLEARWELL TANK AND PS - SECTION
X	600M-1	AREA 600 - CHEMICAL FACILITIES - PLAN
X	600M-2	AREA 600 - CHEMICAL FACILITIES - SECTIONS
X	700M-1	AREA 700 - WASTE WASH WATER STORAGE - PLAN AND SECTIONS
X	700M-2	AREA 700 - DRYING BED MODIFICATIONS - PLAN AND SECTIONS
X	GFM-1	4 MG GHEEN FACILITY RESERVOIR - PLAN
X	GFM-2	4 MG GHEEN FACILITY RESERVOIR - SECTION
X	GFM-3	GHEEN FACILITY PUMP STATION - PLAN AND SECTION
X	GFM-4	GHEEN FACILITY PUMP STATION - SECTIONS
X	GM-1	MISCELLANEOUS PIPING DETAILS
X	GM-2	MISCELLANEOUS MECHANICAL DETAILS
X	GM-3	MISCELLANEOUS MECHANICAL DETAILS
X	GM-4	MISCELLANEOUS MECHANICAL DETAILS
X	GM-5	MISCELLANEOUS MECHANICAL DETAILS
X	GM-6	MISCELLANEOUS MECHANICAL DETAILS
		STRUCTURAL
X	GS-1	GENERAL STRUCTURAL NOTES AND ABBREVIATIONS
X	100S-1	AREA 100 - INLET METER AND FCF VAULT PLAN
X	100S-2	AREA 100 - RETURN FCF SECTIONS AND DETAILS
X	200S-1	AREA 200 - EQUALIZATION TANK PLAN AND SECTION
X	200S-3	AREA 200 - IRON AND MANGANESE FILTRATION SLAB PLAN
X	200S-4	AREA 200 - IRON AND MANGANESE FILTRATION SLAB SECTIONS AND DETAILS
X	300S-1	AREA 300 - RO FEED TANK AND BOOSTER PUMP STATION PLAN AND SECTION
X	300S-2	AREA 300 - RO FEED TANK AND BOOSTER PUMP STATION SECTIONS AND DETAILS
X	400S-1	AREA 400 - RO BUILDING FOUNDATION PLAN
X	500S-1	AREA 500 - CLEARWELL TANK AND PUMP STATION, TANK FOOTING AND SLAB PLAN
X	500S-2	AREA 500 - CLEARWELL TANK AND PUMP STATION SECTION
X	600S-1	AREA 600 - CHEMICAL FACILITIES CONTAINMENT PLAN
X	700S-1	AREA 700 - WASTE WASHWATER STORAGE BOTTOM PLAN
X	700S-2	AREA 700 - WASTE WASHWATER STORAGE TOP PLAN
X	700S-3	AREA 700 - WASTE WASHWATER STORAGE SECTIONS
X	GFS-1	GHEEN FACILITY RESERVOIR PLAN AND SECTION
X	GFS-2	GHEEN FACILITY PUMP STATION FOUNDATION PLAN
X	GFS-3	GHEEN FACILITY PUMP STATION TOP SLAB PLAN AND ROOF FRAMING PLAN
X	GFS-4	GHEEN FACILITY PUMP STATION AND SECTIONS
X	GFS-6	GHEEN FACILITY PUMP STATION PUMP ENCASEMENT SECTIONS AND DETAILS
		ELECTRICAL
X	E-1	STANDARD ELECTRICAL SYMBOLS AND ABBREVIATIONS
X	E-2	PLANT ELECTRICAL SITE PLAN
X	E-3	PLANT SINGLE LINE DIAGRAM
X	E-4	PLANT ELEVATIONS
X	E-5	DETAILS 1
X	E-6	DETAILS 2
X	E-7	SCHEDULES 1
X	E-8	SCHEDULES 2
X	E-9	SCHEDULES 3
X	E-10	SCHEDULES 4
X	E-11	SITE LIGHTING PLAN
X	E-12	OPERATIONS BLDG LIGHTING PLAN
X	E-13	OPERATIONS BLDG POWER AND SIGNAL PLAN

SHT NO.	DWG NO.	DESCRIPTION
		ELECTRICAL (CONTINUED)
X	GFE-1	GHEEN ELECTRICAL SITE PLAN
X	GFE-2	GHEEN SINGLE LINE DIAGRAM AND ELEVATIONS
		INSTRUMENTATION
X	GI-1	P&ID INSTRUMENTATION LEGEND
X	100I-1	AREA 100 P&ID GROUND WATER SUPPLY AND GHEEN RETURN
X	200I-1	AREA 200 P&ID EQUALIZATION TANK AND IM TREATMENT
X	200I-2	AREA 200 AIR SCOUR SYSTEM
X	300I-1	AREA 300 P&ID RO FEED TANK AND IM TREATED WATER BY-PASS
X	300I-2	AREA 300 IM BACKWASH WATER SUPPLY
X	400I-1	AREA 400 P&ID RO CARTRIDGE FILTERS
X	400I-2	AREA 400 P&ID RO TRAINS
X	400I-3	AREA 400 P&ID TRAIN DETAIL - I (RO FEED PUMPING)
X	400I-4	AREA 400 P&ID TRAIN DETAIL - II (RO VESSELS I)
X	400I-5	AREA 400 P&ID TRAIN DETAIL - III (RO VESSELS II)
X	400I-6	AREA 400 P&ID TRAIN DETAIL - IV (RO CONCENTRATE)
X	400I-7	AREA 400 P&ID TRAIN DETAIL - V (RO PERMEATE)
X	400I-8	AREA 400 P&ID RO CLEAN-IN-PLACE SYSTEM
X	500I-1	AREA 500 P&ID CLEARWELL AND PRODUCT WATER PUMP STATION
X	600I-1	AREA 600 P&ID SODIUM HYPOCHLORITE HANDLING FACILITIES
X	600I-2	AREA 600 P&ID SODIUM BISULFITE HANDLING FACILITIES
X	600I-3	AREA 600 P&ID AQUA AMMONIA HANDLING FACILITIES
X	600I-4	AREA 600 P&ID SODIUM HYDROXIDE HANDLING FACILITIES
X	600I-5	AREA 600 P&ID PHOSPHORIC ACID HANDLING FACILITIES
X	600I-6	AREA 600 P&ID FERRIC CHLORIDE HANDLING FACILITIES
X	600I-7	AREA 600 P&ID SULFURIC ACID FEED SYSTEM
X	600I-8	AREA 600 P&ID THRESHOLD INHIBITOR FEED SYSTEM
X	700I-1	AREA 700 WASTE WASHWATER AND RECOVERY
X	GFI-1	GHEEN FACILITY P&ID STATION PLAN
		NETWORK
X	N-1	NETWORK DIAGRAM
X	N-2	CP LAYOUT
X	N-3	SERVER RACK

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE N.T.S.
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY TS
DRAWN BY TS
CHECKED BY RK

Infrastructure ENGINEERING CORPORATION
14271 Danielson Street
Poway, California 92064
T 858.413.2400 F 858.413.2440
www.iecorporation.com

DATE

Fallbrook Public Utility District

990 E. MISSION RD
FALLBROOK, CA 92028

APPROVED BY:

JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

DRAWING INDEX

DRAWING NO. G-2
SHEET NO. X OF XX
CLIENT JOB NO. 2744

P:\Projects\FPUD (0112)\0002 St Marg Conjunctive Use Project\CADD\G-02-NT.dwg 11/02/2015 15:10

LEGEND

IMPROVEMENTS

PROPOSED PIPE — 10+00 OR 10+00

ABANDON / DEMOLISH — OR

FENCE (SDRSD M-6)

CURB AND GUTTER (SDRSD G-2)

GRADING CONTOURS — 1010 1000

ASPHALT CONCRETE

CONCRETE

VALVE — OR

HORIZONTAL CONTROL POINT — 1

LINE DATA — 5

DAYLIGHT LINE

TEMPORARY ACCESS ROAD

EXISTING

EXIST CONTOURS — 1010 1000

EXIST PROPERTY LINE

EXIST EASEMENT

EXIST FENCE

EXIST EDGE OF PAVEMENT

EXIST UTILITY INFORMATION — TYPE, SIZE, MATERIAL, 10" WTR CML&C STL, W, TYPE

EXIST WATER — W

EXIST STORM DRAIN — SD

EXIST SEWER — S

EXIST UNDERGROUND ELECTRIC — E

EXIST DRAIN — D

EXIST OVERHEAD UTILITIES — OH

EXIST HORIZONTAL CONTROL POINT

EXIST MANHOLE — S

EXIST CONC THRUST BLOCK

EXIST POWER POLE

EXIST GUY ANCHOR

EXIST FIRE HYDRANT

EXIST BOLLARD

EXIST BUTTERFLY VALVE

EXIST VALVE

EXIST AIR & VACUUM RELIEF VALVE

GEOTECHNICAL BORING — B-1

SECTION AND DETAIL IDENTIFICATION SYSTEM

SECTION CALLOUT

SECTION LETTER — B / C-9

DRAWING WHERE SECTION IS SHOWN

SECTION TITLE

SECTION LETTER — 2 / C-7

SECTION

SCALE:

DRAWING FROM WHICH SECTION IS CUT

DETAIL CALLOUT

DETAIL NUMBER — 2 / C-9

DRAWING ON WHICH DETAIL APPEARS

DETAIL TITLE

DETAIL NUMBER — 2 / C-7

DETAIL

SCALE:

DRAWING FROM WHICH DETAIL APPLIES

UTILITY CONTACTS

AT&T DISTRIBUTION	(619) 574-3661
SDG&E	1-800-660-7343
TIME WARNER	(858) 805-7184
COUNTY OF SAN DIEGO	(858) 694-2215
FALLBROOK PUBLIC UTILITY DISTRICT	(760) 728-1125

GEOTECHNICAL REPORT

GEOTECHNICAL EVALUATION - SANTA MARGARITA CONJUNCTIVE USE PROJECT, FALLBROOK, CA

DATED JUNE 23,2015
PROJECT NO. 107931001

NINYO & MOORE
5710 RUFFIN ROAD
SAN DIEGO, CA 92123

CONTACT: WILLIAM MORRISON, PE,GE
(858) 576-1000

DECLARATION OF RESPONSIBLE IN CHARGE

I HEREBY DECLARE THAT THE DESIGN OF THE IMPROVEMENTS AS SHOWN ON THESE PLANS COMPLIES WITH PROFESSIONAL ENGINEERING STANDARDS AND PRACTICES. AS THE ENGINEER IN RESPONSIBLE CHARGE OF THE DESIGN OF THESE IMPROVEMENTS, I ASSUME FULL RESPONSIBLE CHARGE FOR SUCH DESIGN. I UNDERSTAND AND ACKNOWLEDGE THAT THE PLAN CHECK OF THESE PLANS BY THE FPUD IS A REVIEW FOR THE LIMITED PURPOSE OF ENSURING THE PLANS COMPLY WITH DISTRICT PROCEDURES AND OTHER APPLICABLE POLICIES AND ORDINANCES. THE PLAN CHECK IS NOT A DETERMINATION OF THE TECHNICAL ADEQUACY OF THE DESIGN OF THE IMPROVEMENTS. SUCH PLAN CHECK DOES NOT, THEREFORE, RELIEVE ME OF MY RESPONSIBILITY FOR THE DESIGN OF THESE IMPROVEMENTS. AS ENGINEER OF WORK, I AGREE TO INDEMNIFY AND SAVE THE FPUD, ITS OFFICERS, AGENTS AND EMPLOYEES HARMLESS FROM ANY AND ALL LIABILITY, CLAIMS, DAMAGES OR INJURIES TO ANY PERSON OR PROPERTY WHICH MIGHT ARISE FROM THE NEGLIGENT ACTS, ERRORS OR OMISSIONS OF THE ENGINEER OF WORK, MY EMPLOYEES, MY EMPLOYEES AGENTS OR CONSULTANTS.

ENGINEER — DATE
R.C.E. CXXXXXX EXPIRES XX-XX-XX

SURVEY BY

IEC
14271 DANIELSON ST
POWAY, CA 92064

CONTACT: GARY RUSH, PLS
(858) 842-6983

GHEEN SITE

BASIS OF BEARINGS/COORDINATES

THE BASIS OF BEARINGS FOR THIS PROJECT IS THE INVERSE OF THE CCS83, ZONE 6, 1991.35 EPOCH ADJUSTMENT COORDINATES BETWEEN STATION EMR FP02 IN THE COUNTY OF SAN DIEGO SURVEY RECORDS SYSTEM, WHICH IS A 1/2" REBAR 3' EAST OF A FIRE HYDRANT AT 2419 EAST MISSION ROAD, 6' SOUTH OF THE EDGE OF PAVEMENT AND 1/2" REBAR WITH CAP STAMPED LS 2961, 10' SOUTH OF 093W083 IN THE COUNTY OF SAN DIEGO SURVEY RECORDS SYSTEM, BEING THE NORTHEAST SECTION CORNER OF SECTION 20, WHICH WAS NOT FOUND. THAT INVERSE IS NORTH 14°04'42" WEST 1656.83 FEET. THE DATUM WAS TRANSFERRED BY GPS SURVEY TO THE FOLLOWING MONUMENTS SET PER MAP 15170 ON THE CENTERLINE OF GUMTREE LANE DESCRIBED AS FOLLOWS:

A STREET SURVEY MONUMENT STAMPED LS 5473 SET PER MAP NO. 15170 (RCE 21245 PER MAP 15170) SET 4 FEET WEST OF THE NORTHEAST CORNER OF THE SUBDIVISION, BEING THE NORTH QUARTER CORNER OF SECTION 20, STATION 093W082, WHICH WAS NOT FOUND:
NORTHING 2085999.651
EASTING 6265892.954

A STREET SURVEY MONUMENT STAMPED LS 5473 SET PER MAP NO. 15170 (RCE 21245 PER MAP 15170) SET IN THE INTERSECTION OF STAGECOACH ROAD AND GUMTREE LANE 20' EAST OF THE NORTHWEST SUBDIVISION CORNER, BEING THE NORTHWEST CORNER OF SECTION 20, STATION 093W081, WHICH WAS NOT FOUND,
NORTHING 2086026.958
EASTING 6263225.366

THE INVERSE BETWEEN THE STREET MONUMENTS IS NORTH 89°24'49" WEST 2667.73 FEET.

BENCH MARK

THE ELEVATION BENCHMARK FOR THIS PROJECT IS THE NGVD29 ELEVATION COUNTY OF SAN DIEGO CONTROL POINT EMR FP02, WHICH IS 952.21 FEET. THE ELEVATION WAS TRANSFERRED BY GPS SURVEY TO A STREET SURVEY MONUMENT SET PER MAP NO. 15170 STAMPED LS 5473 (RCE 21245 PER MAP 15170) SET 4 FEET WEST OF STATION 093W082, THE NORTHEAST CORNER OF THE SUBDIVISION AND THE NORTH QUARTER CORNER OF SECTION 20, WHICH WAS NOT FOUND.

ELEVATION = 923.74 FEET NGVD 29

WTP SITE

BASIS OF BEARINGS/COORDINATES

THE BASIS OF BEARINGS FOR THIS PROJECT IS THE INVERSE OF THE CCS83, ZONE 6, 1991.35 EPOCH ADJUSTMENT COORDINATES OF THE FOLLOWING SURVEY CONTROL MONUMENTS:

COUNTY OF SAN DIEGO SURVEY RECORDS SYSTEM STATION R1835 302-98.76:
A STREET MONUMENT IN THE LEFT TURN LANE FROM SOUTHBOUND MISSION ROAD TO EAST CLEMMENS LANE
NORTHING = 2079531.60 FEET
EASTING = 6256036.24 FEET

A STREET MONUMENT IN THE CENTER OF MISSION ROAD AT THE INTERSECTION WITH ALMOND STREET
NORTHING = 2078334.101
EASTING = 6256390.599

THE INVERSE IS NORTH 16°29'04" WEST 1248.83 FEET.

BENCH MARK

SAN DIEGO COUNTY 3" BRASS DISC STAMPED “SD CO SLR 08 2012 SET IN THE TOP OF A STORM DRAIN INLET AT THE NORTHEAST CORNER OF THE INTERSECTION OF PALOMINO STREET AND OLD STAGE ROAD
ELEVATION = 639.89 NGVD29

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE NTS
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY TS
DRAWN BY TS
CHECKED BY RK

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FPUD Fallbrook Public Utility District
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FALLBROOK, CA 92028

APPROVED BY:
JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

LEGEND AND NOTES

DRAWING NO. G-3
SHEET NO. X OF XX
CLIENT JOB NO. 2744

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GENERAL NOTES

1. IT IS THE CONTRACTOR'S RESPONSIBILITY TO NOTIFY UNDERGROUND SERVICE ALERT AT 1 800-422-4122 A MINIMUM OF 48 HOURS PRIOR TO START OF CONSTRUCTION.
2. THE CONTRACTOR SHALL NOTIFY THE DISTRICT ENGINEER AT LEAST (5) DAYS PRIOR TO STARTING WORK, SO THAT INSPECTION MAY BE PROVIDED. TELEPHONE NO. (760) 728-1125.
3. SEPARATION REQUIREMENTS BETWEEN WATER AND NON-POTABLE FLUID LINES SHALL CONFORM TO CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH) "WATER WORKS STANDARDS".
4. ALL WORK SHALL BE IN ACCORDANCE WITH THE MOST RECENT EDITIONS OF THE CALIFORNIA OCCUPATIONAL AND HEALTH ADMINISTRATION (CAL-OSHA) - CALIFORNIA CODE OF REGULATIONS (CCR) TITLE 8, STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION, WITH SUPPLEMENTS (APWA SPECIFICATIONS), THE SAN DIEGO REGIONAL STANDARD DRAWINGS AND FPUD STANDARDS MANUAL.
5. CONTRACTOR SHALL POTHOLE AND FIELD VERIFY ALL EXISTING UTILITIES THAT ARE CROSSING THE NEW PIPELINE AND AT CONNECTIONS. POTHOLING AND FIELD VERIFICATION SHALL BE DONE SUFFICIENTLY AHEAD OF THE CONTRACTOR'S PIPE SUBMITTAL TO ALLOW TIME FOR DESIGN REVISIONS IF NECESSARY. IF THE CONTRACTOR FAILS TO POTHOLE AND NOTIFY THE DISTRICT IN ADVANCE, ALL COSTS ASSOCIATED WITH CHANGES SHALL BE BORNE BY THE CONTRACTOR.
6. PRIOR TO CONSTRUCTION OF THE WATER AND/OR SEWER LINES, THE CONTRACTOR SHALL EXPOSE THE EXISTING WATER AND/OR SEWER LINES WHERE CONNECTIONS WILL OCCUR AND VERIFY THEIR ELEVATION AND LOCATION. NO CONNECTION SHALL BE DONE WITHOUT DISTRICT STAFF PRESENT AND APPROVAL BY THE DISTRICT ENGINEER. A PROPOSED CONNECTION TO A FPUD FACILITY DOES NOT IMPLY APPROVAL OF THE CORRECTNESS OF THE ELEVATION AND/OR LOCATION SHOWN ON THE PLANS.
7. CONTRACTOR SHALL NOT BACKFILL TRENCH UNTIL THE DISTRICT HAS INSPECTED THE PIPE OR STRUCTURE AND AUTHORIZES THE TRENCH TO BE BACKFILLED. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO PROVIDE ACCURATE "RECORD" DRAWINGS TO THE DISTRICT IMMEDIATELY AFTER CONSTRUCTION.
8. APPROVAL BY THE DISTRICT IMPLIES NO PERMISSION OTHER THAN THAT WITHIN THE DISTRICT'S JURISDICTION. ALL PERMITS REQUIRED BY LAW SHALL BE ACQUIRED BY THE CONTRACTOR. REQUIREMENTS OF FPUD SHALL TAKE PRECEDENCE OVER REQUIREMENTS OF OTHER AGENCIES ONLY WHERE FPUD REQUIREMENTS ARE MORE STRINGENT.
9. THE CONTRACTOR SHALL OBTAIN AN EXCAVATION PERMIT FROM THE DIVISION OF INDUSTRIAL SAFETY.
10. WATER PIPE JOINTS SHALL NOT BE PULLED AT ANY ANGLE GREATER THAN THE MAXIMUM ANGLE RECOMMENDED BY THE PIPE MANUFACTURER.
11. THE PROPOSED WORK SHALL BE SUBORDINATED TO ANY OPERATION FPUD MAY CONDUCT, AND SHALL BE COORDINATED WITH SUCH OPERATIONS AS DIRECTED BY THE DISTRICT ENGINEER.
12. A PRECONSTRUCTION MEETING SHALL OCCUR PRIOR TO CONSTRUCTION. ATTENDEES SHALL INCLUDE THE DISTRICT ENGINEER OR HIS DESIGNATE AND THE CONTRACTOR WHO WILL PERFORM THE WORK, AND OTHER GOVERNMENTAL AGENCIES AND/OR UTILITY COMPANIES AS NECESSARY. "CUT-SHEETS" SHALL BE PROVIDED TO THE DISTRICT PRIOR TO THIS MEETING FOR REVIEW.
13. TRAFFIC CONTROL SHALL BE IN ACCORDANCE WITH THE CURRENT STATE OF CALIFORNIA MANUAL OF TRAFFIC CONTROLS. THE CONTRACTOR IS RESPONSIBLE FOR ALL TRAFFIC CONTROL ON THE JOBSITE.
14. THE CONTRACTOR SHALL BE RESPONSIBLE FOR IMPLEMENTING, ADMINISTRATING AND MAINTAINING A CONFINED SPACE ENTRY PROGRAM.
15. PIPE SHALL BE HANDLED (WITH STRAPS, NO CHAINS) SO AS TO PROTECT PIPE JOINTS, LINING AND COATING, AND CAREFULLY BEDDED TO PROVIDE CONTINUOUS BEARING AND PREVENT SETTLEMENT. PIPE SHALL BE PROTECTED AGAINST FLOTATION AT ALL TIMES. OPEN ENDS SHALL BE SEALED AT ALL TIMES WHEN CONSTRUCTION IS IN PROCESS.

GENERAL NOTES (CONTINUED)

16. UPON COMPLETION OF CONSTRUCTION, THE CONTRACTOR SHALL HIRE A VIDEO COMPANY APPROVED BY THE DISTRICT TO VIDEOTAPE THE CML&C STEEL WATER MAINS. THE DISTRICT ENGINEER SHALL REVIEW SAID VIDEOTAPE FOR POTENTIAL CONSTRUCTION DEFECTS PRIOR TO ACCEPTANCE OF THE PROJECT. PAYMENT FOR ALL SUCH SERVICES SHALL BE BORNE BY THE CONTRACTOR.
17. ALL DISTRICT FACILITIES SHALL HAVE A MINIMUM 5-FOOT HORIZONTAL CLEARANCE FROM OTHER UTILITIES EXCEPT WHERE OTHERWISE NOTED. THIS PERTAINS TO ALL SECTIONS ON ALL SHEETS HEREIN.
18. ALL ROUGH ROAD GRADING SHALL BE COMPLETED PRIOR TO CONSTRUCTION OF WATER AND SEWER FACILITIES.
19. THE DESIGN ENGINEER SHALL PROVIDE THE DISTRICT ENGINEER WITH AS-BUILT PHOTO MYLARS AND ELECTRONIC FILE IN AUTOCAD AND TIF FORMAT.

WATER NOTES

1. CONTRACTOR SHALL FURNISH AND INSTALL ALL FACILITIES IN ACCORDANCE WITH FPUD STANDARD SPECIFICATIONS AND STANDARD DRAWINGS FOR WATER AND SANITARY SEWER FACILITIES (LATEST REVISION). THE SPECIFICATIONS AND STANDARD DRAWINGS ARE AVAILABLE FROM THE DISTRICT. CONTRACTOR SHALL BE IN POSSESSION OF FPUD STANDARDS MANUAL ON THE JOB SITE AT ALL TIMES. ANY CONSTRUCTION OR MATERIAL NOT COVERED IN FPUD STANDARDS SHALL BE APPROVED BY THE DISTRICT.
2. CONTRACTOR SHALL PROVIDE WRITTEN NOTIFICATION REQUESTING A SYSTEM SHUTDOWN FOR CONNECTIONS TO EXISTING SYSTEM. SAID NOTIFICATION SHALL BE MADE TO THE DISTRICT A MINIMUM OF TWO (2) WEEKS PRIOR TO SAID SHUTDOWN.
3. CONTRACTOR SHALL DESIGNATE A QUALIFIED SUPERINTENDENT WITH FULL AUTHORITY TO ACT ON BEHALF OF THE CONTRACTOR. SAID SUPERINTENDENT SHALL BE ON THE JOB SITE AT ALL TIMES.
4. CONTRACTOR SHALL PERFORM ALL ENCROACHMENT PERMIT WORK UNDER SAN DIEGO COUNTY DEPARTMENT OF PUBLIC WORKS, IN ACCORDANCE WITH ALL REQUIREMENTS OF SAID REMOVAL, TEMPORARY PAVEMENT PLACEMENT, PERMANENT PAVEMENT PLACEMENT (INCLUDING BASE MATERIAL) AND TEMPORARY AND PERMANENT TRAFFIC STRIPING.
5. THE WATER LINE SHALL BE INSTALLED BY A PRIVATE CONTRACTOR IN ACCORDANCE WITH FPUD STANDARDS MANUAL. THE CONTRACTOR SHALL BE APPROVED BY THE DISTRICT ENGINEER.
6. MINIMUM COVER OVER THE WATER MAIN SHALL BE 30-INCHES AND THE MAXIMUM COVER SHALL BE 36-INCHES OR AS NOTED OTHERWISE UNLESS PRIOR APPROVAL IS OBTAINED FROM THE DISTRICT ENGINEER.
7. WHEREVER A WATER LINE ENCOUNTERS A STORM DRAIN PIPE OR OTHER OBSTRUCTION, AND CROSSING OVER THE OBSTRUCTION WILL RESULT IN LESS THAN 30-INCHES OF COVER OVER THE WATER LINE, IT SHALL CROSS UNDER THE OBSTRUCTION WITH 6-INCHES MINIMUM CLEARANCE.
8. METER BOXES SHALL BE FIELD LOCATED TO CLEAR DRIVEWAYS AND LOCATED ACCURATELY ON THE AS-BUILT DRAWINGS. THE CONTRACTOR SHALL ADJUST METER BOXES TO SIDEWALK GRADE WHEN SIDEWALKS ARE POURED.
9. ALL WATER MAINS ARE DISTRICT OWNED AND MAINTAINED. THE DISTRICT MAINTAINS WATER SERVICE LINES UP TO AND INCLUDING METER AND BACK-FLOW IF REQUIRED. ALL NEW FIRE HYDRANTS TO BE APPROVED AND ARE OWNED BY THE NORTH COUNTY FIRE PROTECTION DISTRICT.
10. CONTRACTOR TO ADJUST ALL VALVE COVERS, FIRE HYDRANTS, METER BOXES, ETC., TO GRADE AS DIRECTED BY THE DISTRICT.

DIGALERT
DIAL TOLL FREE
811
AT LEAST TWO DAYS BEFORE YOU DIG
UNDERGROUND SERVICE ALERT OF SOUTHERN CALIFORNIA

WATER NOTES (CONTINUED)

11. LAYING DIRECTION OF WATER MAIN SHALL BE IN A GENERAL UPHILL DIRECTION.
12. THE LOCATION OF AIR VALVES AND BLOW-OFFS SHALL BE VERIFIED BY THE DISTRICT ENGINEER IN THE FIELD.
13. ALL VALVES SHALL HAVE ACCESS PIPING THAT CONSISTS OF SDR35 ORC900 PVC AND THE 1208N LID COVERS. (FPUD STANDARD DRAWINGS W-19 AND W-20).
14. WATER METER SERVICE LATERALS SHALL BE 24-INCHES BELOW FINISH GROUND LEVEL. ANGLE STOP SHALL TERMINATE 9-INCHES BELOW FINISH GROUND LEVEL WITH LOCATION STAMPED WITH A "W" IN CURB. ALL OTHERS TO TERMINATE ABOVE GROUND.
15. THE CONTRACTOR SHALL INSTALL SUITABLE THRUST BLOCKS AT SELECTED VERTICAL AND/OR HORIZONTAL CHANGE OF DIRECTION IN ACCORDANCE WITH FPUD STANDARDS, WHETHER OR NOT SPECIFICALLY CALLED FOR OR SHOWN ON THE PLAN.
16. CONTRACTOR TO MAKE CONNECTIONS TO EXISTING MAINS ONLY AFTER SUCCESSFUL PRESSURE TESTING AND DISINFECTION OF NEW FACILITIES AS AUTHORIZED BY THE DISTRICT ENGINEER.
17. ALL MATERIALS , TESTING AND INSPECTION OF PIPE SHALL BE IN CONFORMITY WITH THE REQUIREMENTS OF FPUD, AND THE AMERICAN WATER WORKS ASSOCIATION (AWWA) STANDARDS. COUNTY, AND/OR THE AWWA SPECIFICATIONS WILL BE CAUSE FOR REJECTION.
18. ALL WELDED STEEL PIPE SHALL BE CEMENT MORTAR LINED AND COATED, 12 GAUGE (MINIMUM) WITH FULLY WELDED JOINTS AND HAND HOLES, UNLESS NOTED OTHERWISE.
19. ALL STEEL BENDS AND FITTINGS SHALL BE CEMENT MORTAR LINED AND COATED AND SHALL BE SHOP FABRICATED PER AWWA C208-(LATEST). CONTRACTOR SHALL SUBMIT FABRICATION DRAWINGS (FROM A DISTRICT APPROVED FABRICATOR) FOR ALL AWWA SHOP FABRICATED FITTINGS TO THE DISTRICT FOR APPROVAL PRIOR TO FABRICATION. SERVICE CONNECTIONS MADE TO EXISTING ACP, DIP, OR PVC PIPELINES SHALL UTILIZE A BRASS DOUBLE SERVICE STRAP CONNECTION.
20. FOR HYDRO-STATIC TESTING PURPOSES, ALL WATER PIPES SHALL BE TESTED AT 50 PSI ABOVE THE CLASS RATING OF THE PIPE AT THE LOWEST POINT IN THE SECTION BEING TESTED; AND SHALL BE AT LEAST EQUAL TO THE DESIGN CLASS OF THE PIPE AT THE HIGHEST POINT IN THE LINE.
21. THE MINIMUM REQUIREMENTS OF THE PIPELINE TRENCH SHALL BE PER FPUD STANDARD DRAWING W-3.
22. PIPELINES AND APPURTENANCES SHALL BE TESTED, DISINFECTED, AND DECHLORINATED PER FPUD STANDARDS SECTION 15041, DEPARTMENT OF PUBLIC HEALTH, AND/OR ANY OTHER AGENCY HAVING JURISDICTION OVER THE WORK.
23. CONTRACTOR SHALL UNCOVER LOCATIONS OF CONNECTIONS PRIOR TO STARTING INSTALLATIONS TO ENSURE CONFORMANCE WITH LINES AND GRADES SHOWN ON THESE PLANS. ANY DEVIATION FROM THE PLANS MUST BE APPROVED BY THE DISTRICT PRIOR TO CONSTRUCTION.
24. THE EXISTENCE AND LOCATION OF WATER FACILITIES AS SHOWN ON THE PLANS WERE OBTAINED FROM AVAILABLE RECORDS. TO THE BEST OF OUR KNOWLEDGE, THE EXISTING WATER FACILITIES ARE AS SHOWN ON THE PLANS. THE DISTRICT SHALL NOT BE HELD RESPONSIBLE FOR ANY ERROR IN THE LOCATION AND ELEVATION OF THE EXISTING WATER FACILITIES. THE CONTRACTOR IS REQUIRED TO TAKE PRECAUTIONARY MEASURES TO PROTECT ANY EXISTING FACILITY SHOWN HEREON AND ANY OTHER WHICH IS NOT OF RECORD OR NOT SHOWN ON THESE PLANS.
25. LOCATION AND ELEVATIONS OF IMPROVEMENTS TO BE DONE SHALL BE CONFIRMED BY FIELD MEASUREMENTS PRIOR TO CONSTRUCTION OF NEW WORK. THE CONTRACTOR WILL MAKE EXPLORATORY EXCAVATIONS AND LOCATE EXISTING UNDERGROUND FACILITIES SUFFICIENTLY AHEAD OF CONSTRUCTION TO PERMIT REVISIONS TO PLANS IF REVISIONS ARE NECESSARY BECAUSE OF ACTUAL LOCATION OF EXISTING FACILITIES.
26. CALL THE DISTRICT FIVE (5) WORKING DAYS PRIOR TO STARTING CONSTRUCTION, AND TWO (2) WEEKS IF SHUTDOWN IS REQUIRED. THE DISTRICT SHALL BE NOTIFIED AT LEAST TWO (2) WORKING DAYS PRIOR TO ANY INSPECTION. TO ARRANGE FOR INSPECTION, CALL (760) 728-1125
27. PIPE DEFLECTIONS FOR SHORT RADIUS CURVES AND ANGLE POINTS SHALL NORMALLY BE ACCOMPANIED BY MEANS OF STANDARD FITTINGS, THE LOCATIONS OF WHICH SHALL BE DETAILED ON THE PLANS.

WATER NOTES (CONTINUED)

28. ALL WATER USED ON A CONSTRUCTION PROJECT MUST BE PAID FOR AND WILL BE METERED. THIS INCLUDES WATER FOR LOADING OF NEW WATERLINES, FLUSHING OF LINES, PRESSURE TESTING, ETC. CITATIONS WILL BE ISSUED TO PARTIES TAKING WATER FROM UNMETERED FACILITIES. A CONSTRUCTION WATER METER MAY BE OBTAINED FROM THE DISTRICT.
29. PROPOSED WATER SYSTEM IMPROVEMENTS ARE LOCATED WITHIN THE GHEEN PRESSURE ZONE (MAX HGL = 1037 FT) AND THE RED MOUNTAIN PRESSURE ZONE (MAX HGL = 1137 FT)
30. THE CONTRACTOR SHALL INSTALL A FLANGE ISOLATION KIT AT POINTS OF CONNECTION OF DISSIMILAR MATERIALS OR WHERE SHOWN OR SPECIFIED.
31. WATER METER ABANDONMENT/REMOVAL: THE SERVICE LATERAL AT THE MAINLINE MUST BE CUT AND A CAP OR PLUG MUST BE INSTALLED ON THE CORPORATION VALVE, ENCASE ABANDONED CORPORATION VALVE IN CONCRETE AND REMOVE THE LATERAL FROM THE CORPORATION VALVE TO THE ANGLE STOP. CURRENT INSPECTION FEES WILL BE REQUIRED. SHUTDOWN FEES MAY BE REQUIRED.
32. WATER MAIN ABANDONMENT: ABANDONED PIPELINES SHALL BE CUT AND PLUGGED AT APPROPRIATE INTERVALS PER SDRSD WP-03.
33. EXISTING WATER FACILITIES SHALL BE KEPT IN SERVICE DURING CONSTRUCTION.
34. PIPELINE TRENCH AND BACKFILL SHALL BE PER FPUD STD DWG W-3. TRENCH RESURFACING SHALL BE PER SDRSD G-24-A, TYPE A.

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE NTS
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY TS
DRAWN BY TS
CHECKED BY RK

Infrastructure ENGINEERING CORPORATION
14271 Danielson Street
Poway, California 92064
T 858.413.2400 F 858.413.2440
www.iecorporation.com
DATE

FPUD Fallbrook Public Utility District
990 E. MISSION RD
FALLBROOK, CA 92028
APPROVED BY:
JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES
GENERAL NOTES

DRAWING NO. G-4
SHEET NO. X OF XX
CLIENT JOB NO. 2744

P:\Projects\FPUD (0112)\0002 St Marg Conjunctive Use Project\CADD\G-04-NT.dwg 10/30/2015 10:13

ABBREVIATIONS

A	AIR
AB	ANCHOR BOLT
ABAN	ABANDONED
ABBR	ABBREVIATION
ABS	ABSOLUTE TEMPERATURE
AC	ACTIVATED CARBON
A/C	AIR CONDITIONING
ACOUS	ACOUSTIC OR ACCOUSTICAL
ACP	ASPHALTIC CONCRETE PAVEMENT OR ASBESTOS CEMENT PIPE
ADDL	ADDITIONAL
ADJ	ADJUSTABLE
AER	AERATION
AHD	AHEAD
AL	ALUMINUM OR ALUM
AMB	AMBIENT
ANG	ANGLE
ANSI	AMERICAN NATIONAL STANDARDS INSTITUTE (FORMERLY ASA)
AP	ANGLE POINT
APPD	APPROVED
APPROX	APPROXIMATE
ARCH	ARCHITECTURAL
ASSY	ASSEMBLY
AT	ACOUSTICAL TILE
ATM	ATMOSPHERE
AV	AIR VALVE
AVAR	AIR VACUUM AND AIR RELEASE VALVE
AWWA	AMERICAN WATER WORKS ASSOCIATION
BC	BEGIN CURVE, BOLT CIRCLE OR BETWEEN CENTERS
BCR	BEGIN CURB RETURN
BD	BOARD
BF	BLIND FLANGE
BFP	BACK FLOW PREVENTER
BFV	BUTTERFLY VALVE
BHP	BRAKE HORSEPOWER
BK	BACK
BLDG	BUILDING
BLD FLG	BLIND FLANGE
BLK	BLACK OR BLOCK
BLKG	BLOCKING
BM	BEAM OR BENCH MARK
BO	BLOW-OFF ASSEMBLY
BOD	BIOCHEMICAL OXYGEN DEMAND
BOT	BOTTOM
BVP	BACK PRESSURE VALVE
BRK	BRICK
B & S	BELL AND SPIGOT
BSMT	BASEMENT
BT	BOLT
BTU	BRITISH THERMAL UNIT
BVC	BEGIN VERTICAL CURVE
BW	BACK WATER VALVE
C	CENTIGRADE
CAB	CABINET
CAO	CAPACITY
CB	CATCH BASIN
CC	CENTER TO CENTER
CD	CEILING DIFFUSER
CLR	CLEAR
CEM	CEMENT
CER	CERAMIC
CFH	CUBIC FEET PER HOUR
CFM	CUBIC FEET PER MINUTE
CFS	CUBIC FEET PER SECOND
CHEM	CHEMICAL
CHG	CHANGE
CHK V	CHECK VALVE
CHKD PL	CHECKERED PLATE
CI	CAST IRON
CJ	CONSTRUCTION JOINT
CL	CHLORINE GAS, CHLORINATOR, CHAIN LINK OR CENTERLINE
CLG	CEILING
CLOS	CLOSET
CLR	CLEAR
CM	CENTIMETER
CML&C	CEMENT MORTAR LINED AND COATED
CMP	CORRUGATED METAL PIPE
CMU	CONCRETE MASONRY UNIT
CO	CLEANOUT
COL	COLUMN
COMP	COMPRESSOR
CONC	CONCRETE
COND	CONDENSER OR CONDENSATE
CONN	CONNECTION
CONSTR	CONSTRUCTION OR CONSTRUCT
CONT	CONTINUED OR CONTINUOUS
CONTR	CONTRACTOR
COTG	CLEAN-OUT TO GRADE
CPLG	COUPLING
CPVC	CHLORINATED POLYVINYL CHLORIDE
CS	CAUSTIC SODA OR CAST STEEL
CT	CERAMIC TILE
CTSK	COUNTERSUNK
CTR	CENTER
CU	COPPER OR CUBIC
CYL	CYLINDER
d	PENNY
DBL	DOUBLE
DC	DIRECT CURRENT
DET	DETAIL
DF	DRINKING FOUNTAIN
DG	DOOR GRILLE
DI	DUCTILE IRON
DIA	DIAMETER
DIAG	DIAGONAL
DIAPH	DIAPHRAGM
DISCH	DISCHARGE
DISP	DISPENSE
DN	DOWN OR DECANT
DO	DISSOLVED OXYGEN
DR	DOOR OR DRAIN
DS	DRENCH SHOWER AND EYEWASH
DWG	DRAWING
DIFF	DIFFUSER OR DIFFERENTIAL
E	EAST
EA	EACH
EB	EXPANSION BOLT OR ANCHOR
EC	END CURVE
ECC	ECCENTRIC
ECR	END CURB RETURN
EF	EACH FACE OR EXHAUST FAN
EFF	EFFLUENT
EG	EXISTING GRADE
EL	ELEVATION
ELEC	ELECTRICAL
ENC	ENCASEMENT
ENG	ENGINE
EOP	EDGE OF PAVEMENT
EPT	ETHYLENE PROPYLENE
ENCL	ENCLOSURE
ENT	ENTRANCE
EQ	EQUAL
EQUIP	EQUIPMENT
ESMT	EASEMENT
EVAP	EVAPORATOR
EVC	END VERTICAL CURVE
EW	EACH WAY OR EYE WASH
EXH	EXHAUST
EX-HY	EXTRA HEAVY
EXIST	EXISTING
EXP JT	EXPANSION JOINT
EXT	EXTERIOR OR EXTENSION
EXTR	EXTRUDED
F	FAHRENHEIT OR FINISH
FABR	FABRICATE
FAI	FRESH AIR INTAKE
FB	FLOOR BEAM
FCF	FLOW CONTROL FACILITY
FCO	FLOOR CLEANOUT
FD	FLOOR DRAIN
FE	FIRE EXTINGUISHER OR FINAL EFFLUENT
FEM	FEMALE PIPE THREAD
FF	FAR FACE
F TO F	FACE TO FACE
FG	FINISHED GRADE
FH	FIRE HYDRANT
FIG	FIGURE
FIN	FINISHED
FIX	FIXTURE
FL	FLOOR OR FLOWLINE
FLEX	FLEXIBLE
FLOCC	FLOCCULATOR OR FLOCCULATION
FLG/FLGD	FLANGED
FM	FORCE MAIN
FMH	FLEXIBLE METAL HOSE
FND	FOUNDATION
FOC	FACE OF CONCRETE
FOM	FACE OF MASONRY
FOS	FACE OF STUDS
FOW	FACE OF WALL
FPC	FLEXIBLE PIPE COUPLING
FPM	FEET PER MINUTE
FPS	FEET PER SECOND
FPUD	FALLBROOK PUBLIC UTILITY DISTRICT
FS	FINISHED SURFACE
GA	GAUGE
GAL	GALLON
GALV	GALVANIZED
GEN	GENERATOR
GFA	GROOVED FLANGE ADAPTER
GL	GLASS
GLV	GLOBE VALVE
GPD	GALLONS PER DAY
GPH	GALLONS PER HOUR
GPM	GALLONS PER MINUTE
GRD	GROUND OR GRADE
GR BRK	GRADE BREAK
GRTG	GRATING
GV	GATE VALVE
GYP	GYPSUM
HDR	HEADER
HDW	HARDWARE
HEX	HEXAGONAL
Hg	MERCURY
HGL	HYDRAULIC GRADE LINE
HGR	HANGER
HGT	HEIGHT
HM	HOLLOW METAL
HORIZ	HORIZONTAL
HP	HORSEPOWER OR HIGH PRESSURE
H/P	HIGH POINT
HR	HEATING RETURN OR HOUR
H & V	HEATING AND VENTILATION
HWL	HIGH WATER LEVEL
HWO	HANDWHEEL OPERATED
HYD	HYDRANT OR HYDRAULIC
ID	INSIDE DIAMETER
IE	INVERT ELEVATION
IF	INSIDE FACE
IN	INCH
INFL	INFLUENT
IN LB	INCH POUND
INSL	INSULATION OR INSULATED
INSTR	INSTRUMENT
INT	INTERIOR
INV	INVERT ELEVATION
IP	IRON PIPE
IPS	IRON PIPE SIZE
IRRG	IRRIGATION
JT	JOINT
K	KELVIN, KILO OR KARAT
KG	KILOGRAM
KM	KILOMETER
KV	KILOVOLT
KW	KILOWATT
KWH	KILOWATT HOUR
L/P	LOW POINT
L	LITER OR LENGTH
LAB	LABORATORY
LAM	LAMINATED
LAV	LAVATORY
LB	POUND
LDG	LANDING
LEV	LEVEL
LF	LINEAR FEET
LFLG	LENGTH OR LONG
LT	LEFT OR LIGHT
LWL	LOW WATER LEVEL
LWR	LOWER
M	METER OR MALE PIPE THREAD
MAG	MAGNETIC
MAN	MANUAL
MACH	MACHINE
MAX	MAXIMUM
MCC	MOTOR CONTROL CENTER
MECH	MECHANICAL
MED	MEDIUM
MEMB	MEMBRANE
MFR	MANUFACTURER
MFR'D	MANUFACTURED
MGD	MILLION GALLONS PER DAY
MH	MANHOLE
MI	MALLABLE IRON
MICRON	1/1,000,000 METER
MIL	MILITARY, 1/1,000 INCH
MIN	MINUTE OR MINIMUM
MIR	MIRROR
MISC	MISCELLANEOUS
MO	MOTOR OPERATED OR MASONRY OPENING
MOD	MODEL
MOL	MAXIMUM OPERATING LEVEL
MS	MOP SINK
MTC	MECHANICAL-TYPE COUPLING
MTD	MOUNTED
MTG	MOUNTING
MTL	MATERIAL OR METAL
N	NORTH
NBS	NATIONAL BUREAU OF STANDARDS
NC	NORMALLY CLOSED
NEC	NATIONAL ELECTRICAL CODE
NEMA	NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
NSPA	NATIONAL FIRE PROTECTION ASSOCIATION
NF	NEAR FACE
NG	NATURAL GAS OR NATURAL GRADE
NIC	NOT IN CONTRACT
NO	NORMALLY OPEN OR NUMBER
NOM	NOMINAL
NPS	NOMINAL PIPE SIZE (FORMELY I.P.S.)
NPT	NATIONAL PIPE THREAD
NRS	NON-RISING STEM
NS	NEAR SIDE
NTS	NOT TO SCALE
OC	OVER-CROSSING OR ON CENTER
OD	OUTSIDE DIAMETER OR OVERALL DIMENSION
OF	OVERFLOW OR OUTSIDE FACE
OFF	OFFICE
OH	OVER HEAD
OPER	OPERATOR OR OPERATING
OPNG	OPENING
OS & Y	OUTSIDE SCREW AND YOKE
OWG	OIL, WATER, GAS
OZ	ONCE
P/S	POLE AND SHELF
P	POLE, PAGE OR PIPE
PART	PARTITION
PVMT	PAVEMENT
PB	POLYBUTYLENE
PC	PRIIMARY CLARIFIER OR PORTLAND CEMENT
PCC	PORTLAND CEMENT CONCRETE
PCTOG	PRESSURE CLEANOUT TO GRADE
PE	PLANT EFFELENT, POLYELECTROLYTE POLYMER OR POLYETHYLENE
PG	PRESSURE GAGE OR GAUGE
pH	HYDROGEN IRON CONCENTRATION
PI	PLANT INFLUENT OR POINT OF INTERSECTION
PL	PLATE, PROPERTY LINE OR PLACE
PLAS	PLASTER OR PLASTIC
PLYWD	PLYWOOD
PNEU	PNEUMATIC
PNL	PANEL
PM	PRESSED METAL
PP	POWER POLE OR POLYPROPYLENE
PLT	PLANT
PPD	POUNDS PER DAY
PPH	POUNDS PER HOUR
PPM	POUNDS PER MINUTE
PR	PAIR
PRCT	PRECAST
PREFAB	PREFABRICATED
PRESS	PRESSURE
PRS	PRESSURE REGULATING OR REDUCING STATION
PRV	PRESSURE REGULATING, RELIEF OR REDUCING VALVE
PS	PRESSURE SWITCH
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
PSIA	POUNDS PER SQUARE INCH ABSOLUTE
PSIG	POUNDS PER SQUARE INCH GAGE
PT	PAINT, POINT
PTDF	PRESSURE TREATED DOUGLAS FIR
PTFE	POLYETRAFLUOROETHYLENE (*TEFLON)
PV	PLUG VALVE
PVC	POLYVINYL CHLORIDE
PVDF	POLYVINYLIDENE FLORIDE (*KYNAR)
QT	QUARY TILE
QTY	QUANTITY
R	RADIUS, RISER, RETURN OR RATE OF SLOPE
RAG	RETURN AIR GRILLE
RC	REINFORCED CONCRETE
RCP	REINFORCED CONCRETE PIPE
RD	ROOF DRAIN, ROUND OR ROAD
RDWD	REDWOOD
RECIRC	RECIRCULATED
RED	REDUCER OR REDUCING
REF	REFERENCE OR REFER
REG	REGULATING
REIN	REINFORCE OR REINFORCED
RE-STL	REINFORCING STEEL
REQD	REQUIRED
RESIL	RESILIENT
REV	REVISION
RFG	ROOFING
RF	ROOF OR RAISED FACE
RO	ROUGH OPENING
RPM	REVOLUTIONS PER MINUTE
RR	RAILROAD
RS	RISING STEM
RT	RIGHT
RTP	REINFORCED THERMOSTATIC PLASTIC
R/W	RIGHT OF WAY
RW	REDWOOD, RECYCLED WATER
RWGV	RESILIENT WEDGE GATE VALVE
RWL	RAINWATER LEADER
S	SOUTH, SCUM, SINK, SECOND OR SLOPE
SA	SAMPLE
SBR	STYRENE BUTADENE (RUBBER)
SC	SPARE CHEMICAL OR SECONDARY EFFLUENT
SCD	SCREWED
SCFM	STANDARD CUBIC FEET PER MINUTE
SCH	SCHEDULE
SDR	STORM DRAINS
SEC	SECONDARY
SECT	SECTION
SER	SERIES
SETT	SETTLING
SHT	SHEET OR SHELF
SHTG	SHEATHING
SIM	SIMILAR
SL	SLOPE, OR SLUDGE
SOLN	SOLENOID OR SOLUTION
SLDG	SLIDING
SP	STATIC PRESSURE
SPECS	SPECIFICATIONS
SPECF	SPECIFIED
SQ	SQUARE
SS	SANITARY SEWER OR SERVICE SINK
SSU	SECONDS SAYBOLT UNIVERSAL
STA	STATION
STC	SLEEVE-TYPE COUPLING
STD	STANDARD
STL	STEEL
STM	STEAM
SST	STAINLESS STEEL
STRUCT	STRUCTURAL OR STRUCTURE
SUCT	SUCTION
SV	SOLENOID VALVE
SWBD	SWITCHBOARD
SWR	SIDEWALL REGISTER, SEWER
SYM	SYMETRICAL OR SYMBOL
SYS	SYSTEM
T	THERMOSTAT, TREAD OF STAIR, TANGENT OR TOP
TB	TACK AND BOTTOM
T & B	TOP AND BOTTOM
TBE	THREAD BOTH ENDS
TBM	TEMPORARY BENCH MARK
TC	TOP OF CURB
TEL	TELEPHONE
TEMP	TEMPORARY, TEMPERATURE
T & G	TONGUE AND GROOVE
THK	THICK OR THICKNESS
THR	THRESHOLD
THR'D	THREADED
TOE	THREAD ON END
TP	TELEPHONE POLE OR TELEGRAPH POLE
TRANS	TRANSITION OR TRANSMITTER
TSB	TOP SET BASE
TV	THERMOSTATIC VALVE OR TELEVISION
TW	TOP OF WALL OR THERMOMETER WELL
TYP	TYPICAL
UC	UNDER-CROSSING
UG	UNDERGROUND
UGC	UNDERGROUND CONDUIT
UH	UNIT HEATER
V	VACUUM, VALVE, VERTICAL, VENT, VOLT OR VOLUME
VAR	VARIABLE OR VARIES
VCP	VITRIFIED CLAY PIPE
VERT	VERTICAL
VOL	VOLUME
VTC	VENT TO CEILING
VTR	VENT TO ROOF
VWC	VINYL WALL COVERING
W	WEST OR WASTE
W/	WITH
WC	WATER COLUMN OR WATER CLOSET
WCO	WALL CLEAN OUT
WH	WATER HEATER
WI	WROUGHT IRON
W/O	WITHOUT
WOG	WATER, OIL OR GAS WORKING PRESSURE
WP	WATER PROOFING
WS	WATER SURFACE
WSTP	WATER STOP
WT	WEIGHT
WTP	WATER TREATMENT PLANT
WTR	WATER
WWF	WELDED WIRE FABRIC
WWM	WELDED WIRE MESH
WWP	WATER WORKING PRESSURE
WWW	WASTE WASH WATER
XS	EXTRA STRONG
XXS	DOUBLE EXTRA STRONG
YD	YARD
YR	YEAR
Z	ZERO OR ZONE
ZN	ZINC

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE NTS
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY TS
DRAWN BY TS
CHECKED BY RK

Infrastructure
ENGINEERING CORPORATION
14271 Danielson Street
Poway, California 92064
T 858.413.2400 F 858.413.2440
www.iecorporation.com

DATE

Fallbrook Public Utility District
990 E. MISSION RD
FALLBROOK, CA 92028

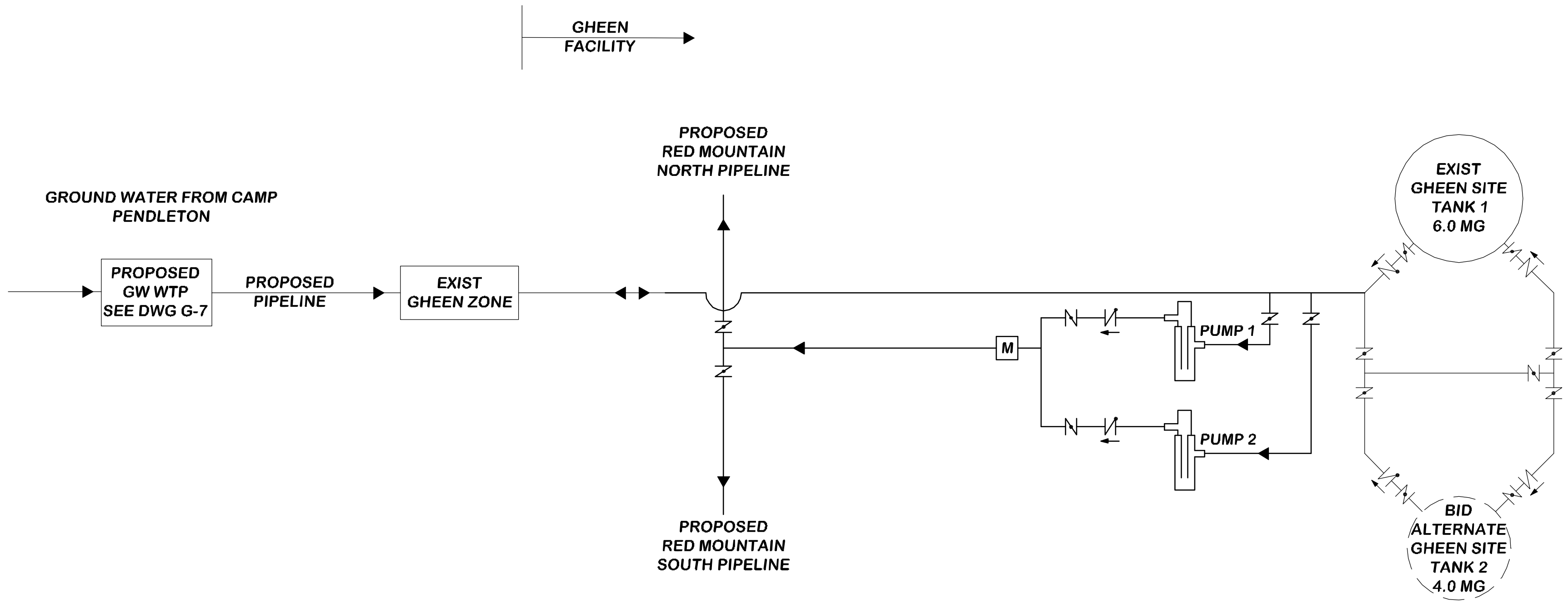
APPROVED BY:
JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

ABBREVIATIONS

DRAWING NO. G-5
SHEET NO. X OF XX
CLIENT JOB NO. 2744

P:\Projects\FPUD (0112)\0002 St Marg Conjunctive Use Project\CADD\G-05-NT.dwg 10/30/2015 10:14



LEGEND

	BUTTERFLY VALVE
	CHECK VALVE
	GATE VALVE
	FLOW DIRECTION
M	FLOW METER
	VERTICAL TURBINE PUMP
	PRESSURE REDUCING VALVE
WTP	WATER TREATMENT PLANT

OPTIONS

PUMP FROM GHEEN ZONE (EITHER TANK OR BOTH) TO RED MOUNTAIN:

* NORTH ONLY (ONE OR BOTH PUMPS)
* SOUTH ONLY (ONE OR BOTH PUMPS)
* BOTH NORTH AND SOUTH (ONE OR BOTH PUMPS)
* EMPTY ONE OR BOTH TANKS

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE NTS
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY AW
DRAWN BY AW
CHECKED BY RK

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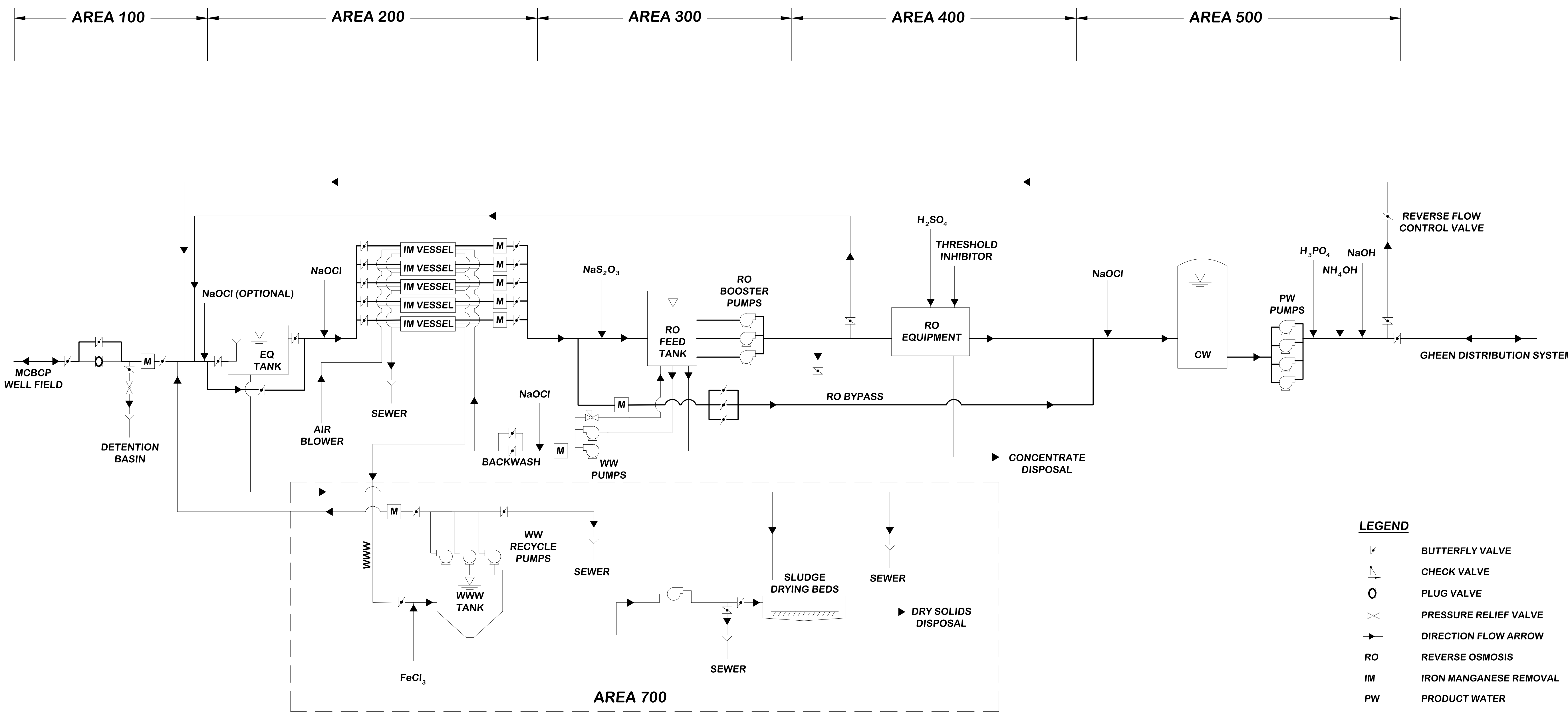
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

OVERALL FLOW DIAGRAM

DRAWING NO. G-6
SHEET NO. X OF XX
CLIENT JOB NO. 2744



LEGEND

	BUTTERFLY VALVE
	CHECK VALVE
	PLUG VALVE
	PRESSURE RELIEF VALVE
	DIRECTION FLOW ARROW
RO	REVERSE OSMOSIS
IM	IRON MANGANESE REMOVAL
PW	PRODUCT WATER
CW	CLEARWELL
WW	WASHWATER
WWW	WASTE WASHWATER
FTW	FILTER TO WASTE
MCBCP	MARINE CORP BASE CAMP PENDLETON

FOR AREA 600 - CHEMICAL FACILITIES SEE 600 M-1

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE NTS
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RK
DRAWN BY TS
CHECKED BY RM

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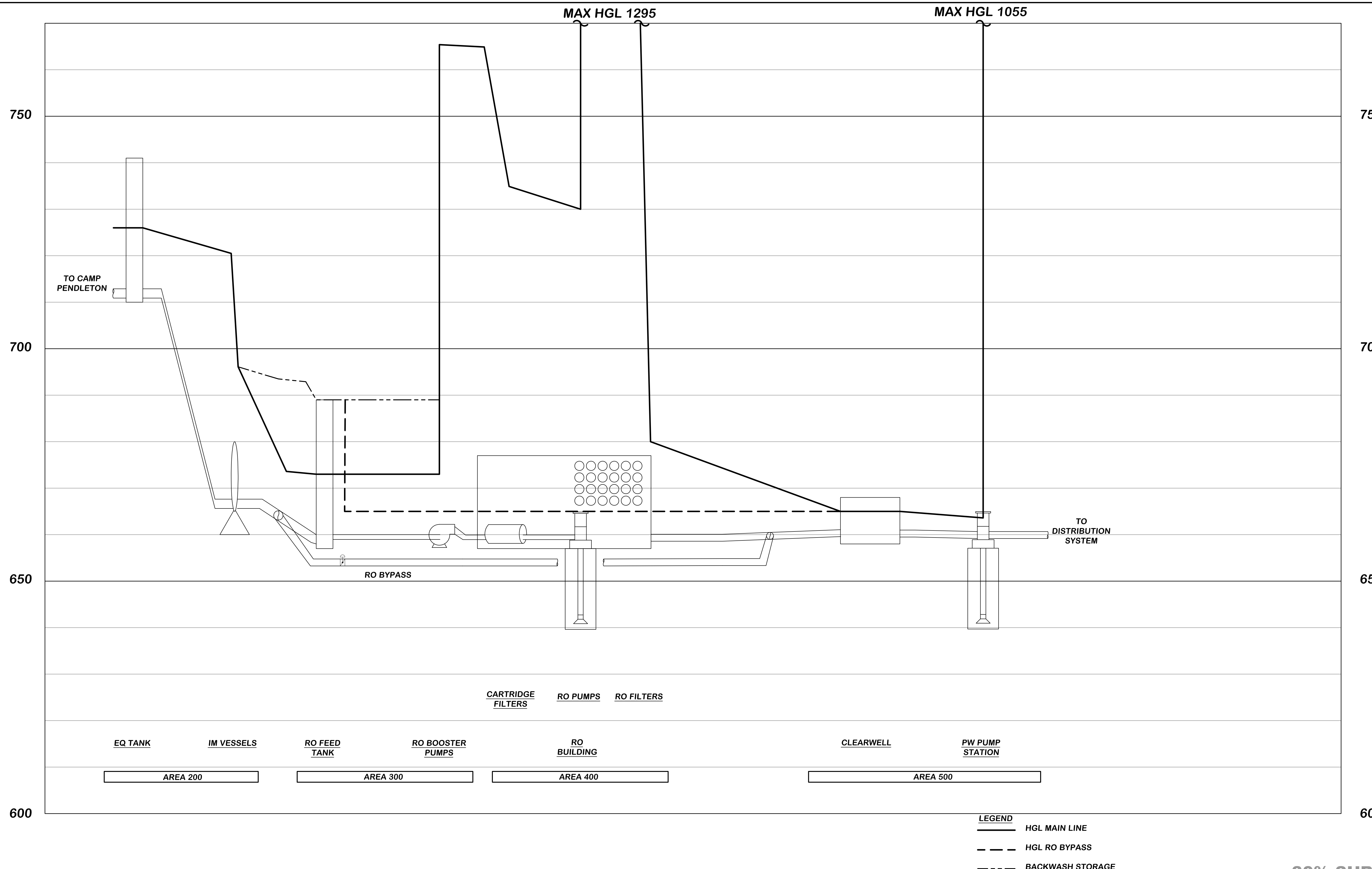
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

PLANT PROCESS FLOW DIAGRAM

DRAWING NO. G-7
SHEET NO. X OF XX
CLIENT JOB NO. 2744



30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE NTS
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RM
DRAWN BY RM
CHECKED BY RK

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DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

PLANT HYDRAULIC PROFILE

DRAWING NO. G-8
SHEET NO. X OF XX
CLIENT JOB NO. 2744

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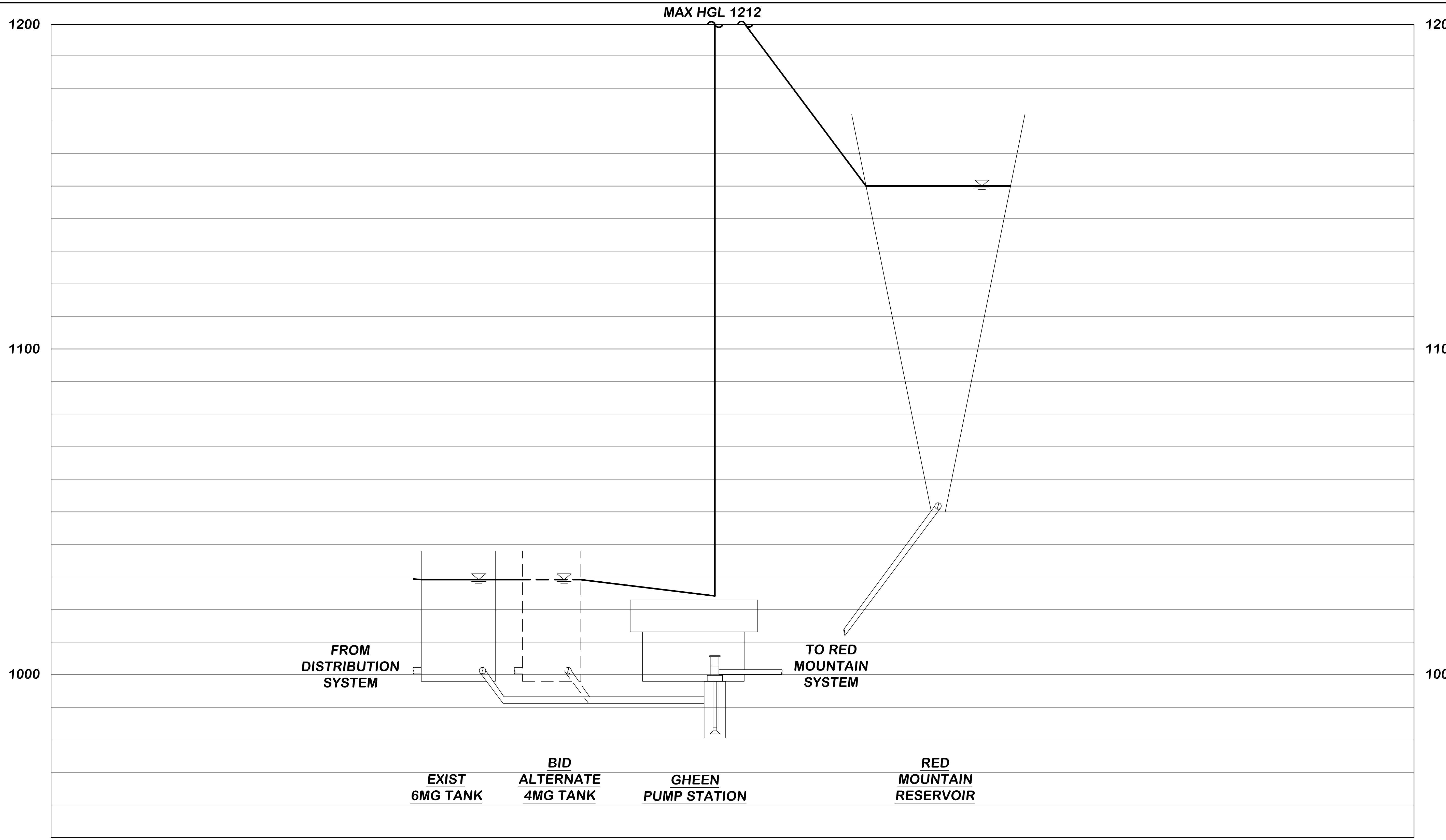

LEGEND

HGL MAIN LINE

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE NTS
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY AW
DRAWN BY AW
CHECKED BY RK

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SANTA MARGARITA CONJUNCTIVE USE
PROJECT FACILITIES

GHEEN HYDRAULIC PROFILE

DRAWING NO. G-9
SHEET NO. X OF XX
CLIENT JOB NO. 2744

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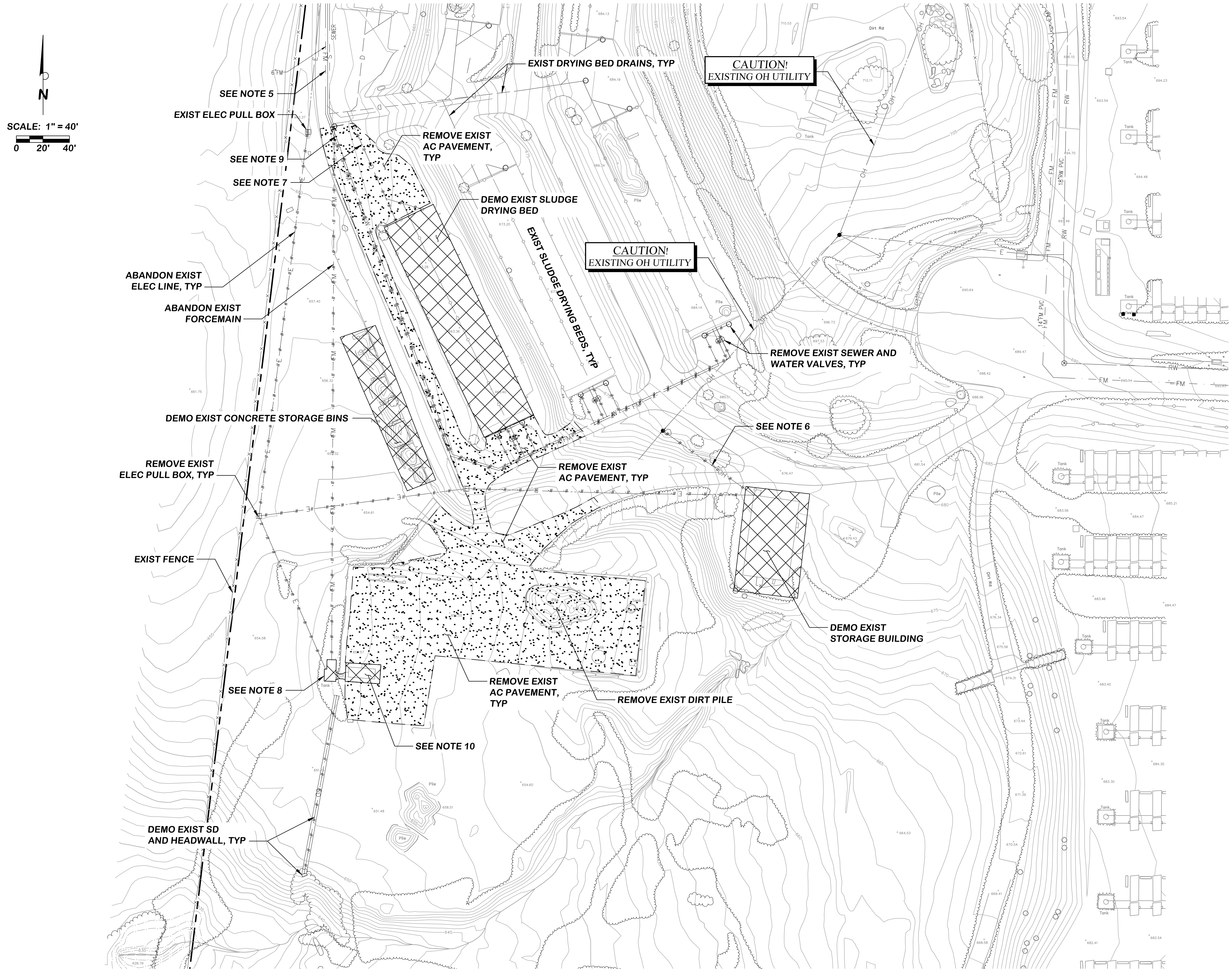

NOTES:

1. CONTRACTOR IS RESPONSIBLE FOR LEGAL DISPOSAL OF ALL ITEMS INDICATED FOR DEMO/REMOVAL OFF-SITE..
2. ALL IMPROVEMENTS NOT INDICATED FOR DEMO/REMOVAL SHALL BE PROTECTED IN PLACE.
3. LIMITS OF DEMOLITION AND ABANDONMENT OF EXISTING PIPE OR CONDUIT SHALL BE FIELD VERIFIED IN THE PRESENCE OF THE DISTRICT OR ITS REPRESENTATIVE PRIOR TO THE START OF WORK.
4. CONTRACTOR IS RESPONSIBLE TO VISIT SITE PRIOR TO BID FOR CURRENT SITE CONDITIONS.
5. ABANDON PORTION OF EXIST FORCEMAIN. SAWCUT AND INSTALL END CAP WITH CONCRETE THRUST BLOCK.
6. SDG&E TO REMOVE OVERHEAD SERVICE TO EXIST STORAGE BARN.
7. ABANDON PORTION OF EXIST DRAIN. SAWCUT AND INSTALL 12" CONCRETE PLUG.
8. DEMO EXIST WET WELL, PUMP STATION AND ALL APPURTENANCES.
9. ABANDON PORTION OF EXIST WATER PIPE. SAWCUT AND INSTALL END CAP WITH CONCRETE THRUST BLOCK.
10. DEMO EXIST CONCRETE PAD. RELOCATE WASTE CONTAINER WITH THE DISTRICT.

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE 1" = 40'
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RM
DRAWN BY SF
CHECKED BY DP

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APPROVED BY:

JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

WTP SITE DEMOLITION PLAN

DRAWING NO. D-1
SHEET NO. X OF XX
CLIENT JOB NO. 2744

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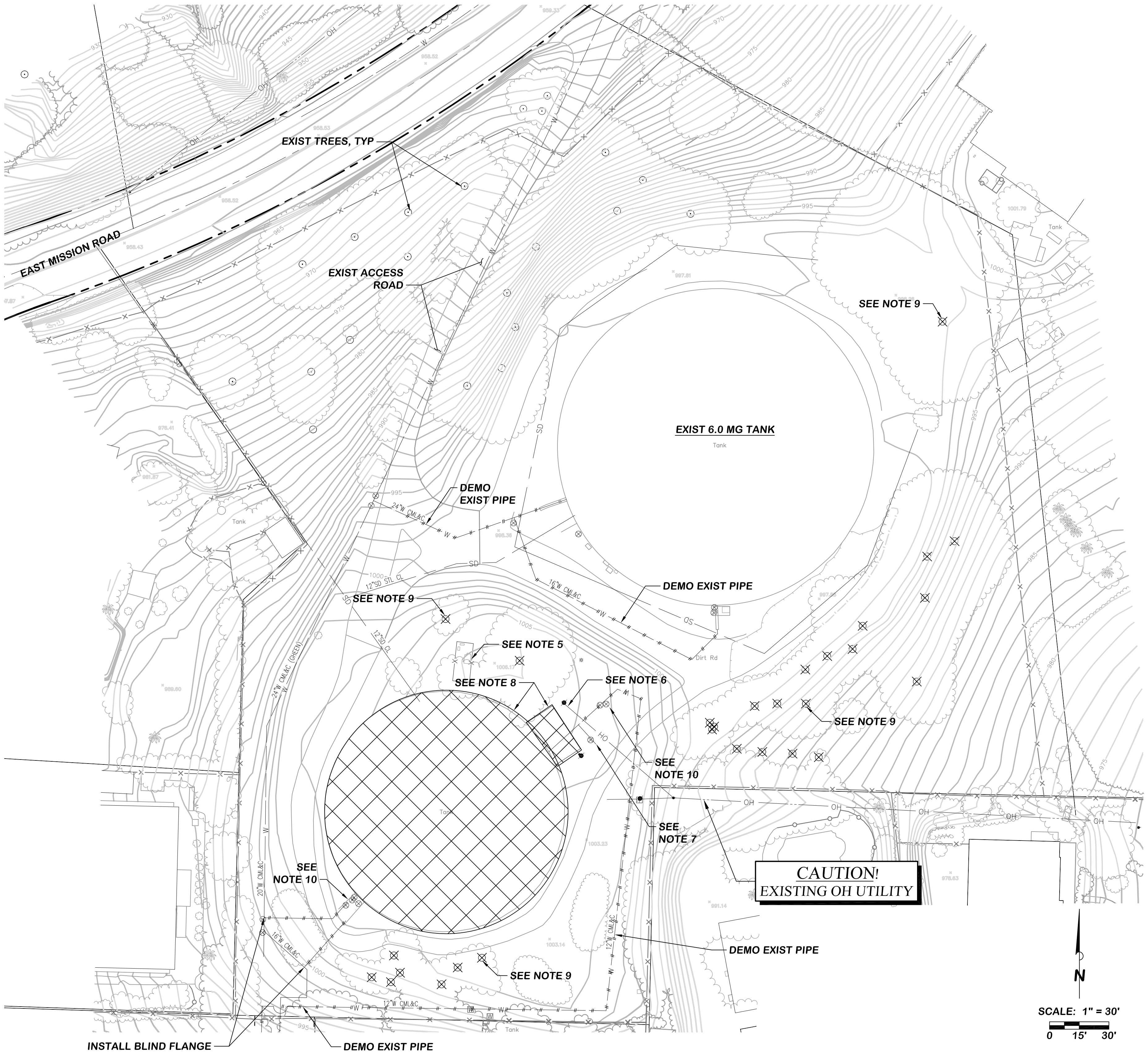

NOTES:

1. CONTRACTOR IS RESPONSIBLE FOR LEGAL DISPOSAL OF ALL ITEMS OFF-SITE.
2. ALL IMPROVEMENTS NOT INDICATED FOR DEMO/REMOVAL SHALL BE PROTECTED IN PLACE.
3. LIMITS OF DEMOLITION AND ABANDONMENTS OF EXISTING PIPE OR CONDUIT SHALL BE FIELD VERIFIED IN THE PRESENCE OF THE DISTRICT OR ITS REPRESENTATIVE PRIOR TO THE START OF WORK.
4. TREE REMOVALS SHOWN ON THIS SHEET ARE APPROXIMATE. CONTRACTOR SHALL FIELD VERIFY THE QUANTITY OF TREES REQUIRED FOR REMOVAL IN ORDER TO CONSTRUCT THE GHEEN SITE IMPROVEMENTS.
5. RELOCATE EXISTING TELECOMMUNICATIONS EQUIPMENT WITH THE DISTRICT AND THE EQUIPMENT OWNER.
6. COORDINATE DEMOLITION OF EXISTING RESERVOIR ELECTRICAL SERVICE WITH SDG&E.
7. RELOCATE EXISTING WHARF HEAD HYDRANT (IRRIGATION CONNECT) WITH THE DISTRICT.
8. DEMO EXISTING 1 MG MARTIN RESERVOIR AND ATTACHED STRUCTURE. CONTRACTOR TO NOTIFY THE AIR POLLUTION CONTROL DISTRICT PRIOR TO DEMOLITION. SEE SPECS.
9. REMOVE EXISTING TREE, TYP OF EACH MARKED WITH "╳"
10. DEMO EXISTING VALVES AND PIPE.

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE 1"=30'
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY ARW
DRAWN BY SJF
CHECKED BY DP

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990 E. MISSION RD
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APPROVED BY:

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ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

GHEEN SITE DEMOLITION PLAN

DRAWING NO. D-2
SHEET NO. X OF XX
CLIENT JOB NO. 2744

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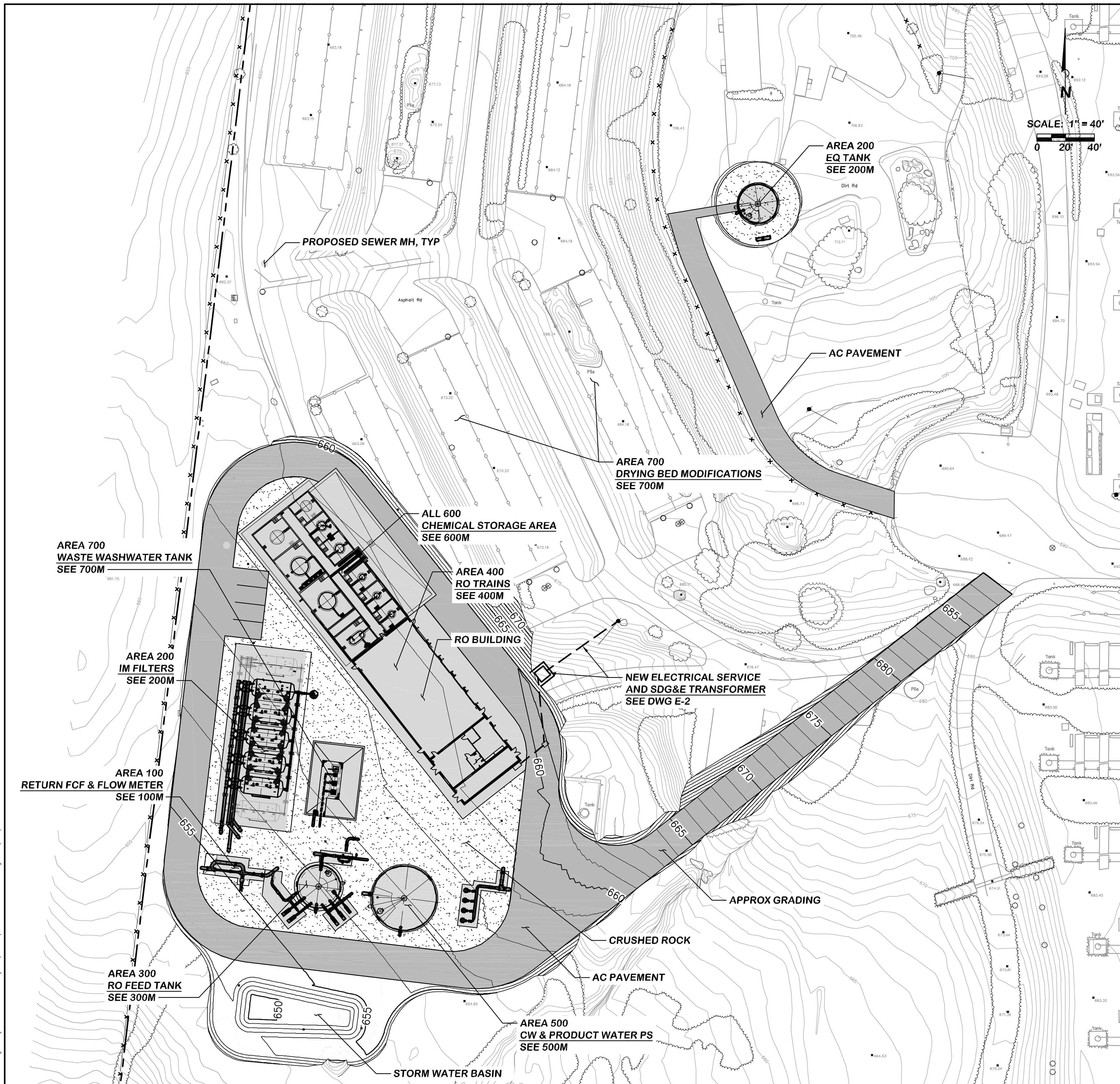

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE 1" = 40'
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RM
DRAWN BY RM
CHECKED BY RK

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FPUD Fallbrook Public Utility District
990 E. MISSION RD
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APPROVED BY:

JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

WTP SITE PLAN

DRAWING NO. C-1
SHEET NO. X OF XX
CLIENT JOB NO. 2744

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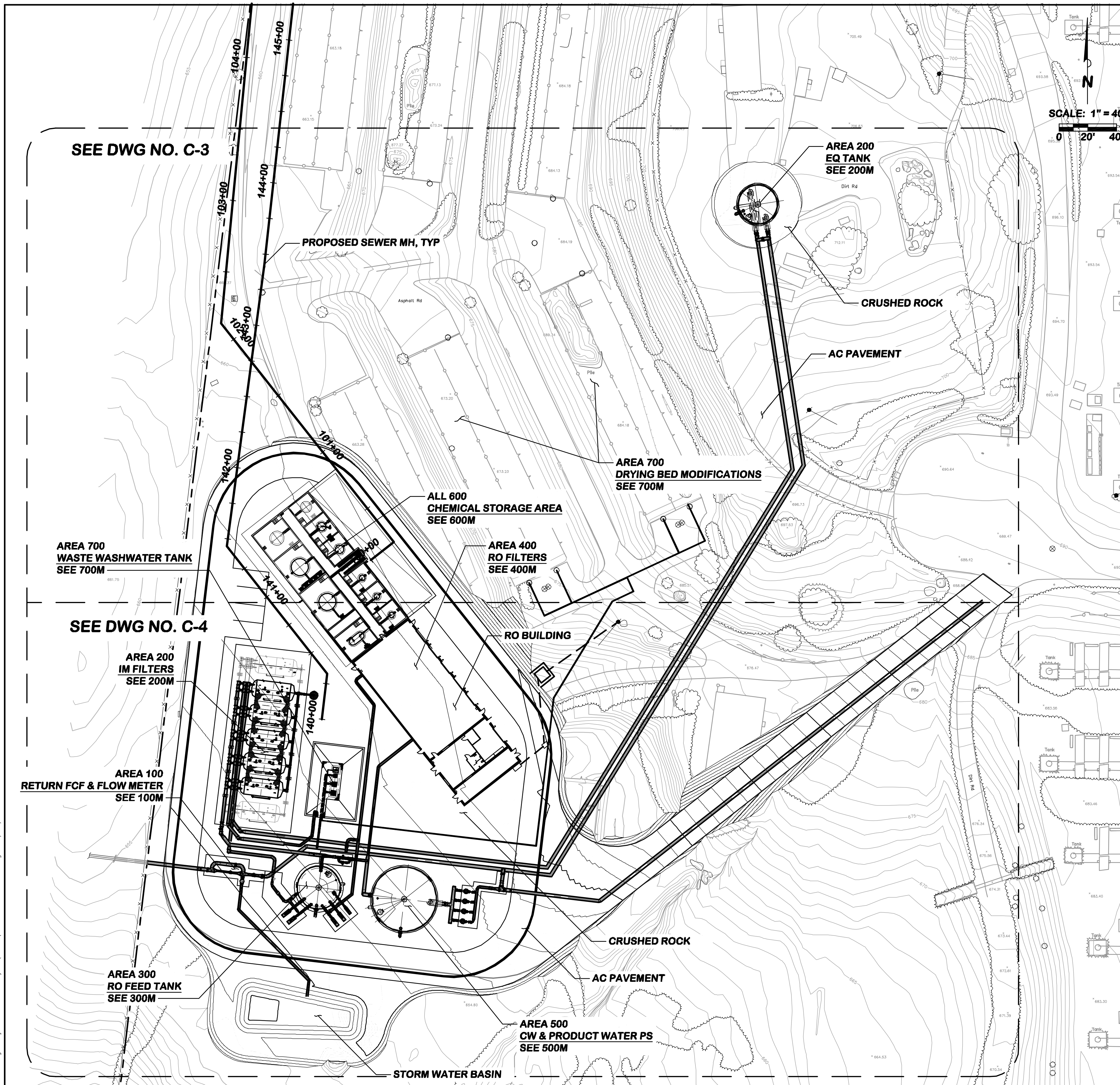

SEE DWG NO. C-3 & C-4 FOR YARD PIPING DETAILS

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE 1" = 40'
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RM
DRAWN BY RM
CHECKED BY RK

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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

WTP YARD PIPING PLAN (OVERALL)

DRAWING NO. C-2
SHEET NO. X OF XX
CLIENT JOB NO. 2744

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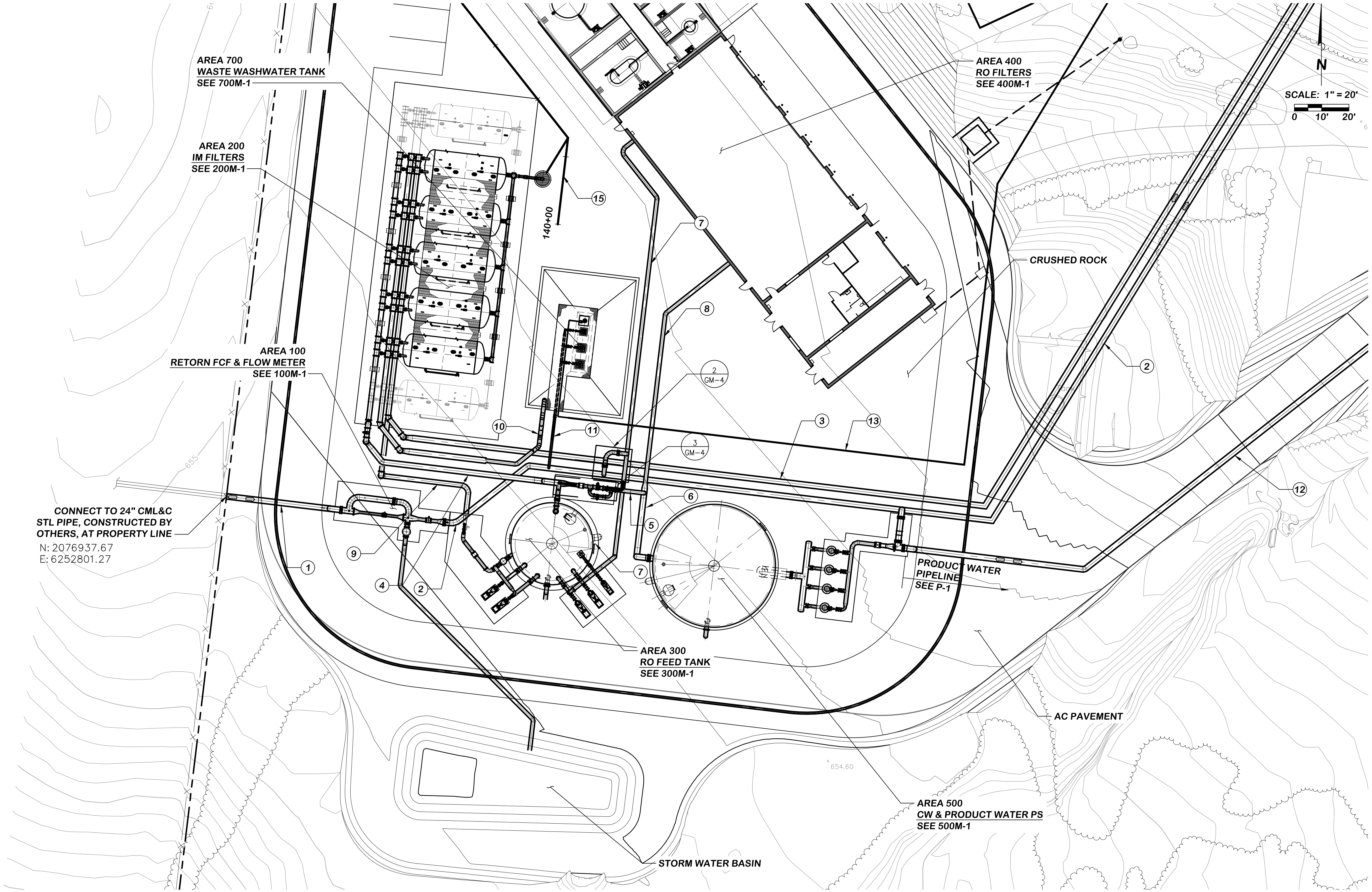

NUM	DESCRIPTION	PIPE SIZE	MATERIAL
1	CPAC SUPPLY	24"	CMC & C STL
2	IM SUPPLY	24"	CMC & C STL
3	IM SUPPLY	24"	CMC & C STL
4	IM TREATED	24"	CMC & C STL
5	RO BYPASS	16"	HDPE
6	RO BYPASS & PERMEATE	24"	HDPE
7	RO FEED	16"	CMC & C STL
8	RO PERMEATE	16"	HDPE
9	IM BACKWASH	16"	CMC & C STL
10	IM BACKWASH WASTE	16"	CMC & C STL
11	RECLAIMED BACKWASH WATER	8"	CMC & C STL
12	PRODUCT WATER	24"	CMC & C STL
13	SLUDGE	2"	PVC
14	BRINE	6"	PVC
15	SEWER	15"	PVC

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE 1" = 20'
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RM
DRAWN BY IH
CHECKED BY RK

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Fallbrook Public Utility District
990 E. MISSION RD
FALLBROOK, CA 92028

APPROVED BY:

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ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

WTP PIPING - ENLARGED PLAN 1

DRAWING NO. C-3
SHEET NO. X OF XX
CLIENT JOB NO. 2744

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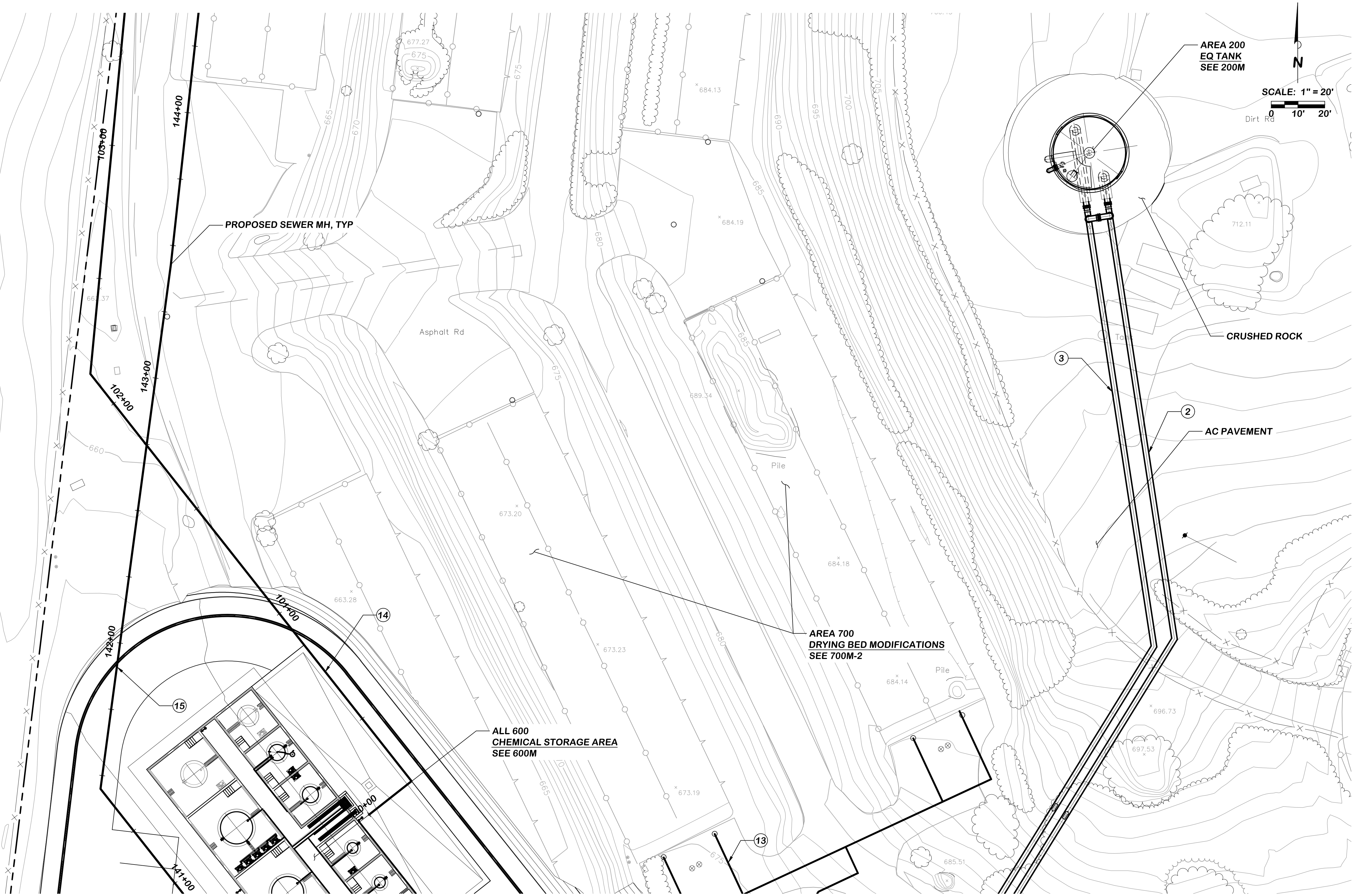

NUM	DESCRIPTION	PIPE SIZE	MATERIAL
1	CPAC SUPPLY	24"	CMC & C STL
2	IM SUPPLY	24"	CMC & C STL
3	IM SUPPLY	24"	CMC & C STL
4	IM TREATED	24"	CMC & C STL
5	RO BYPASS	16"	HDPE
6	RO BYPASS & PERMEATE	24"	HDPE
7	RO FEED	16"	CMC & C STL
8	RO PERMEATE	16"	HDPE
9	IM BACKWASH	16"	CMC & C STL
10	IM BACKWASH WASTE	16"	CMC & C STL
11	RECLAIMED BACKWASH WATER	8"	CMC & C STL
12	PRODUCT WATER	24"	CMC & C STL
13	SLUDGE	2"	PVC
14	BRINE	6"	PVC
15	SEWER	15"	PVC

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE 1" = 20'
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RM
DRAWN BY IH
CHECKED BY RK

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DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

WTP PIPING - ENLARGED PLAN 2

DRAWING NO. C-4
SHEET NO. X OF XX
CLIENT JOB NO. 2744

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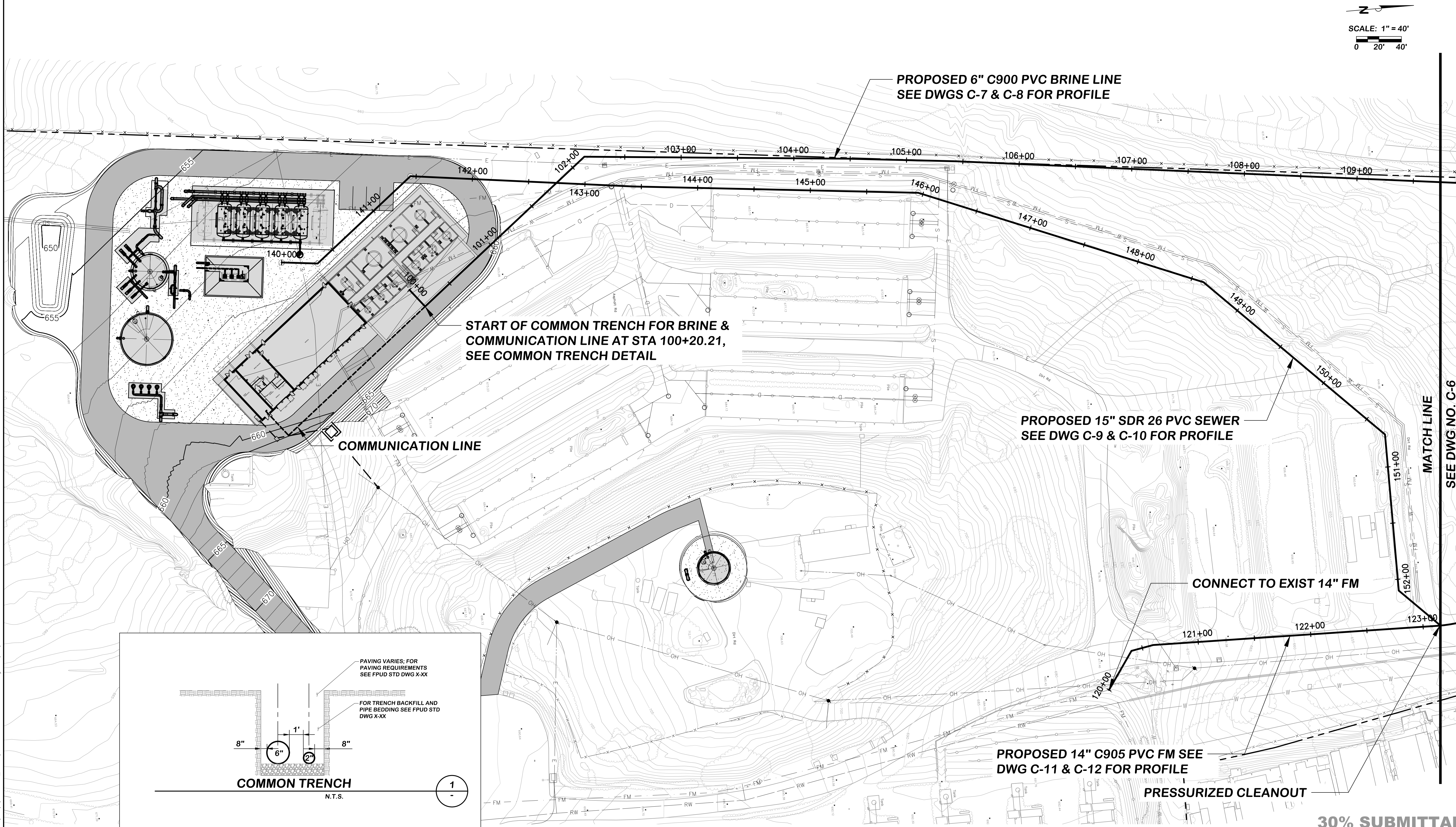

NO.	DESCRIPTION	DATE	APPROVED

SCALE 1"=80'
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RI/DP
DRAWN BY RI
CHECKED BY RK

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DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

COMMUNICATION, BRINE & SEWER PIPELINE TO WWTP-SOUTH

DRAWING NO. C-5
SHEET NO. X OF XX
CLIENT JOB NO. 2744

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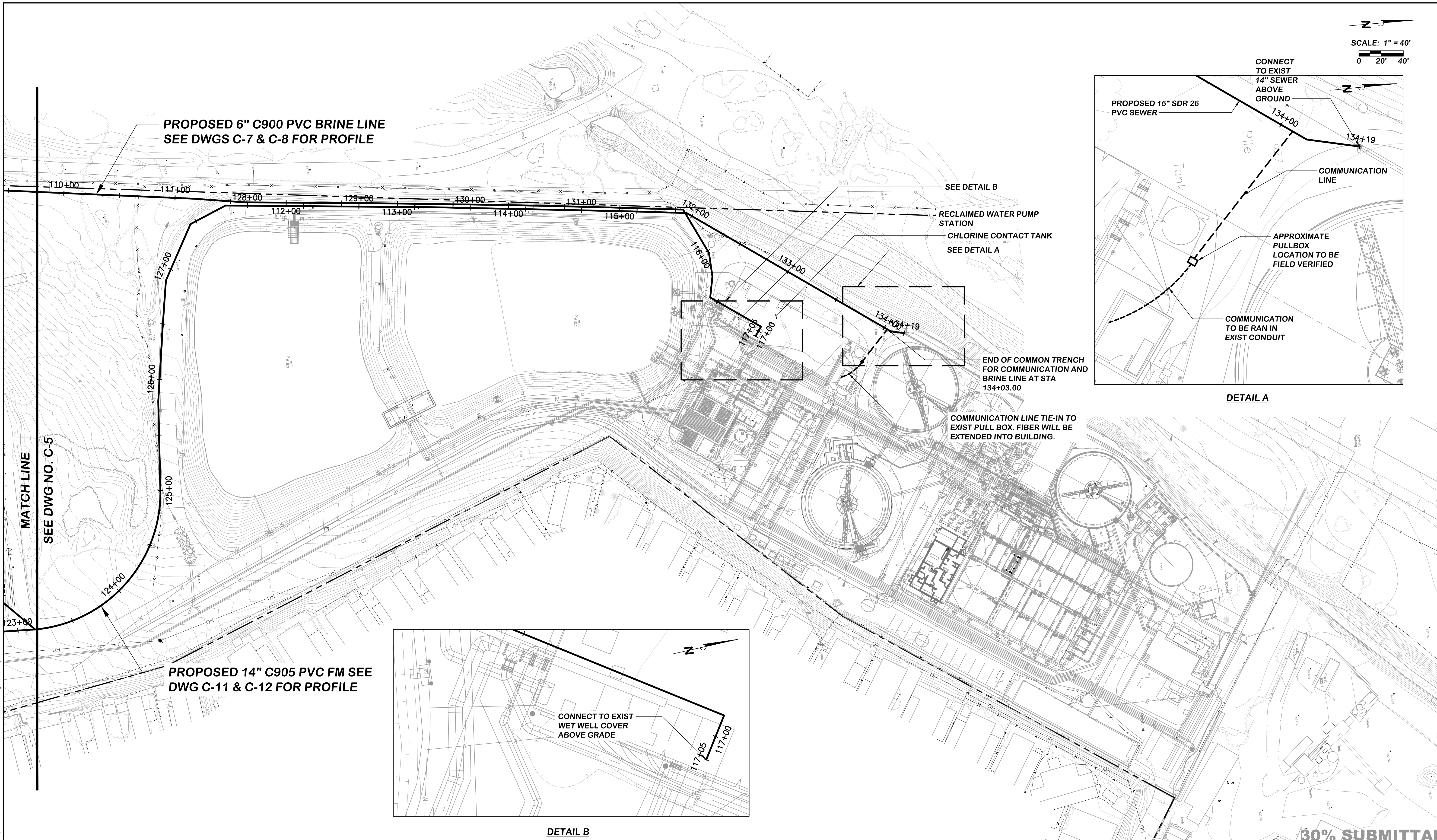

NO.	DESCRIPTION	DATE	APPROVED

SCALE 1"=80'
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RI/DP
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ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

COMMUNICATION, BRINE & SEWER PIPELINE TO WWTP-NORTH

DRAWING NO. C-6
SHEET NO. X OF XX
CLIENT JOB NO. 2744

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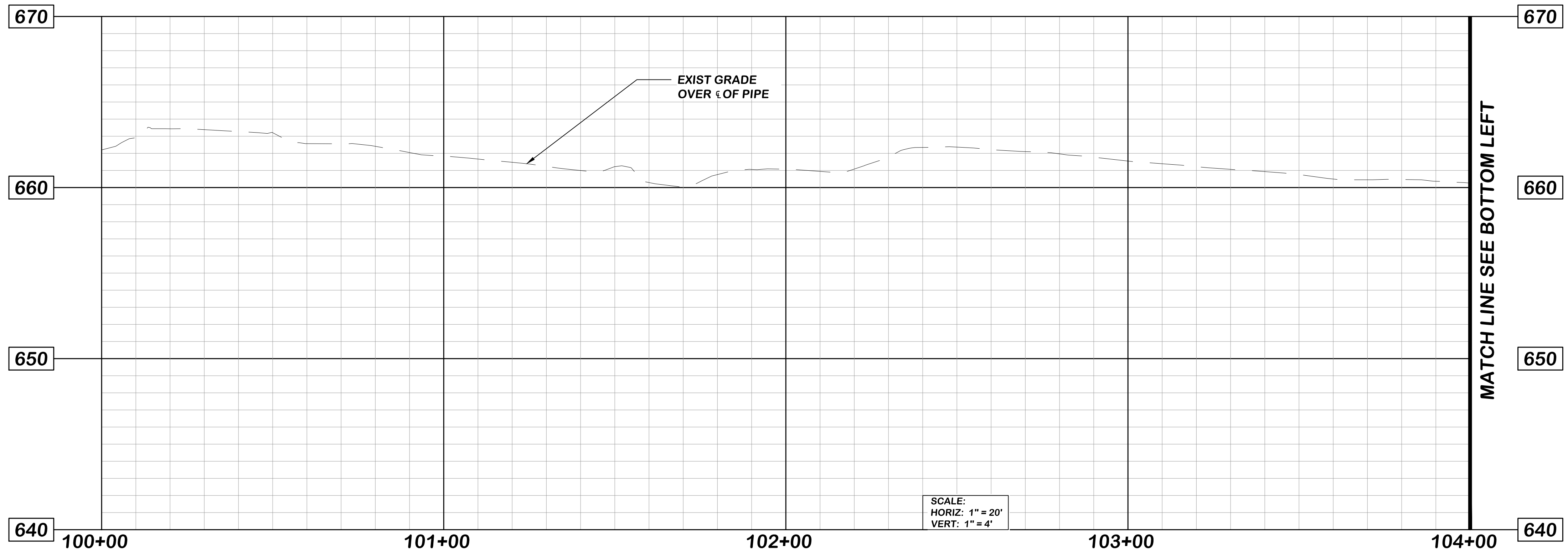

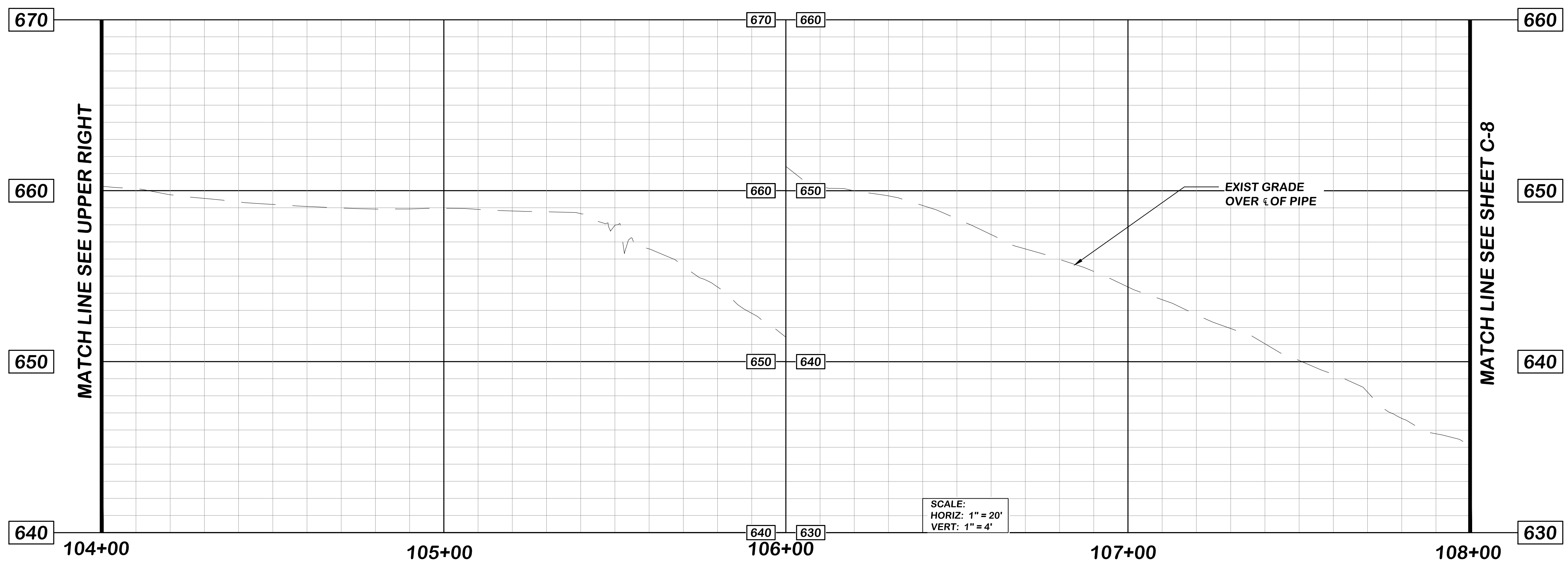

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE 1" = 20'
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RTI
DRAWN BY SJF
CHECKED BY DP

Infrastructure
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APPROVED BY:

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ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

BRINE LINE PROFILE
STA 100+00.00 TO STA 108+00.00

DRAWING NO. C-7
SHEET NO. X OF XX
CLIENT JOB NO. 2744

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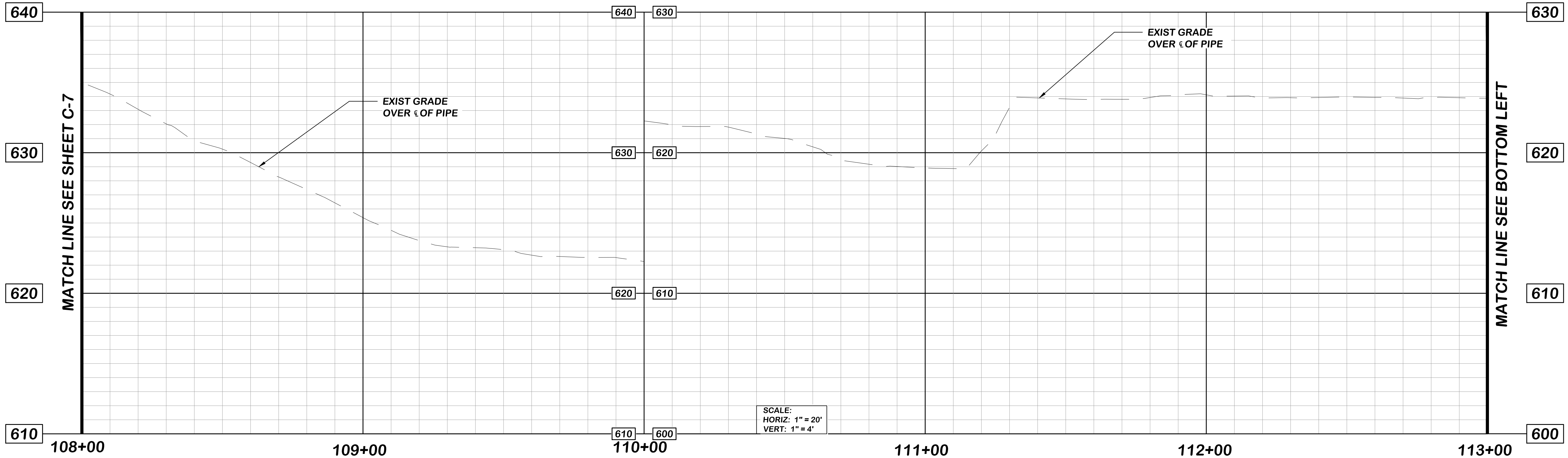

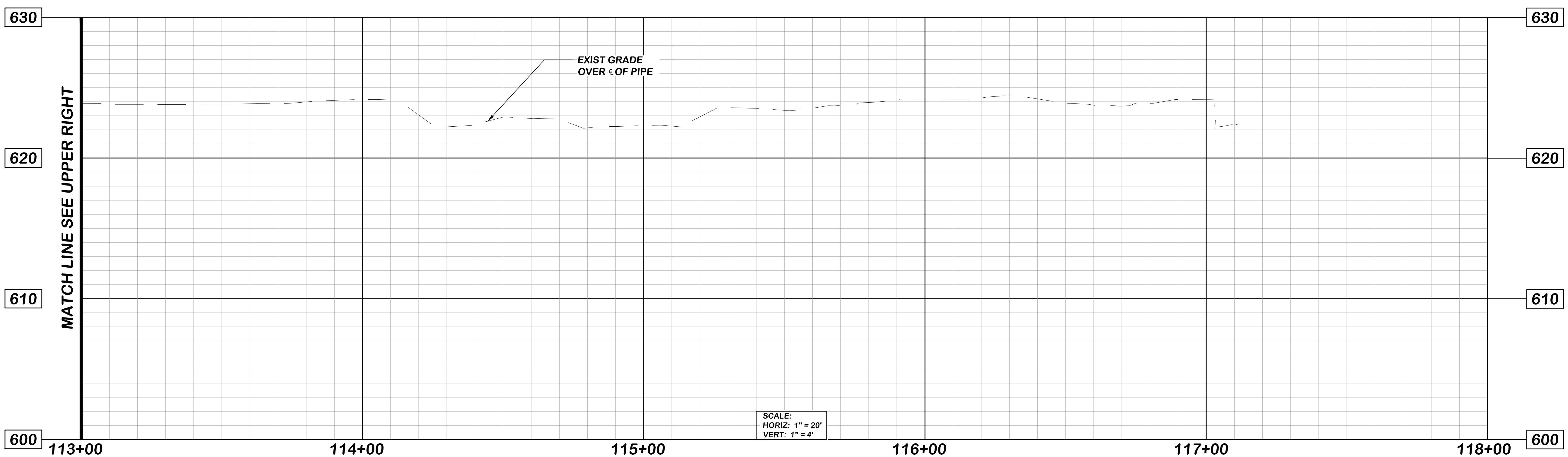

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

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APPROVED BY:

JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

BRINE LINE PROFILE
STA 108+00.00 TO STA 117+11.21

DRAWING NO. C-8
SHEET NO. X OF XX
CLIENT JOB NO. 2744

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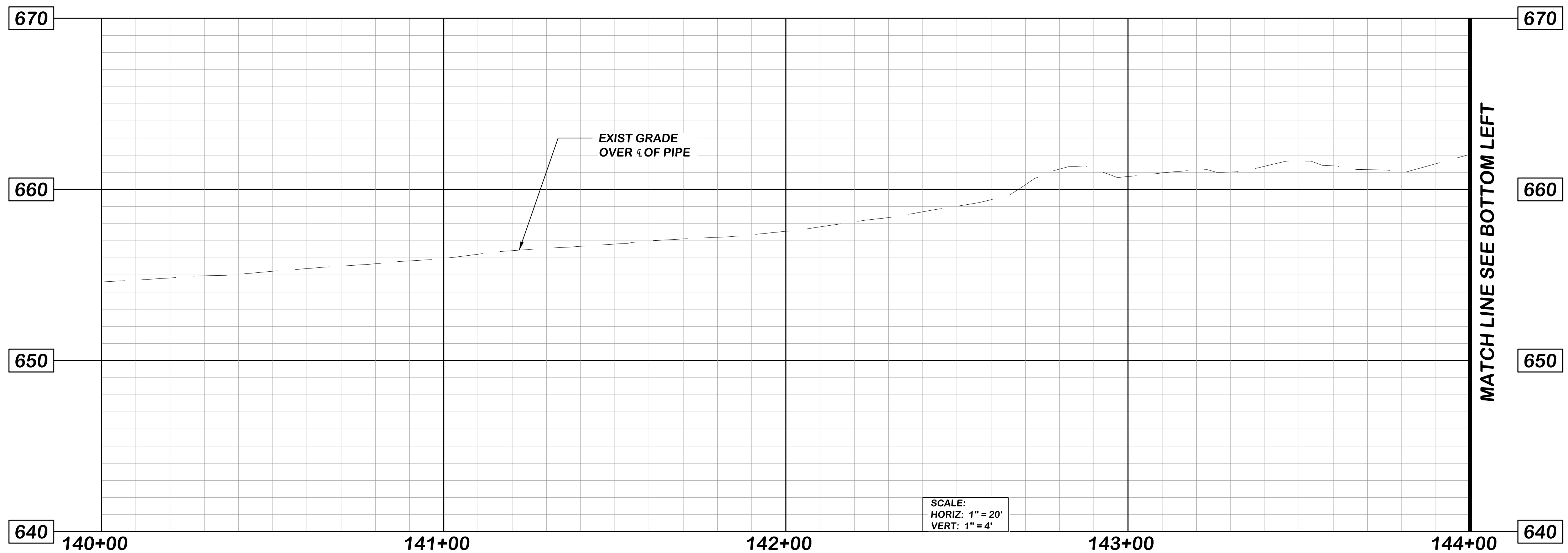

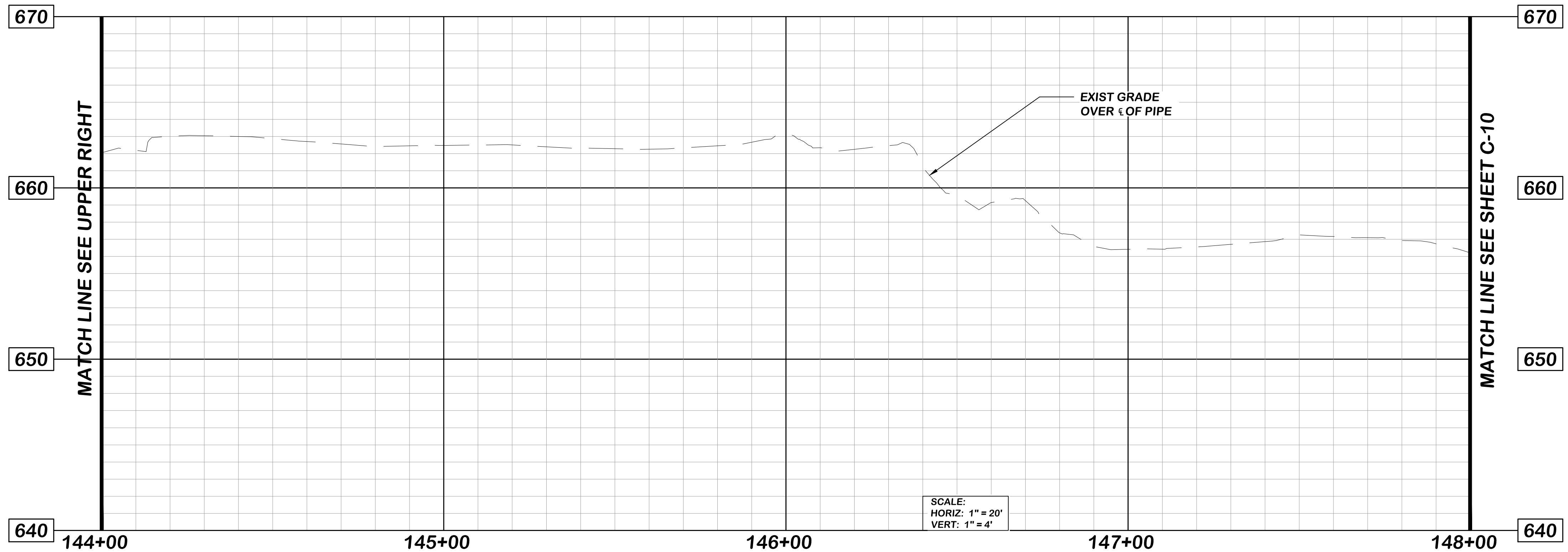

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE 1" = 20'
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RI
DRAWN BY SF
CHECKED BY DP

Infrastructure
ENGINEERING CORPORATION
14271 Danielson Street
Poway, California 92064
T 858.413.2400 F 858.413.2440
www.iecorporation.com

DATE

FPUD Fallbrook Public Utility District
990 E. MISSION RD
FALLBROOK, CA 92028

APPROVED BY:
JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

WTP SEWER PROFILES
STA 140+00.00 TO STA 148+00.00

DRAWING NO. C-9
SHEET NO. X OF XX
CLIENT JOB NO. 2744

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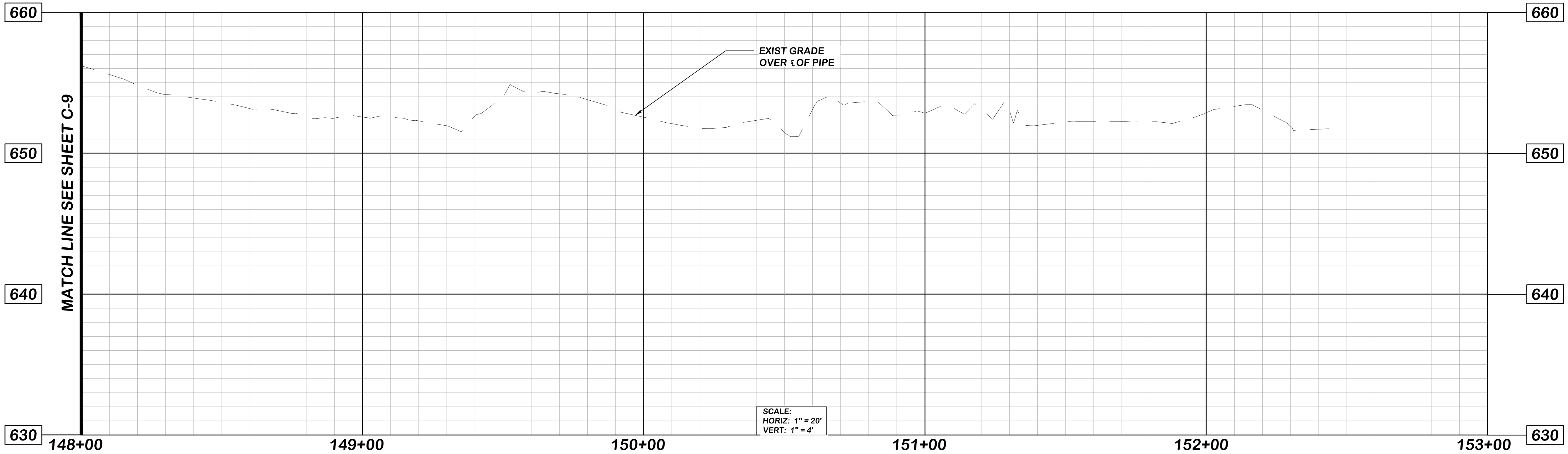

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NO.	DESCRIPTION	DATE	APPROVED

SCALE 1" = 20'
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RI
DRAWN BY SF
CHECKED BY DP

Infrastructure
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FPUD
Fallbrook Public Utility District

990 E. MISSION RD
FALLBROOK, CA 92028

APPROVED BY:

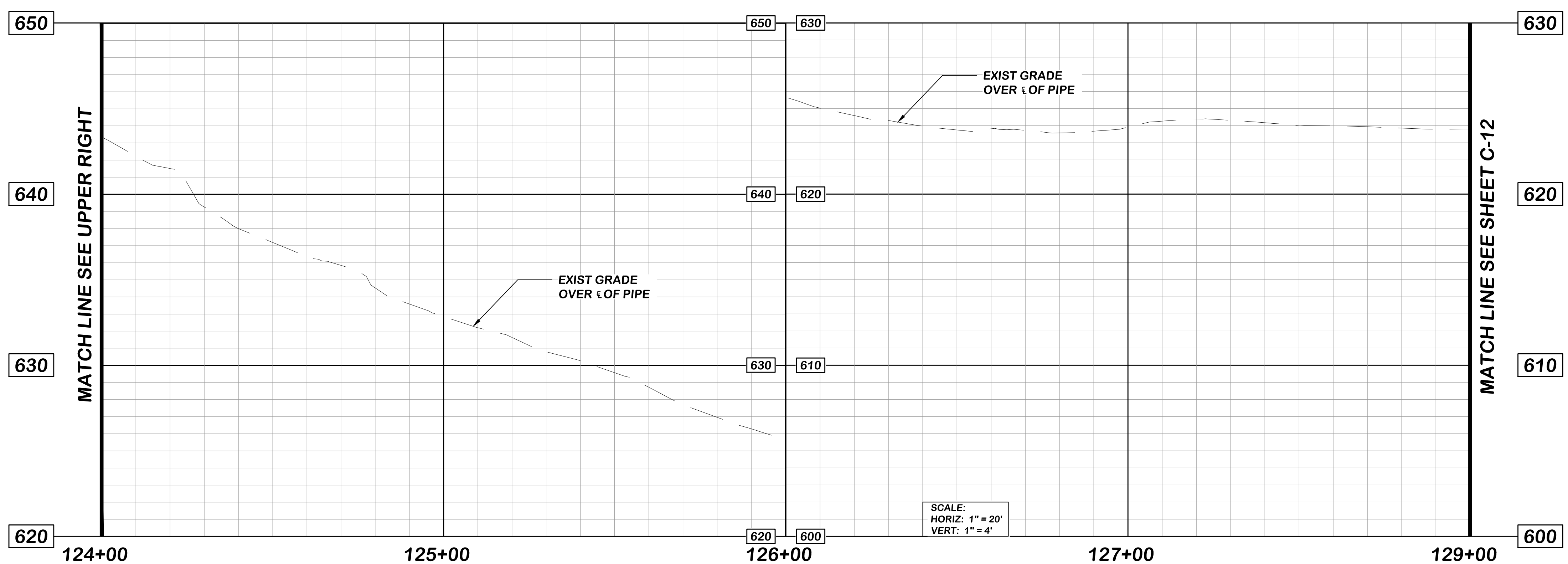
JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER

DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

WTP SEWER PROFILE
STA 148+00.00 TO STA 152+43.37

DRAWING NO. C-10
SHEET NO. X OF XX
CLIENT JOB NO. 2744



30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE 1" = 20'
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RI
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Fallbrook Public Utility District
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FALLBROOK, CA 92028

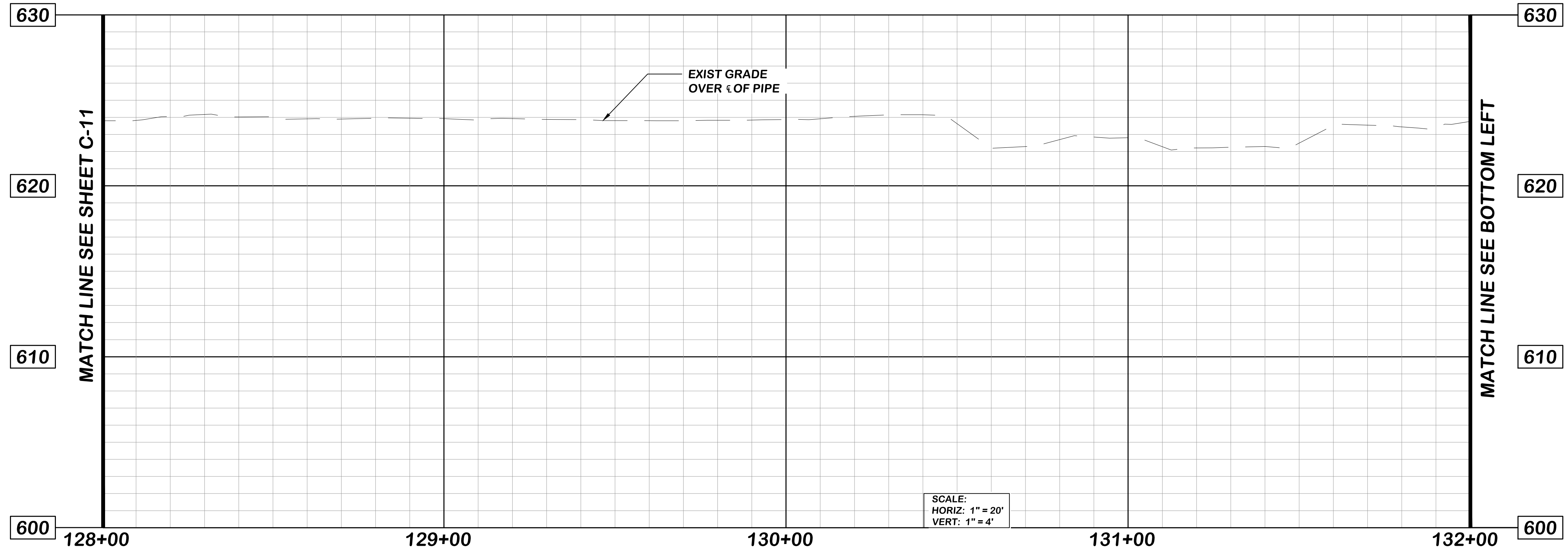
APPROVED BY:

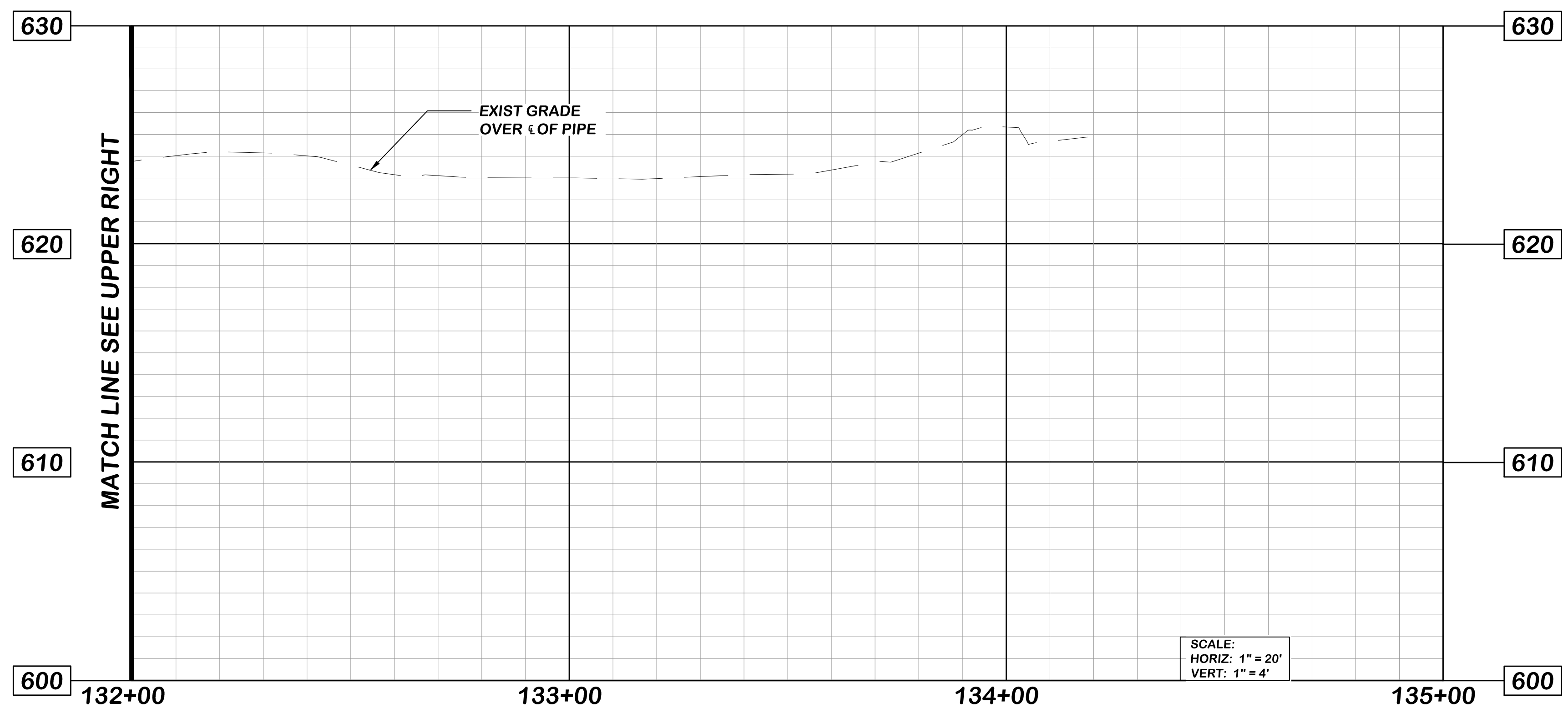
JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

WTP FM PROFILE
STA 120+00.00 TO STA 128+00.00

DRAWING NO. C-11
SHEET NO. X OF XX
CLIENT JOB NO. 2744





30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE 1" = 20'
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RI
DRAWN BY SF
CHECKED BY DP

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990 E. MISSION RD
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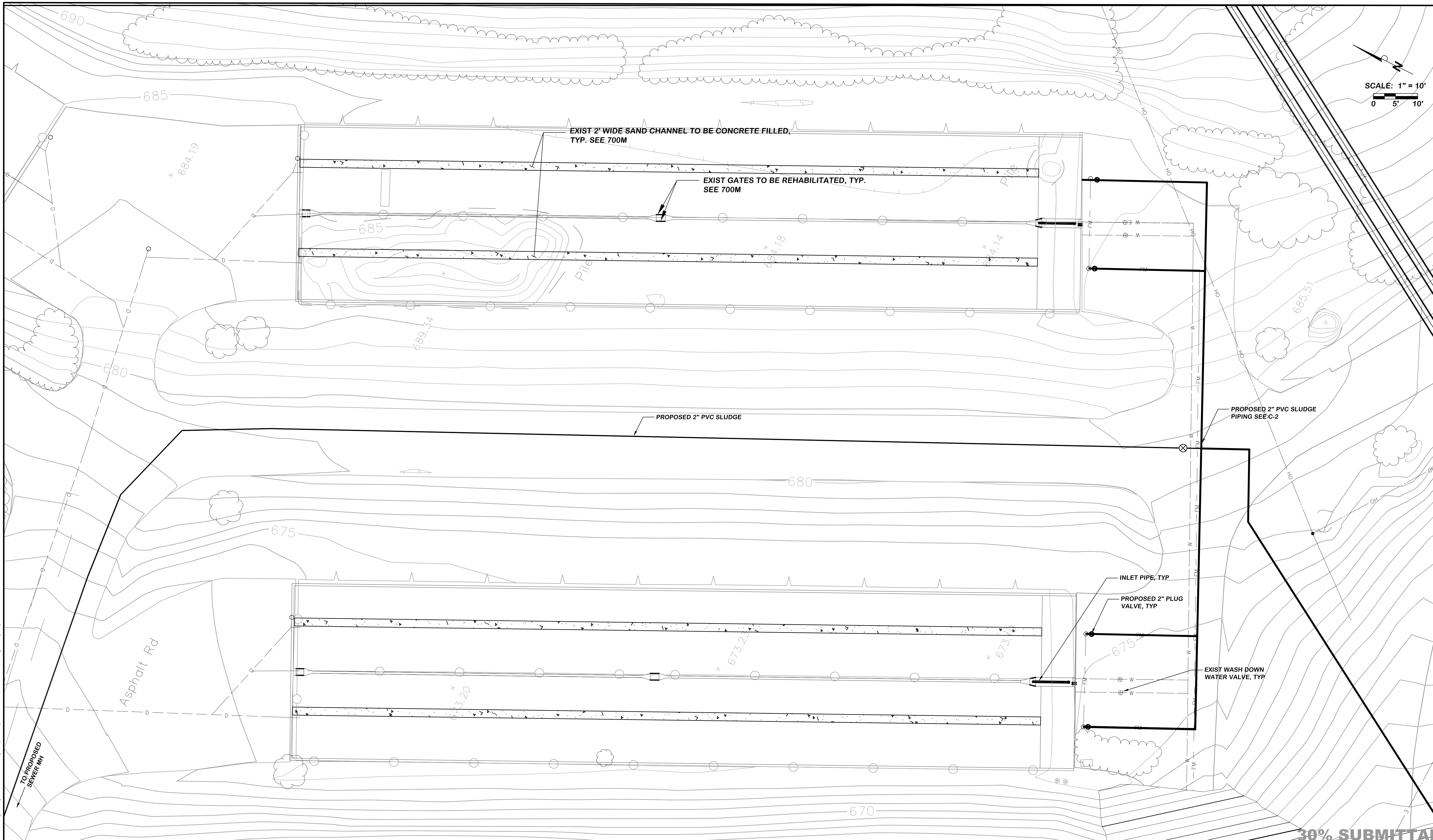
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

WTP FM PROFILE
STA 128+00.00 TO STA 134+24.10

DRAWING NO. C-12
SHEET NO. X OF XX
CLIENT JOB NO. 2744



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NO.	DESCRIPTION	DATE	APPROVED

SCALE 1" = 10'
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RM
DRAWN BY SF
CHECKED BY RK

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FPUD Fallbrook Public Utility District
990 E. MISSION RD
FALLBROOK, CA 92028

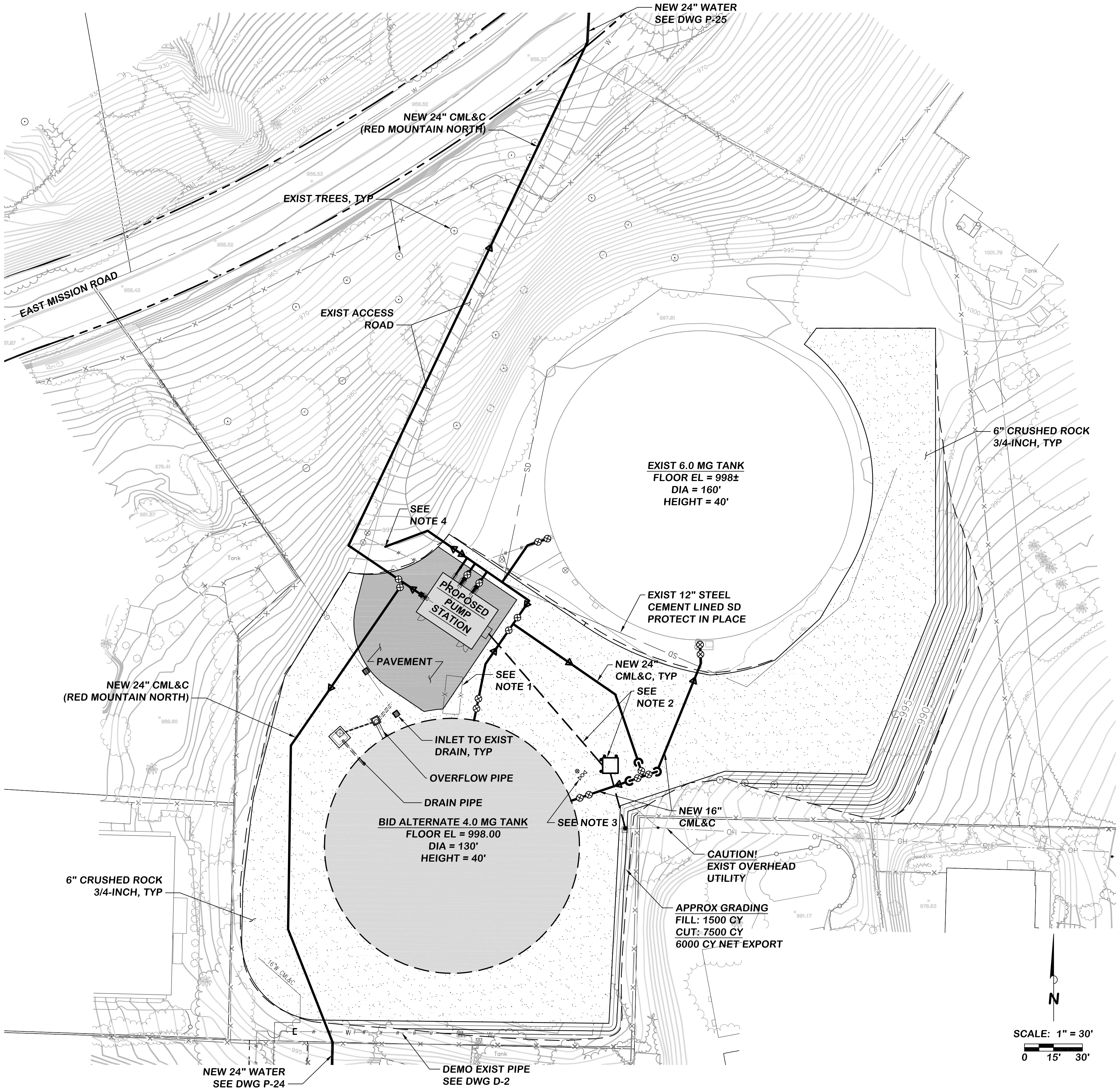
APPROVED BY:

JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

DRYING BED MODIFICATIONS

DRAWING NO. C-13
SHEET NO. X OF XX
CLIENT JOB NO. 2744



NOTES:

1. RELOCATE EXISTING TELECOMMUNICATIONS EQUIPMENT IN COORDINATION WITH THE DISTRICT AND EQUIPMENT OWNER.
2. INSTALL NEW ELECTRICAL SERVICE AND TRANSFORMER PER SDG&E WORK ORDER. SEE DWG GFE-1.
3. RELOCATE EXISTING WHARF HEAD HYDRANT (IRRIGATION CONNECT) WITH THE DISTRICT.
4. EXCAVATE AND CONNECT TO EXISTING 24" CML&C PIPE WITH NEW 45° BEND.

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE XXX
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY ARW
DRAWN BY ARW
CHECKED BY DP

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FPUD Fallbrook Public Utility District
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FALLBROOK, CA 92028
APPROVED BY:
JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

GHEEN FACILITY AND YARD PIPING PLAN

DRAWING NO. C-14
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

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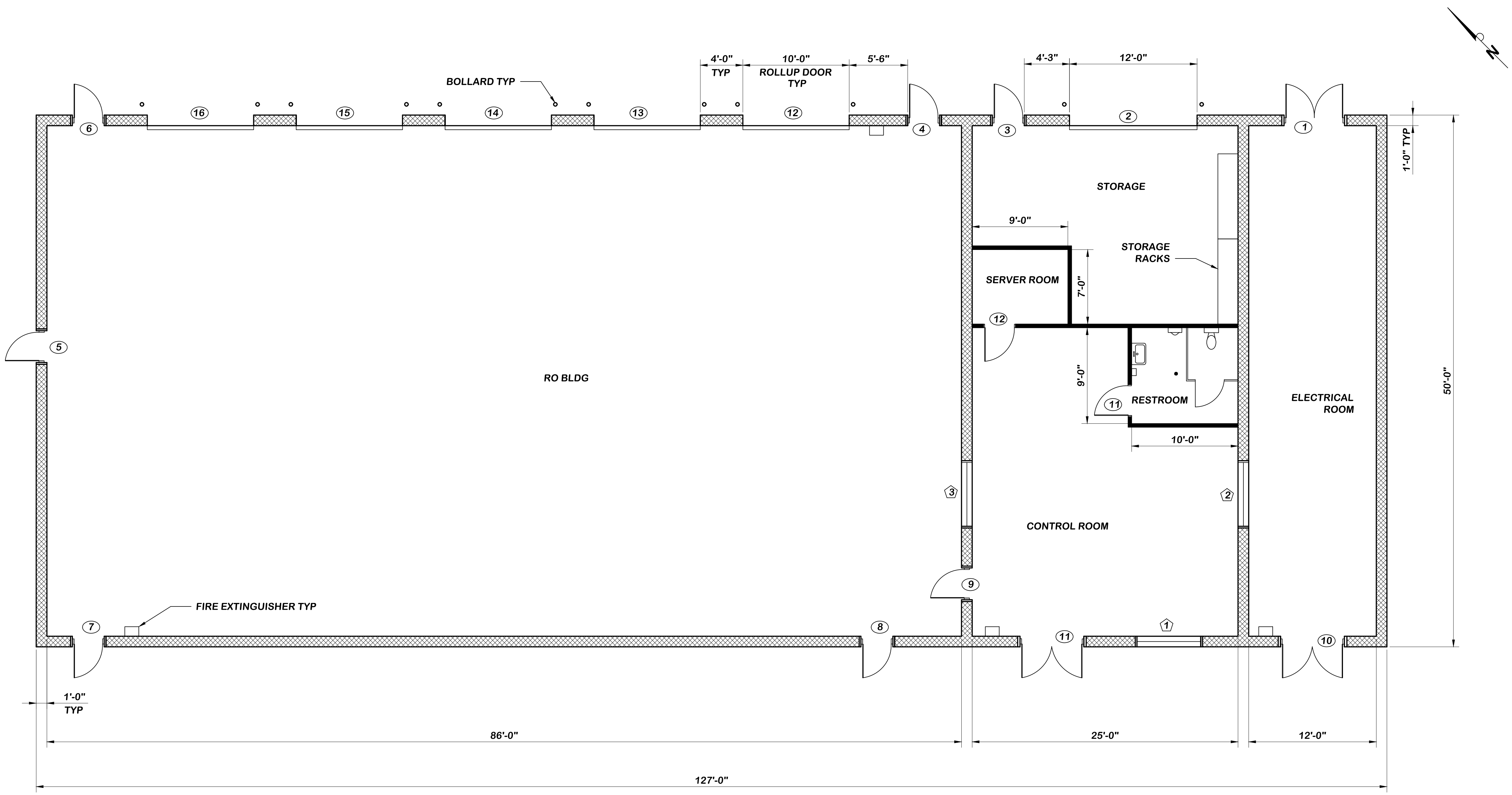

LEGEND

CONCRETE MASONRY (SEE STRUCTURAL DWGS)

FULL HEIGHT WALL (SEE DETAIL X/A-X)

FLOOR PLAN

SCALE: 3/16" = 1'-0"

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE AS SHOWN
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RM
DRAWN BY TS
CHECKED BY RK

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ASSISTANT GENERAL MANAGER

DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

RO BUILDING FLOOR PLAN

DRAWING NO. 400A-1
SHEET NO. X OF XX
CLIENT JOB NO. 2744

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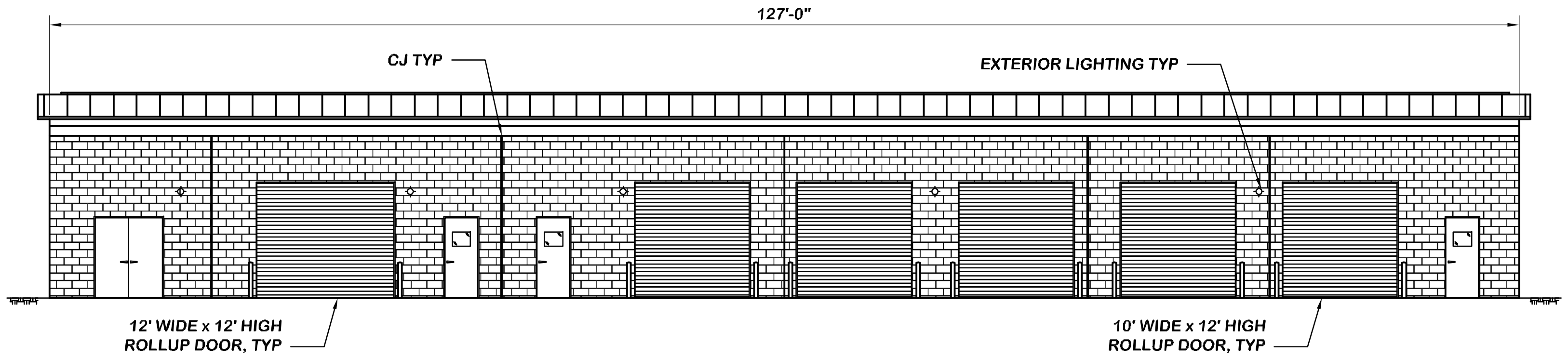
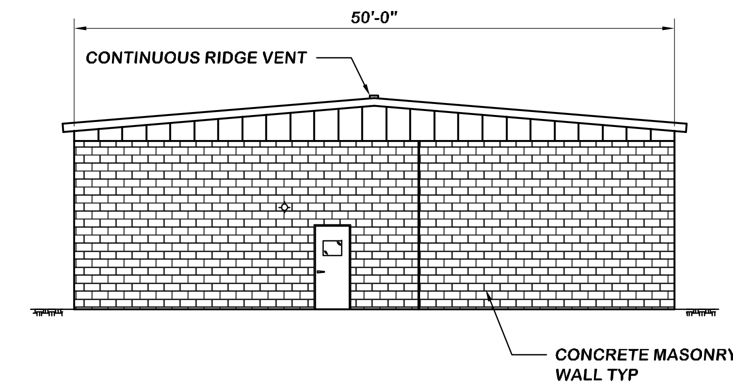
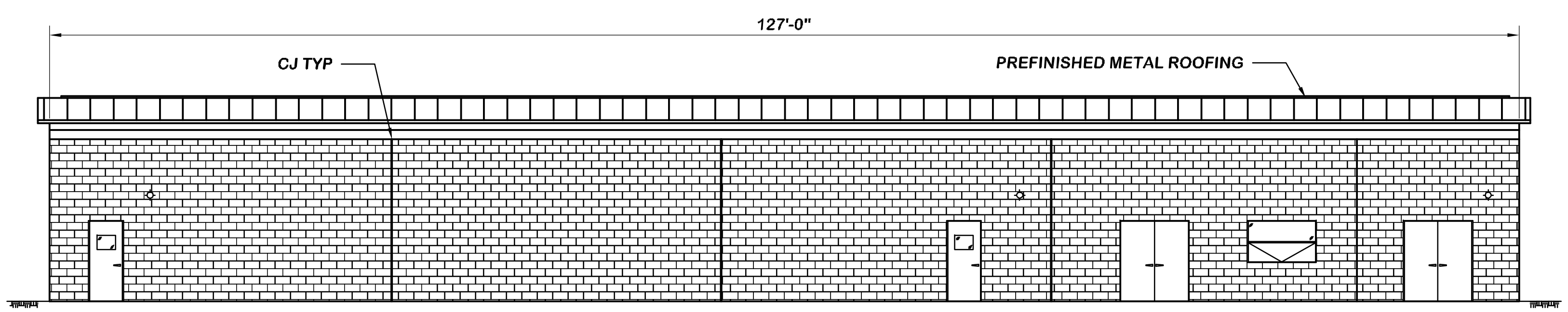


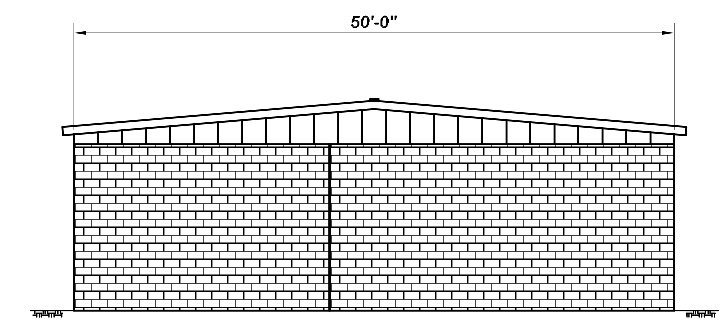
NORTH ELEVATION
SCALE: 1/8" = 1'-0"



WEST ELEVATION
SCALE: 1/8" = 1'-0"



SOUTH ELEVATION
SCALE: 1/8" = 1'-0"



EAST ELEVATION
SCALE: 1/8" = 1'-0"

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE AS SHOWN
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RM
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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

RO BUILDING ELEVATIONS

DRAWING NO. 400A-2
SHEET NO. X OF XX
CLIENT JOB NO. 2744

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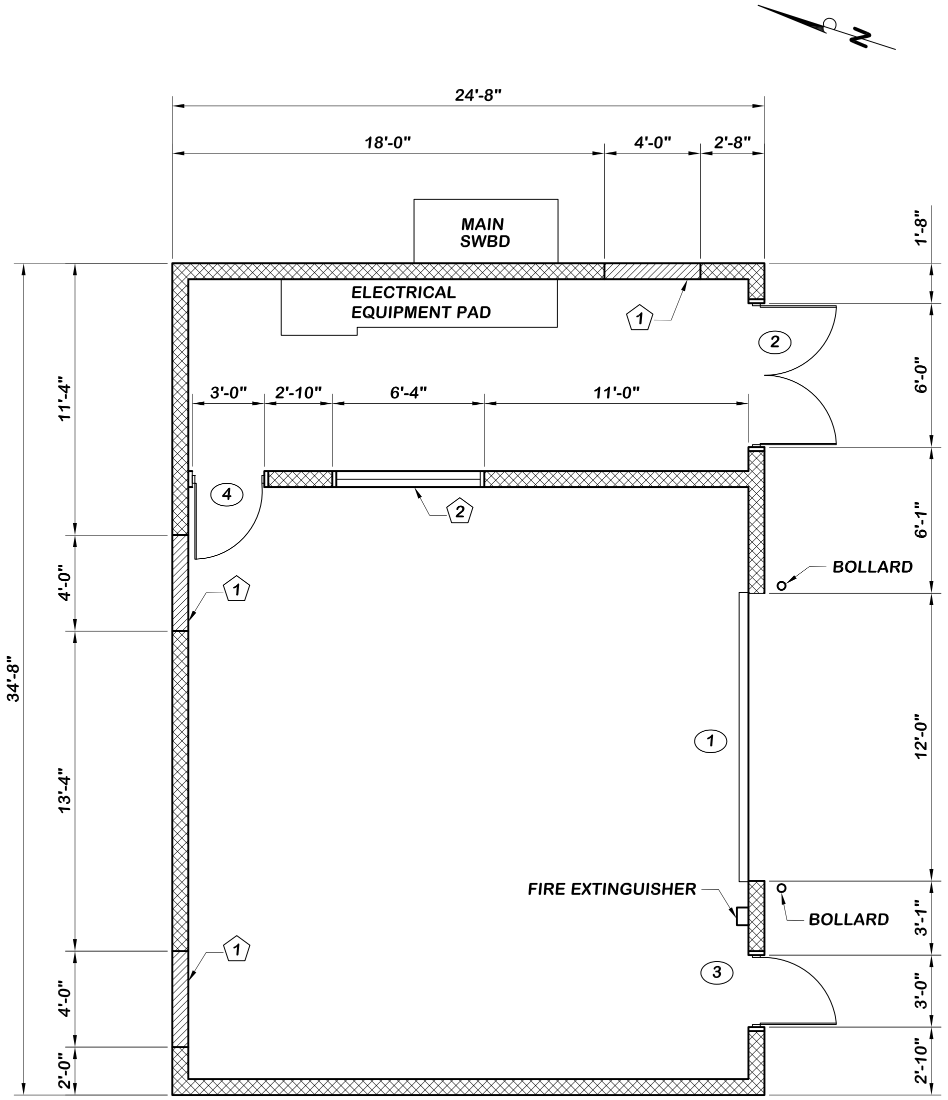
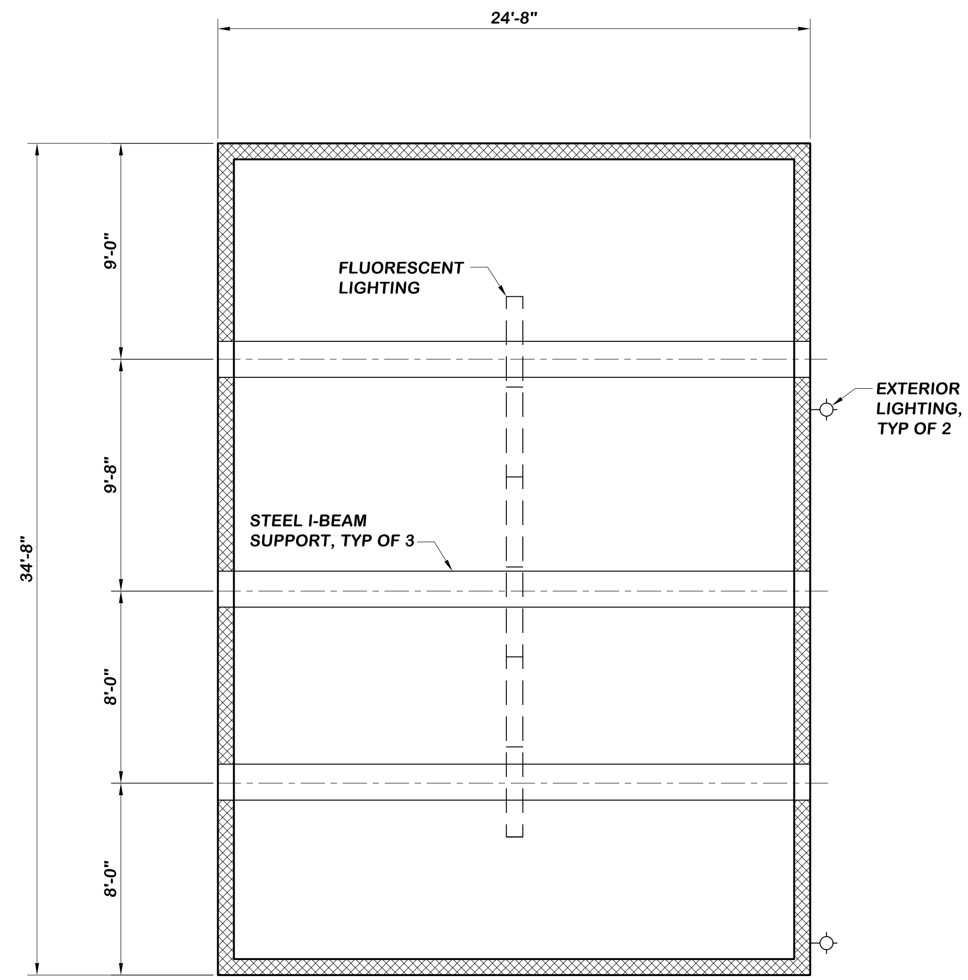
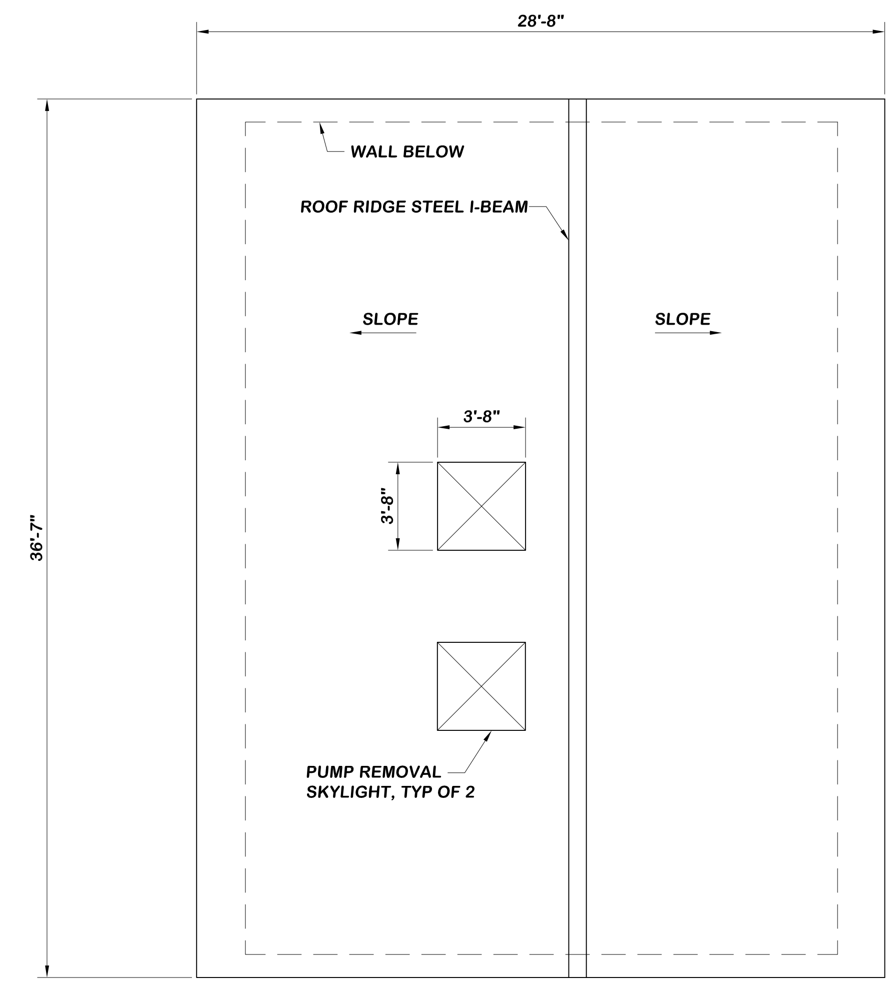


FLOOR PLAN
SCALE: 1/4" = 1'-0"



REFLECTED CEILING PLAN
SCALE: 1/4" = 1'-0"



ROOF PLAN
SCALE: 1/4" = 1'-0"

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE AS SHOWN
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY AW
DRAWN BY TS
CHECKED BY RK

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990 E. MISSION RD
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APPROVED BY:

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ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

GHEEN PUMP STATION PLANS

DRAWING NO. GFA-1
SHEET NO. X OF XX
CLIENT JOB NO. 2744

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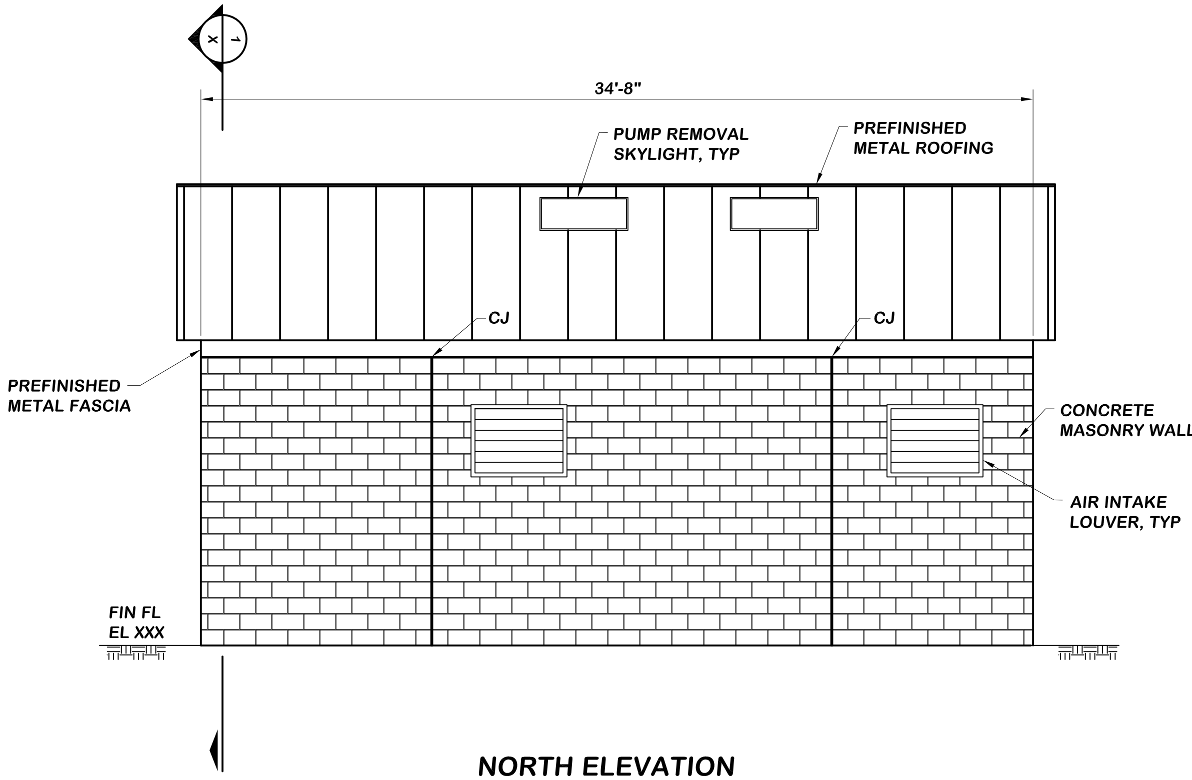
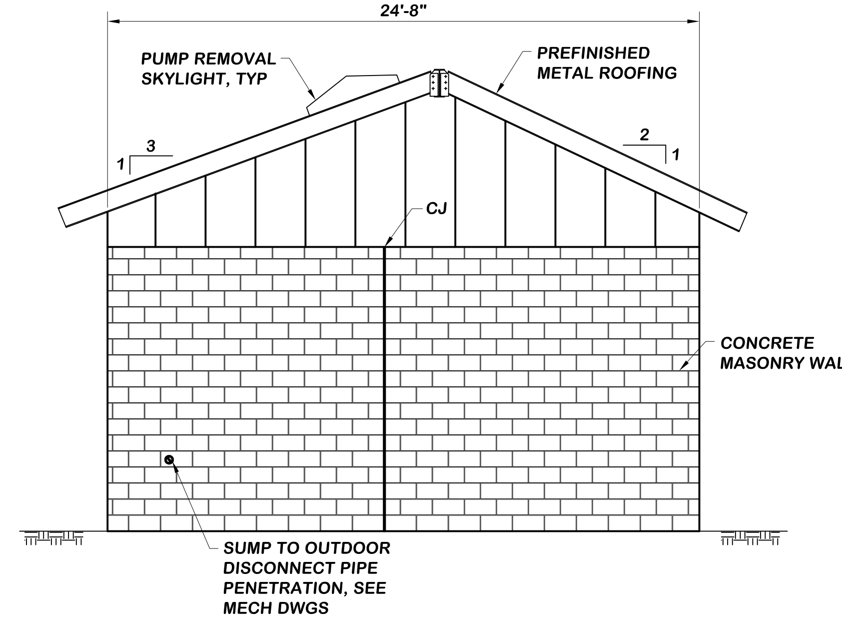
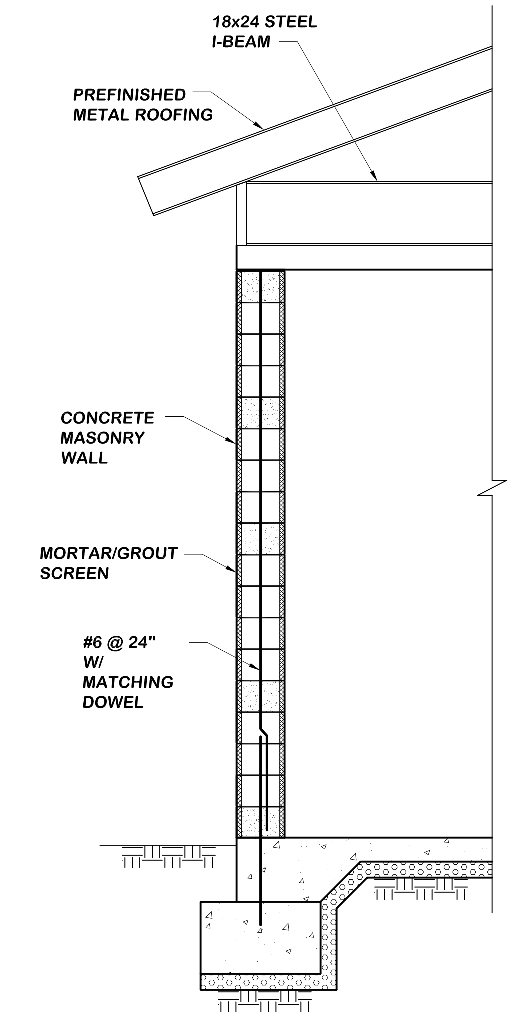


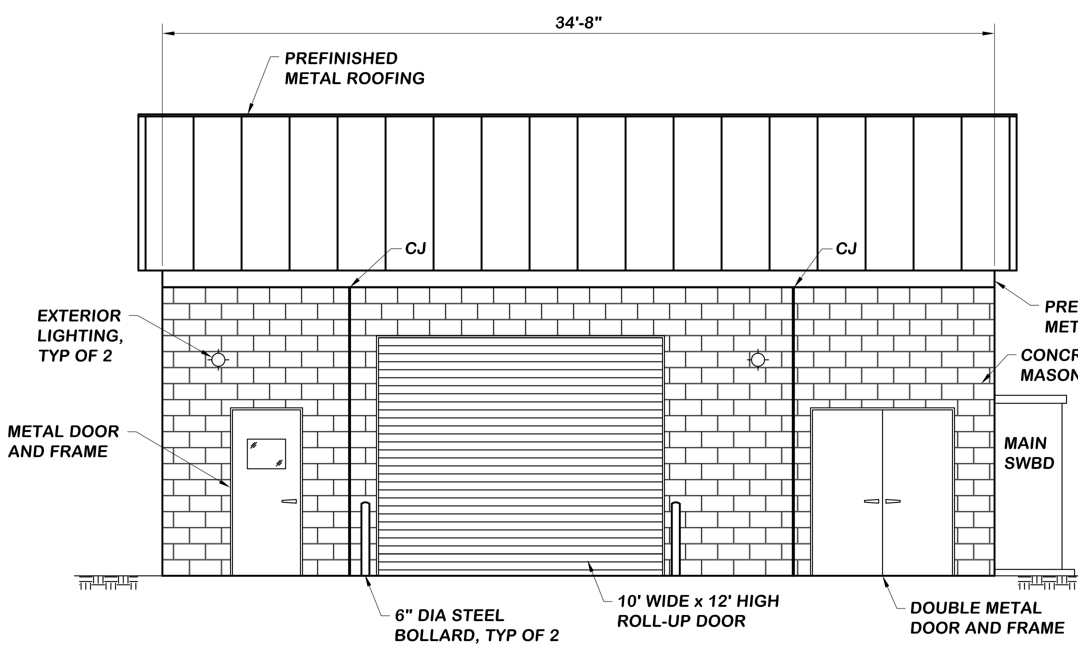
NORTH ELEVATION
SCALE: 1/4" = 1'-0"



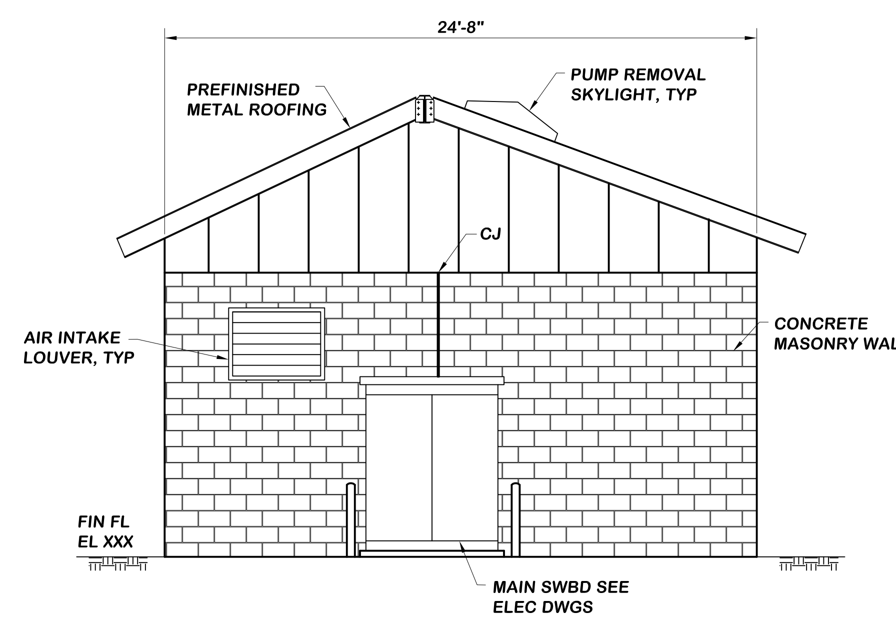
WEST ELEVATION
SCALE: 1/4" = 1'-0"



SECTION 1 X
SCALE: 1/2" = 1'-0"



SOUTH ELEVATION
SCALE: 1/4" = 1'-0"



EAST ELEVATION
SCALE: 1/4" = 1'-0"

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE AS SHOWN
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY AW
DRAWN BY TS
CHECKED BY RK

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JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

GHEEN PUMP STATION ELEVATIONS

DRAWING NO. GFA-2
SHEET NO. X OF XX
CLIENT JOB NO. 2744

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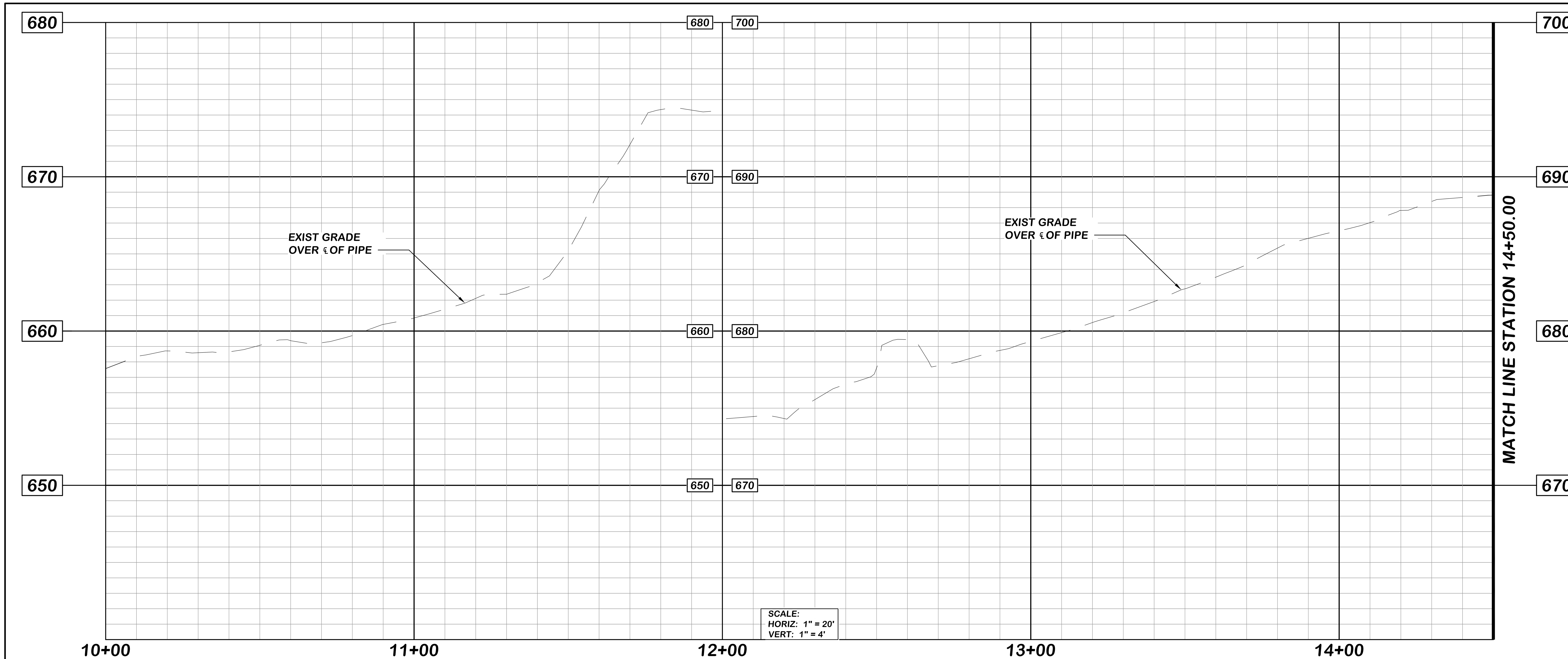

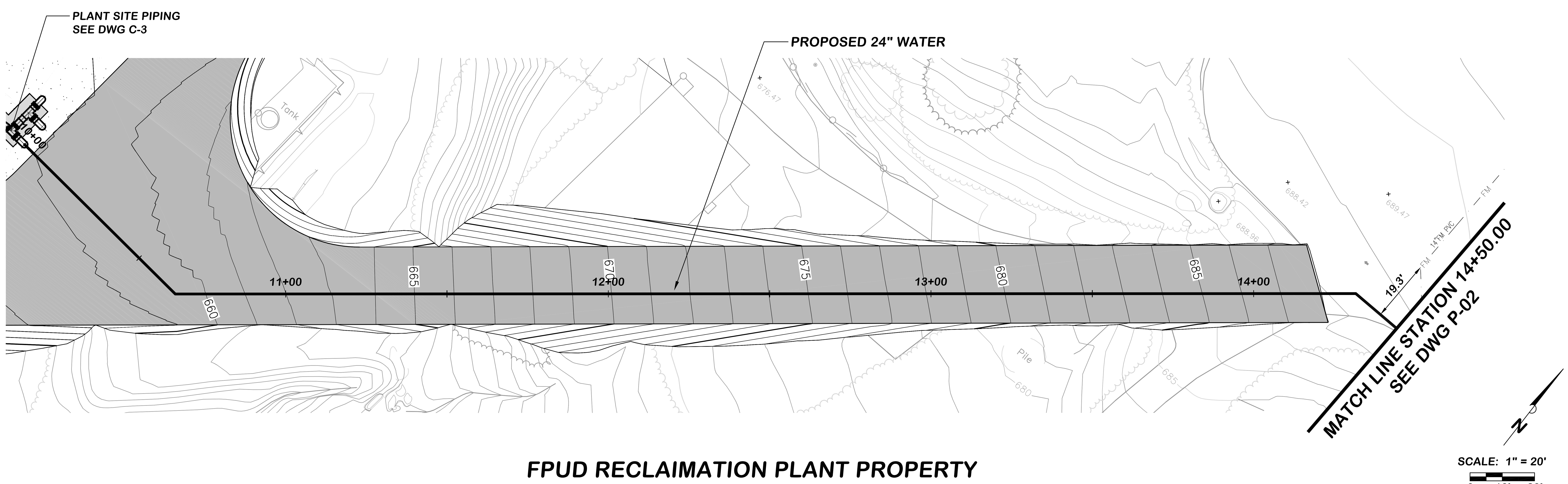

FPUD RECLAIMATION PLANT PROPERTY

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE 1" = 20'
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RK
DRAWN BY RI
CHECKED BY DP

Infrastructure Engineering Corporation
14271 Danielson Street
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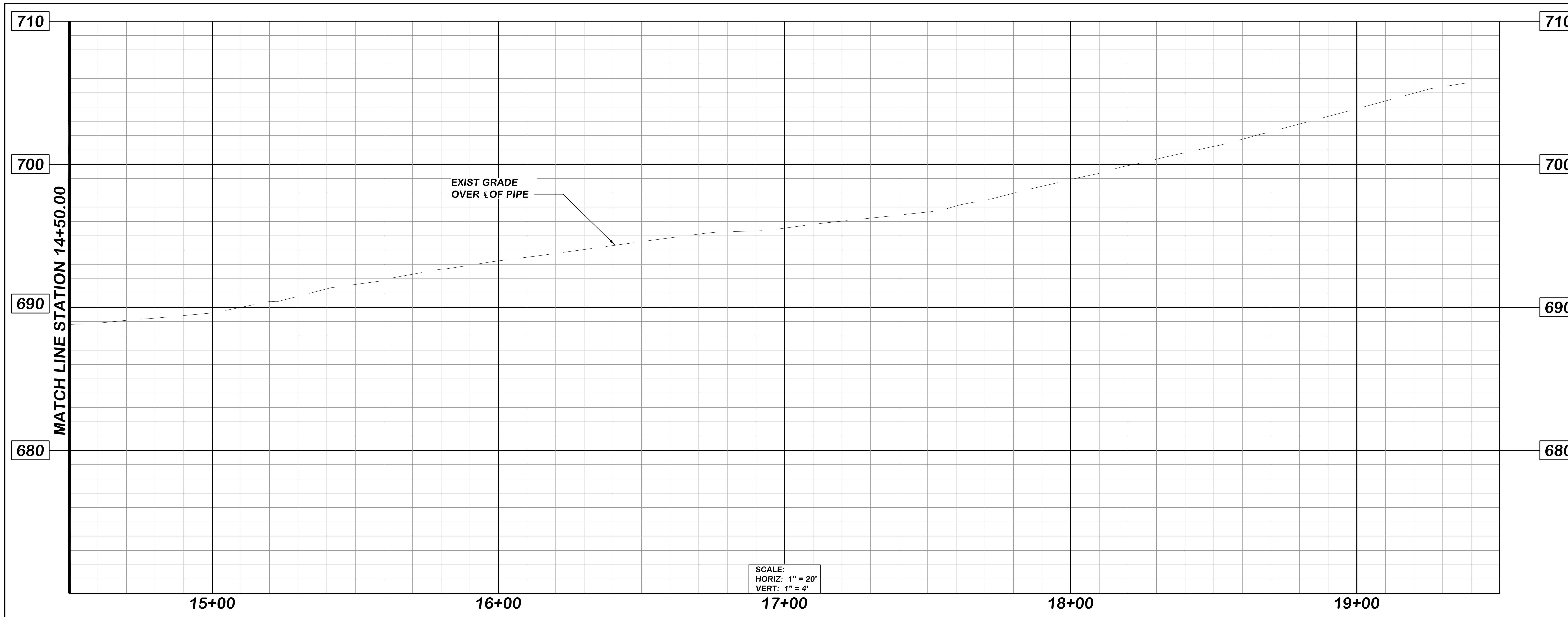
APPROVED BY:
JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

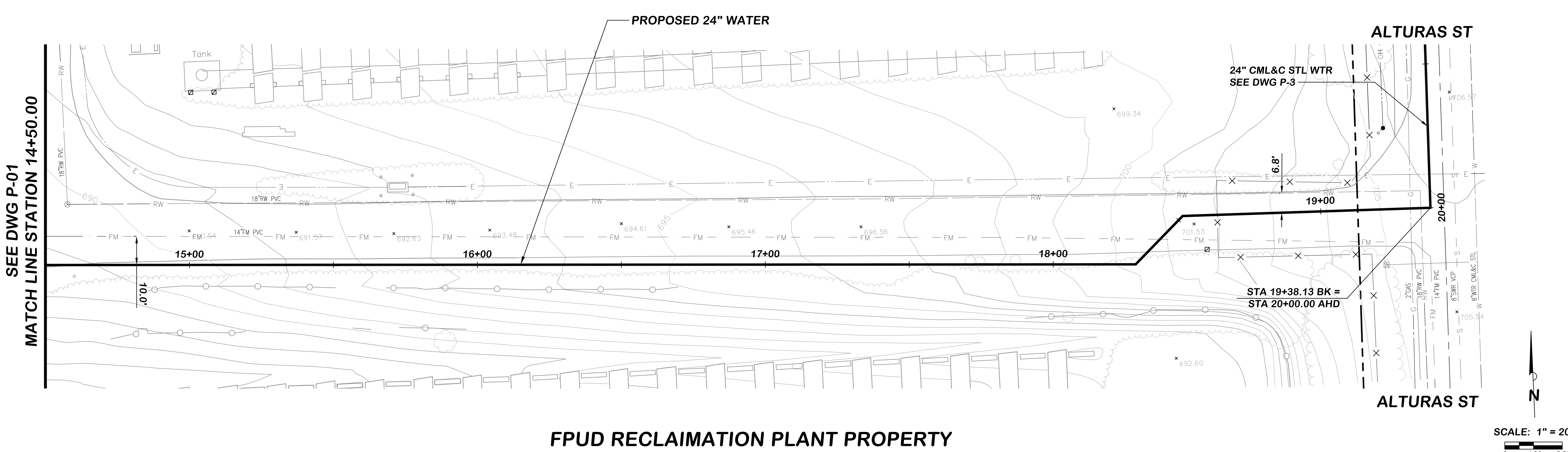
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

PRODUCT WATER PLAN AND PROFILE
STA 10+00.00 TO STA 14+50.00

DRAWING NO. P-01
SHEET NO. X OF XX
CLIENT JOB NO. 2744

P:\Projects\FPUD (0112)\0002 St. Marg Conjunctive Use Project\CADD\P-01 & P-02 - WTP.dwg 10/16/2015 09:21





FPUD RECLAIMATION PLANT PROPERTY

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE 1" = 20'
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RK
DRAWN BY RI
CHECKED BY DP

Infrastructure
ENGINEERING CORPORATION
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Poway, California 92064
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DATE

FPUD
Fallbrook Public Utility District
990 E. MISSION RD
FALLBROOK, CA 92028

APPROVED BY:

JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

PRODUCT WATER PLAN AND PROFILE
STA 14+50.00 TO 19+38.13

DRAWING NO. P-02
SHEET NO. X OF XX
CLIENT JOB NO. 2744

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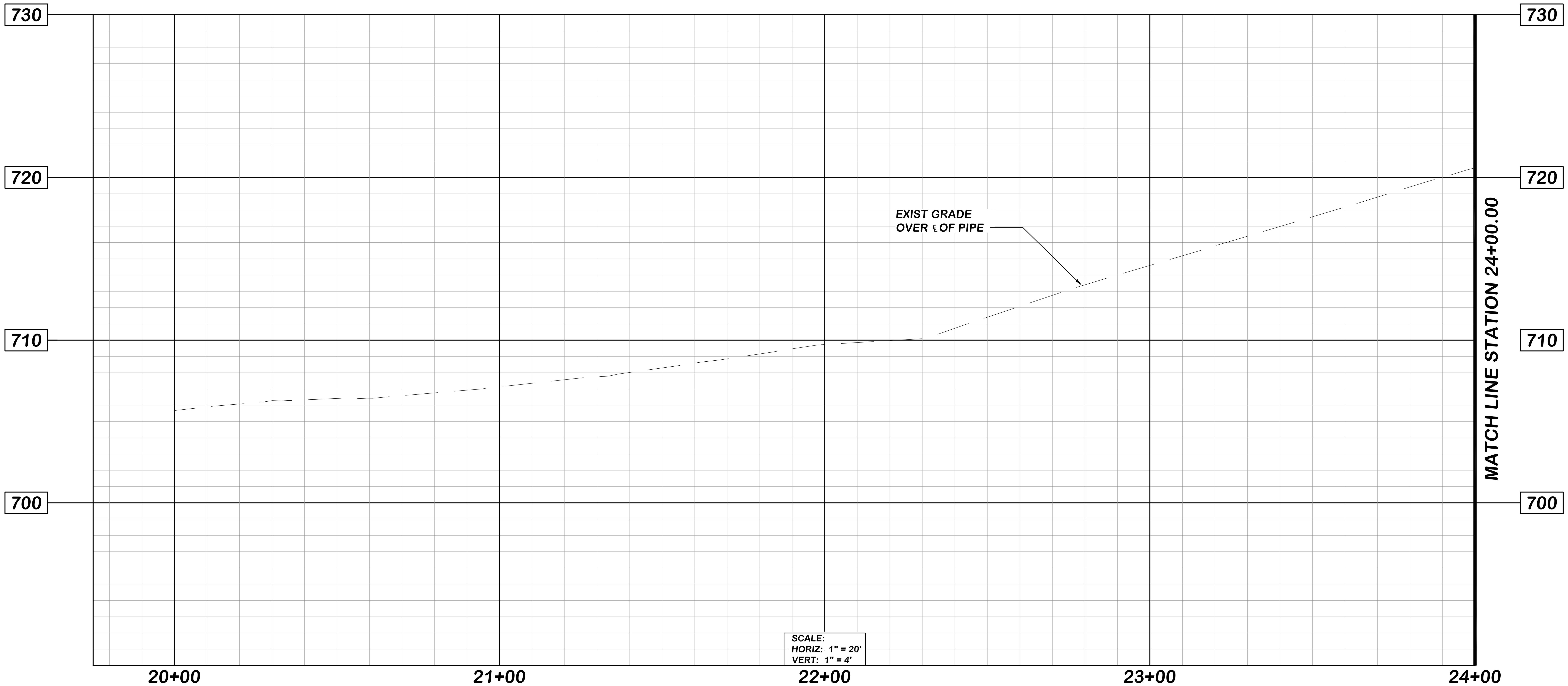

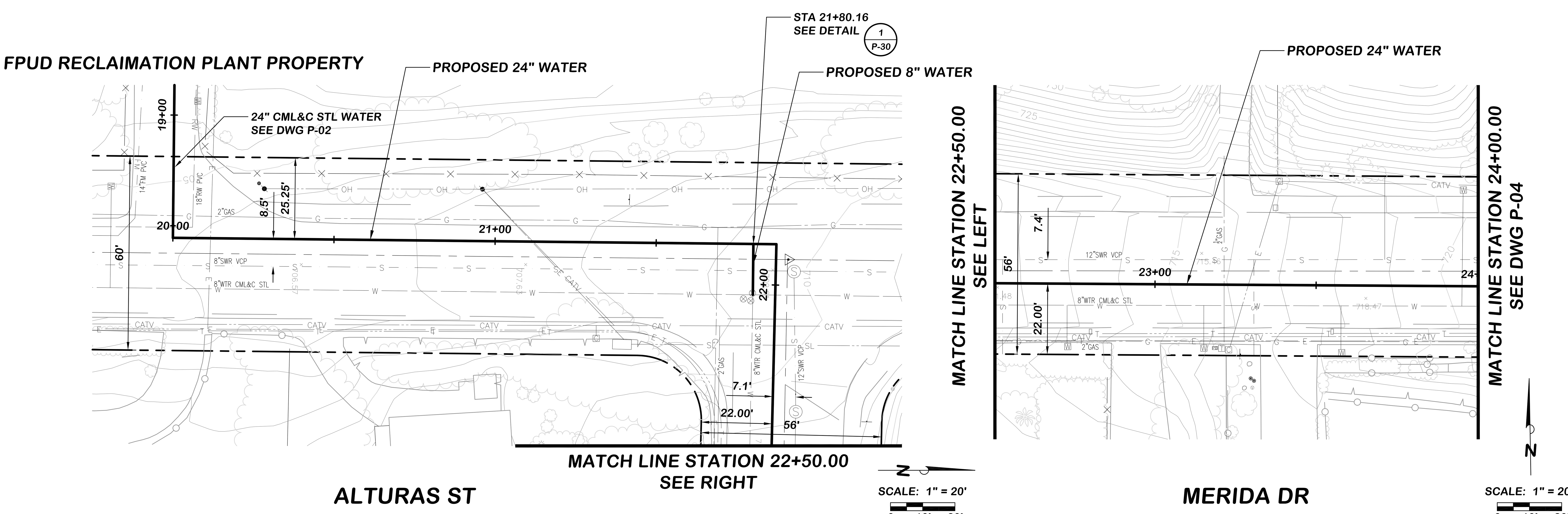

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE 1" = 20'
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RK
DRAWN BY RI
CHECKED BY DP

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990 E. MISSION RD
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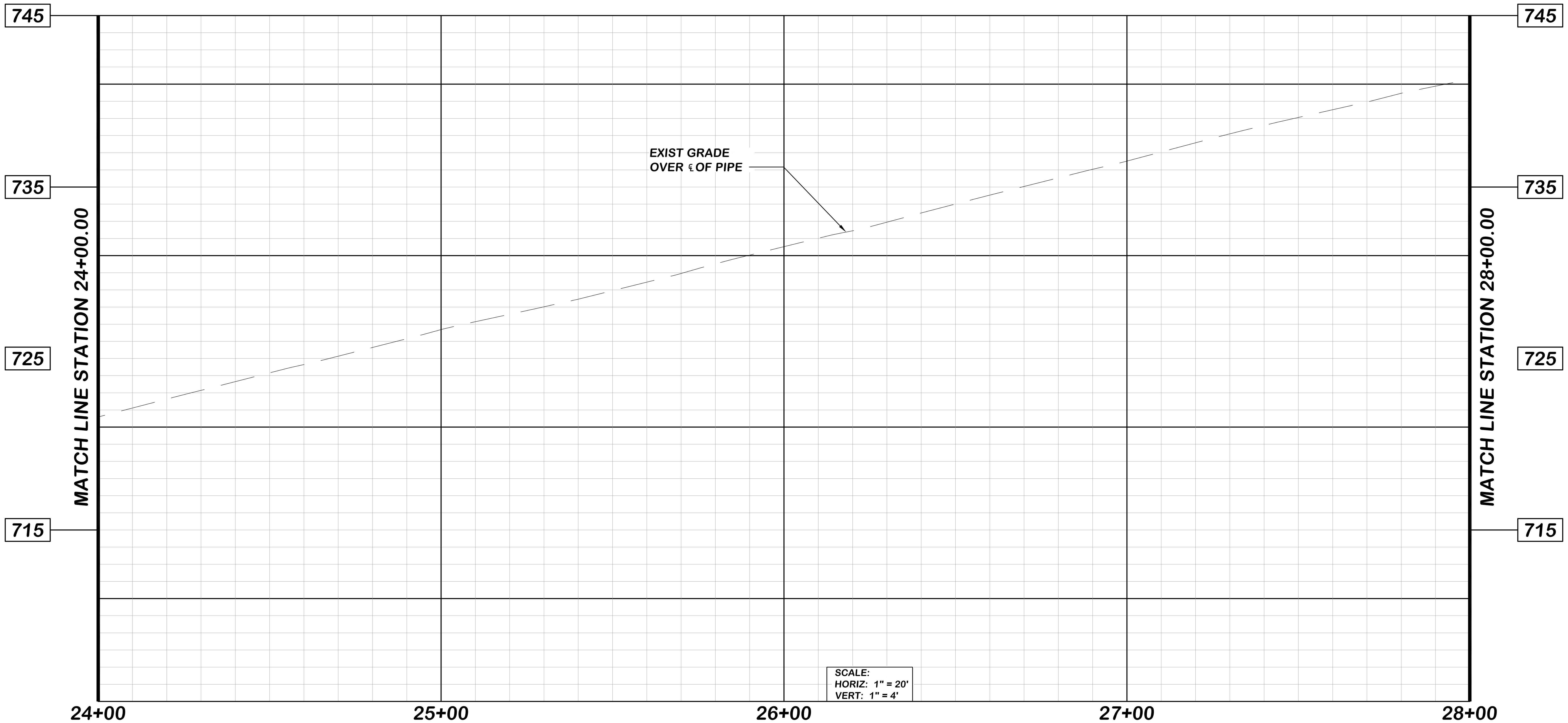
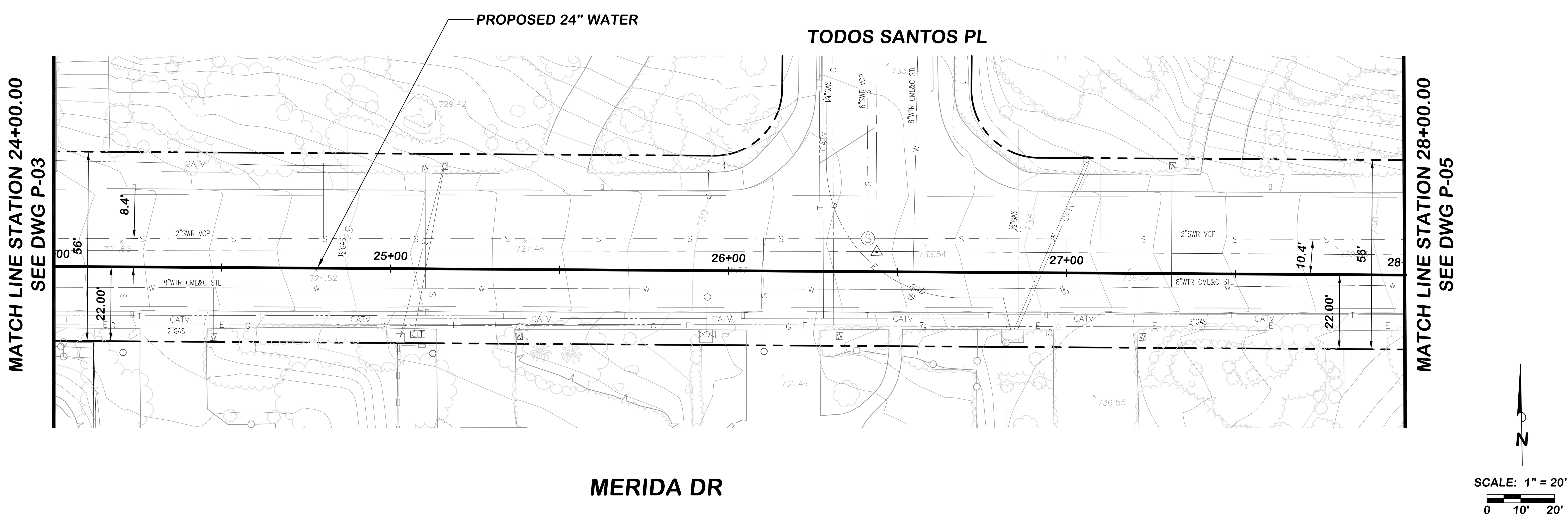
APPROVED BY:
JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

PRODUCT WATER PLAN AND PROFILE
STA 20+00.00 TO STA 24+00.00

DRAWING NO. P-03
SHEET NO. XX OF XX
CLIENT JOB NO. 2744





30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE 1" = 20'
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RK
DRAWN BY RI
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DATE

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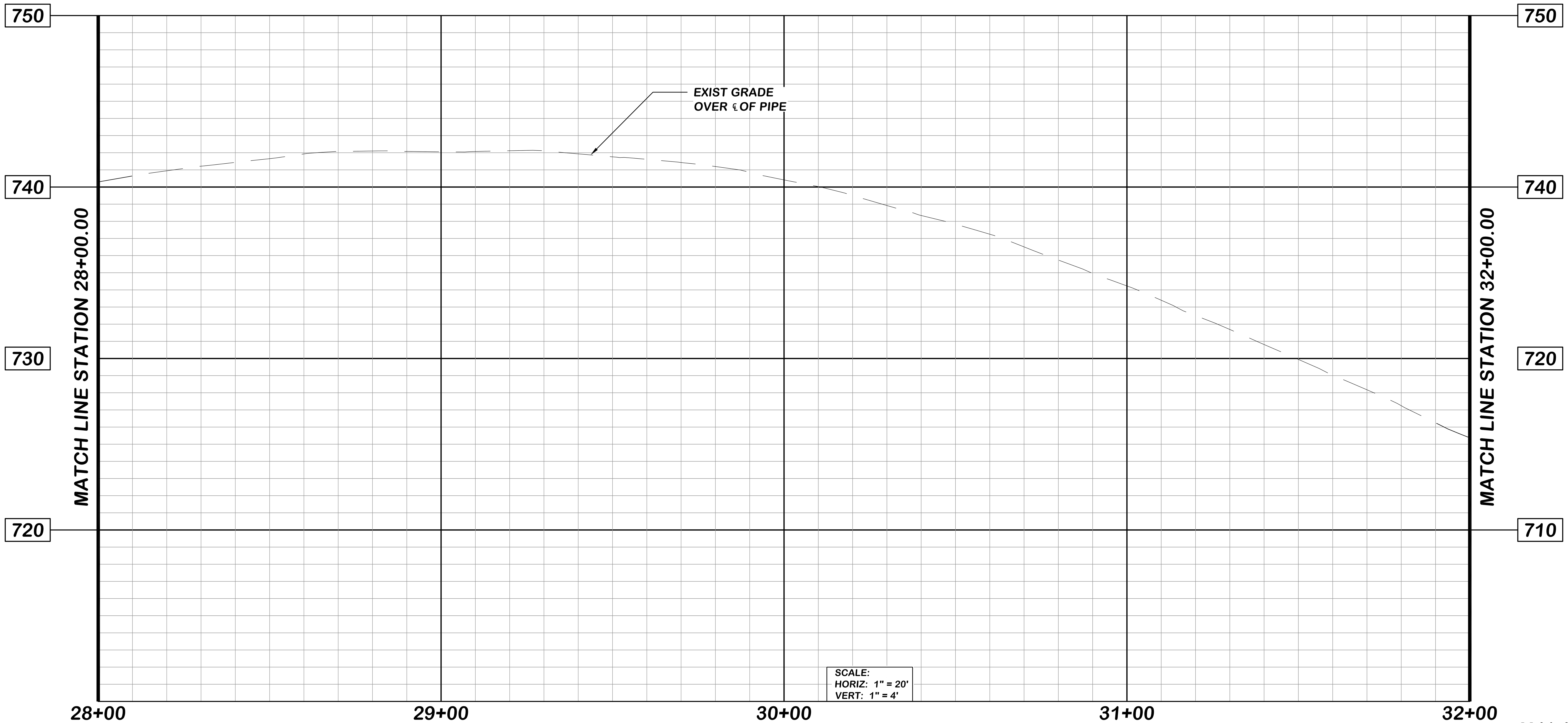
FALLBROOK, CA 92028

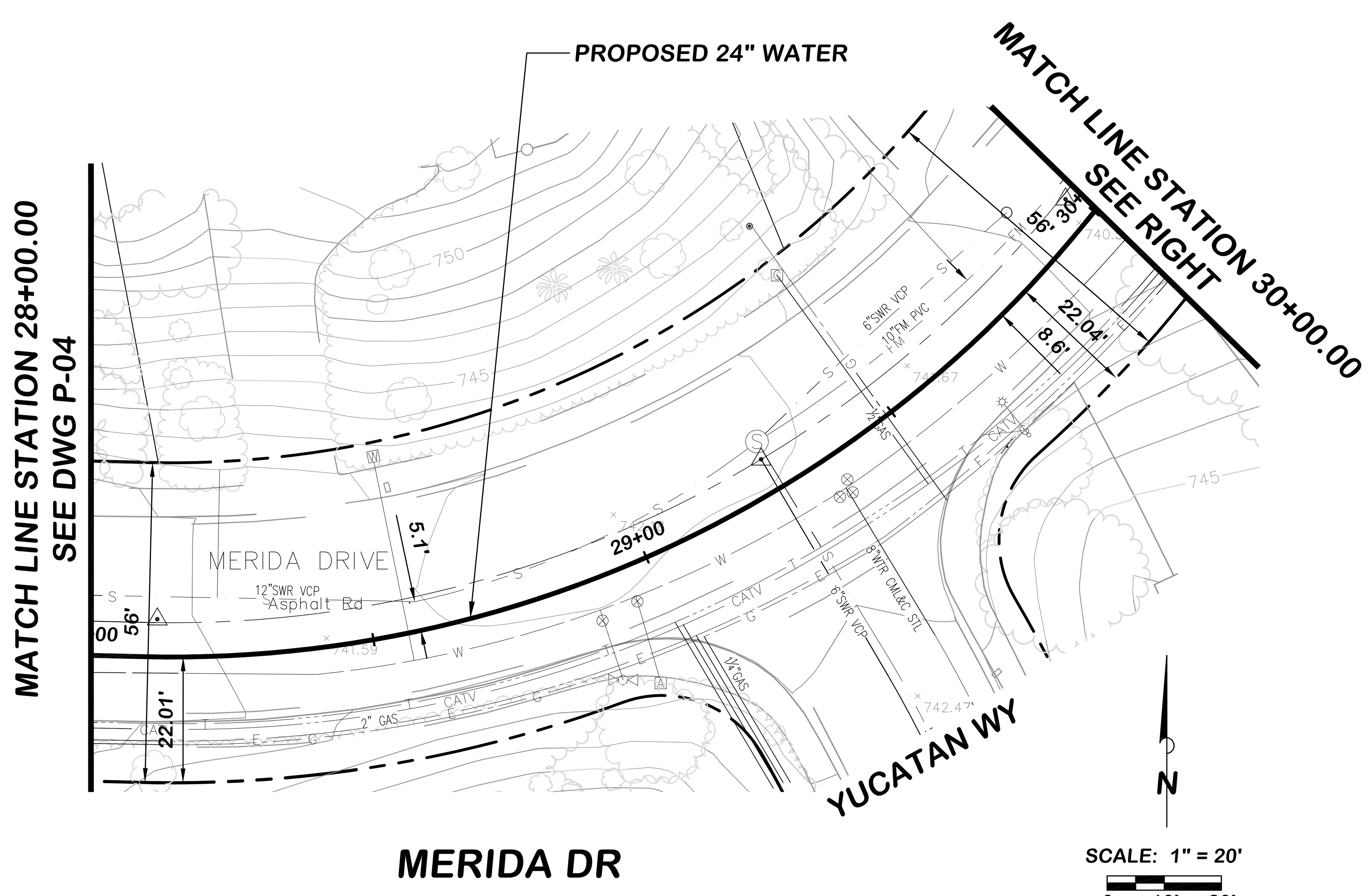
APPROVED BY:
JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

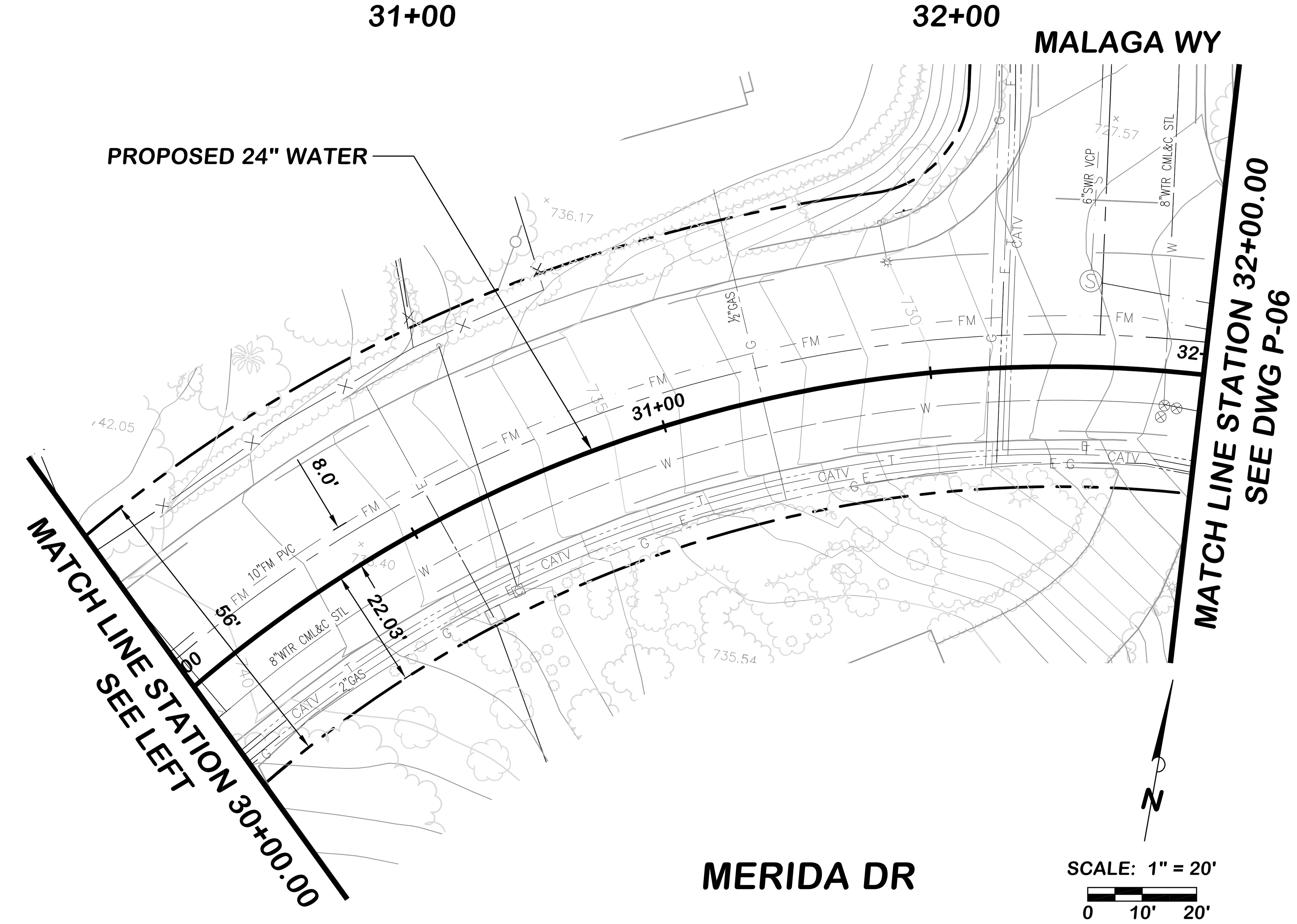
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

PRODUCT WATER PLAN AND PROFILE
STA 24+00.00 TO STA 28+00.00

DRAWING NO. P-04
SHEET NO. XX OF XX
CLIENT JOB NO. 2744







30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

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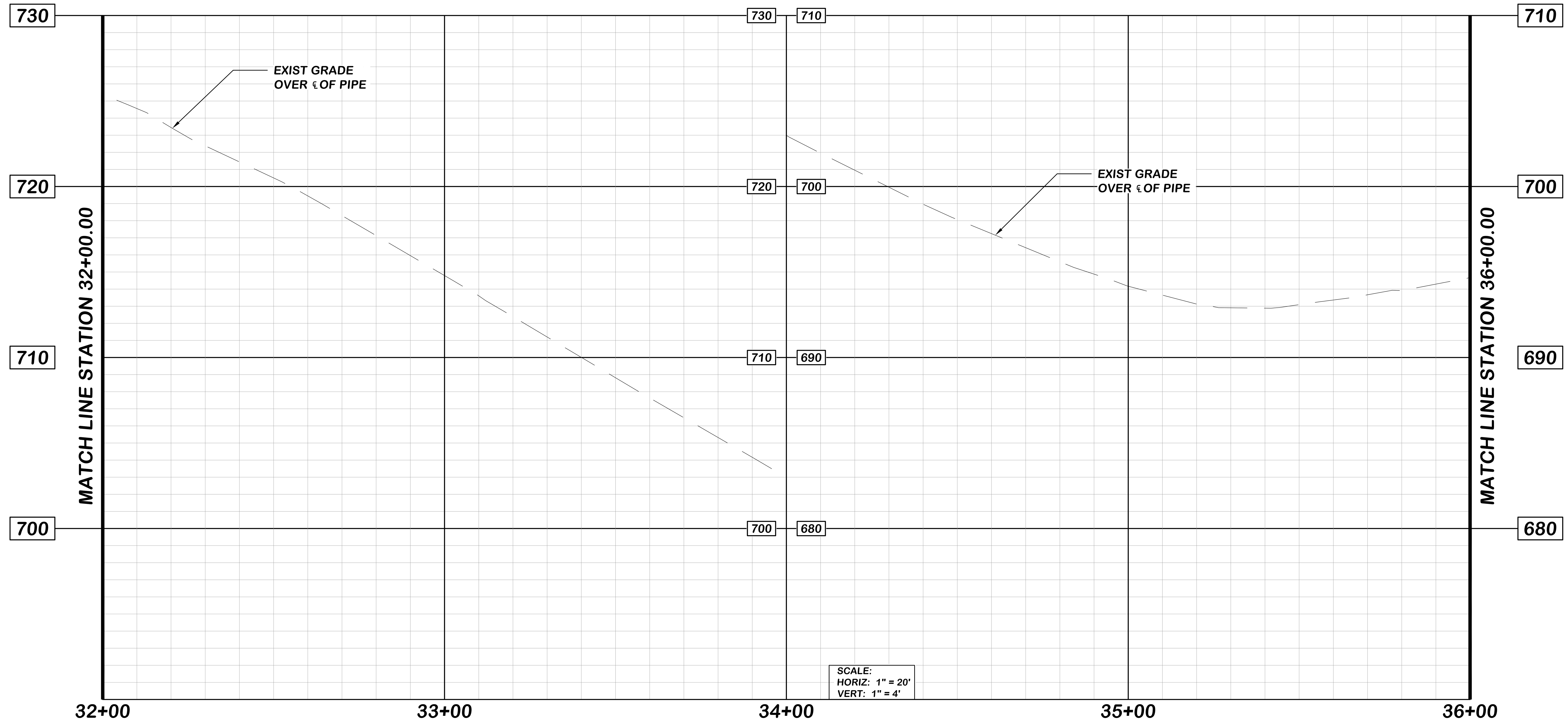
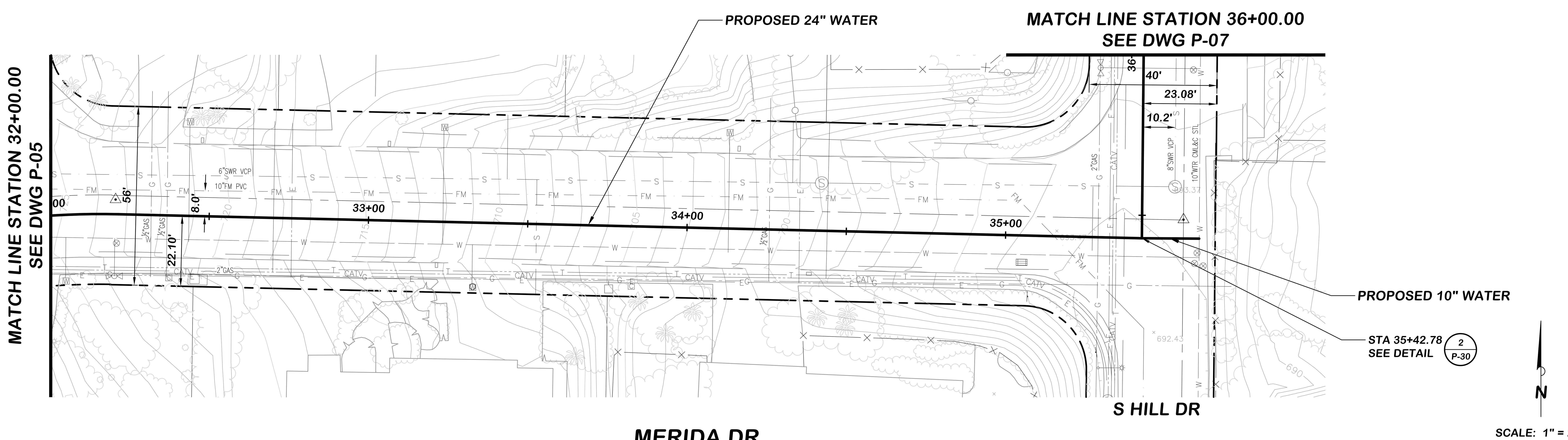
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

PRODUCT WATER PLAN AND PROFILE
STA 28+00.00 TO STA 32+00.00

DRAWING NO. P-05
SHEET NO. XX OF XX
CLIENT JOB NO. 2744





30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE 1" = 20'
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RK
DRAWN BY RI
CHECKED BY DP

Infrastructure ENGINEERING CORPORATION
14271 Danielson Street
Poway, California 92064
T 858.413.2400 F 858.413.2440
www.iecorporation.com

DATE

FPUD Fallbrook Public Utility District
990 E. MISSION RD
FALLBROOK, CA 92028

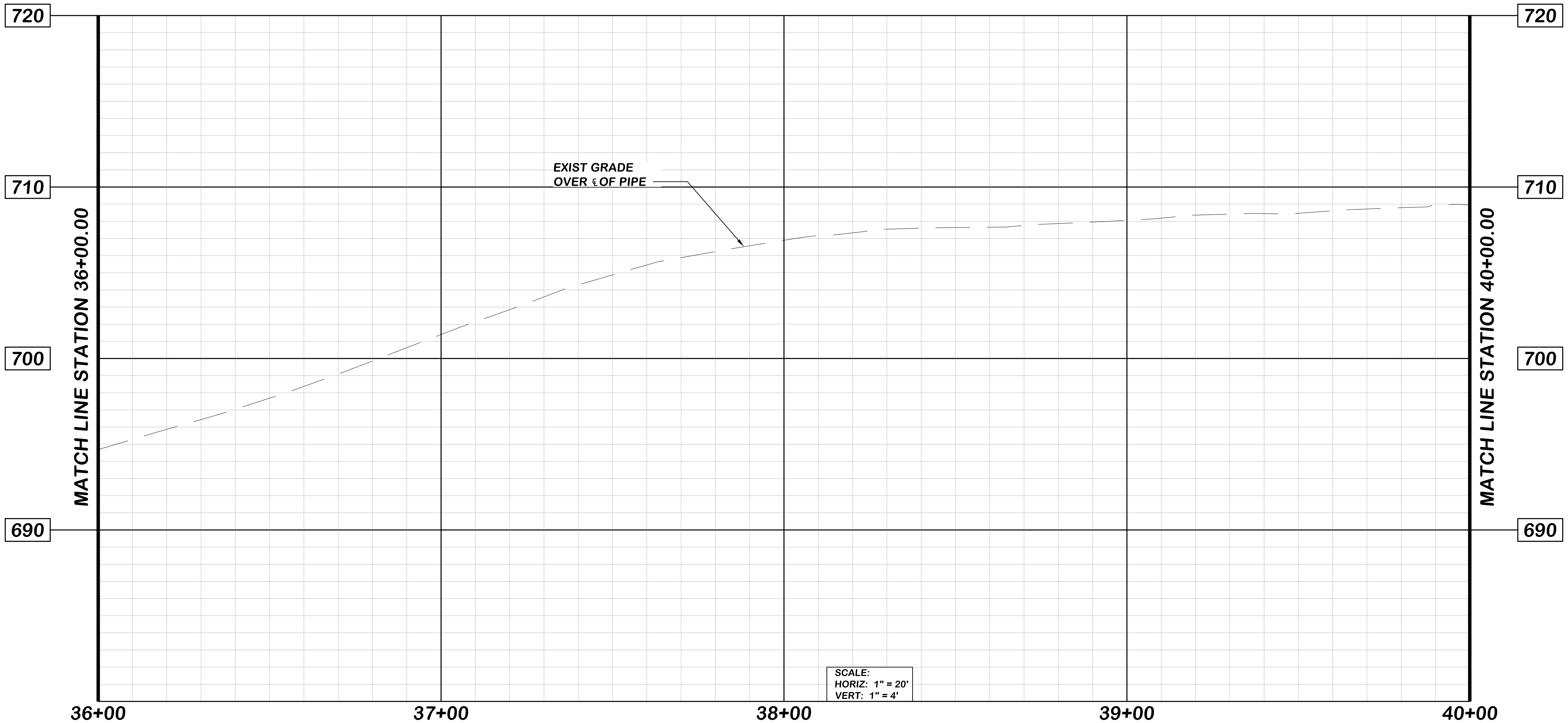
APPROVED BY:
JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

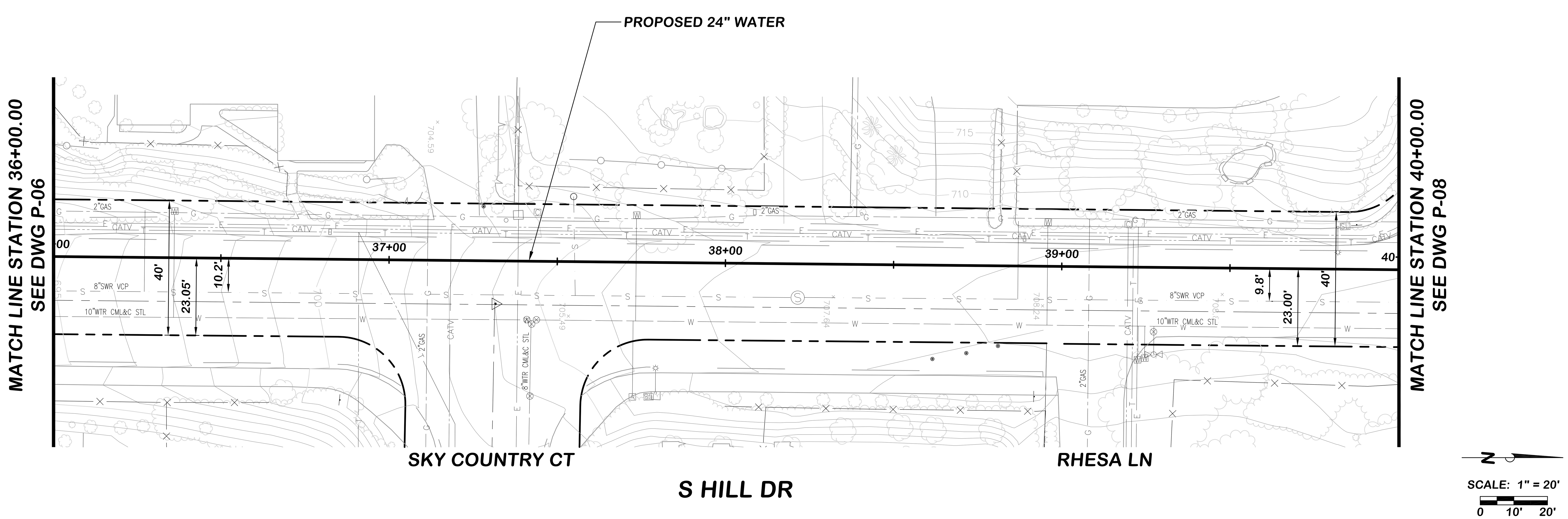
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

PRODUCT WATER PLAN AND PROFILE
STA 32+00.00 TO STA 36+00.00

DRAWING NO. P-06
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

P:\Projects\FPUD (0112)\0002 St Marg Conjunctive Use Project\CADD\P-03 thru P-07.dwg 10/16/2015 09:27





30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE 1" = 20'
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RK
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APPROVED BY:

JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

PRODUCT WATER PLAN AND PROFILE
STA 36+00.00 TO STA 40+00.00

DRAWING NO. P-07
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

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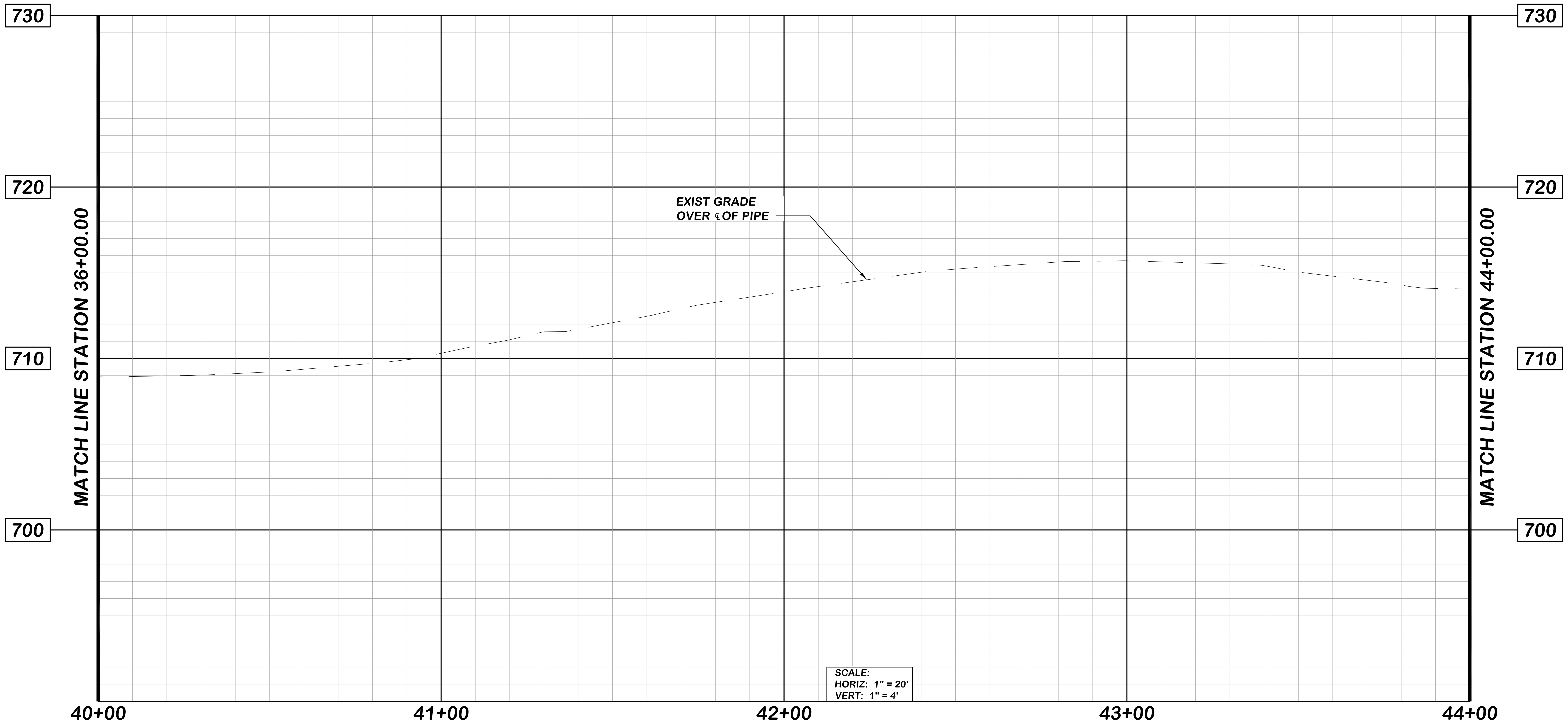

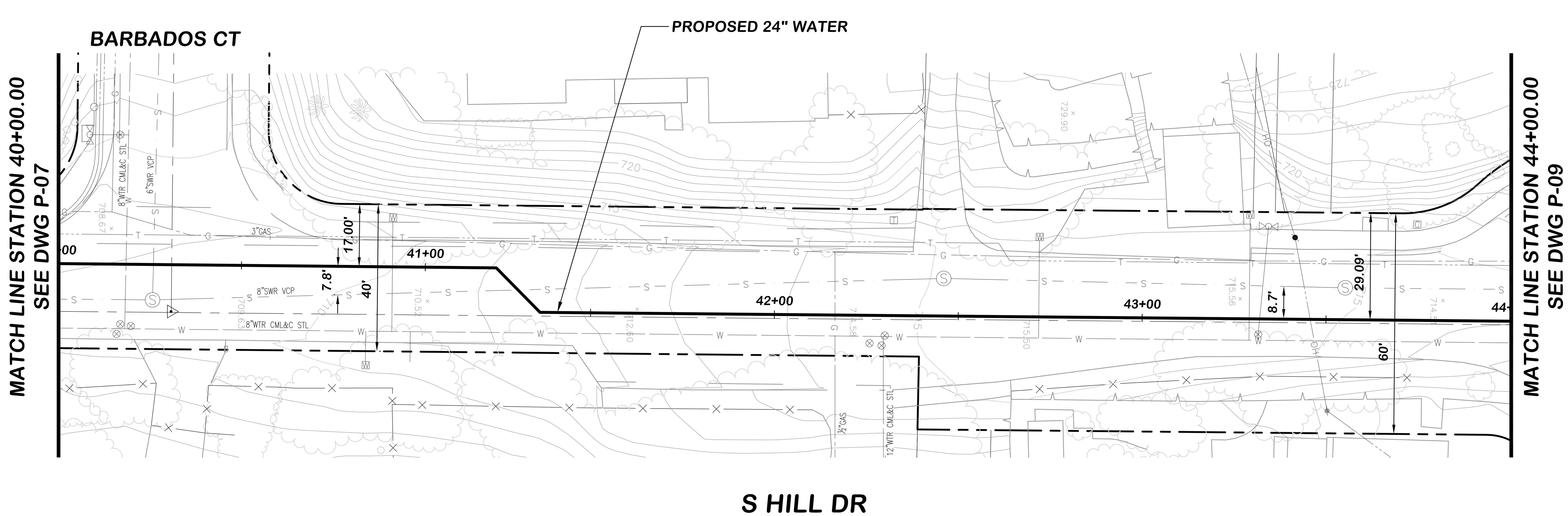

30% SUBMITTAL

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DATE 10/2015
PROJECT NO. 112.FPUD.0002
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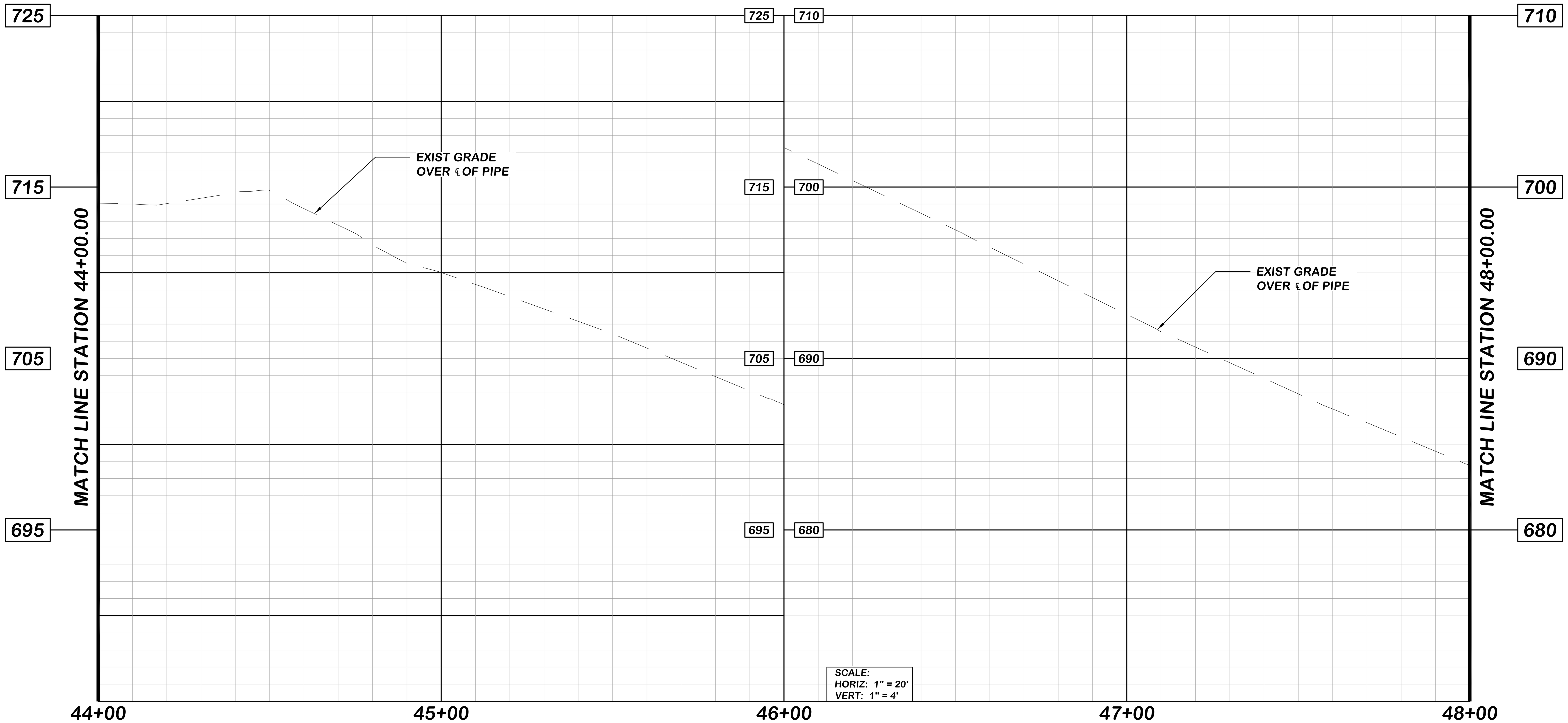
ASSISTANT GENERAL MANAGER
DATE

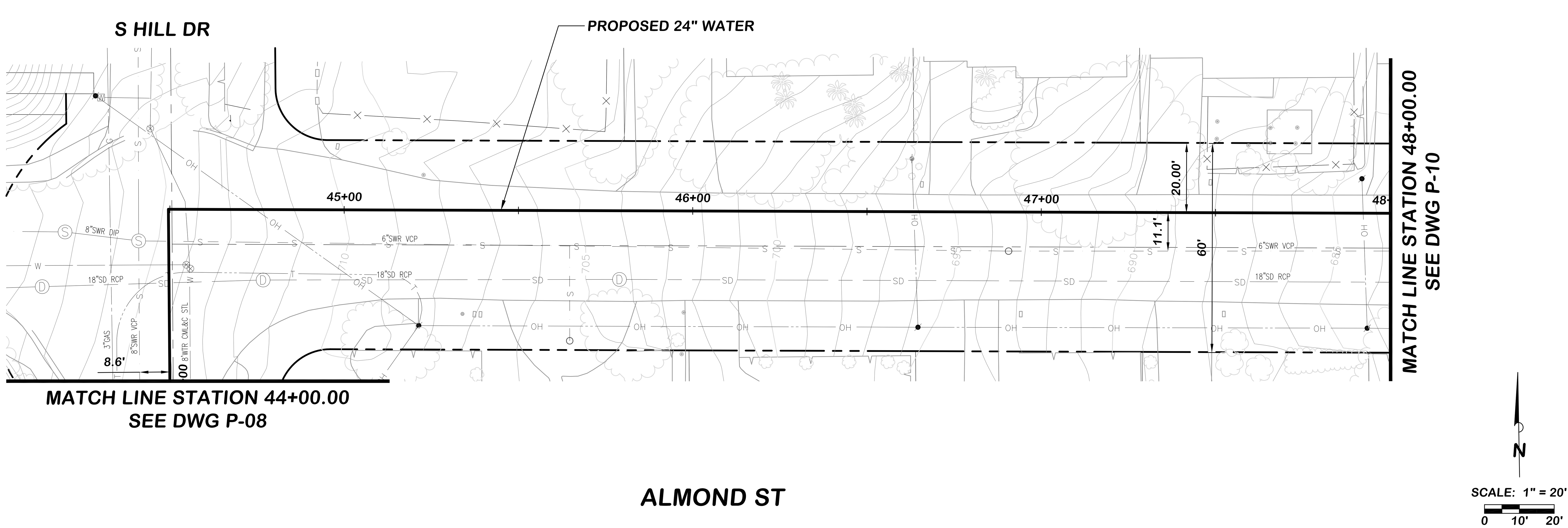
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

PRODUCT WATER PLAN AND PROFILE
STA 40+00.00 TO STA 44+00.00

DRAWING NO. P-08
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

P:\Projects\FPUD (0112)\0002 St. Marg Conjunctive Use Project\CADD\P-08 thru P-12.dwg 10/16/2015 09:37





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SCALE 1" = 20'
DATE 10/2015
PROJECT NO. 112.FPUD.0002
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JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

PRODUCT WATER PLAN AND PROFILE
STA 44+00.00 TO STA 48+00.00

DRAWING NO. P-09
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

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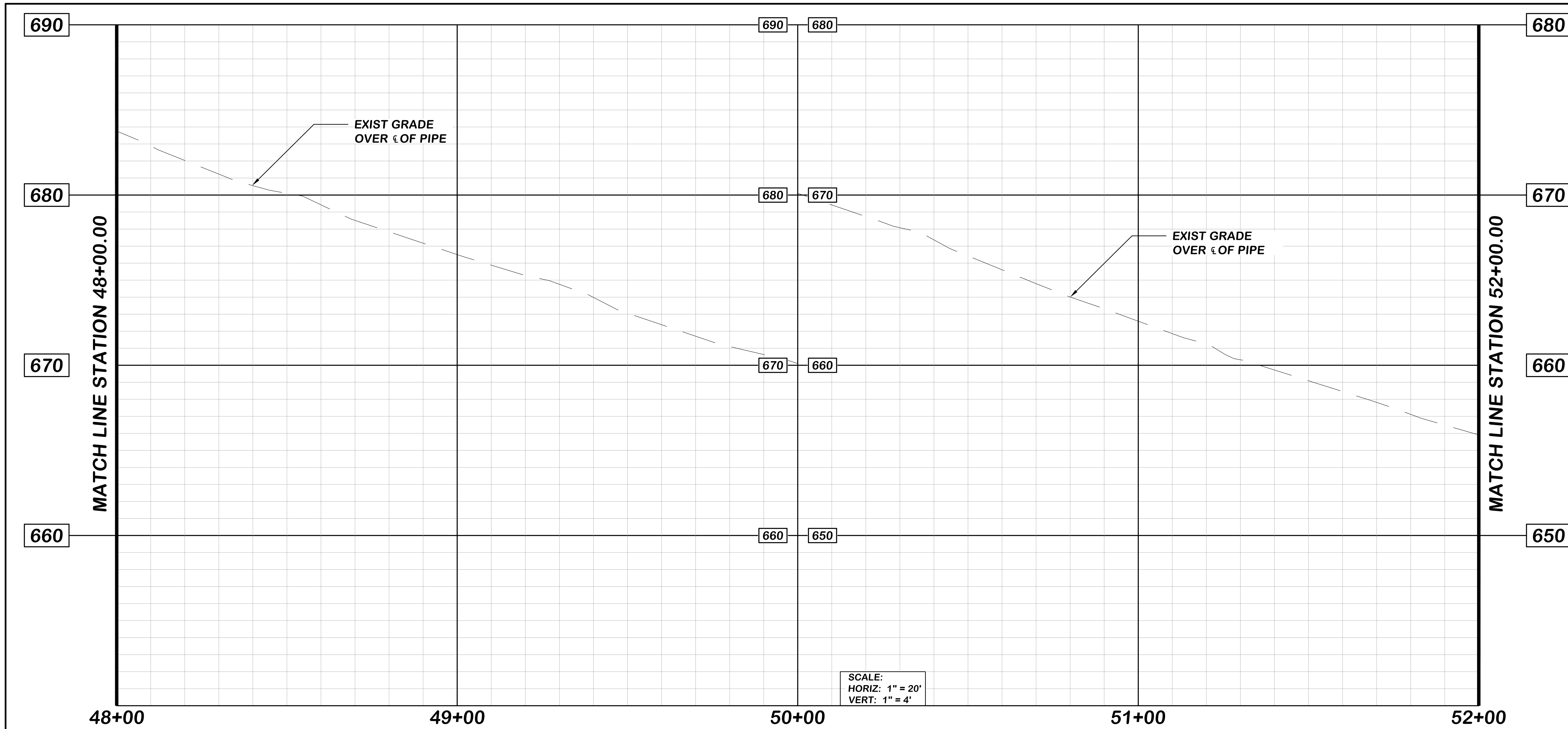

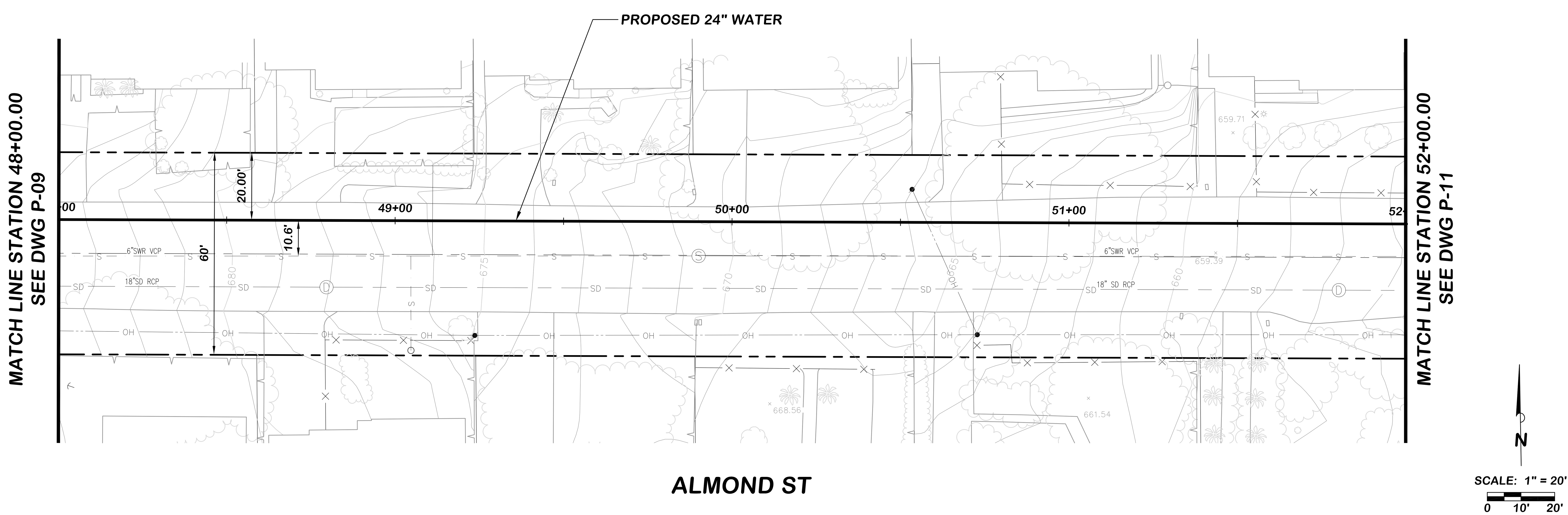

ALMOND ST

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE 1" = 20'
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RK
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FPUD
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APPROVED BY:

JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

PRODUCT WATER PLAN AND PROFILE
STA 48+00.00 TO STA 52+00.00

DRAWING NO. P-10
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

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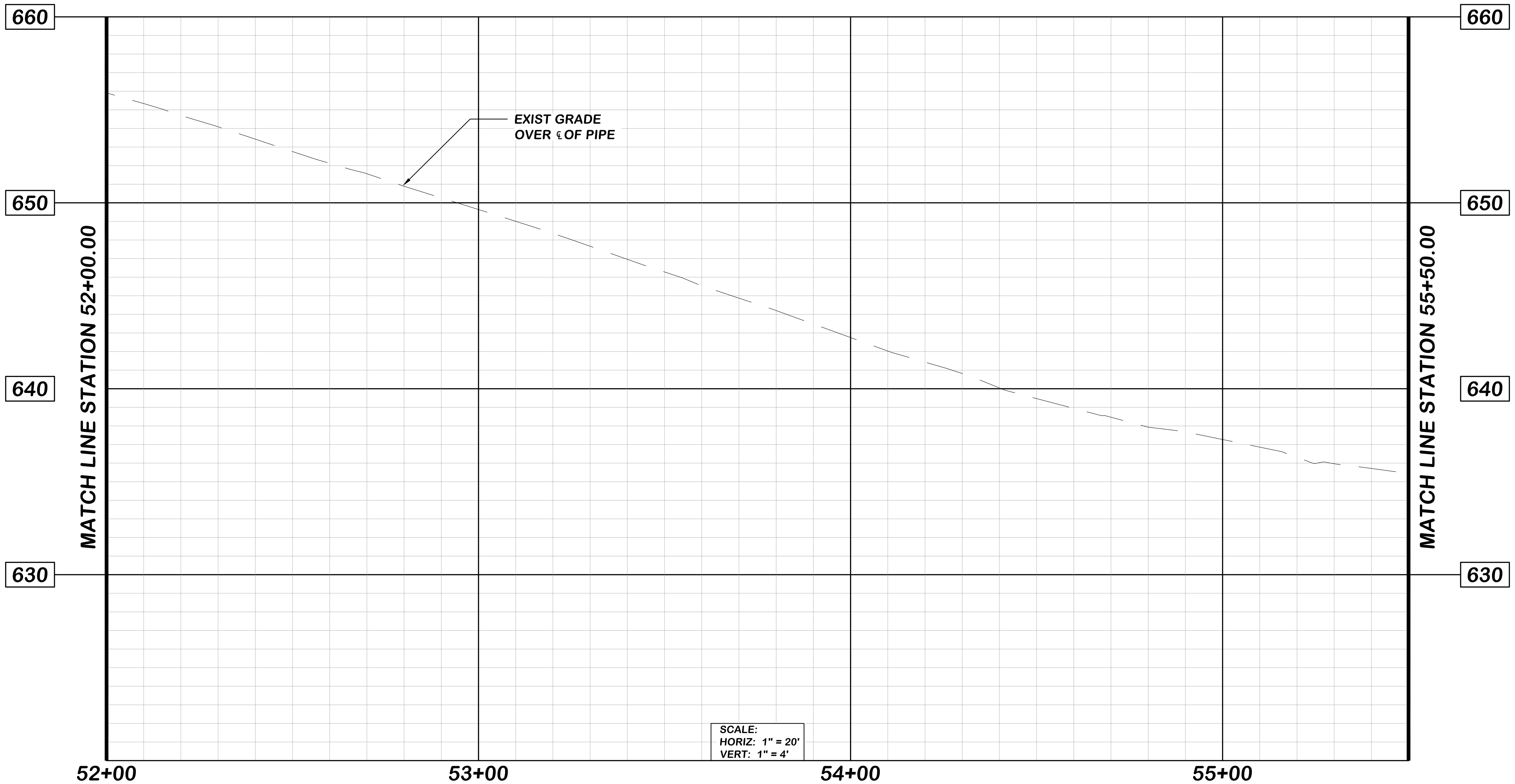

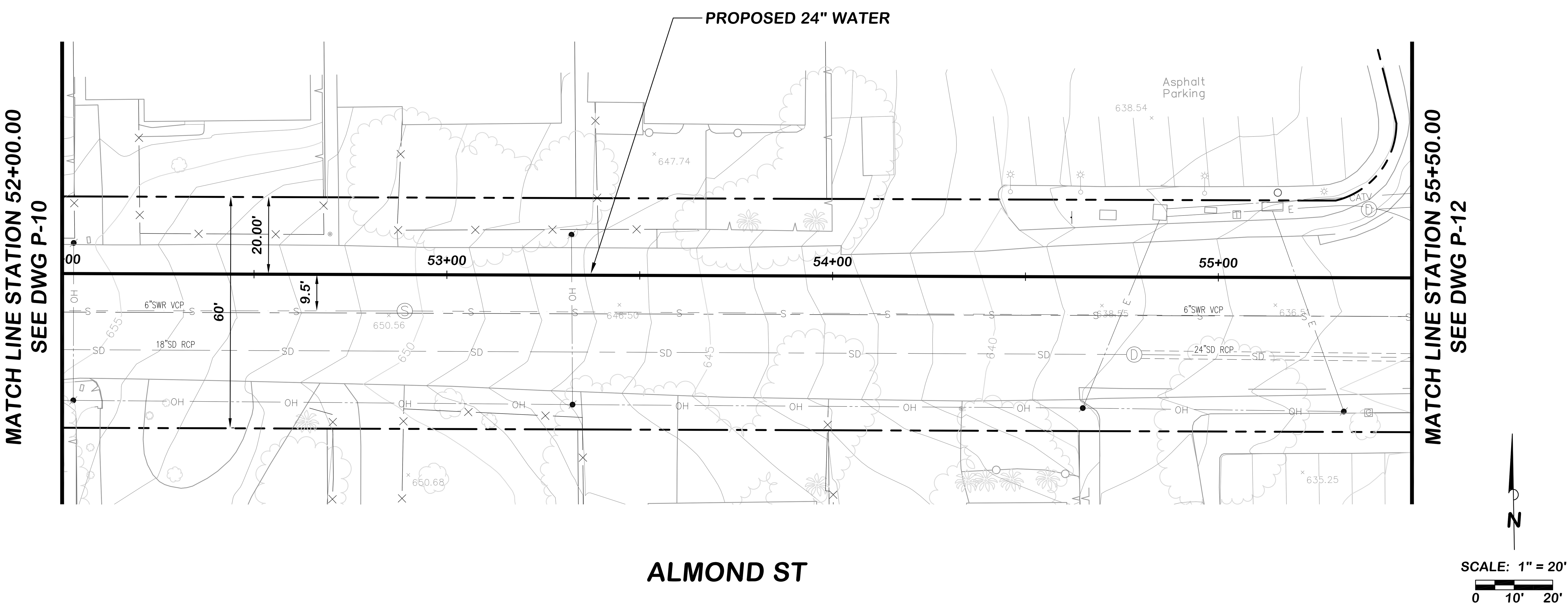

ALMOND ST

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

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DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RK
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FALLBROOK, CA 92028

APPROVED BY:

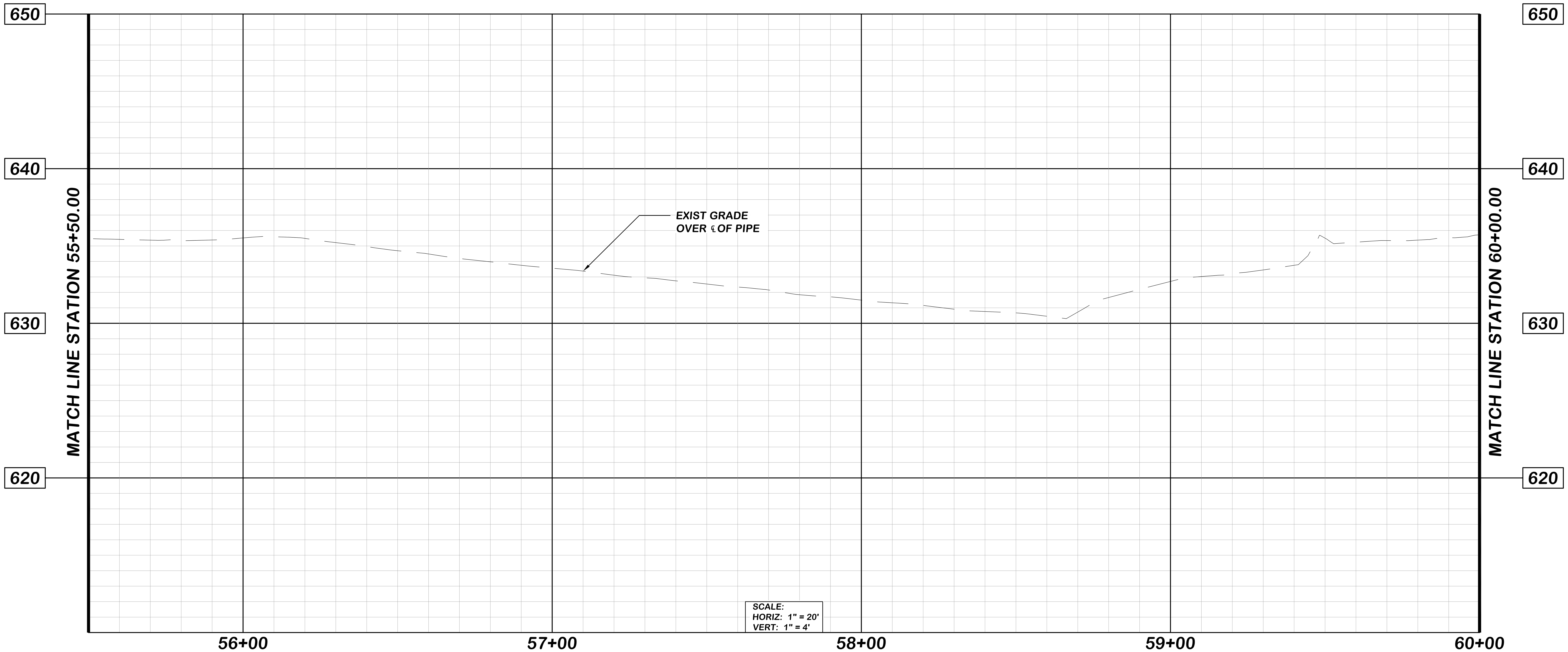
JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

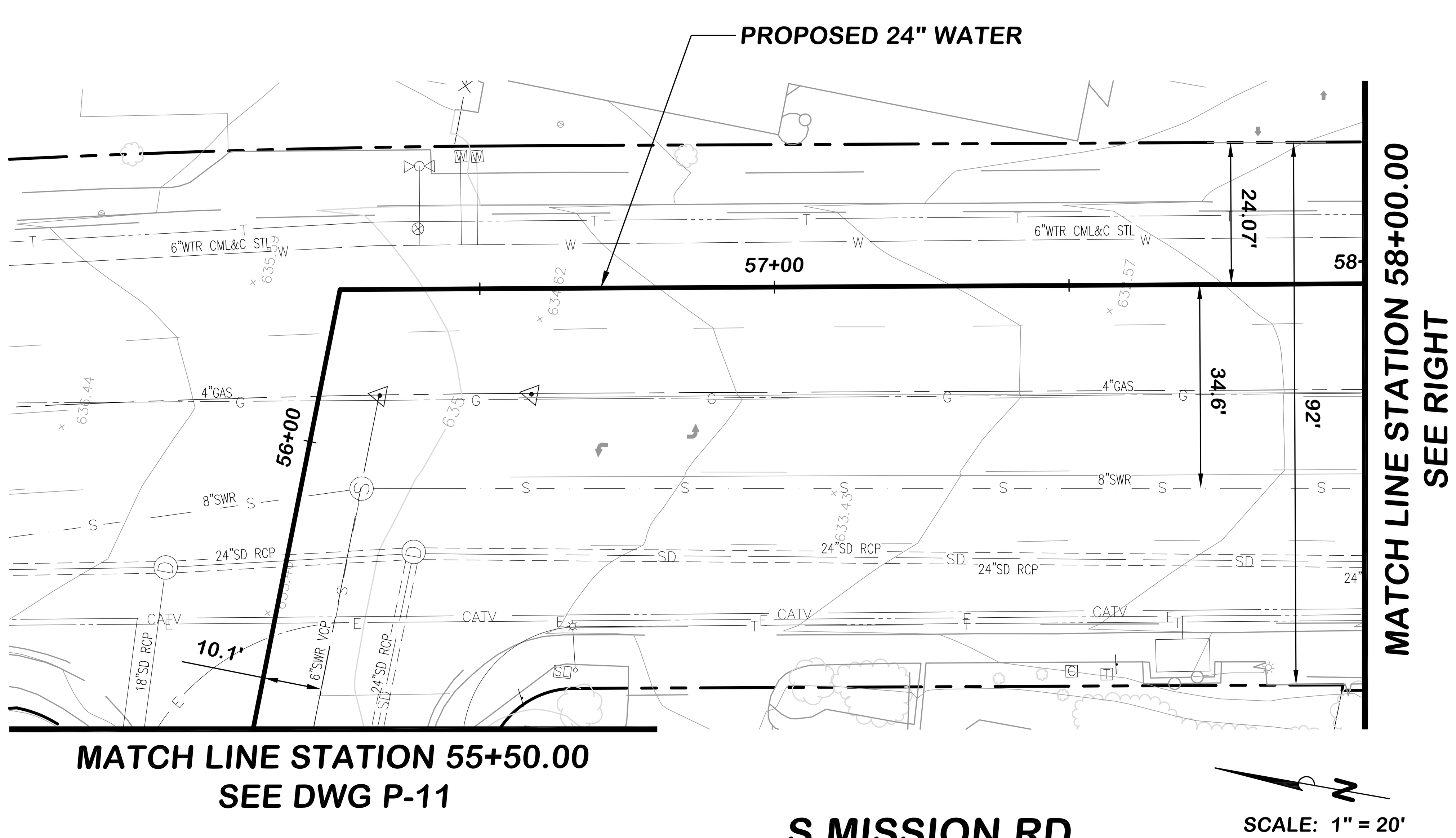
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

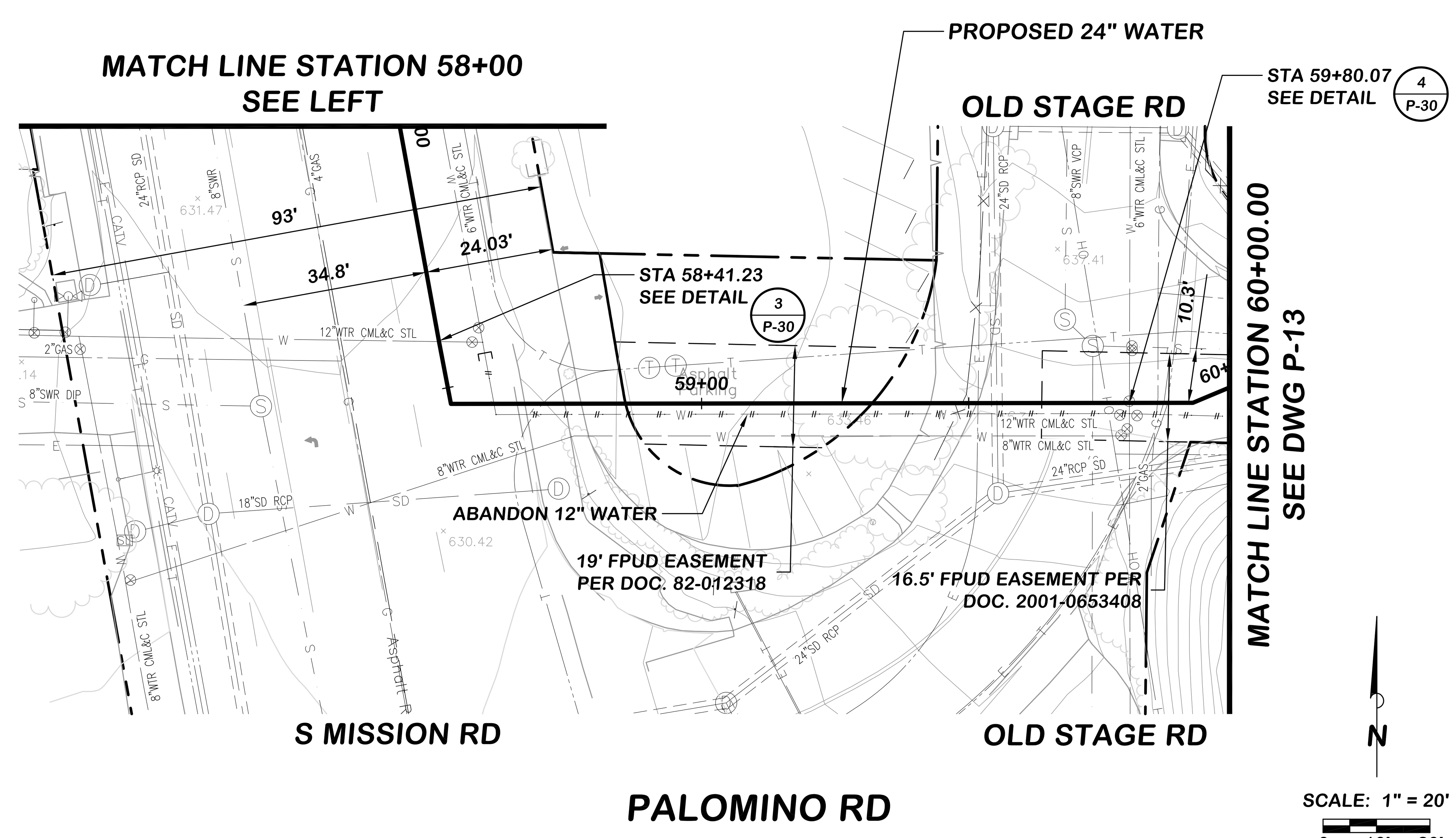
PRODUCT WATER PLAN AND PROFILE
STA 52+00.00 TO STA 55+50.00

DRAWING NO. P-11
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

P:\Projects\FPUD (0112)\0002 St. Marg Conjunctive Use Project\CADD\P-08 thru P-12.dwg 10/16/2015 09:40







30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

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PROJECT NO. 112.FPUD.0002
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APPROVED BY:

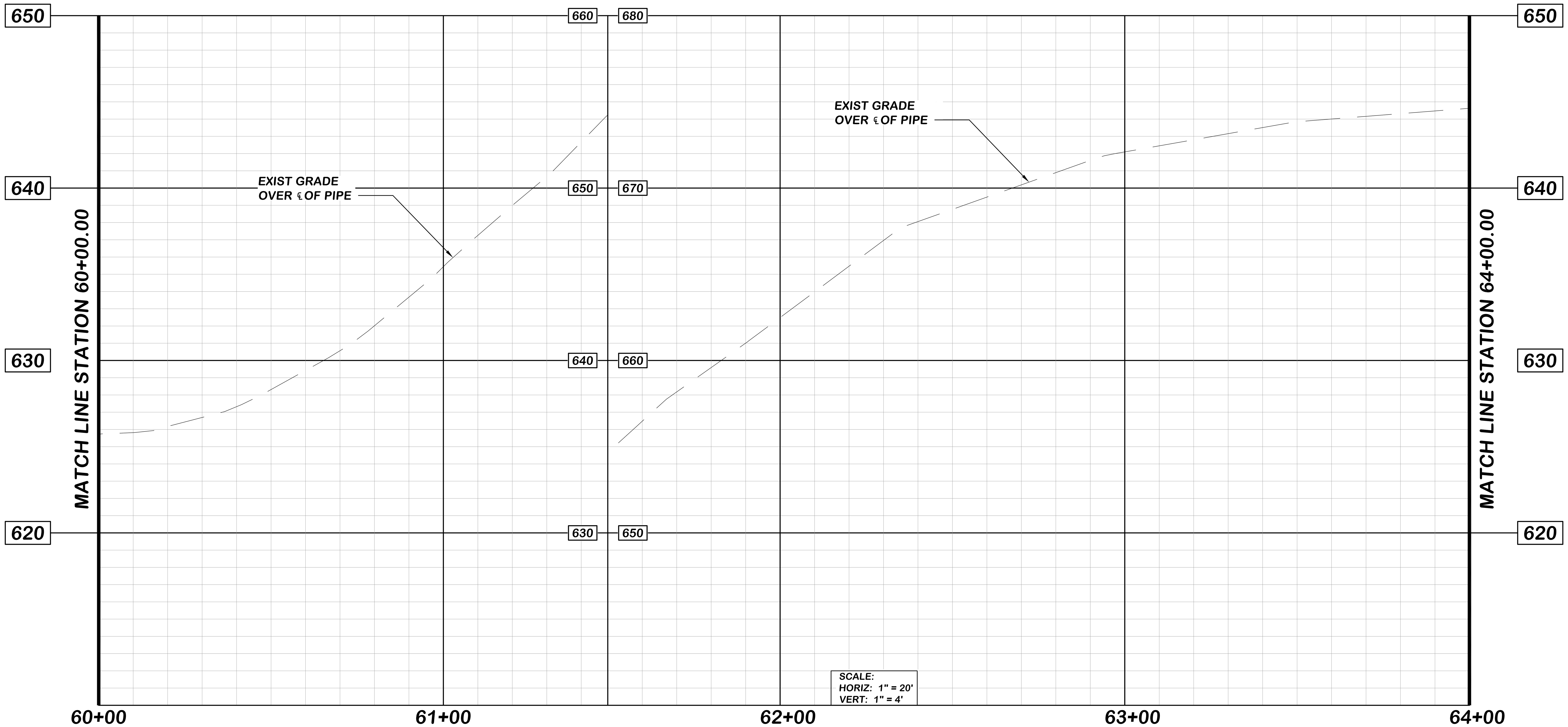
JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

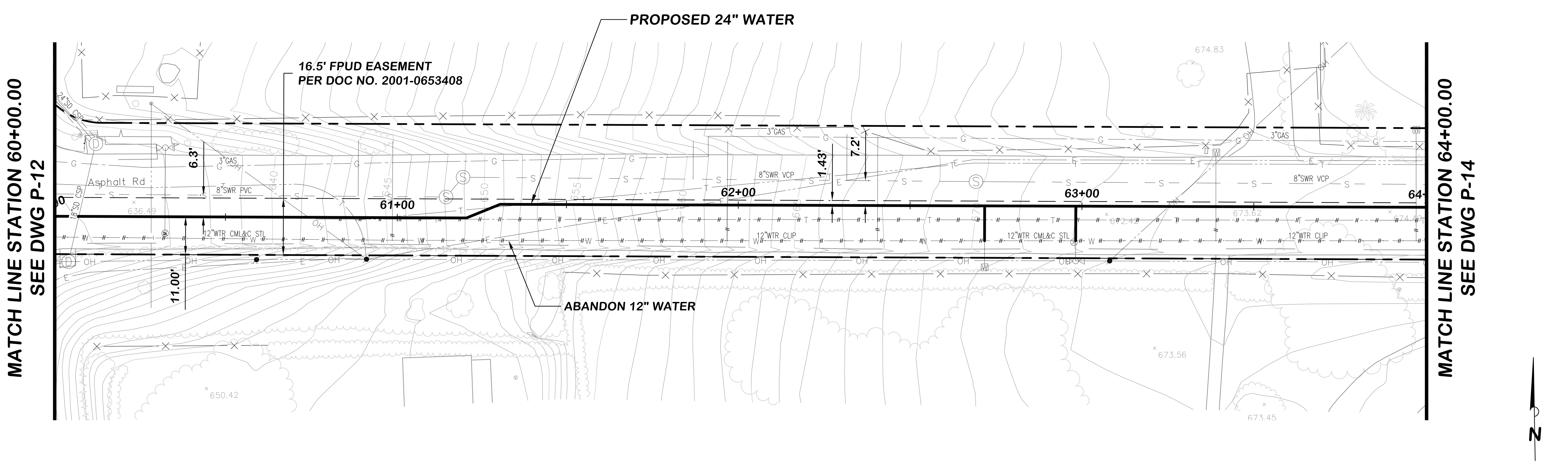
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

PRODUCT WATER PLAN AND PROFILE
STA 55+50.00 TO STA 60+00.00

DRAWING NO. P-12
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

P:\Projects\FPUD (0112)\0002 St. Marg Conjunctive Use Project\CADD\P-08 thru P-12.dwg 10/16/2015 09:43





PALOMINO RD

SCALE: 1" = 20'
0 10' 20'

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE 1" = 20'
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RK
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DATE

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FALLBROOK, CA 92028

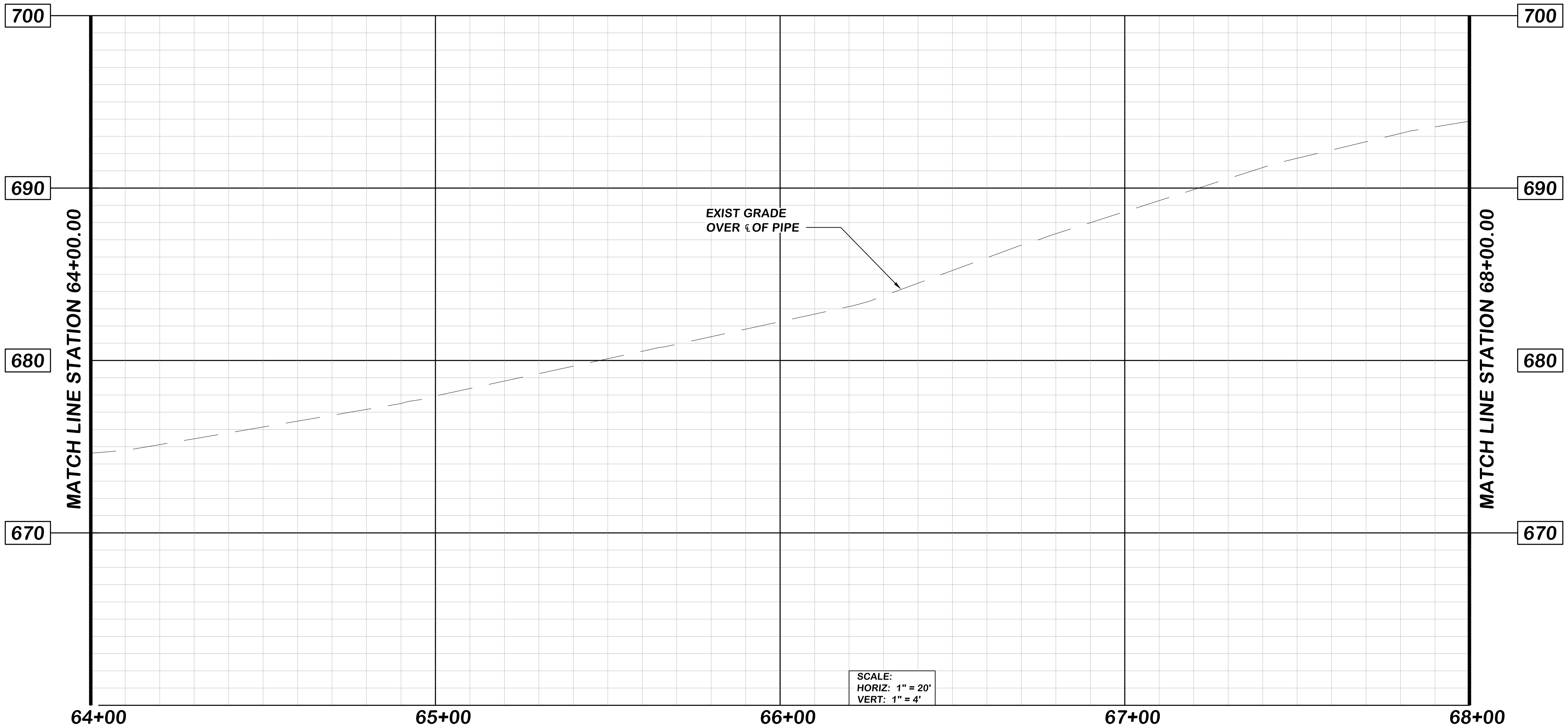
APPROVED BY:

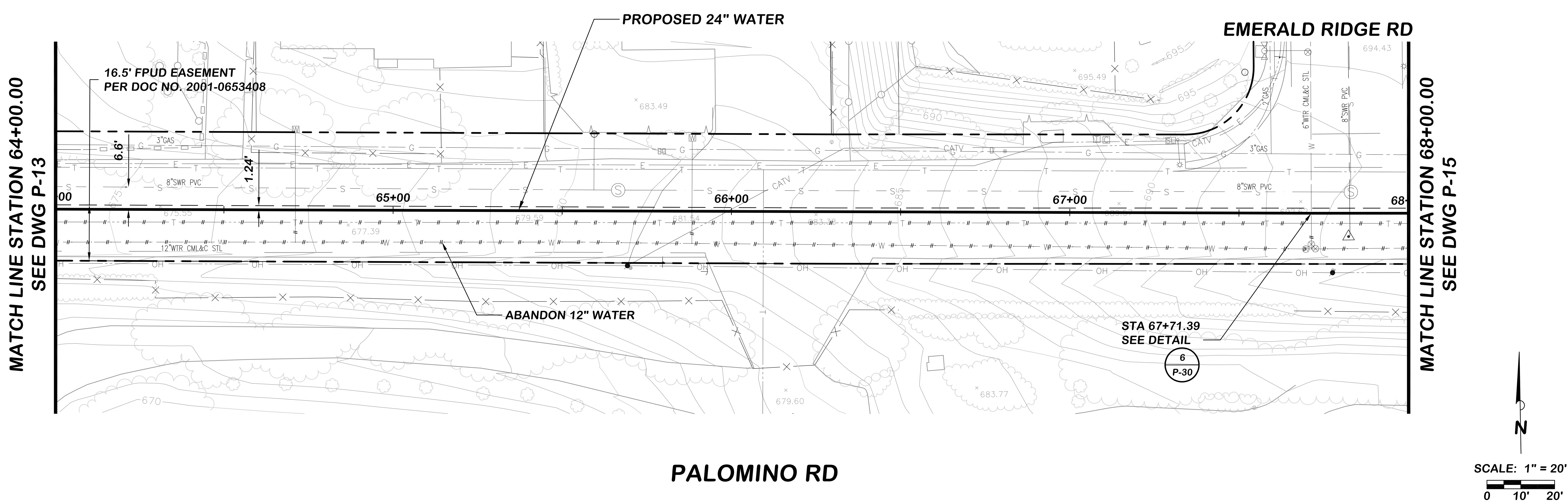
JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

PRODUCT WATER PLAN AND PROFILE
STA 60+00.00 TO STA 64+00.00

DRAWING NO. P-13
SHEET NO. XX OF XX
CLIENT JOB NO. 2744





30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE 1" = 20'
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RK
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www.iecorporation.com

DATE

FPUD Fallbrook Public Utility District
990 E. MISSION RD
FALLBROOK, CA 92028

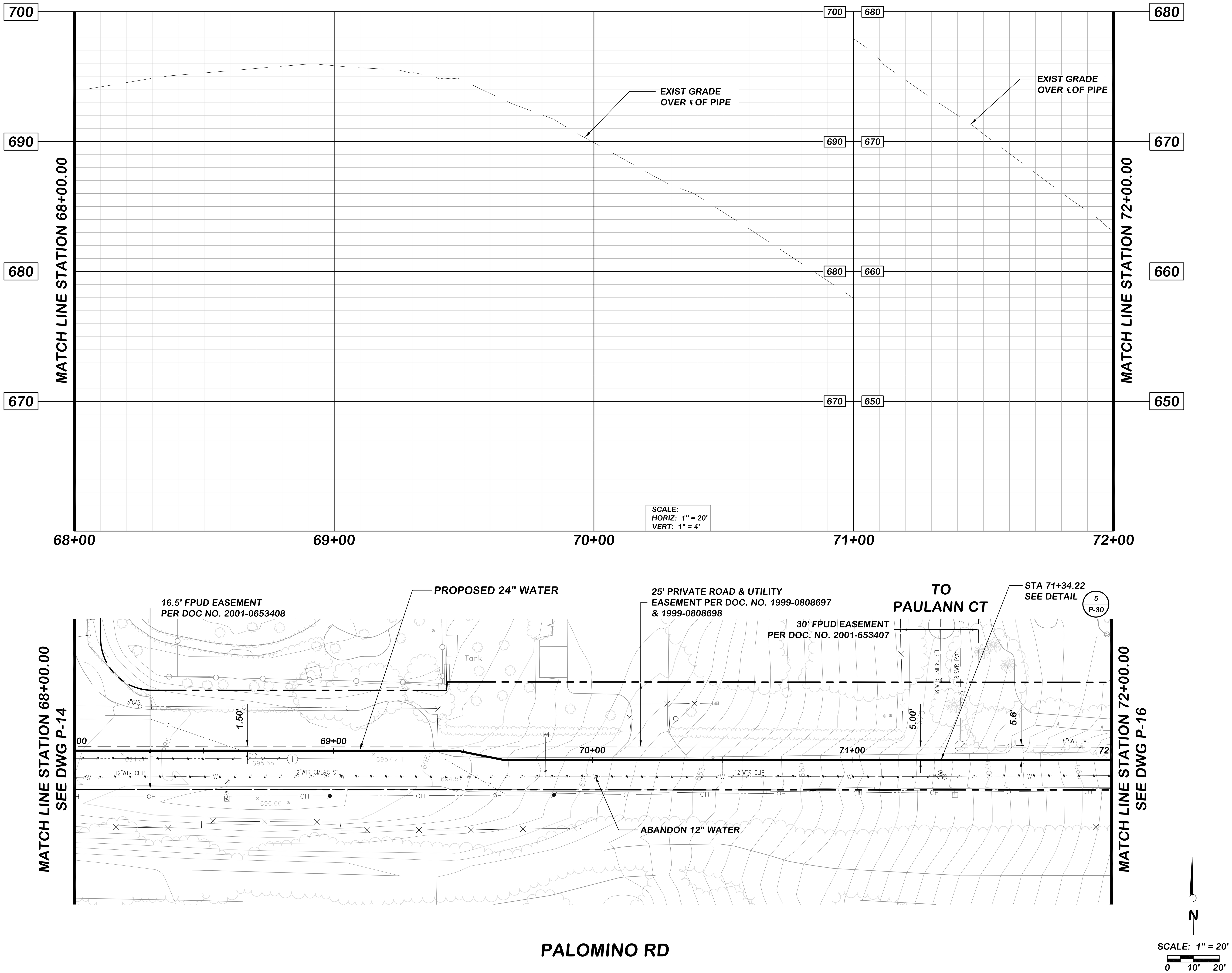
APPROVED BY:

JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

PRODUCT WATER PLAN AND PROFILE
STA 64+00.00 TO STA 68+00.00

DRAWING NO. P-14
SHEET NO. XX OF XX
CLIENT JOB NO. 2744



30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE 1" = 20'
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RK
DRAWN BY RI
CHECKED BY DP

Infrastructure
ENGINEERING CORPORATION
14271 Danielson Street
Poway, California 92064
T 858.413.2400 F 858.413.2440
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DATE

FPUD Fallbrook Public Utility District
990 E. MISSION RD
FALLBROOK, CA 92028

APPROVED BY:

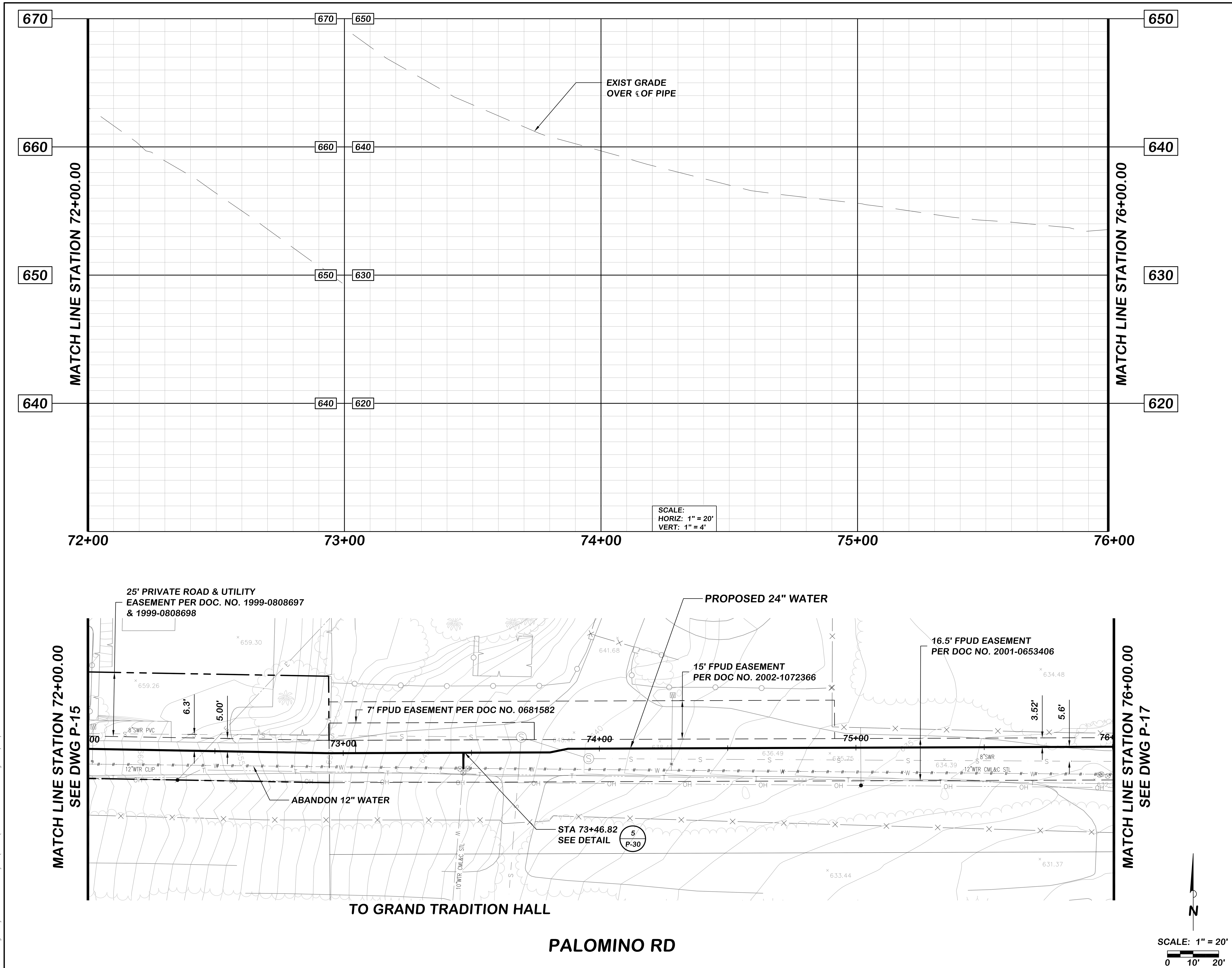
JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

PRODUCT WATER PLAN AND PROFILE
STA 68+00.00 TO STA 72+00.00

DRAWING NO. P-15
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

P:\Projects\FPUD (0112)\0002 St. Marg Conjunctive Use Project\CADD\P-13 thru P-17.dwg 10/19/2015 14:03



30% SUBMITTAL

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APPROVED BY:

JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

PRODUCT WATER PLAN AND PROFILE
STA 72+00.00 TO STA 76+00.00

DRAWING NO. P-16
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

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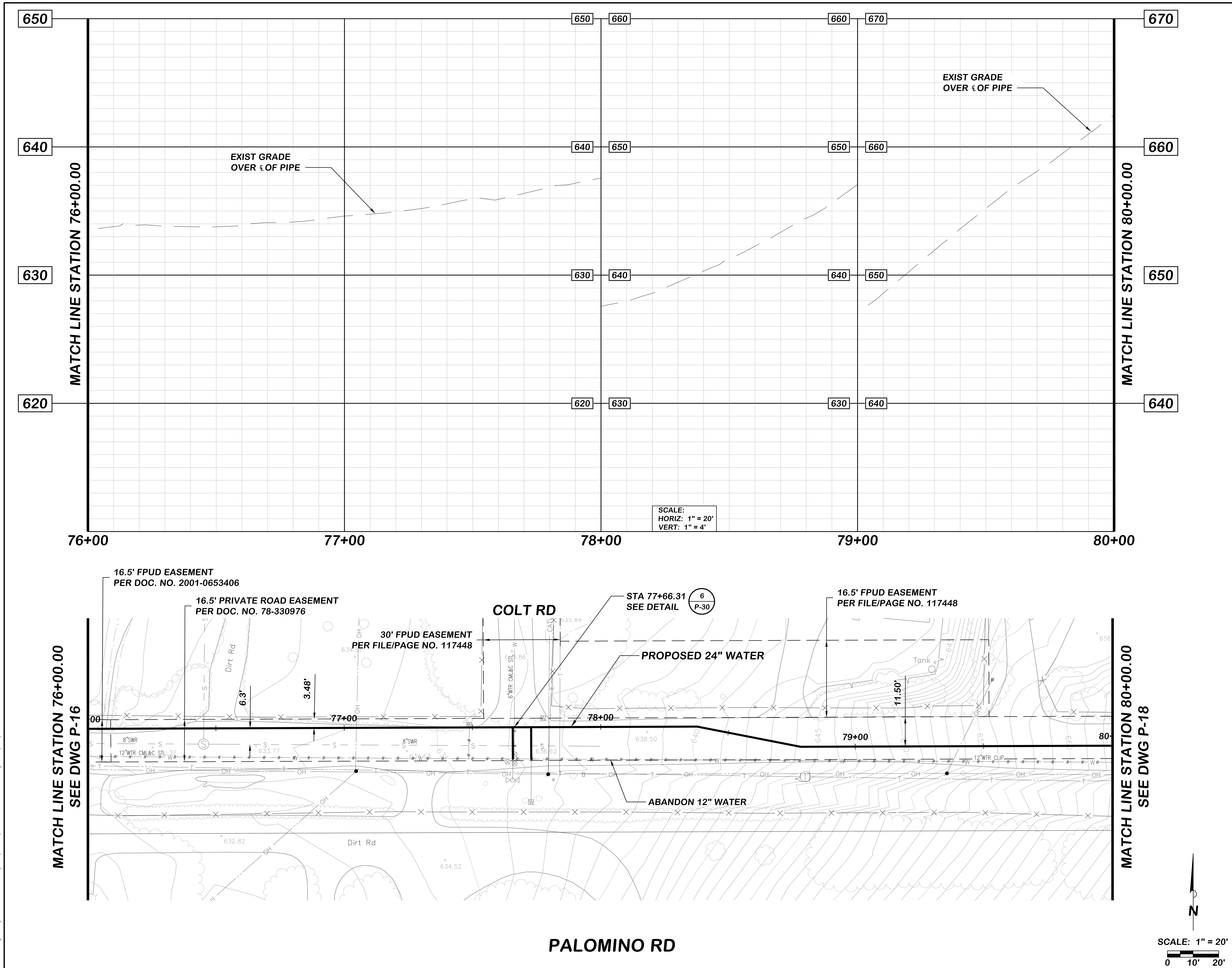

30% SUBMITTAL

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DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RK
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APPROVED BY:

JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

PRODUCT WATER PLAN AND PROFILE STA 76+00.00 TO STA 80+00.00

DRAWING NO. P-17
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

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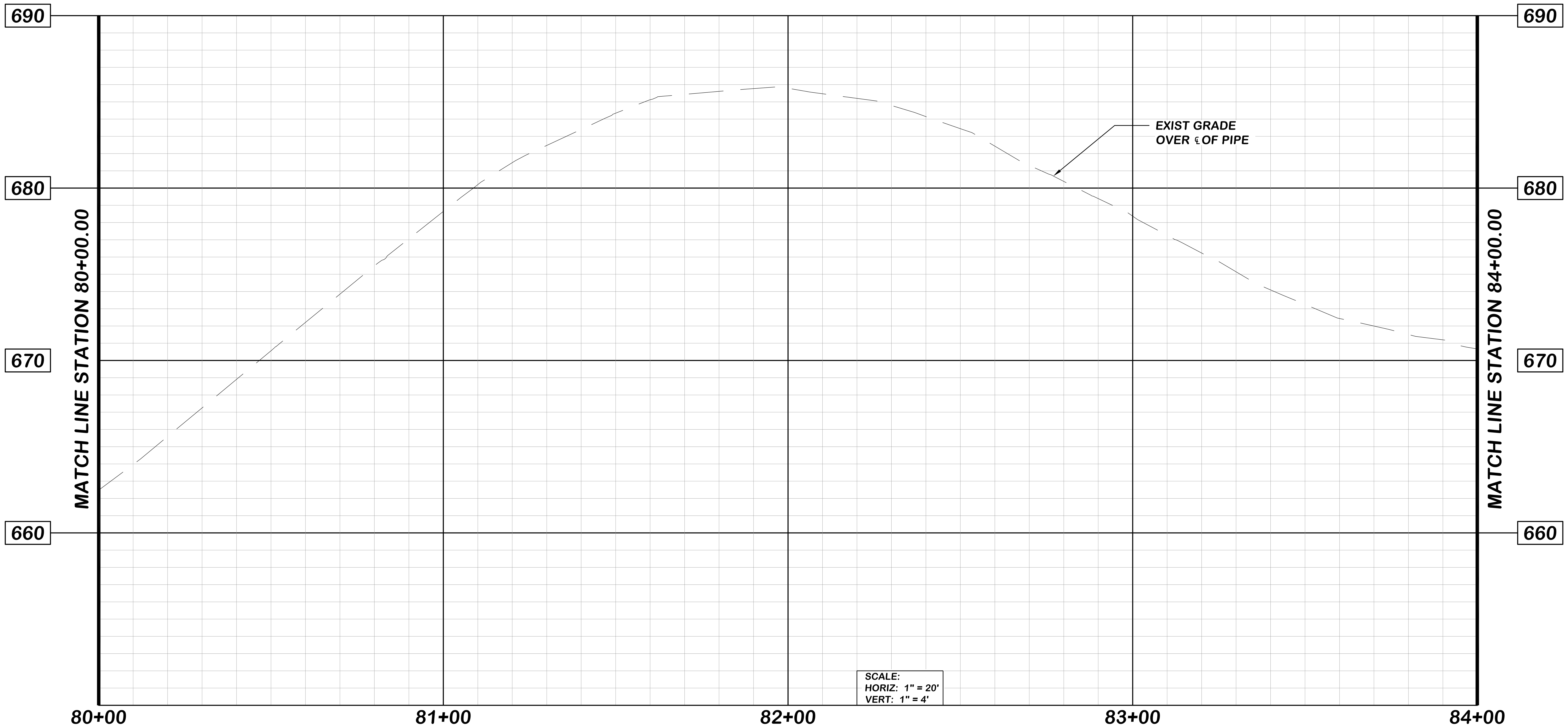

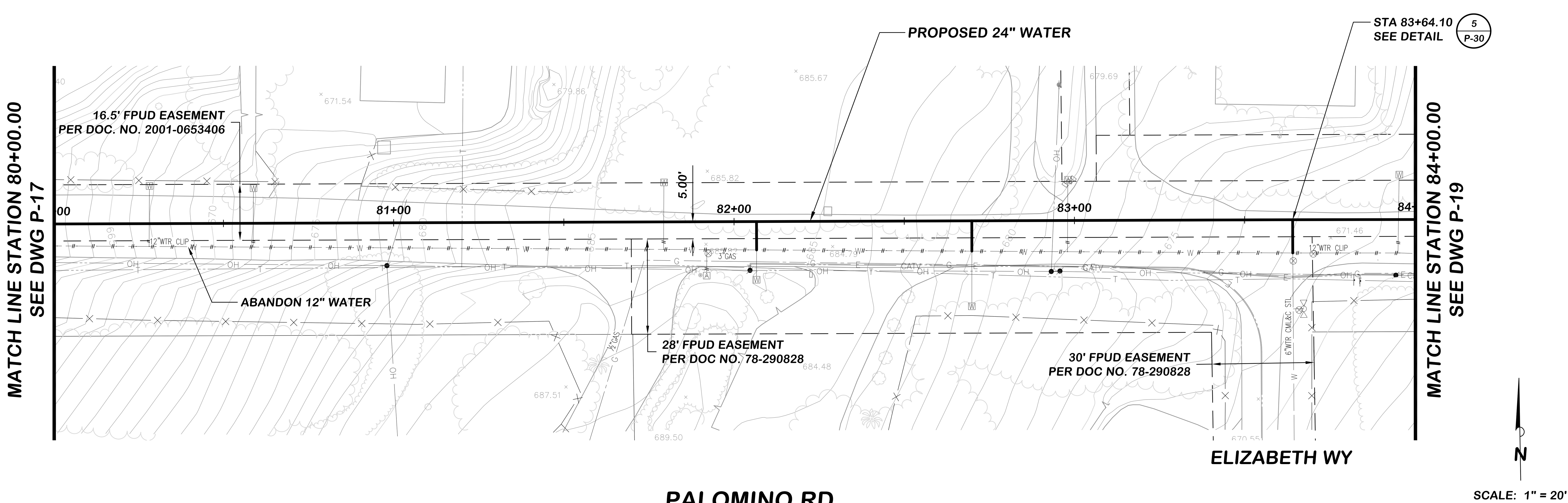

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PROJECT NO. 112.FPUD.0002
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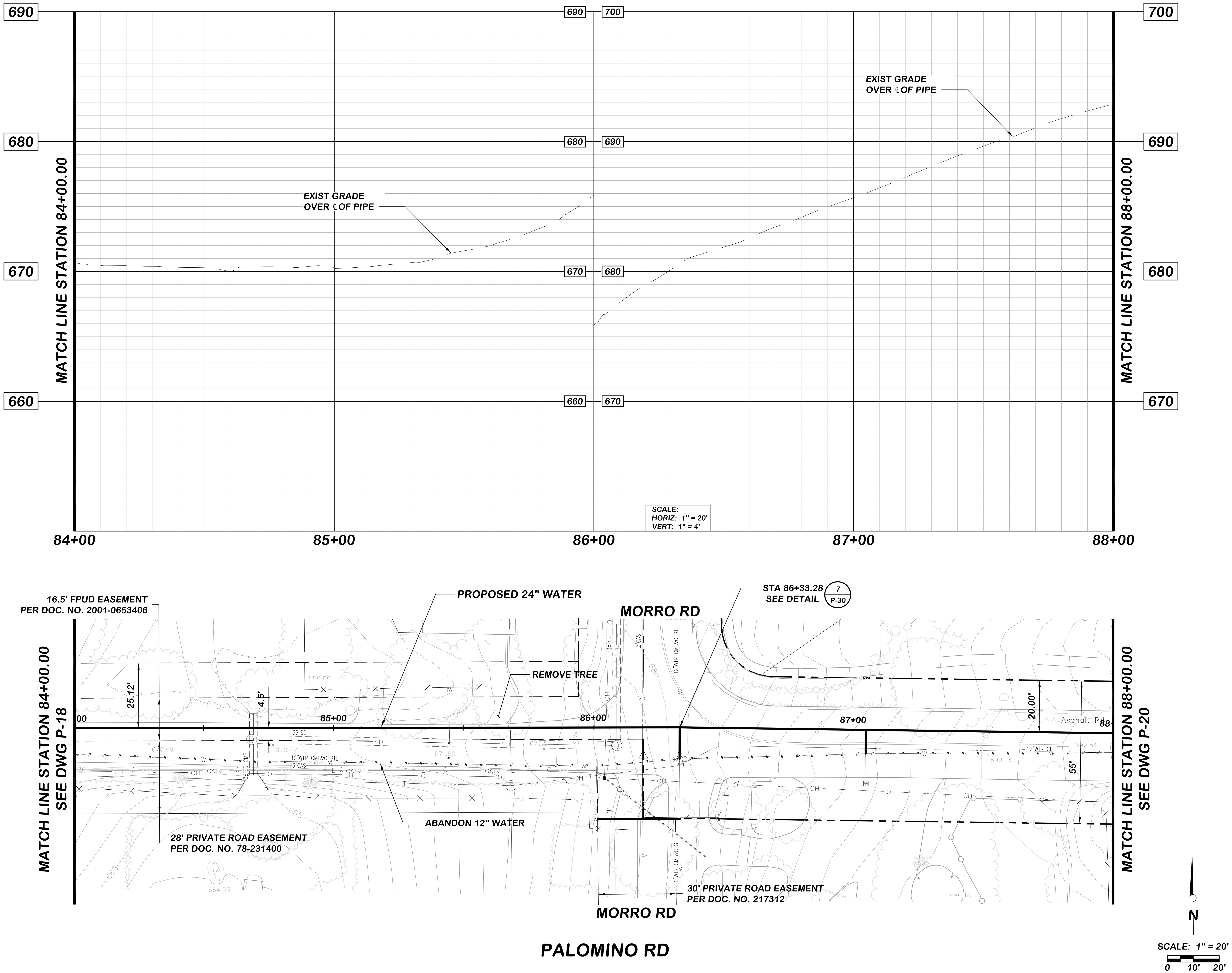
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

PRODUCT WATER PLAN AND PROFILE
STA 80+00.00 TO STA 84+00.00

DRAWING NO. P-18
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

P:\Projects\FPUD (0112)\0002 St. Marg Conjunctive Use Project\CADD\P-18 thru P-22.dwg 10/19/2015 13:57



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NO.	DESCRIPTION	DATE	APPROVED

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PROJECT NO. 112.FPUD.0002
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DATE

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APPROVED BY:

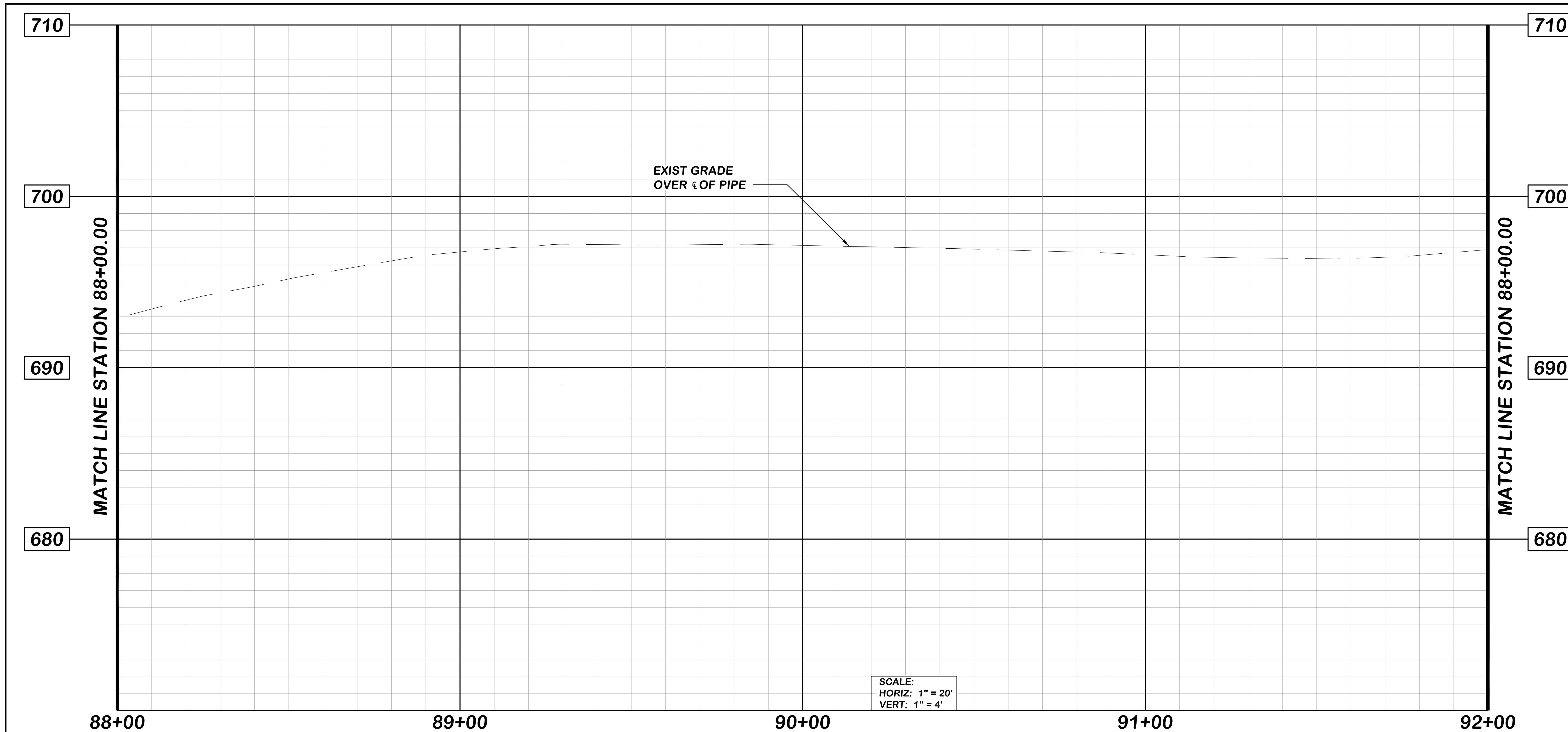
JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

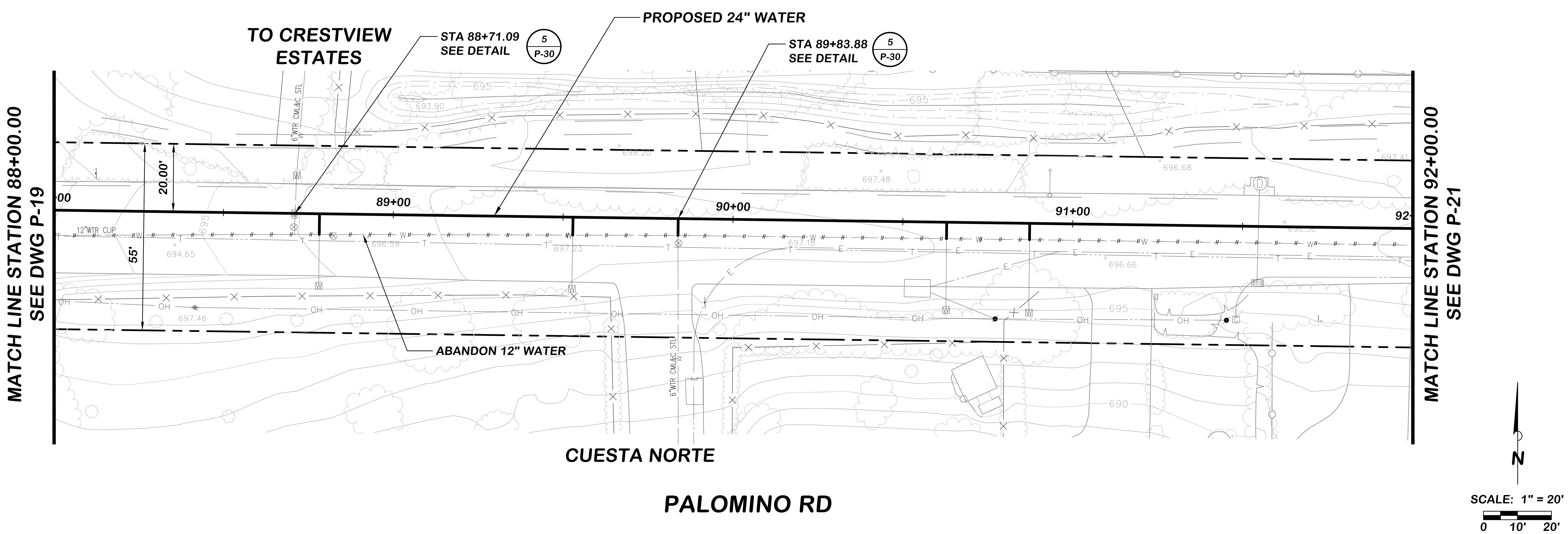
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

PRODUCT WATER PLAN AND PROFILE
STA 84+00.00 TO STA 88+00.00

DRAWING NO. P-19
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

P:\Projects\FPUD (0112)\0002 St. Marg Conjunctive Use Project\CADD\P-18 thru P-22.dwg 10/16/2015 10:05





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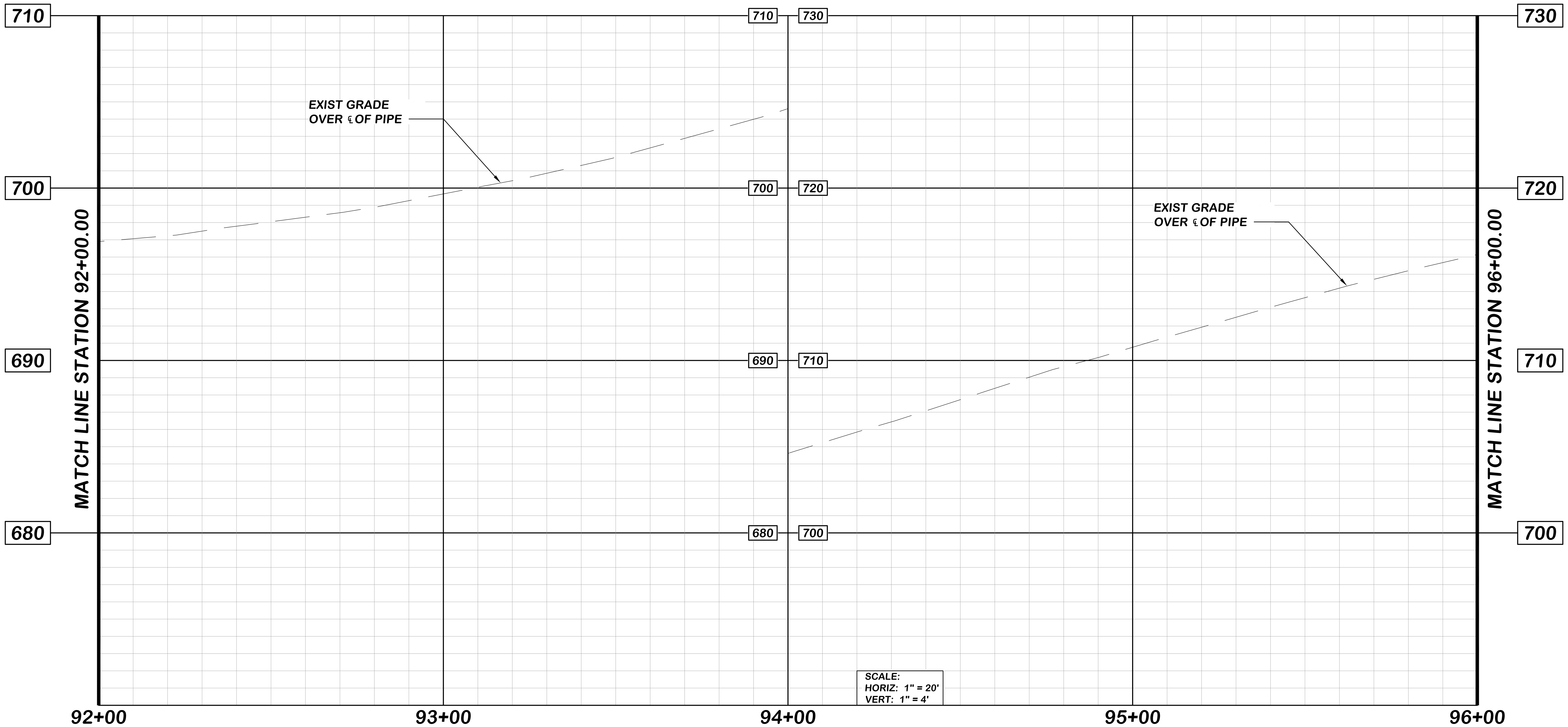
JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

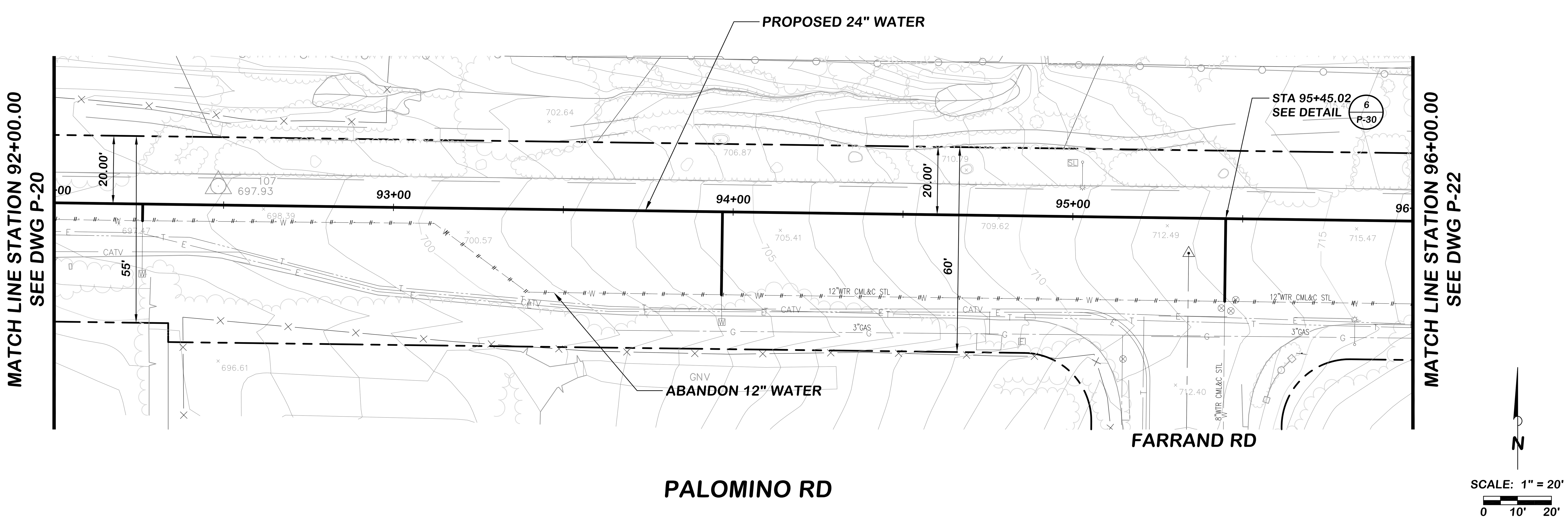
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

PRODUCT WATER PLAN AND PROFILE
STA 88+00.00 TO STA 92+00.00

DRAWING NO. P-20
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

P:\Projects\FPUD (0112)\0002 St. Marg Conjunctive Use Project\CAD\P-18 thru P-22.dwg 10/16/2015 10:06





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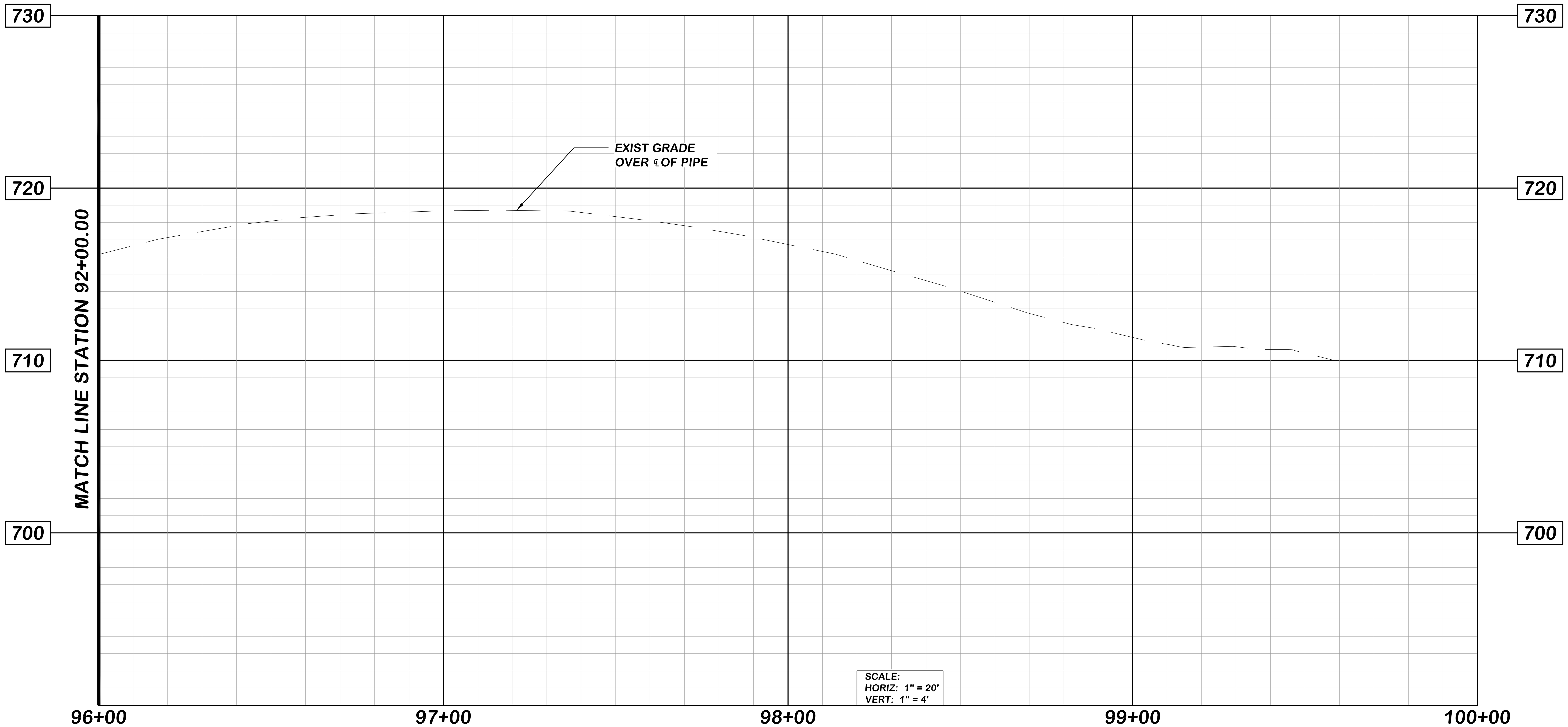
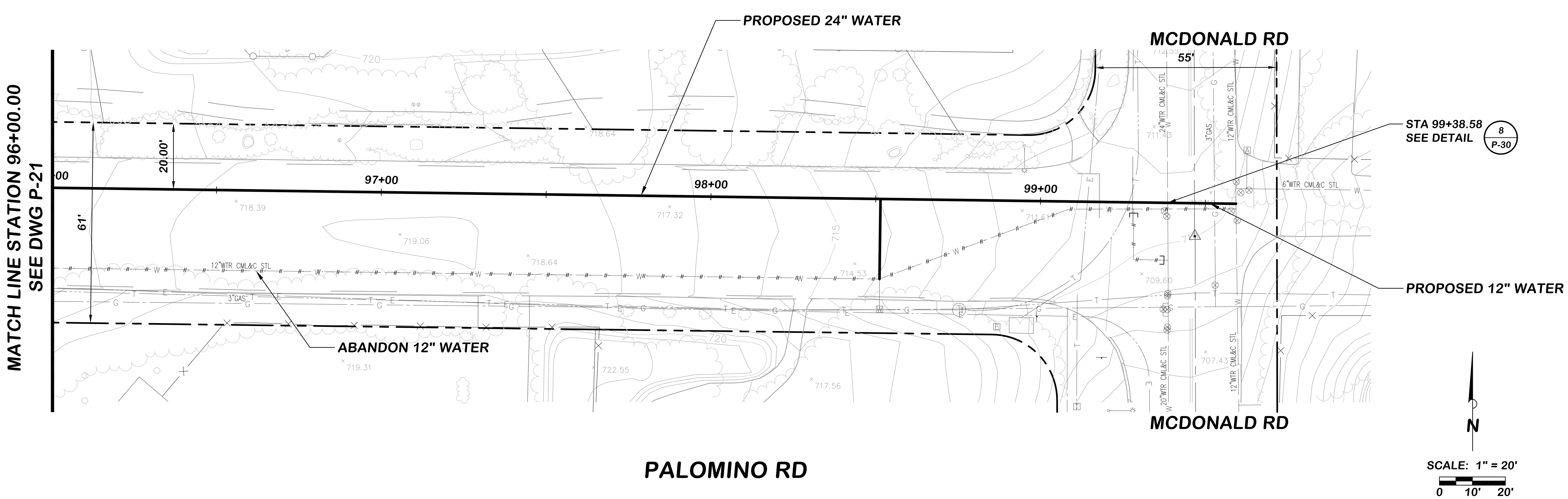
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

PRODUCT WATER PLAN AND PROFILE
STA 92+00.00 TO STA 96+00.00

DRAWING NO. P-21
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

P:\Projects\FPUD (0112)\0002 St. Marg Conjunctive Use Project\CADD\P-18 thru P-22.dwg 10/16/2015 10:08





30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE 1" = 20'
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RK
DRAWN BY RI
CHECKED BY DP

Infrastructure
ENGINEERING CORPORATION
14271 Danielson Street
Poway, California 92064
T 858.413.2400 F 858.413.2440
www.iecorporation.com

DATE

FPUD Fallbrook Public Utility District
990 E. MISSION RD
FALLBROOK, CA 92028

APPROVED BY:

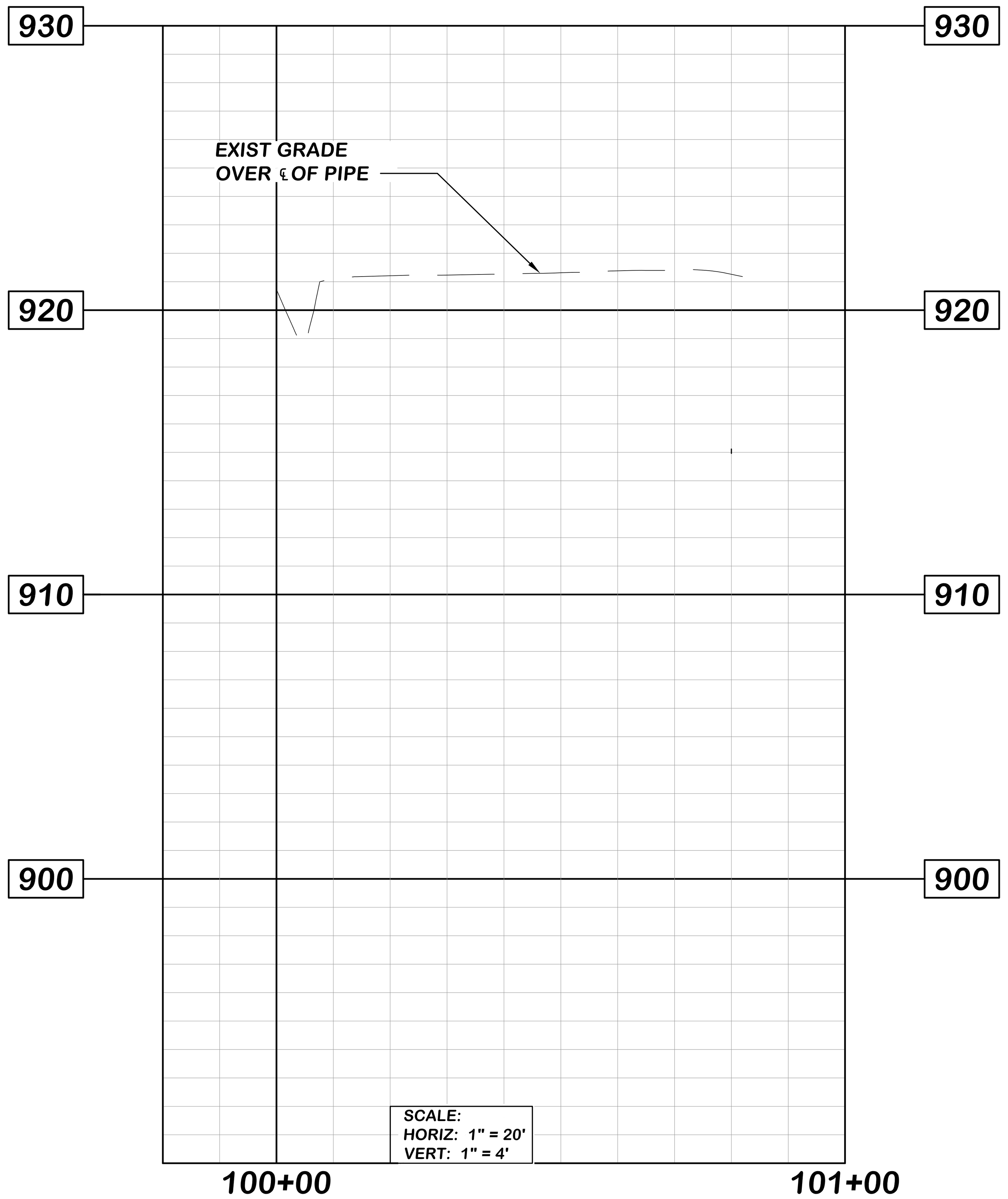
JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

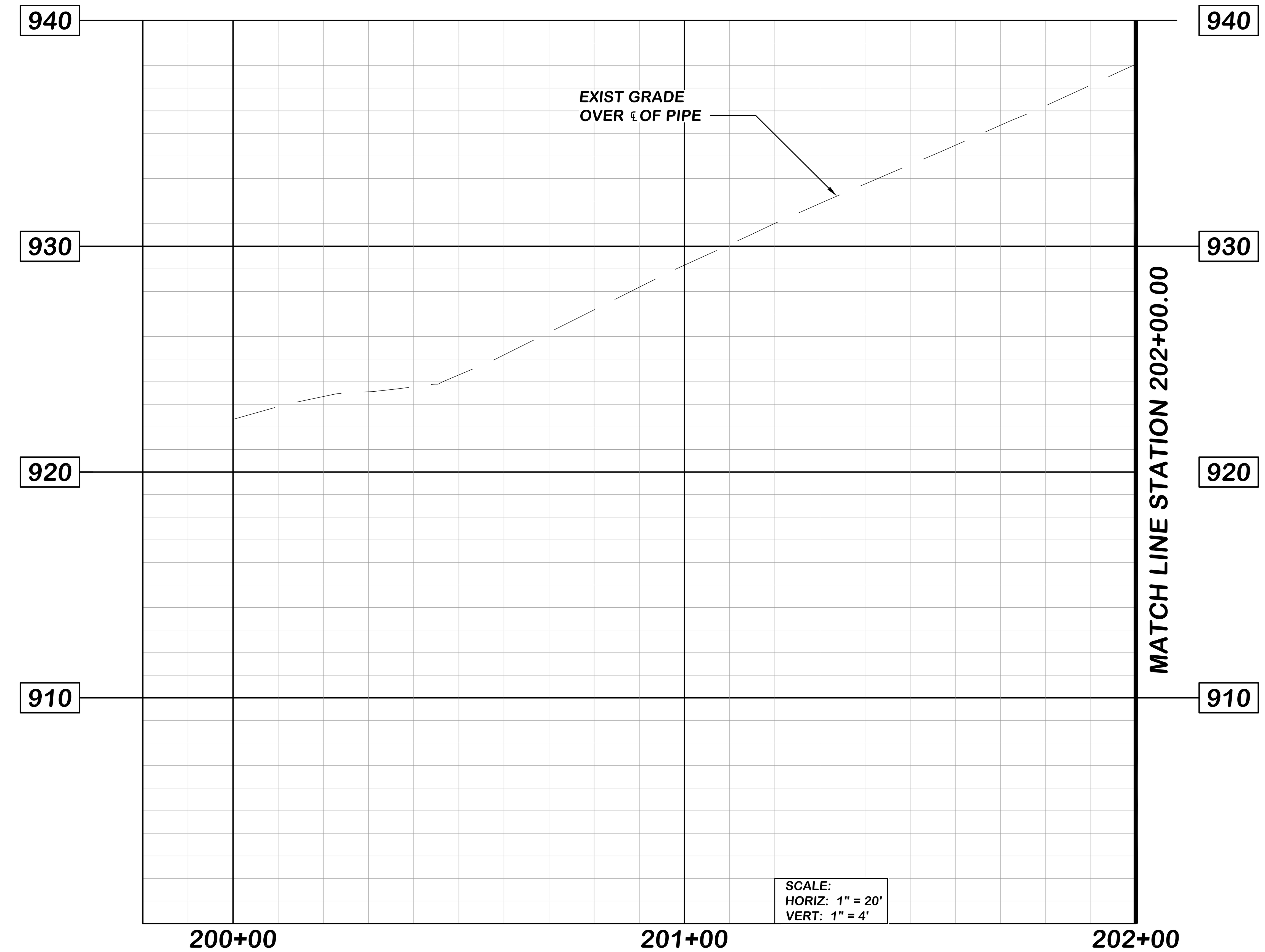
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

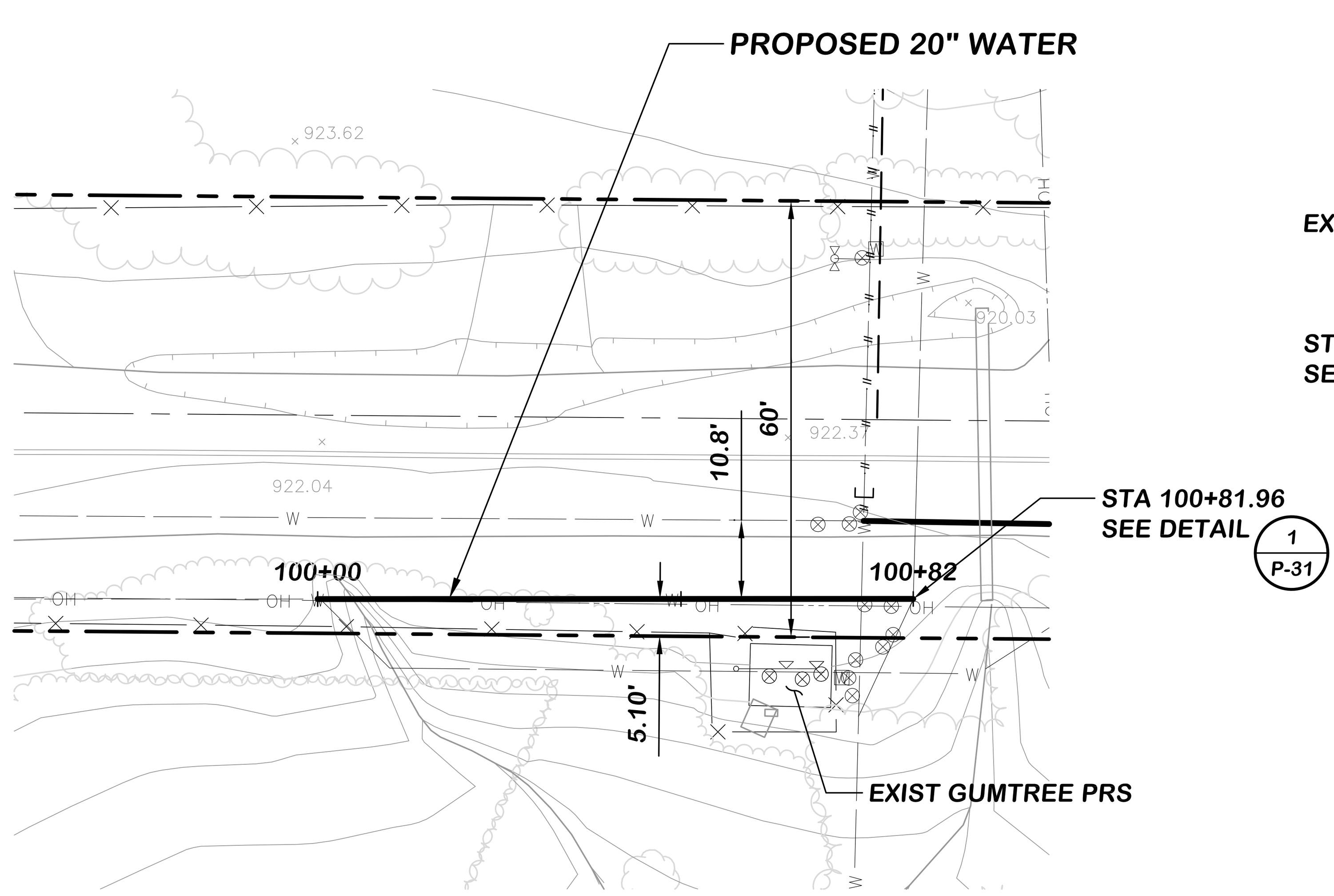
PRODUCT WATER PLAN AND PROFILE
STA 96+00.00 TO STA 99+59.29

DRAWING NO. P-22
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

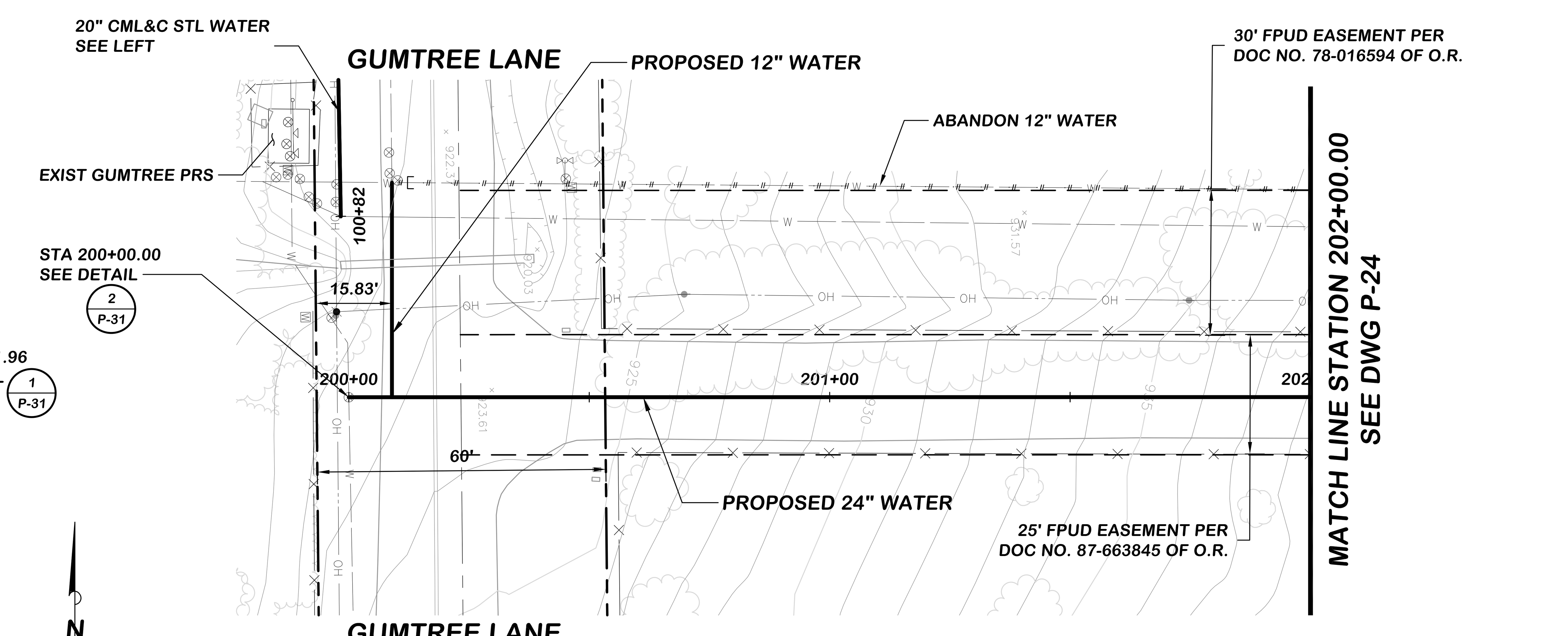
P:\Projects\FPUD (0112)\0002 St. Marg Conjunctive Use Project\CADD\P-18 thru P-22.dwg 10/16/2015 10:08







GUMTREE LANE



DISTRICT EASEMENT

SCALE: 1" = 20'
0 10' 20'

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE 1" = 20'
DATE 10/2015
PROJECT NO. 112.FPUD.0002
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FALLBROOK, CA 92028

APPROVED BY:

JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

PRODUCT WATER PLAN AND PROFILE

STA 100+00.00 TO STA 100+81.96 AND STA 200+00.00 TO STA 202+00.00

DRAWING NO. P-23
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

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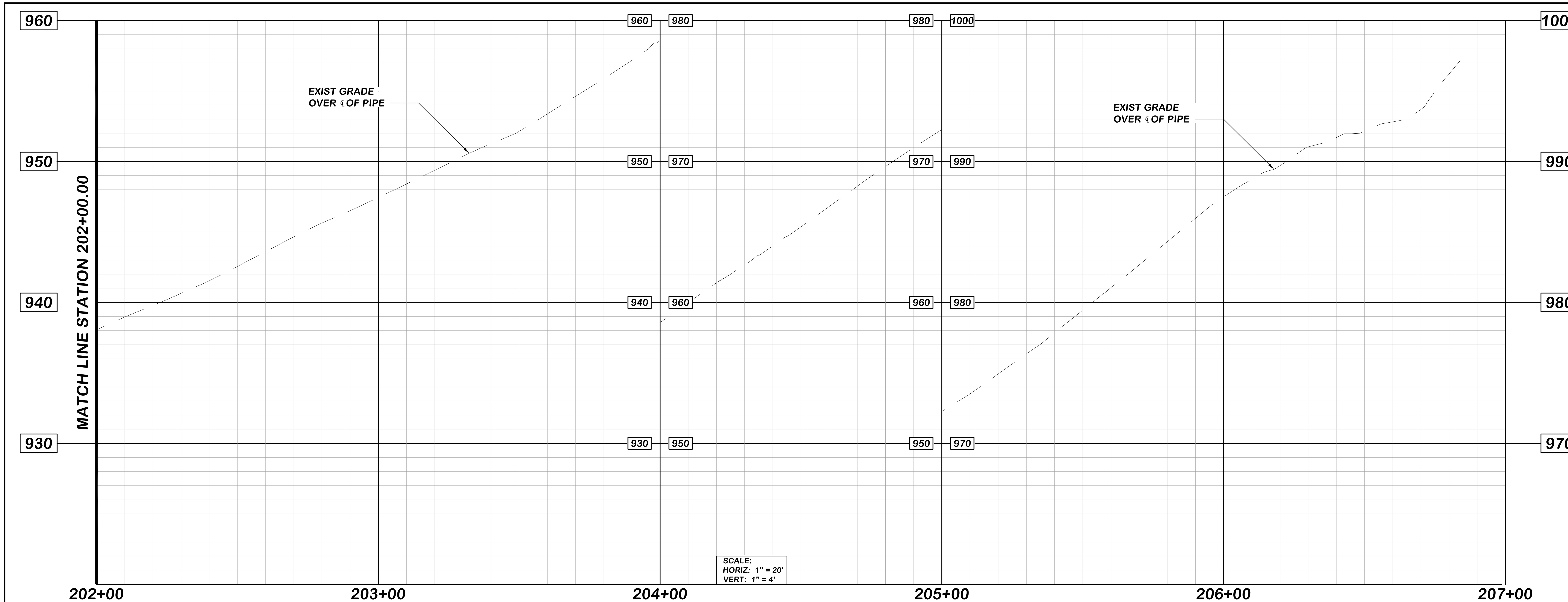

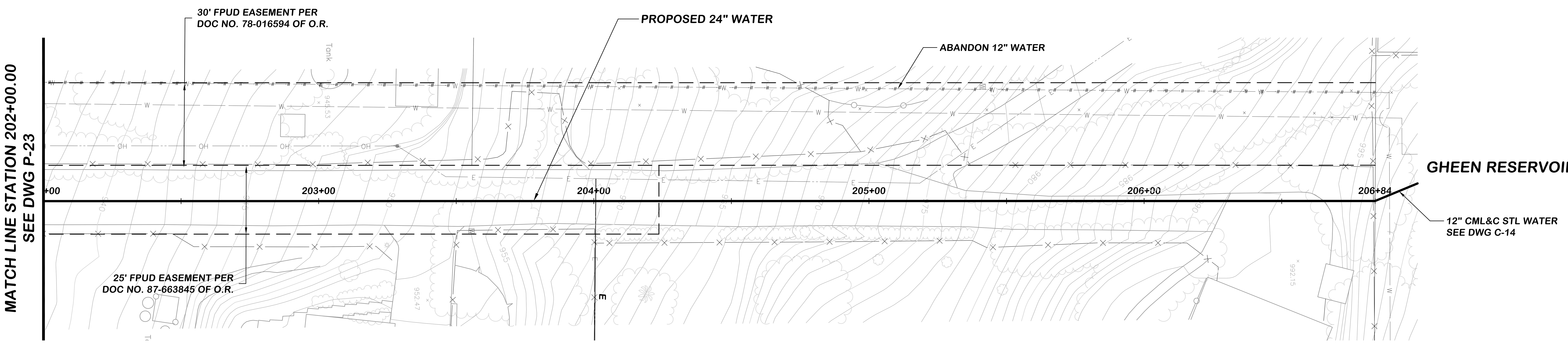

DISTRICT EASEMENT

SCALE: 1" = 20'
0 10' 20'

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE 1" = 20'
DATE 10/2015
PROJECT NO. 112.FPUD.0002
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FALLBROOK, CA 92028

APPROVED BY:
JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

PRODUCT WATER PLAN AND PROFILE
STA 202+00.00 TO STA 206+83.96

DRAWING NO. P-24
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

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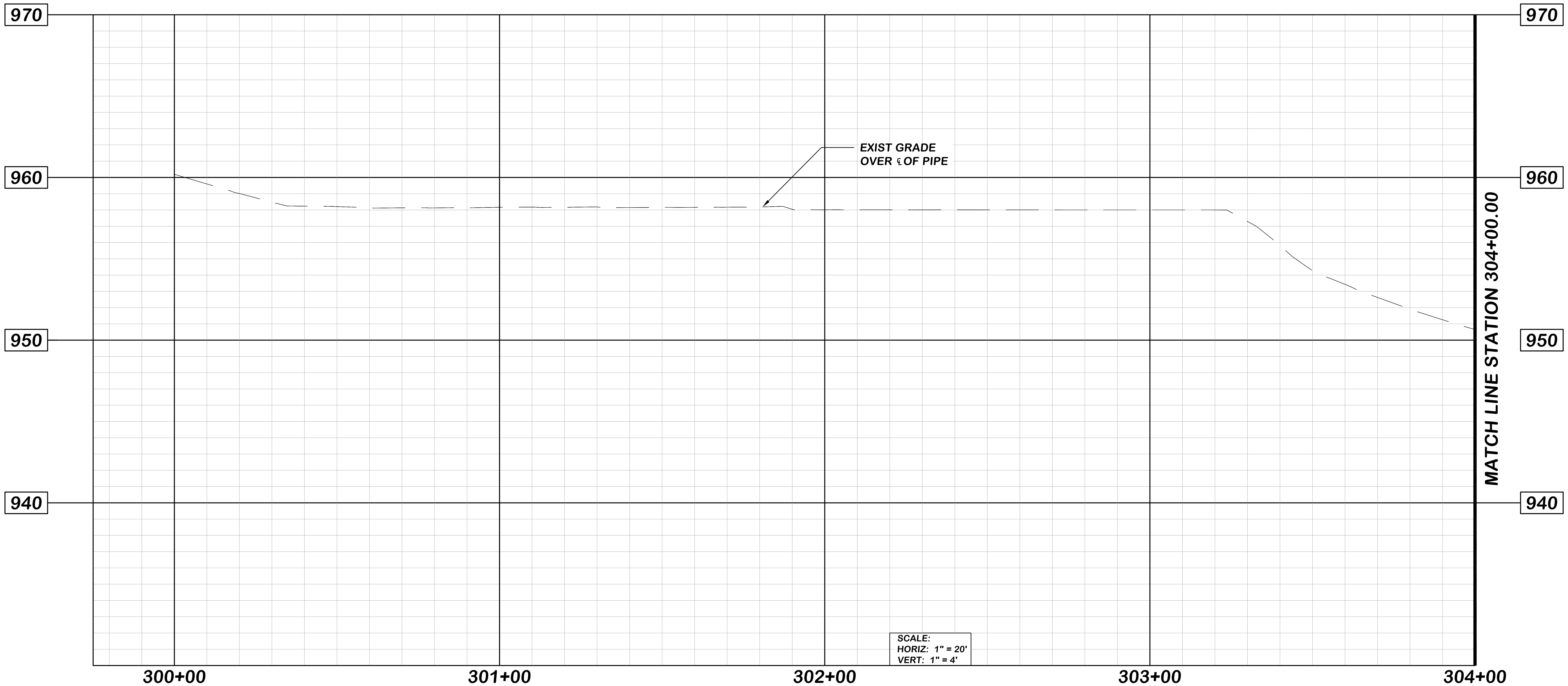

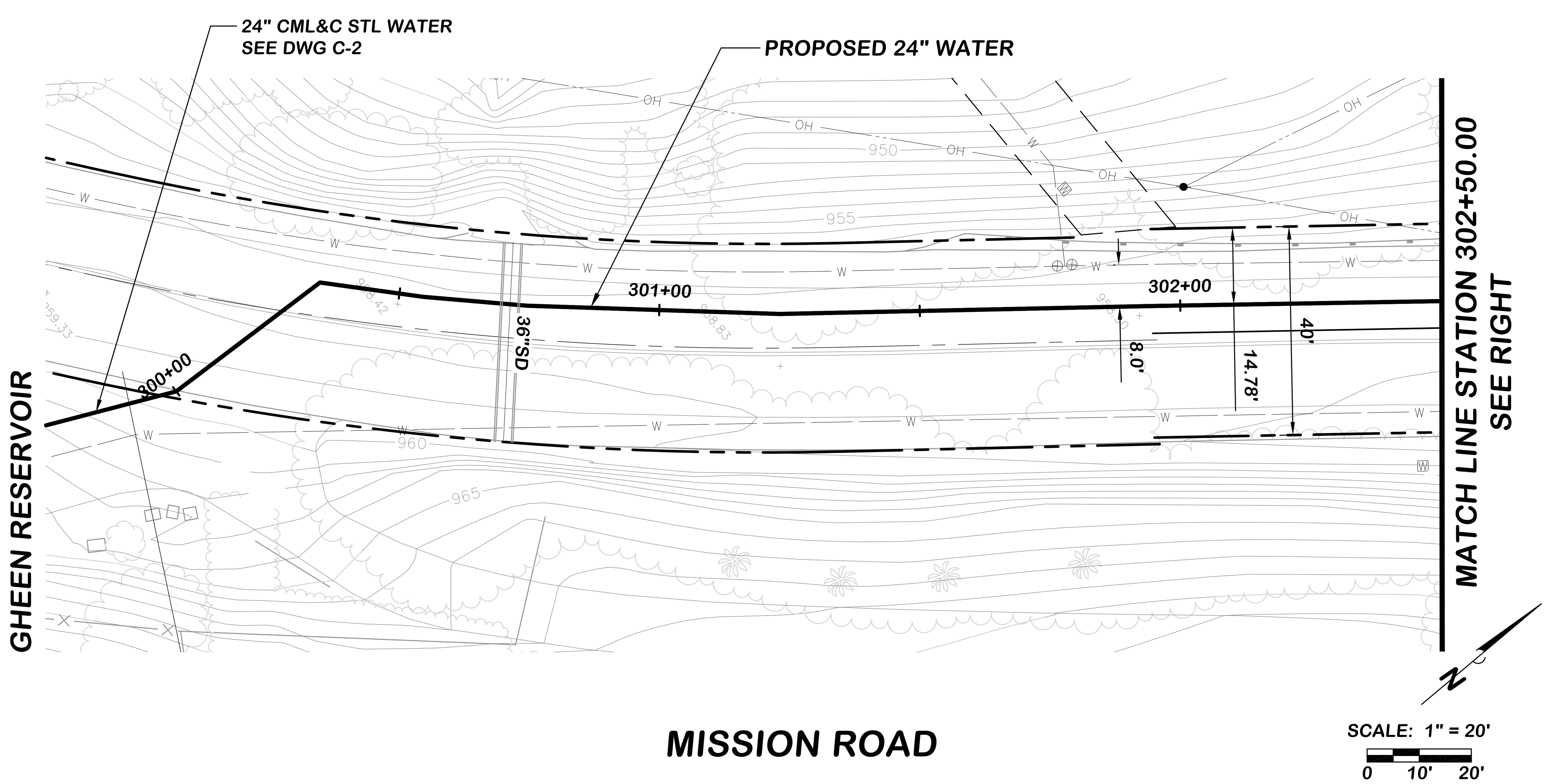

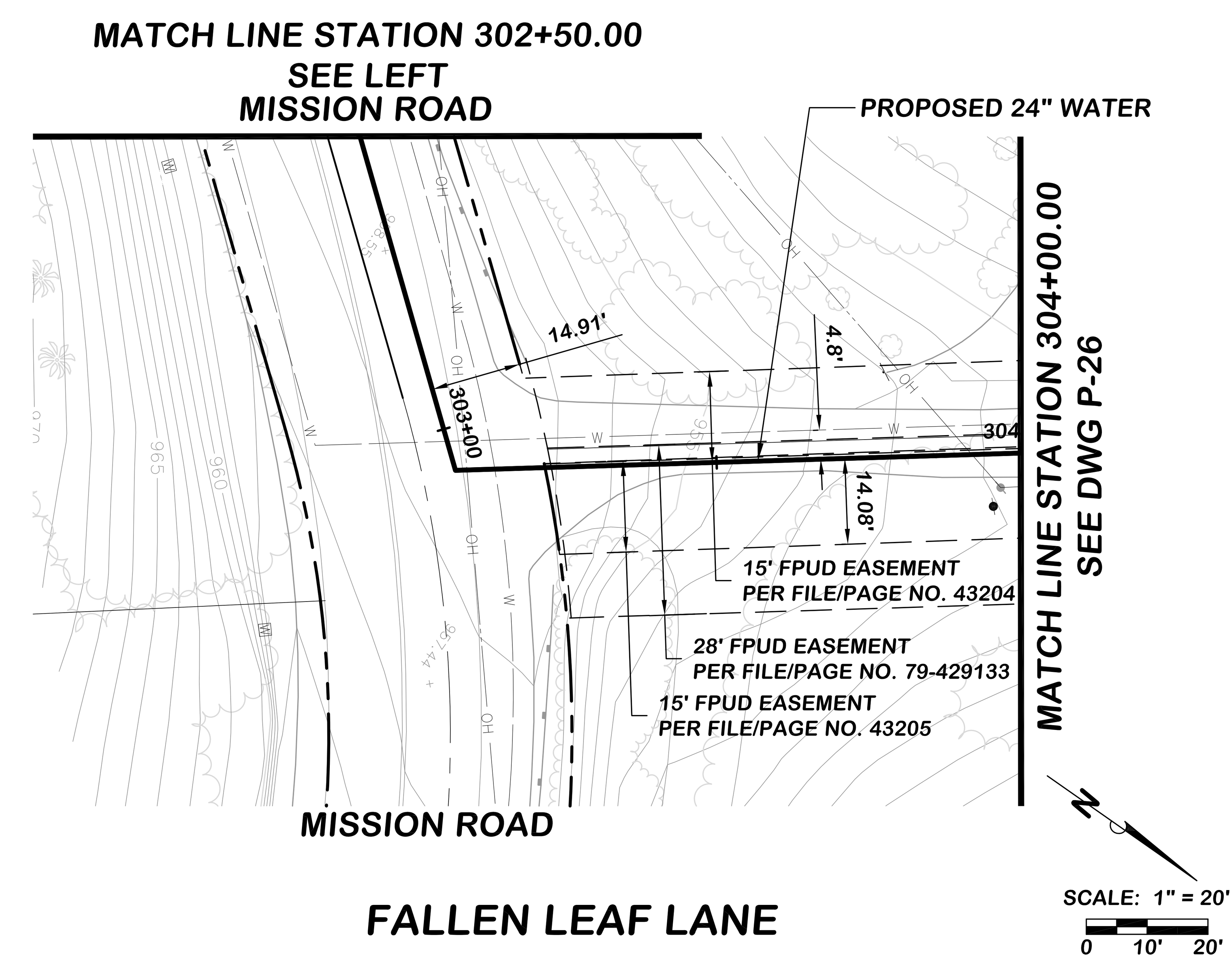

30% SUBMITTAL

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PROJECT NO. 112.FPUD.0002
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ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE
PROJECT FACILITIES

PRODUCT WATER PLAN AND PROFILE
STA 300+00.00 TO STA 304+00.00

DRAWING NO. P-25
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

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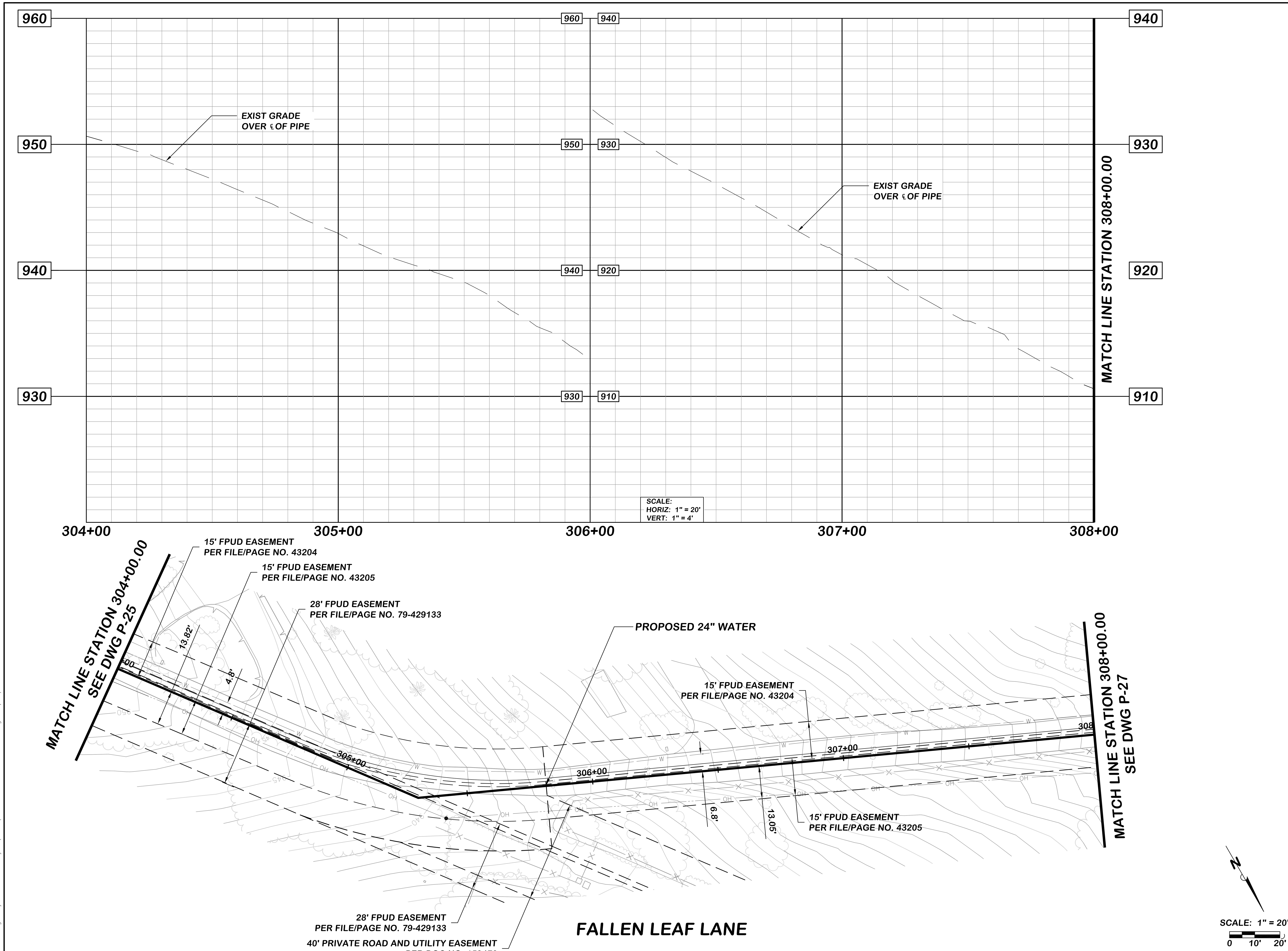

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE 1" = 20'
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RK
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FALLBROOK, CA 92028

APPROVED BY:

JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

PRODUCT WATER PLAN AND PROFILE
STA 304+00.00 TO STA 308+00.00

DRAWING NO. P-26
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

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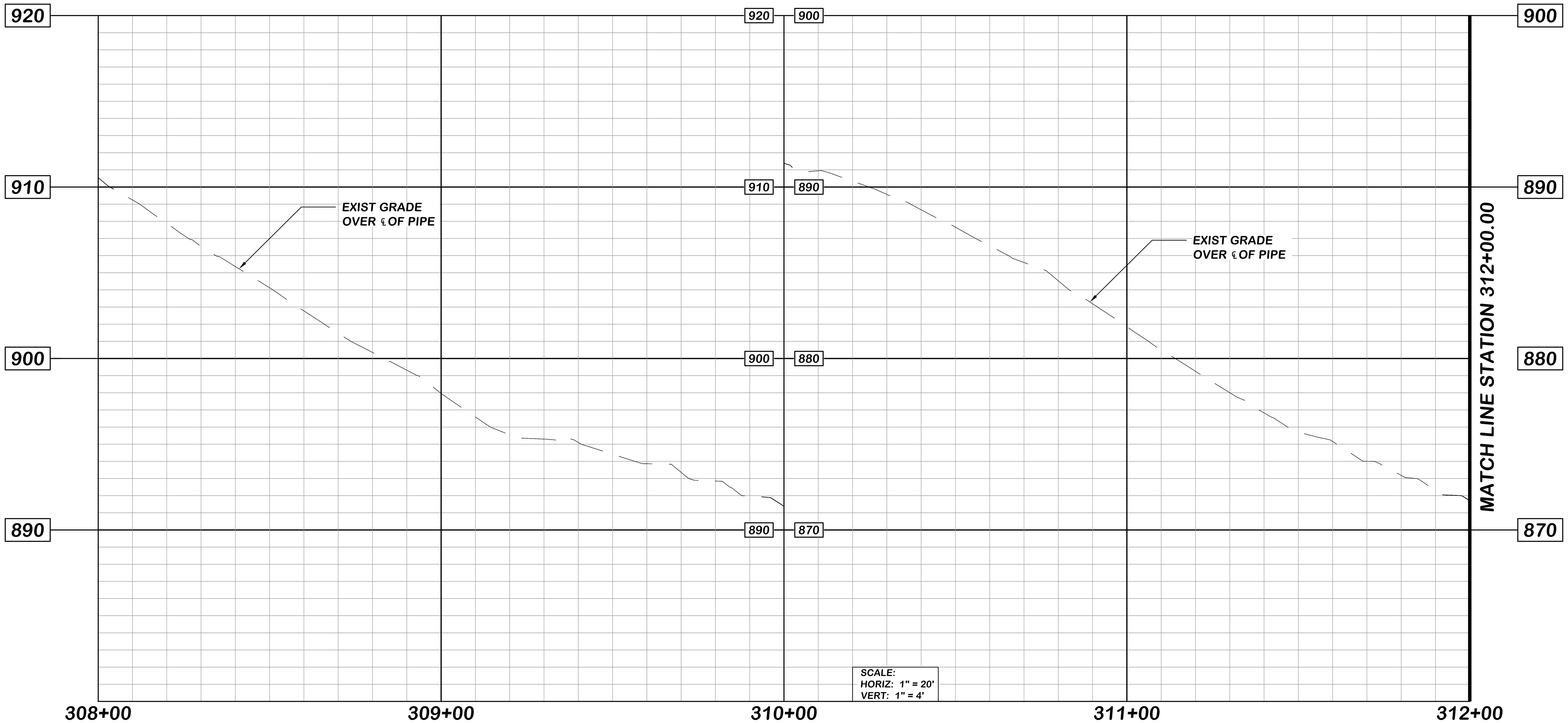
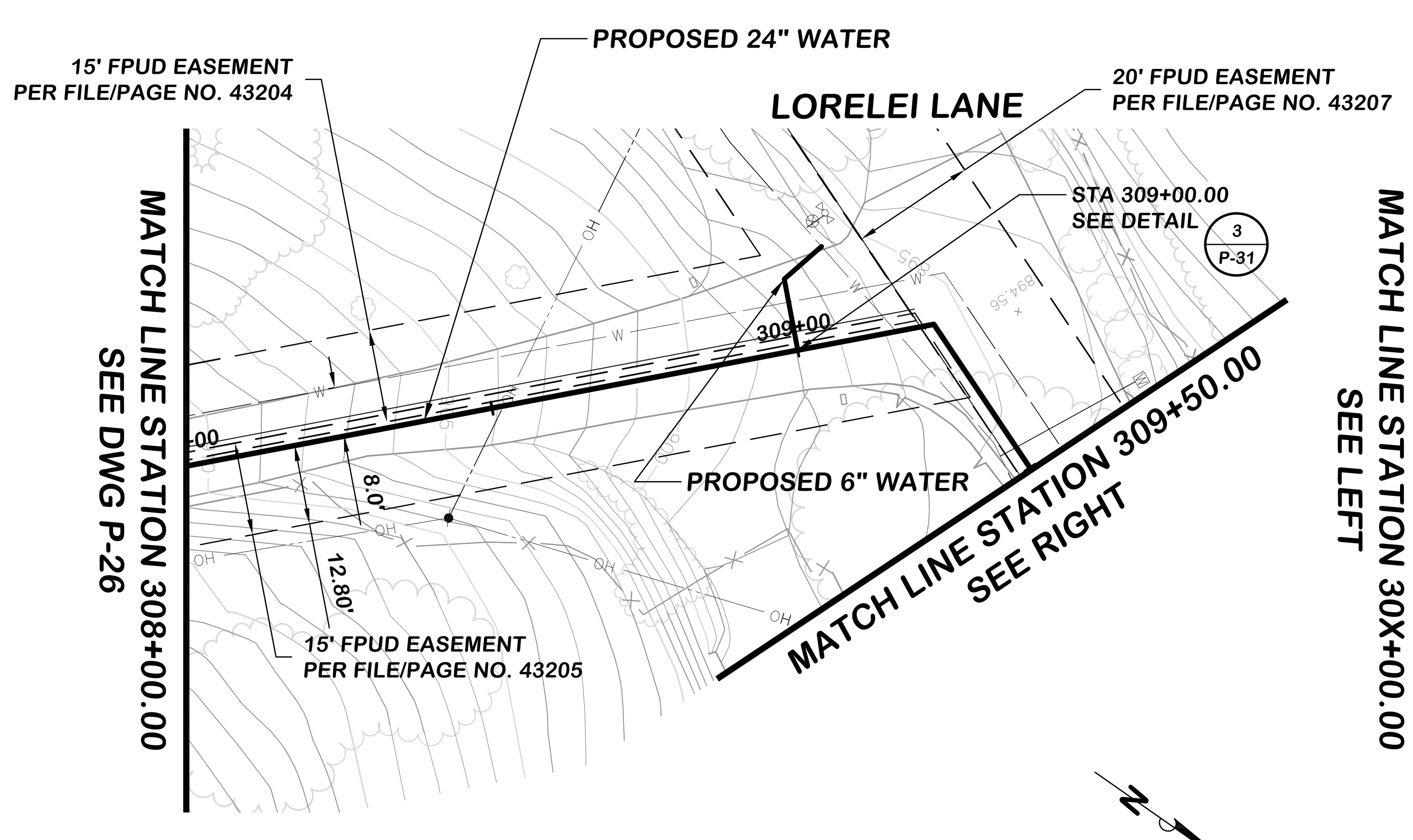
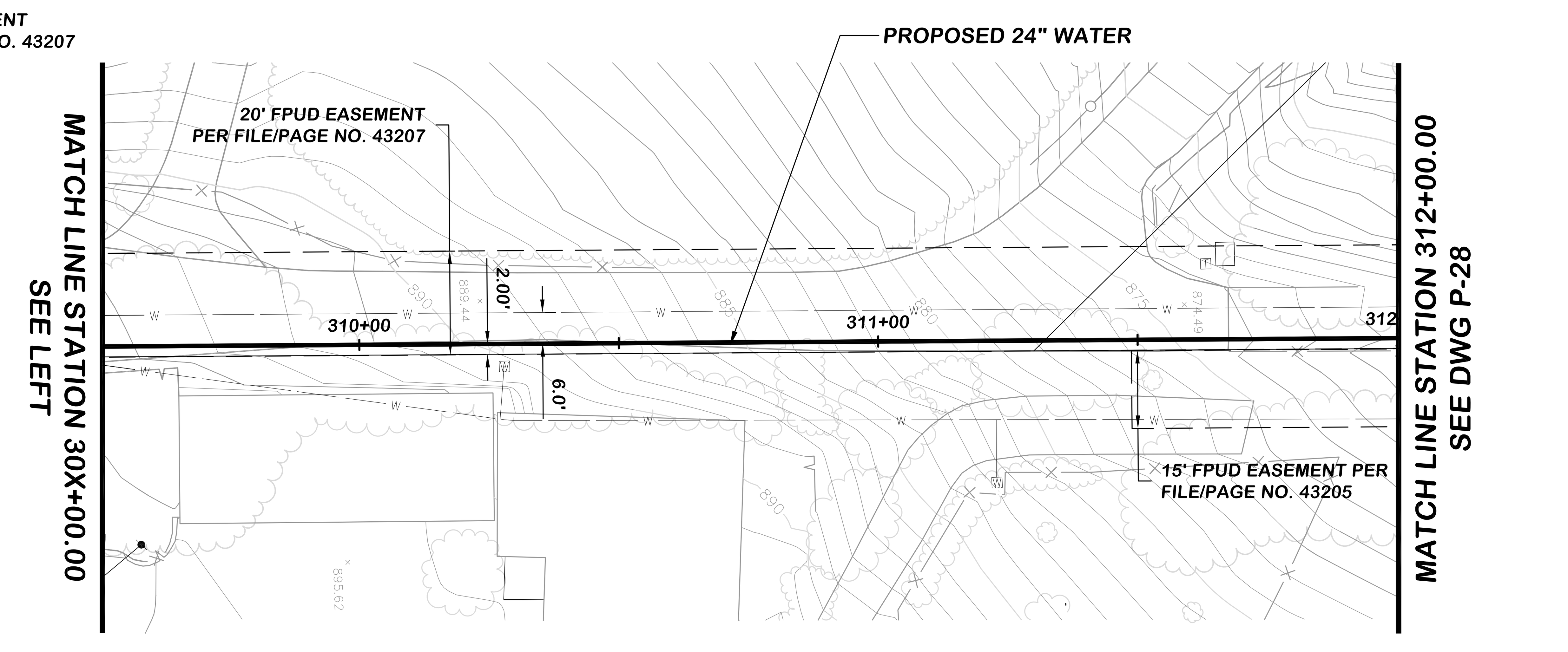




FALLEN LEAF LANE



LORELEI LANE

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE 1" = 20'
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RK
DRAWN BY RI
CHECKED BY DP

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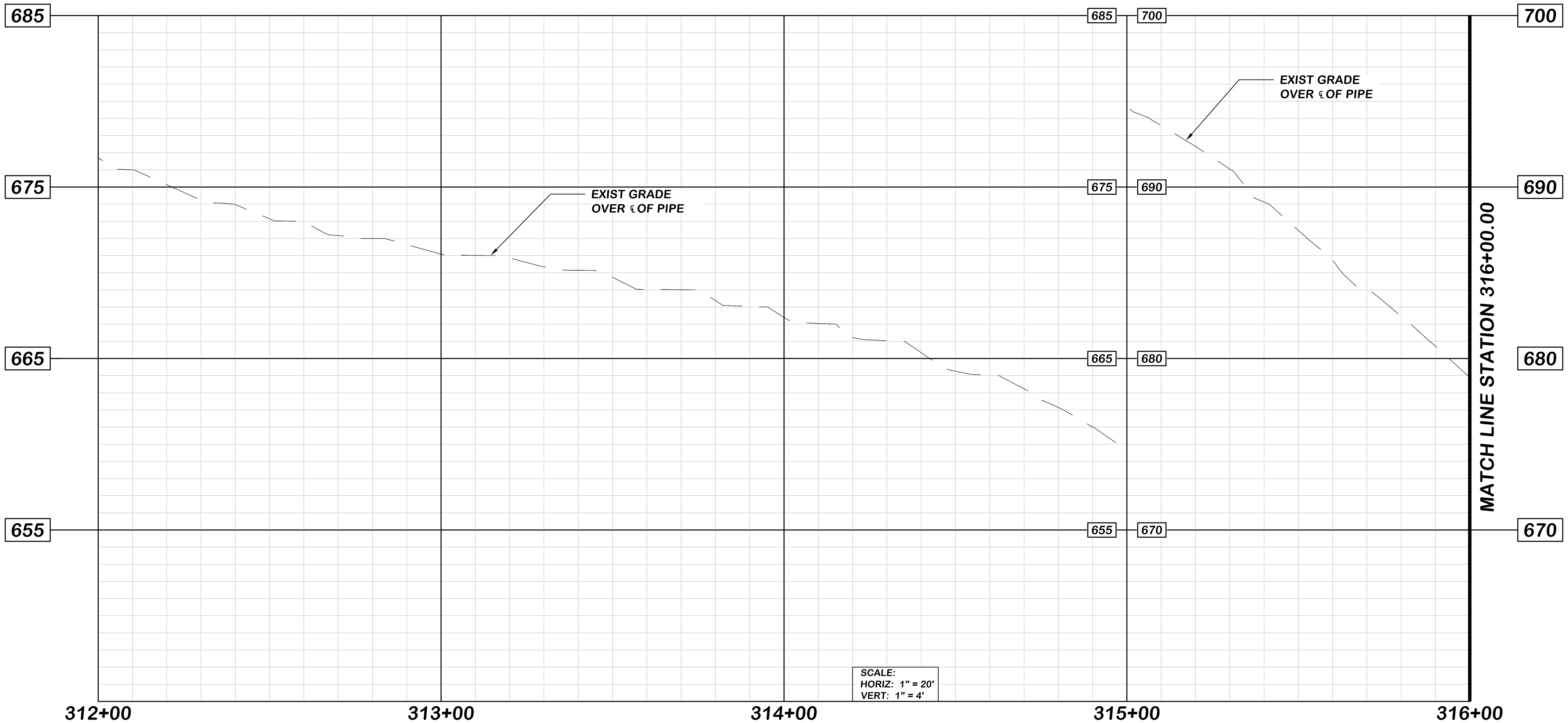
APPROVED BY:

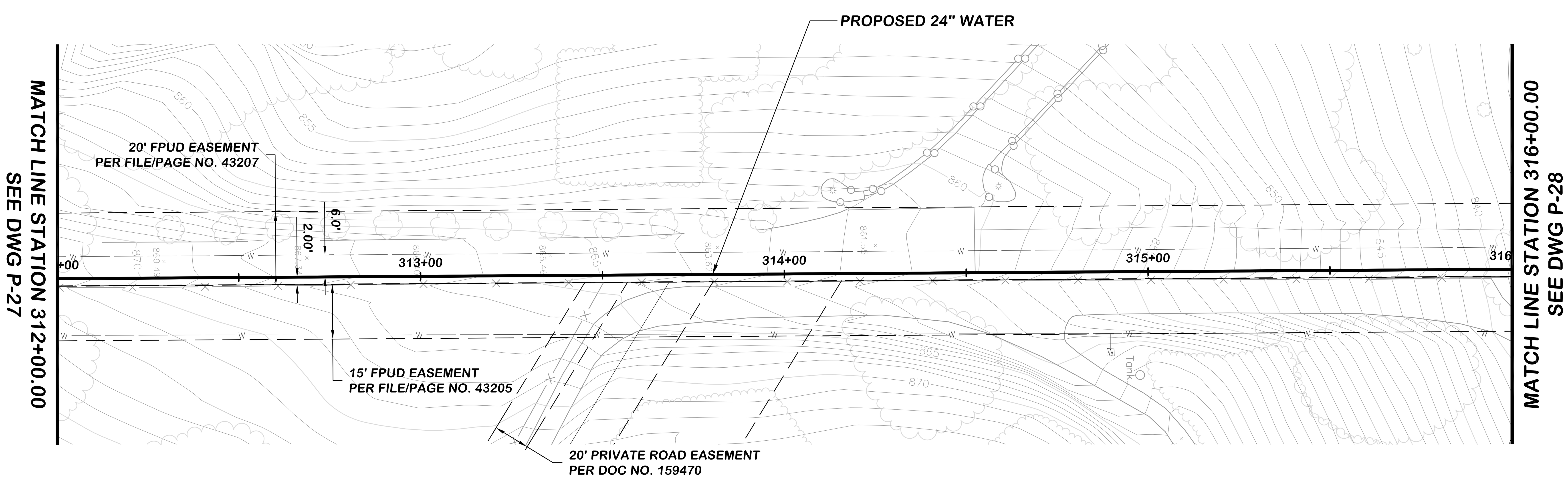
JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

PRODUCT WATER PLAN AND PROFILE
STA 308+00.00 TO STA 312+00.00

DRAWING NO. P-27
SHEET NO. XX OF XX
CLIENT JOB NO. 2744





LORELEI LANE

SCALE: 1" = 20'
0 10' 20'

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE	1" = 20'
DATE	10/2015
PROJECT NO.	112.FPUD.0002
DESIGNED BY	RK
DRAWN BY	RI
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Infrastructure
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ASSISTANT GENERAL MANAGER
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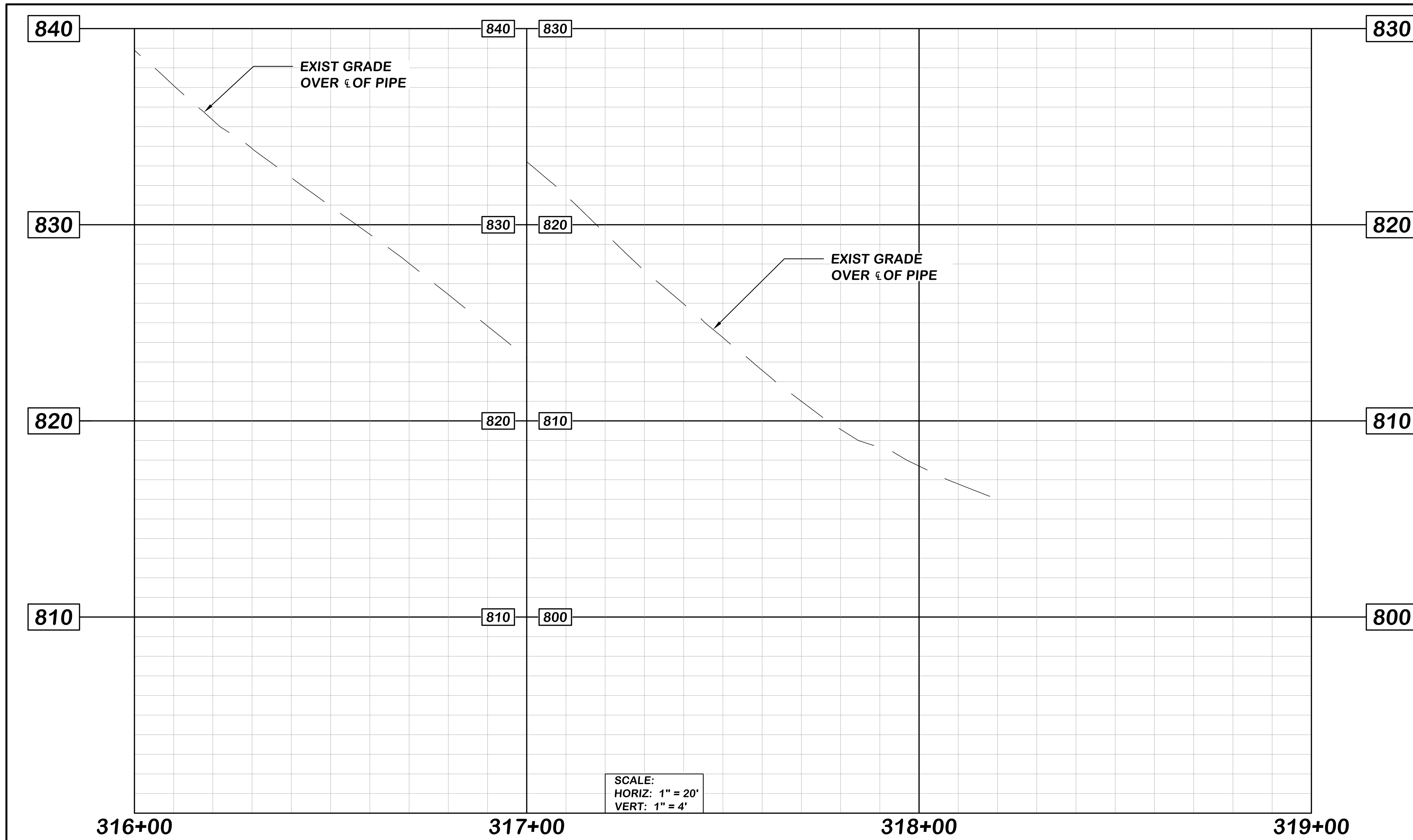
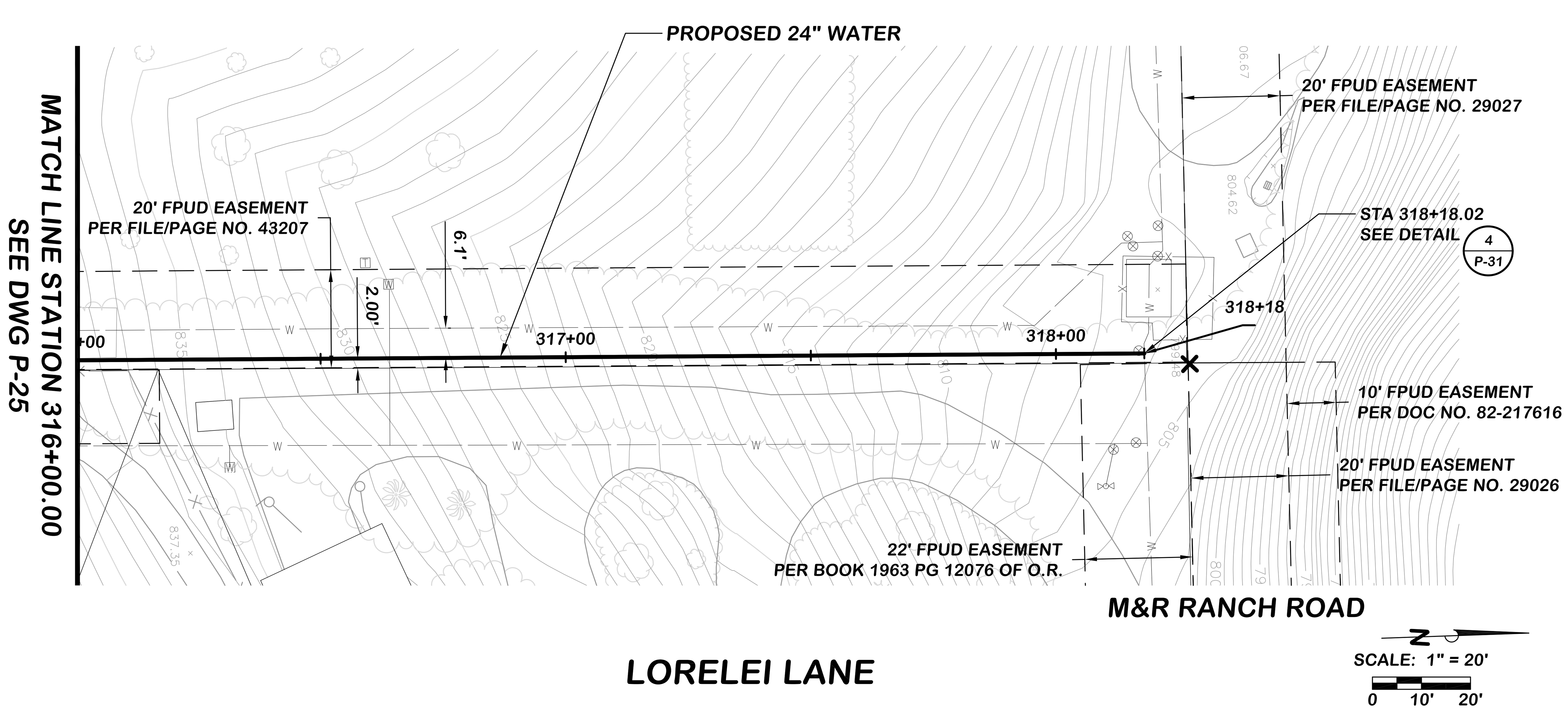
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

PRODUCT WATER PLAN AND PROFILE
STA 312+00.00 TO STA 316+00.00

DRAWING NO.	P-28
SHEET NO.	XX OF XX
CLIENT JOB NO.	2744

P:\Projects\FPUD (0112)\0002 St Marg Conjunctive Use Project\CADD\P-25 thru P-29 ~ Gheen.dwg 10/16/2015 10:38





30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE 1" = 20'
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RK
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DATE

Fallbrook Public Utility District
990 E. MISSION RD
FALLBROOK, CA 92028

APPROVED BY:

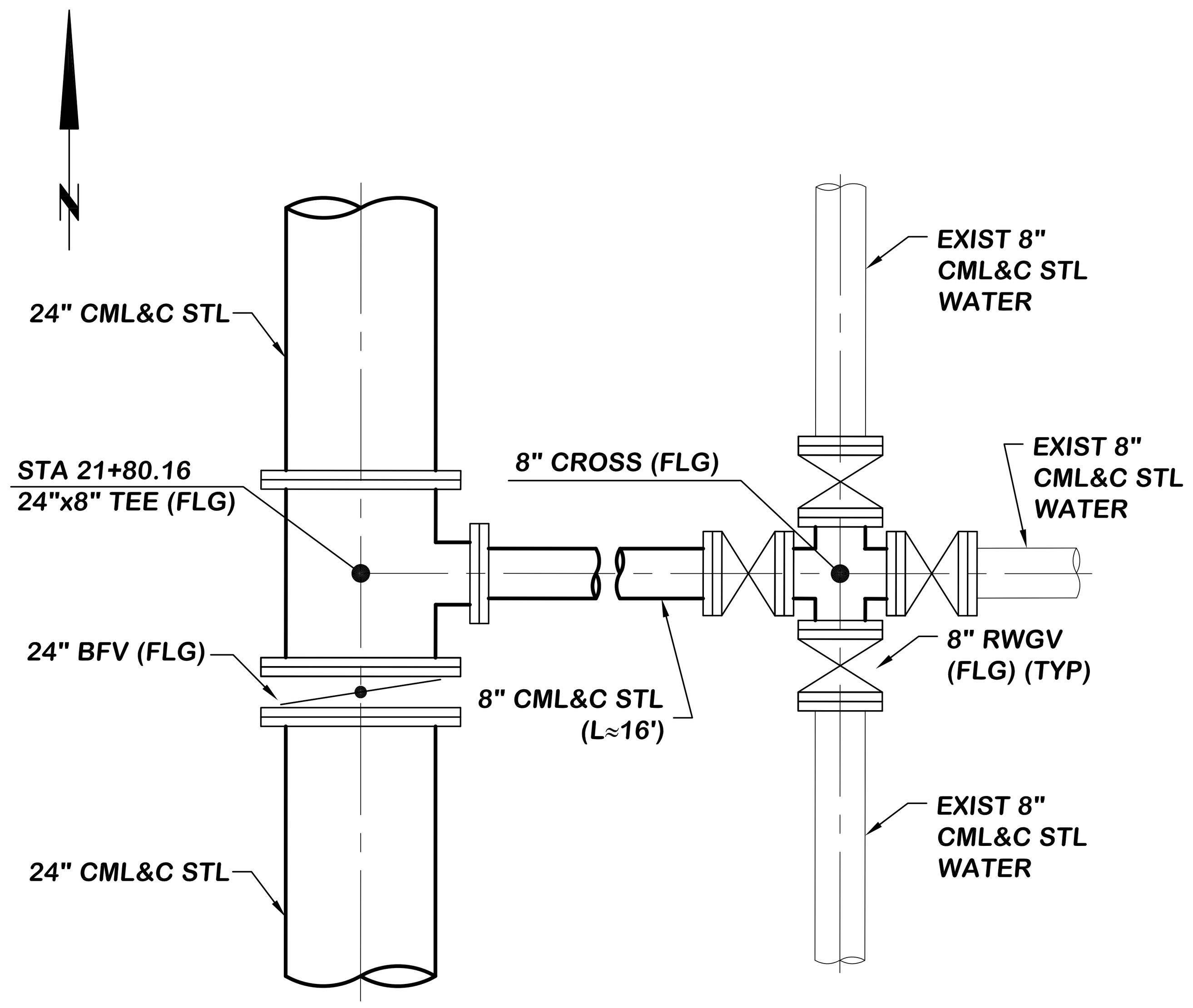
JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

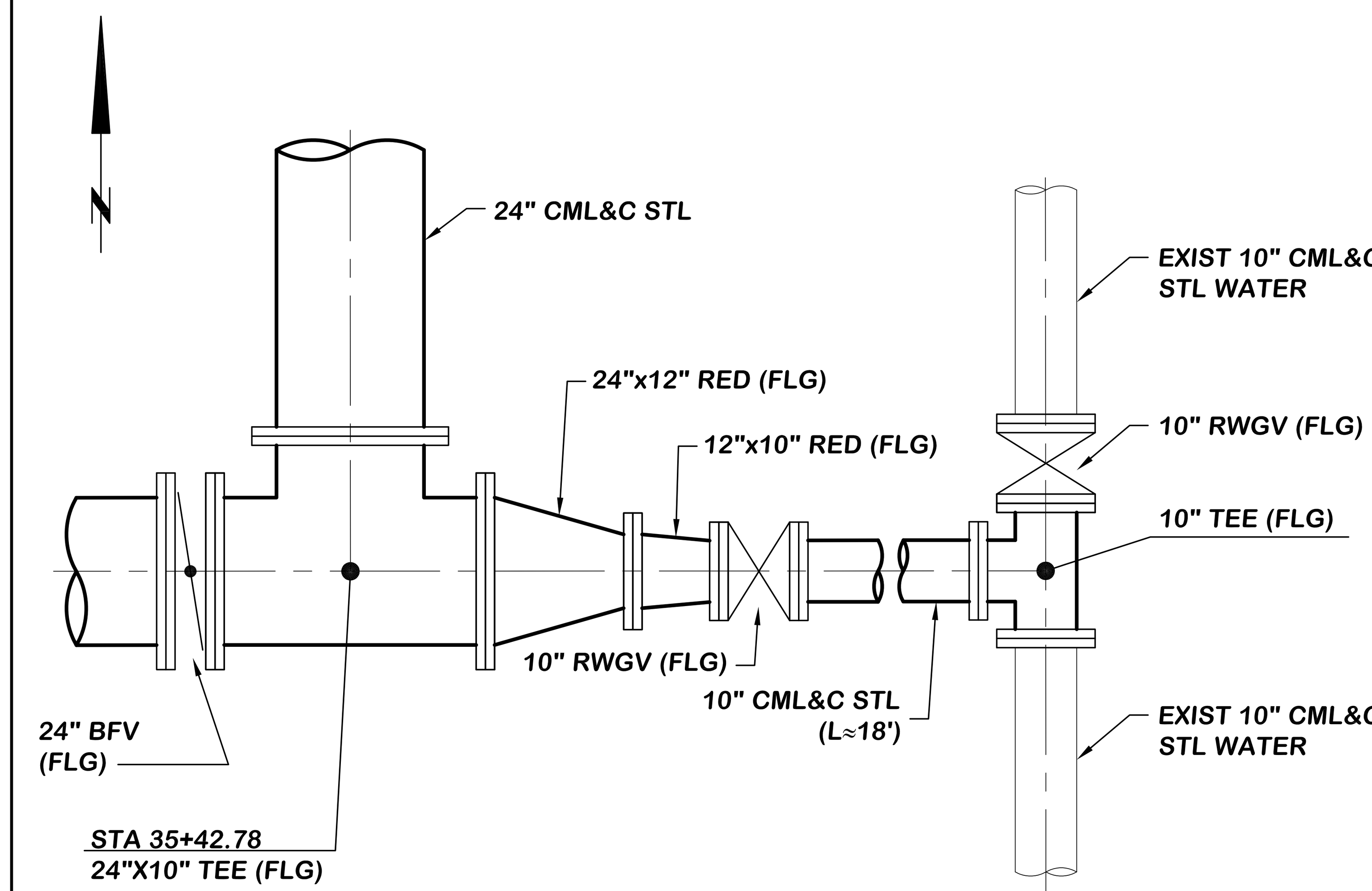
PRODUCT WATER PLAN AND PROFILE
STA 316+00.00 TO STA 318+18.02

DRAWING NO. P-29
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

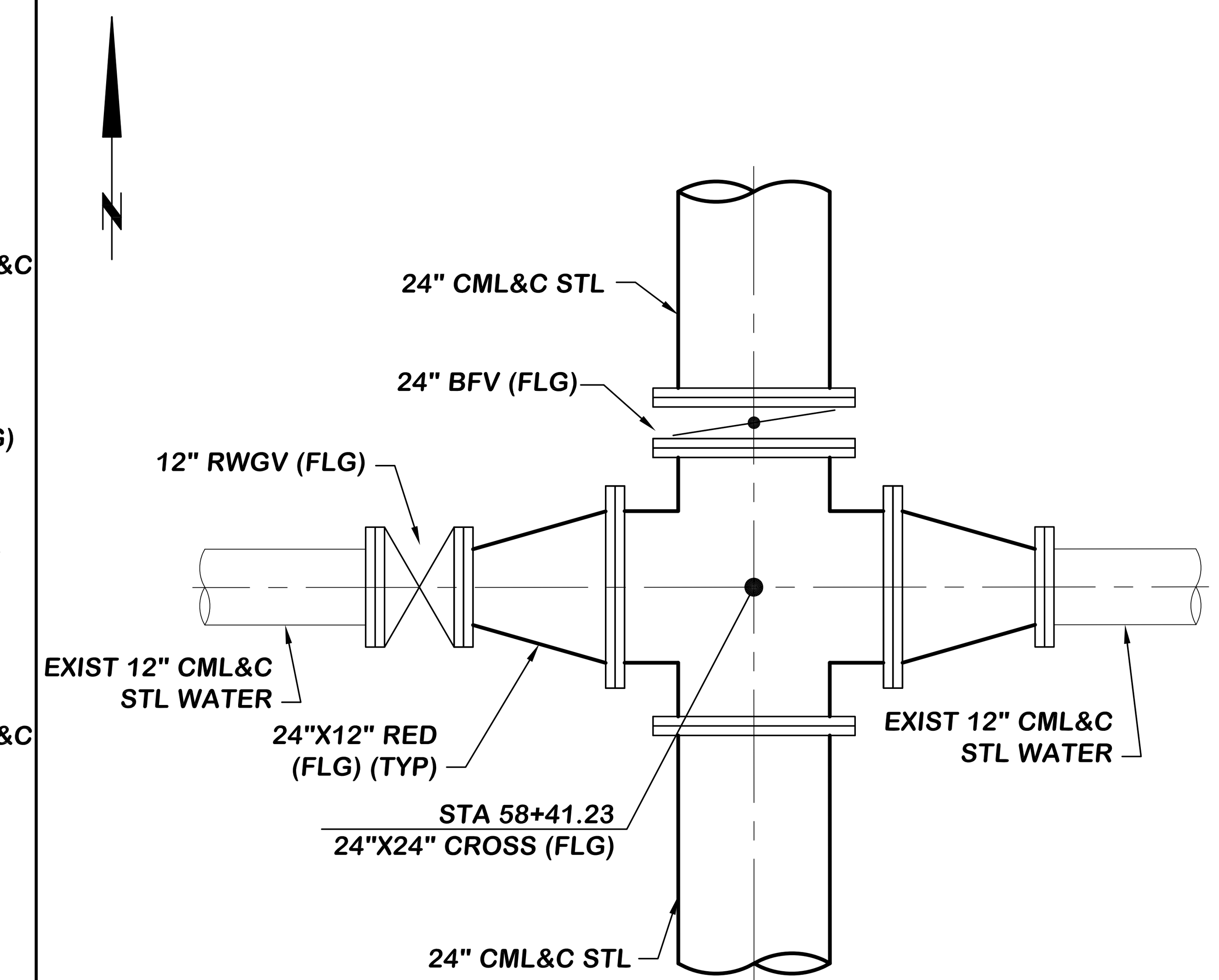
P:\Projects\FPUD (0112)\0002 St Marg Conjunctive Use Project\CADD\P-25 thru P-29 - Gheen.dwg 10/16/2015 10:38



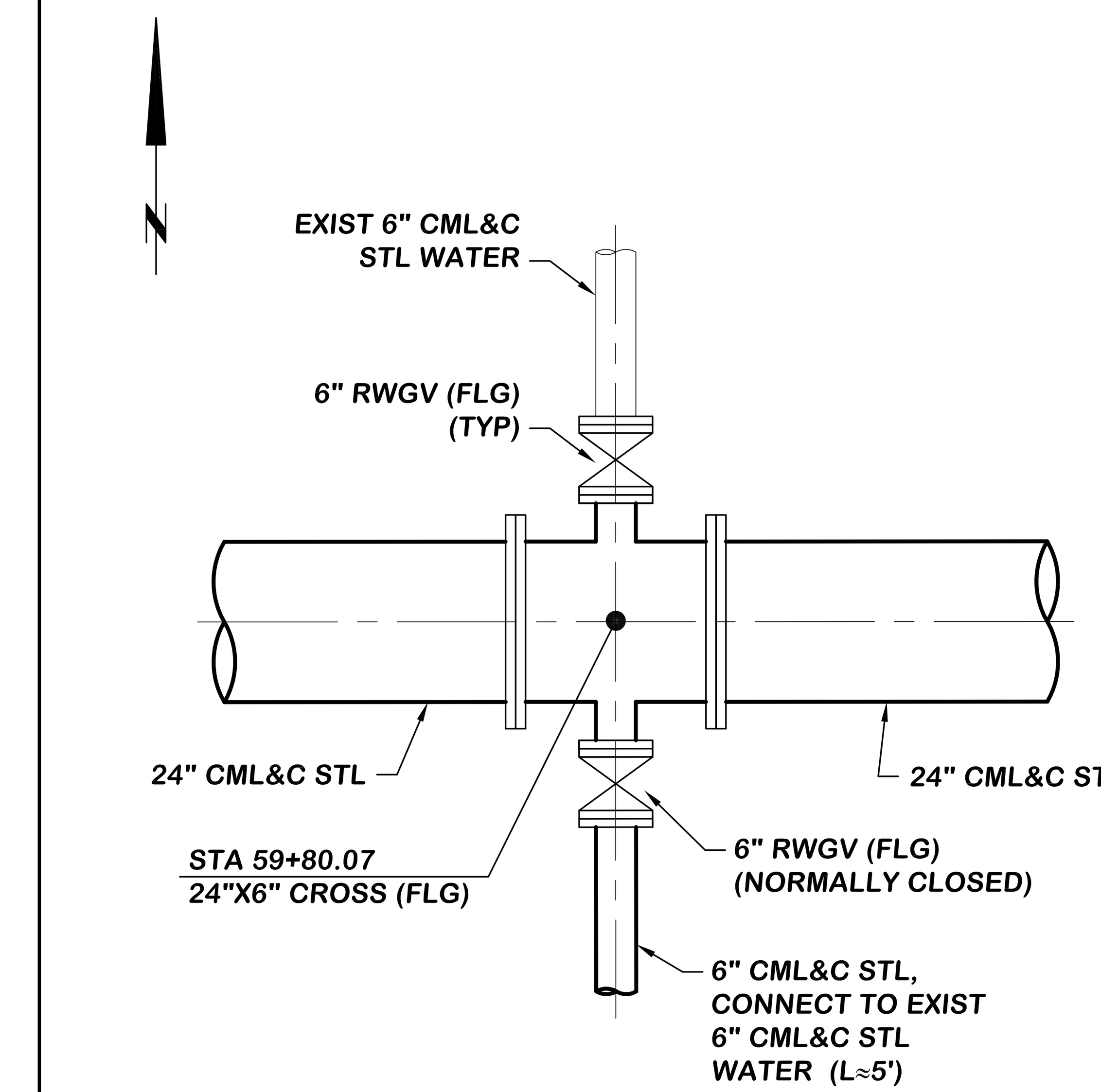
CONNECTION AT ALTURAS RD & MERIDA DR
STA 21+80.16
SCALE: NTS
1 / P-03



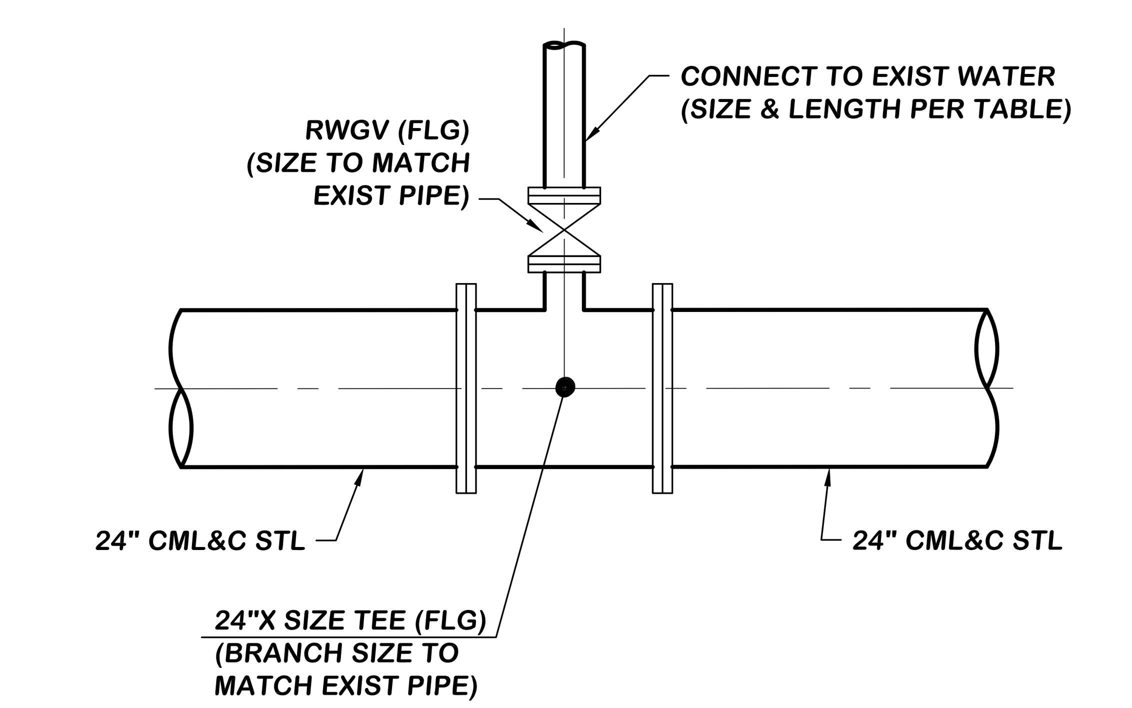
CONNECTION AT MERIDA DR & S HILL AVE
STA 35+42.78
SCALE: NTS
2 / P-06



CONNECTION IN S MISSION RD
STA 58+41.23
SCALE: NTS
3 / P-12

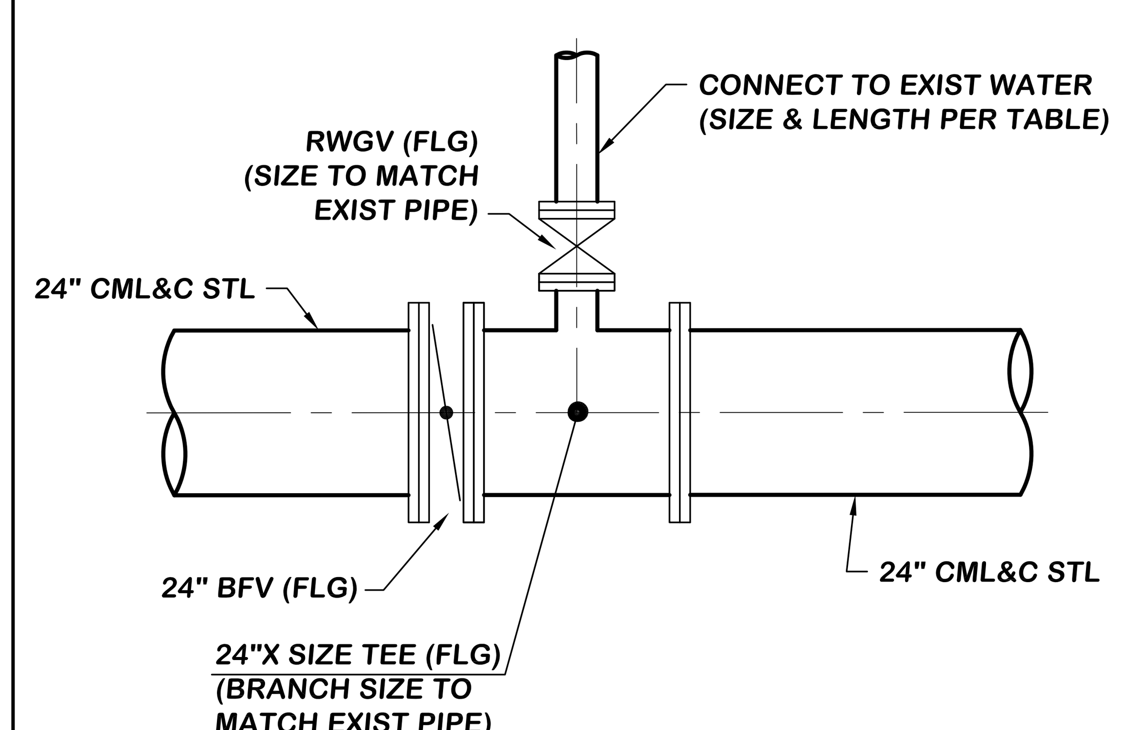


CONNECTION AT PALOMINO ROAD & OLD STAGE RD
STA 59+80.07
SCALE: NTS
4 / P-12



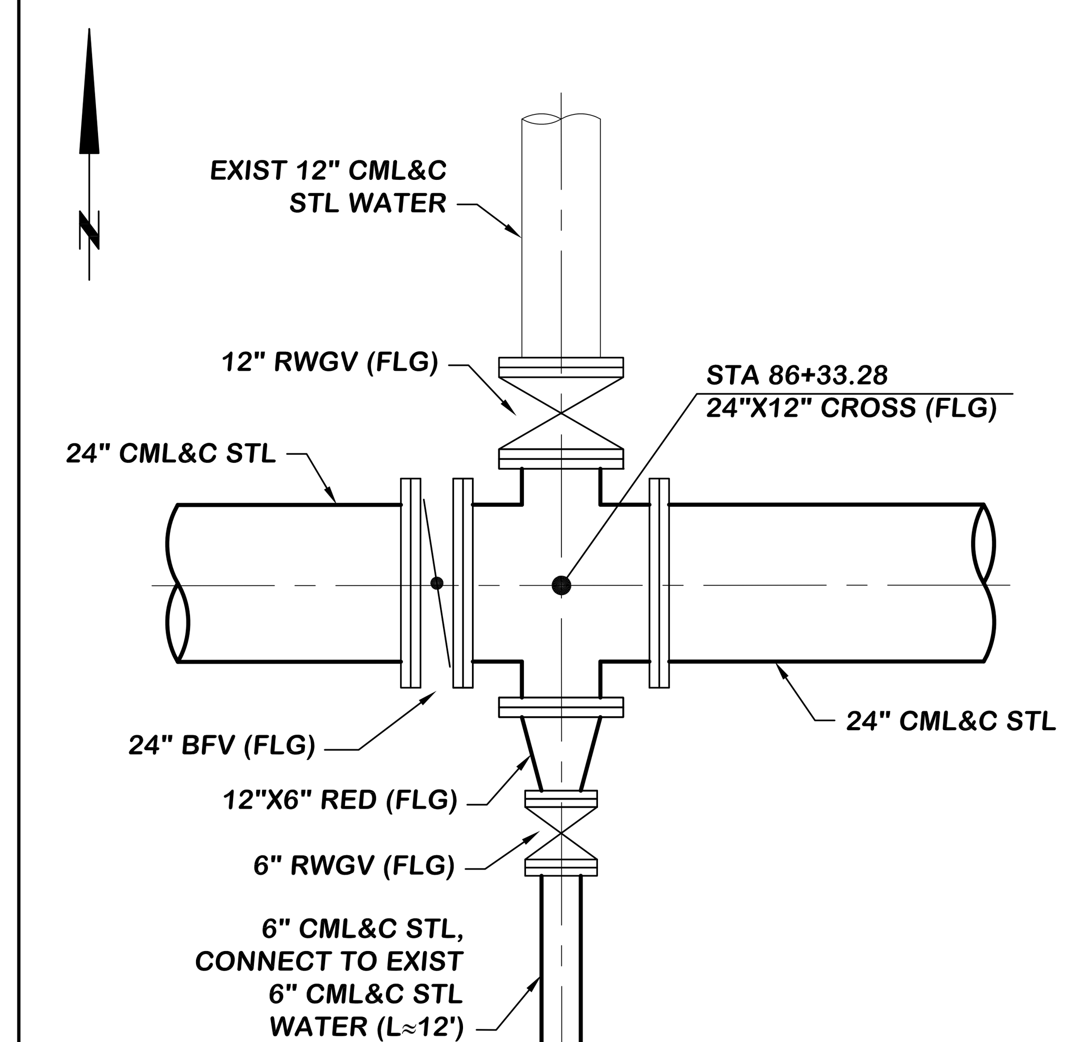
CROSS STREET	STATION	BRANCH SIZE	DISTANCE TO EXIST
TO PAULANN CT	71+34.22	8"	0
TO GRAND TRADITION HALL	73+46.82	10"	~6'
ELIZABETH WY	83+64.10	6"	~10'
TO CRESTVIEW ESTATES	88+71.09	6"	0
CUESTA NORTE	89+83.88	6"	~5'

CONNECTION TO DISTRIBUTION PIPE ALONG PALOMINO ROAD
SCALE: NTS
5 / -

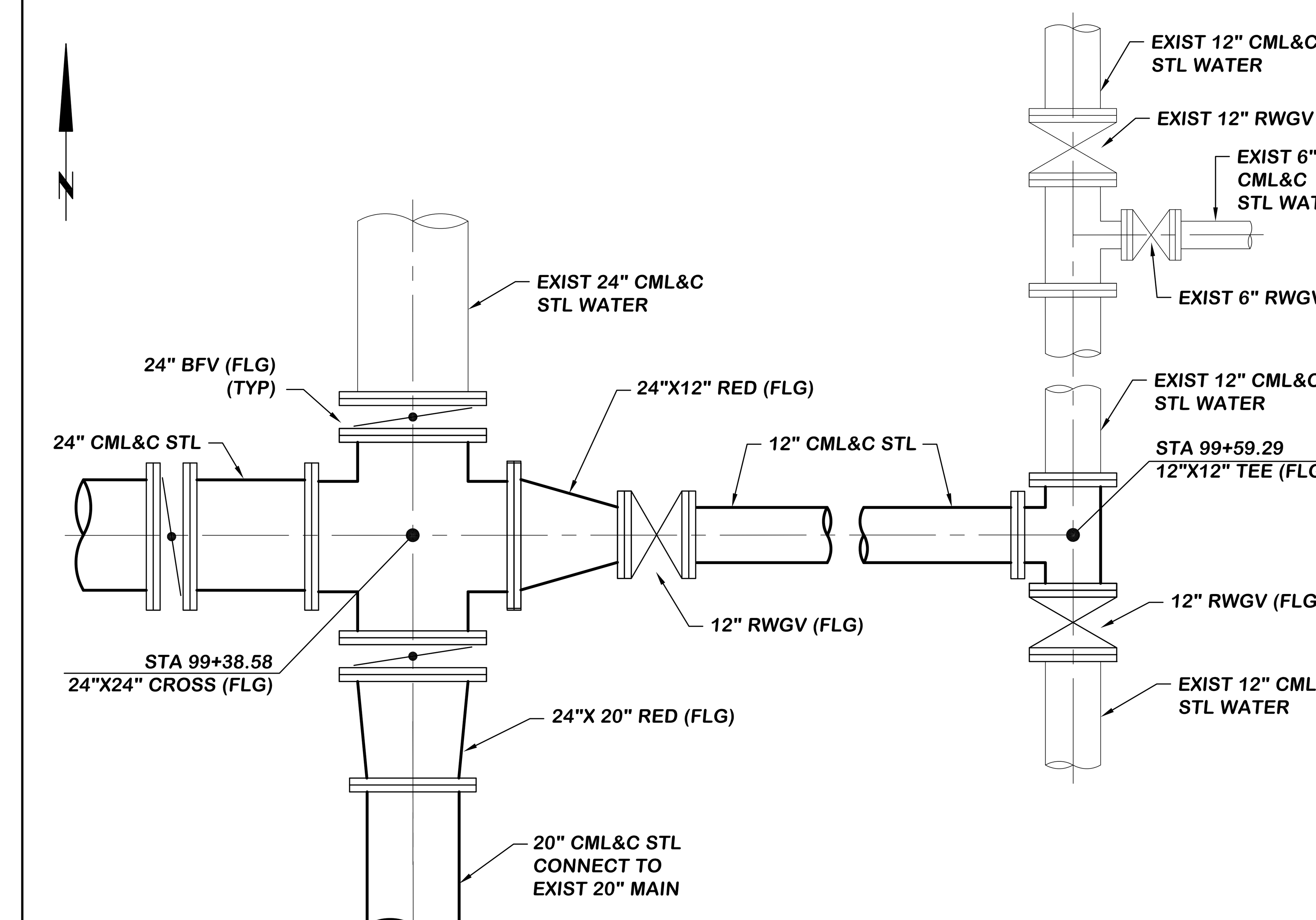


CROSS STREET	STATION	BRANCH SIZE	DISTANCE TO EXIST
EMERALD RIDGE RD	67+71.39	6"	0
COLT RD	77+66.31	6"	~12'
FARRAND RD	95+45.02	8"	~24'

CONNECTION TO DISTRIBUTION PIPE ALONG PALOMINO ROAD WITH ISOLATION VALVE
SCALE: NTS
6 / -



CONNECTION AT PALOMINO RD & MORRO RD
STA 86+33.28
SCALE: NTS
7 / P-19



CONNECTION AT PALOMINO RD & MCDONALD RD
SCALE: NTS
8 / P-22

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY
DRAWN BY
CHECKED BY

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DATE

FPUD Fallbrook Public Utility District
990 E. MISSION RD
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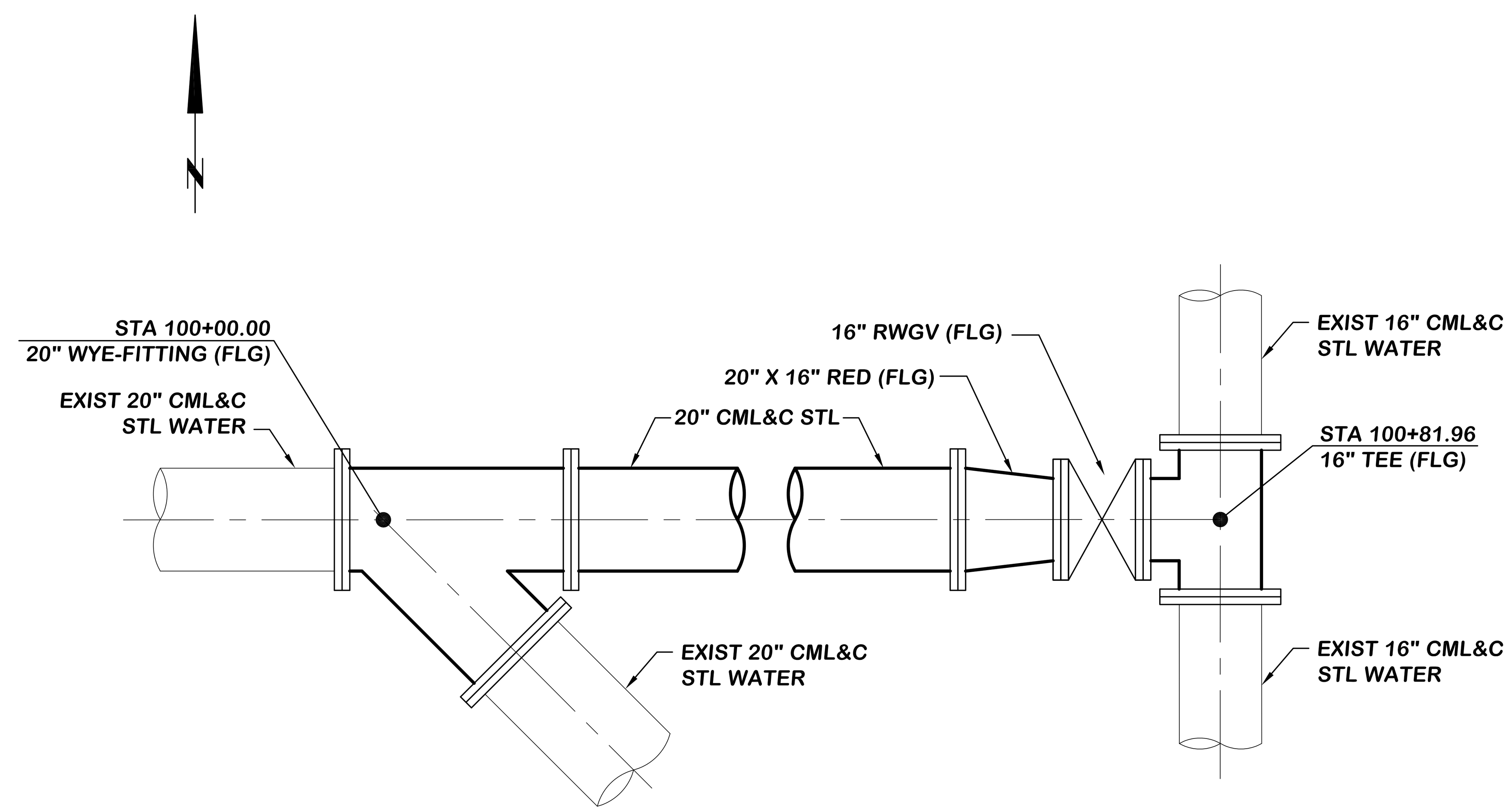
APPROVED BY:
JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES
PIPELINE CONNECTION DETAILS I

DRAWING NO. P-30
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

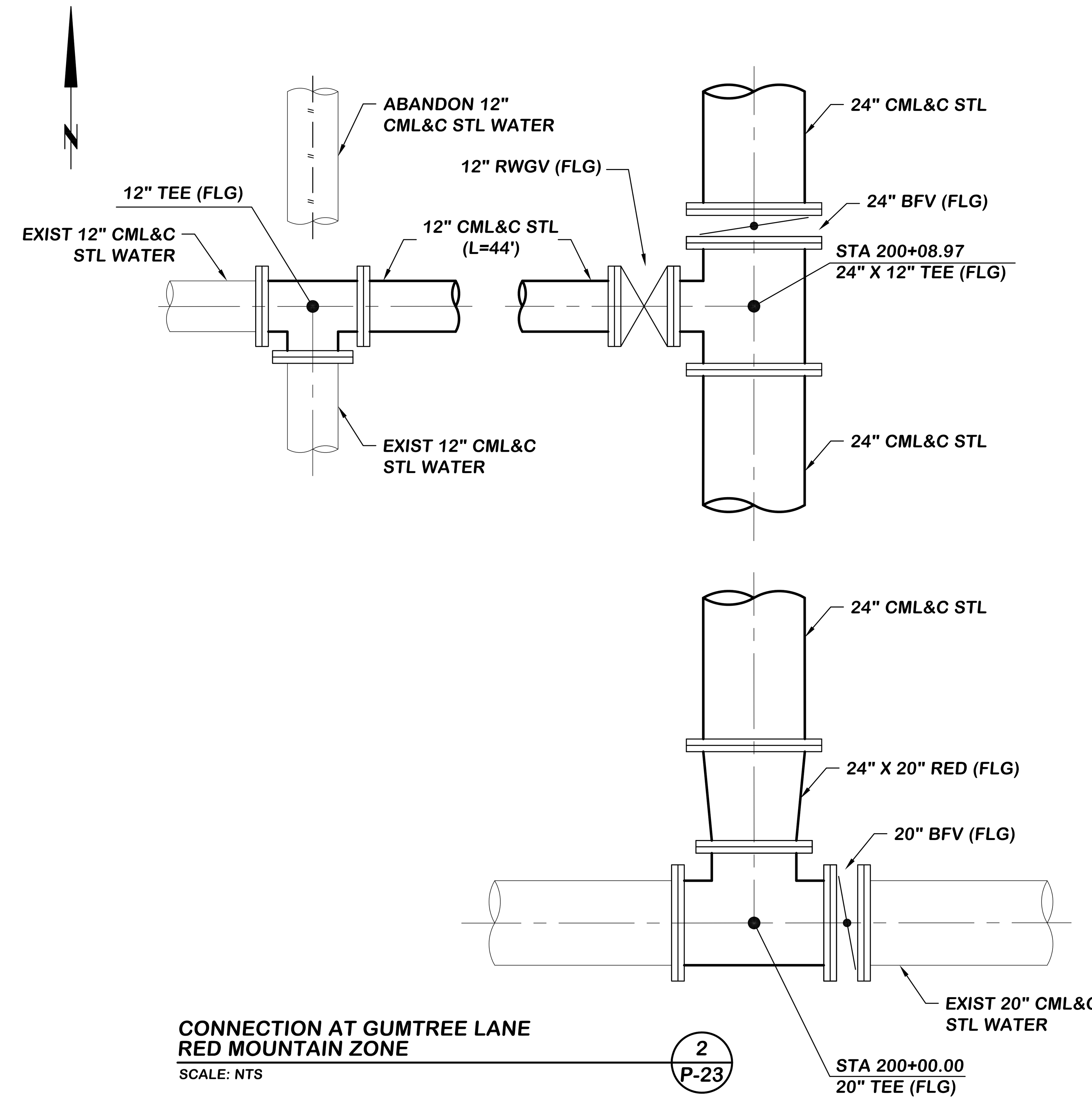
P:\Projects\FPUD (0112)\0002 St. Marg Conjunctive Use Project\CADD\P-30.dwg 10/23/2015 10:34



CONNECTION AT GUMTREE LANE - GHEEN ZONE

SCALE: NTS

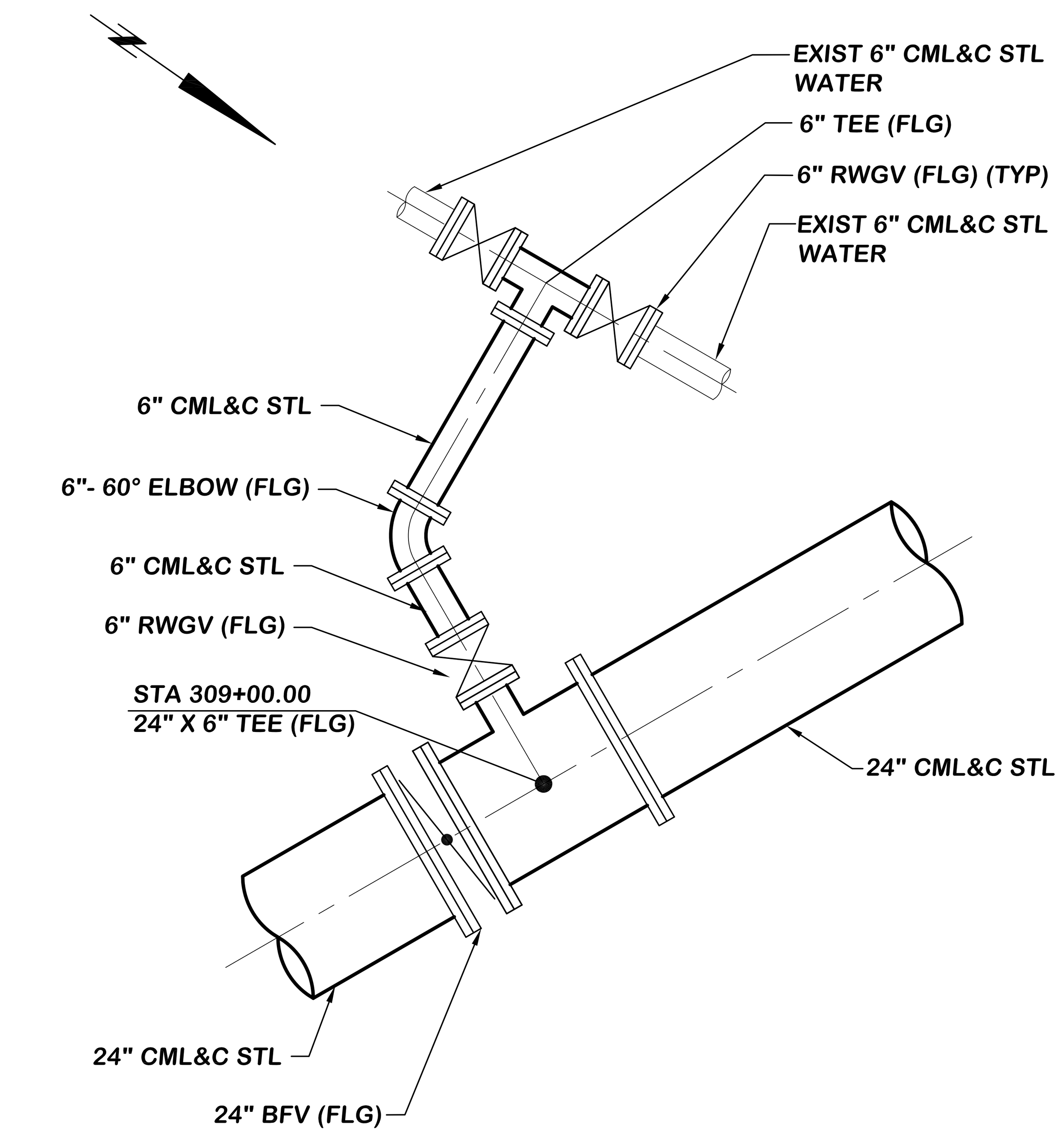
1 / P-23



CONNECTION AT GUMTREE LANE RED MOUNTAIN ZONE

SCALE: NTS

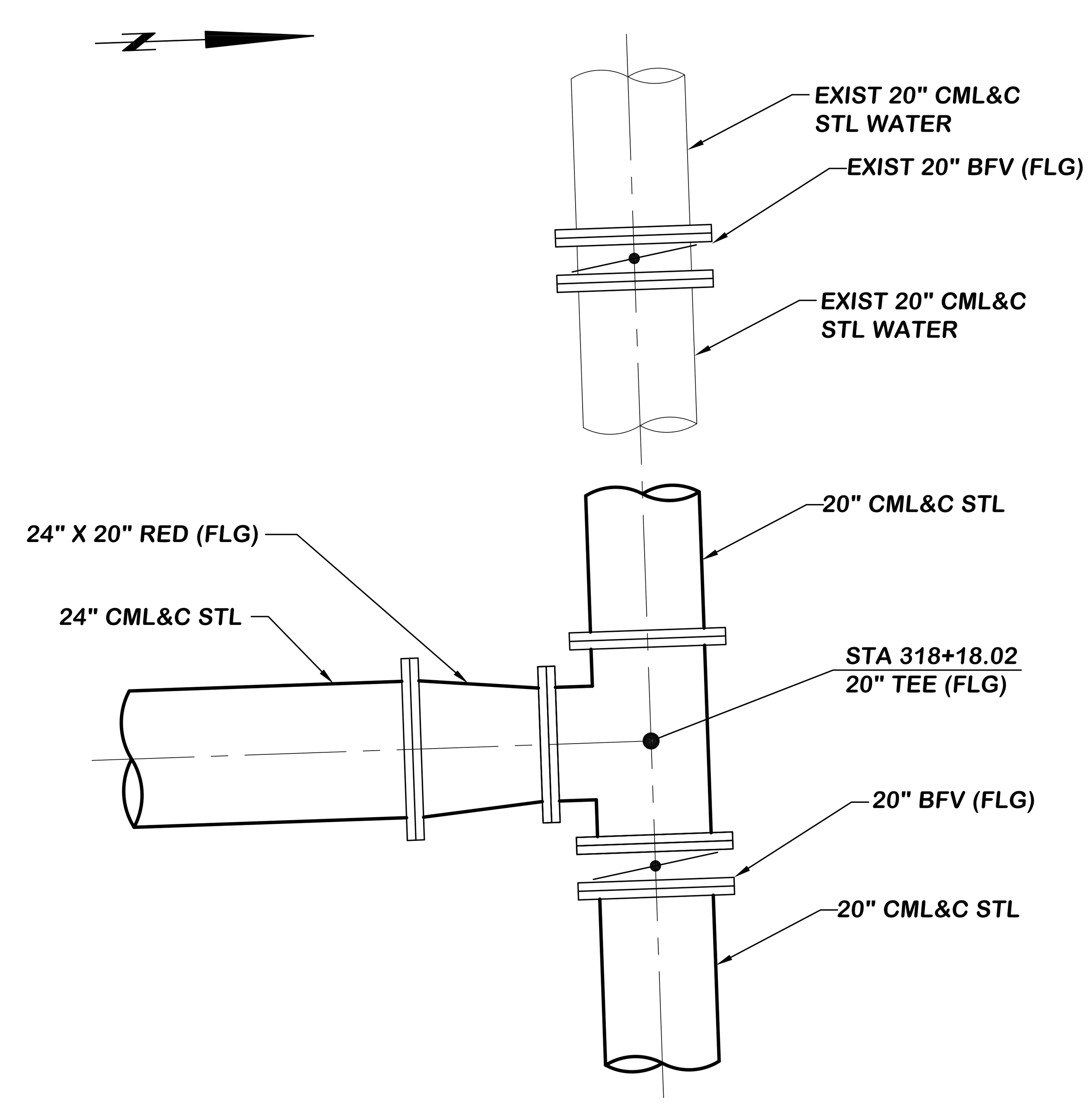
2 / P-23



CONNECTION AT FALLEN LEAF LANE AND LORELEI LANE STA 309+00.00

SCALE: NTS

3 / P-27



CONNECTION AT LORELEI LANE AND M&R RANCH ROAD STA 318+18.02

SCALE: NTS

4 / P-29

NOTES:

1. CONTRACTOR SHALL LOCATE HORIZONTAL AND VERTICAL LOCATION, BEARING, AND INCLINATION OF EXISTING PIPE AT CONNECTIONS PRIOR TO PURCHASING OR FABRICATING MATERIALS.
2. FURNISH AND INSTALL AWWA C207 CLASS F STEEL FLANGE(S) FOR CONNECTIONS TO EXISTING PIPE AT NEW VALVES OR FITTINGS.

GENERAL CONNECTION NOTES

SCALE: NTS

5 / -

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE

DATE 10/2015

PROJECT NO. 112.FPUD.0002

DESIGNED BY

DRAWN BY

CHECKED BY

Infrastructure ENGINEERING CORPORATION

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Fallbrook Public Utility District

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APPROVED BY:

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ASSISTANT GENERAL MANAGER

DATE

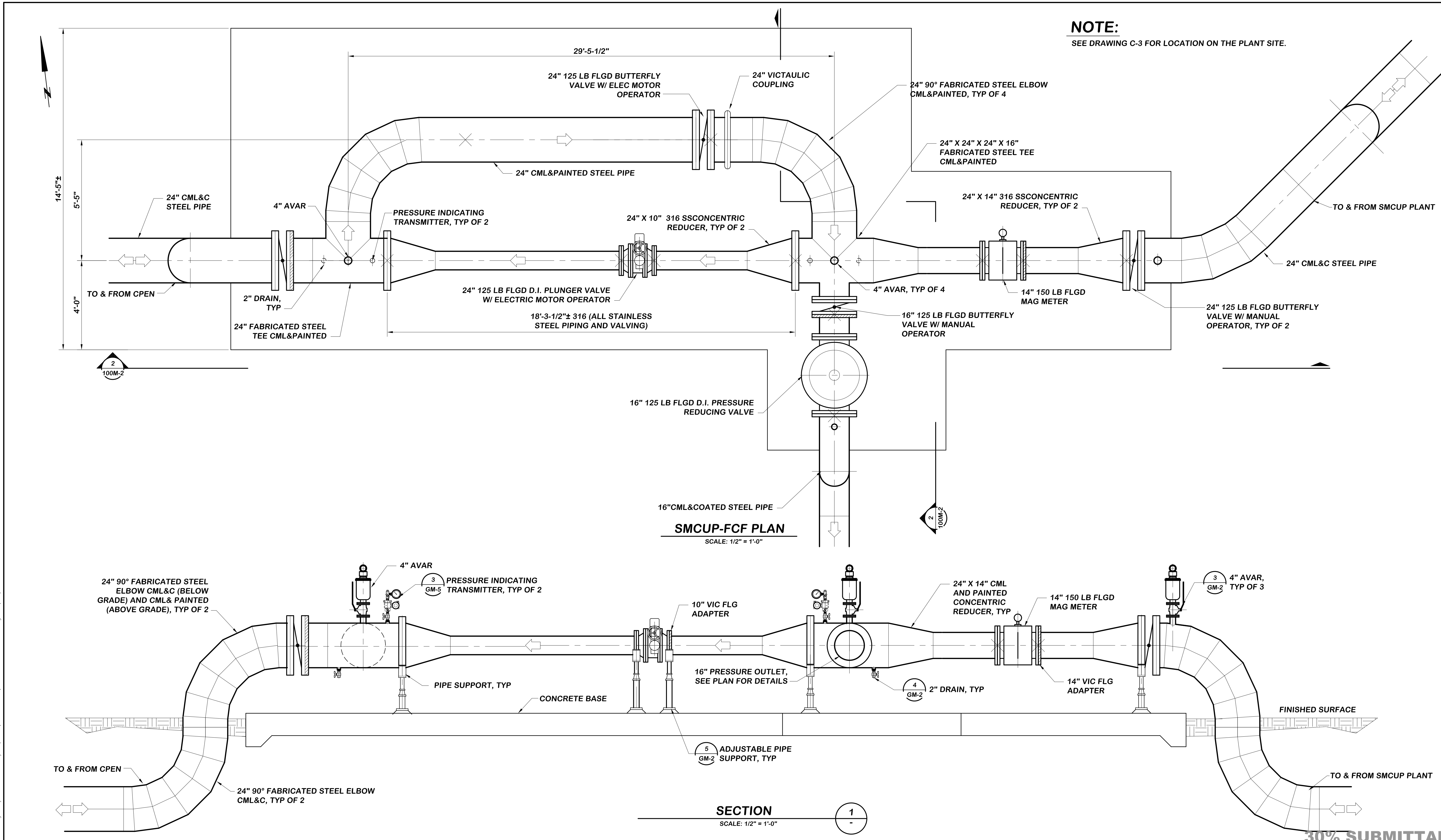
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

PIPELINE CONNECTION DETAILS II

DRAWING NO. P-31

SHEET NO. XX OF XX

CLIENT JOB NO. 2744



30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE AS SHOWN
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RLG
DRAWN BY RLG
CHECKED BY RK

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ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES
AREA 100 - RETURN FCF
PLAN AND SECTIONS

DRAWING NO. 100M-1
SHEET NO. X OF XX
CLIENT JOB NO. 2744

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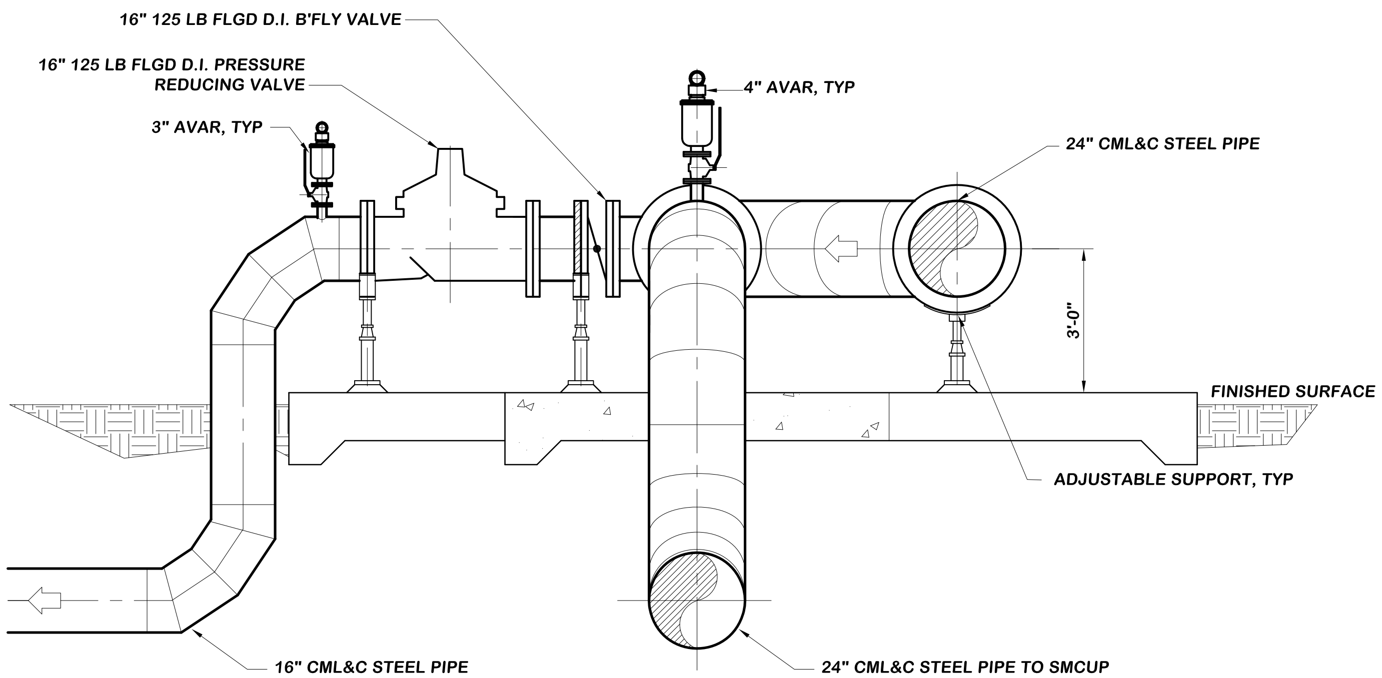

SECTION 2 / 100M-1

SCALE: 1/2" = 1'-0"

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE AS SHOWN
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RLG
DRAWN BY RLG
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JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

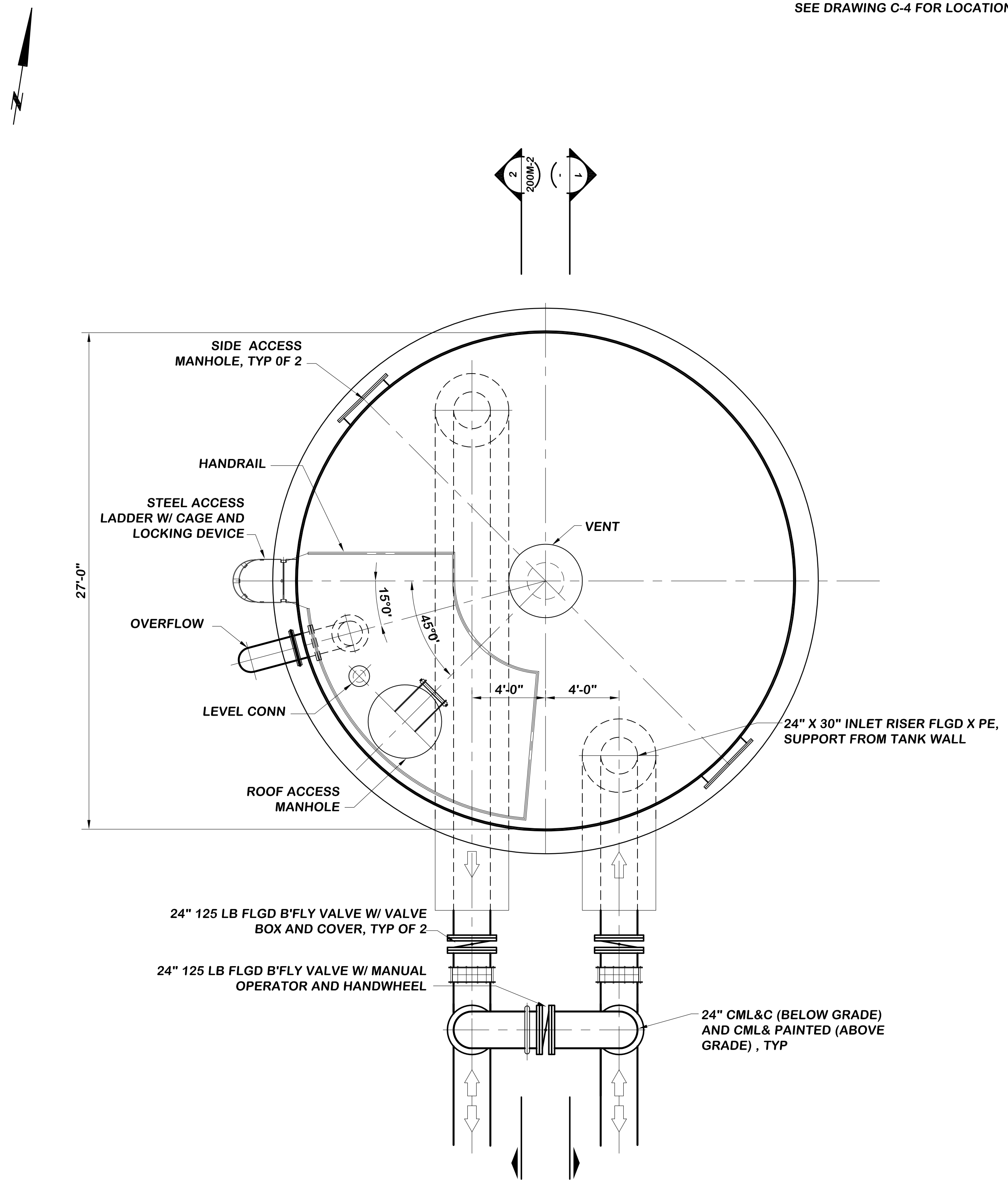
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 100 - RETURN FCF
SECTIONS

DRAWING NO. 100M-2
SHEET NO. X OF XX
CLIENT JOB NO. 2744

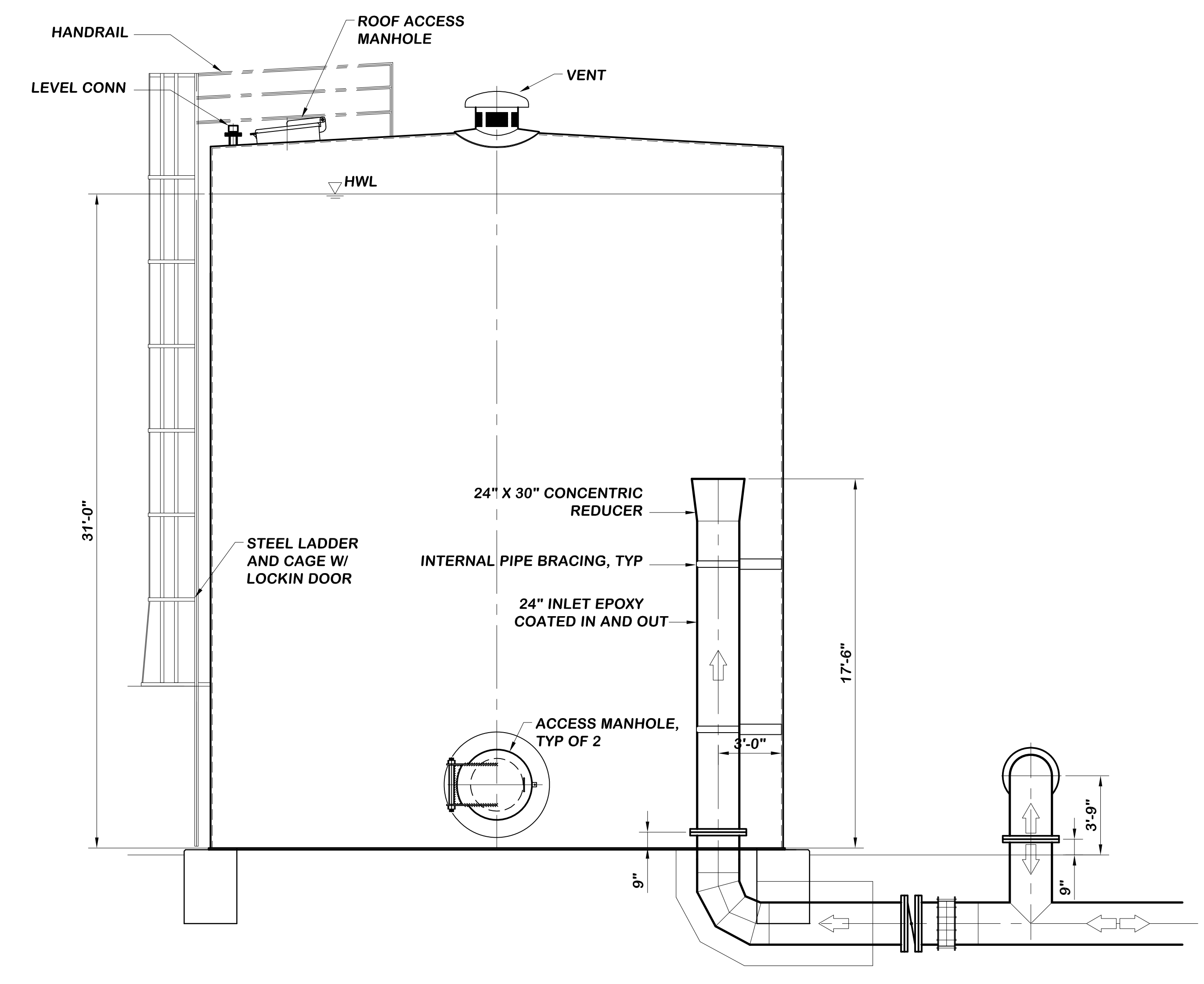
P:\Projects\FPUD (0112)\0002 St Marg Conjunctive Use Project\CADD\MECHANICAL\100M-2-SMCUP-FCF.dwg 10/30/2015 10:30

NOTE:
SEE DRAWING C-4 FOR LOCATION ON THE PLANT SITE.



EQUALIZATION TANK PLAN

SCALE: 1/4" = 1'-0"



SECTION

SCALE: 1/4" = 1'-0"

1
-

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE AS SHOWN
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RLG
DRAWN BY RLG
CHECKED BY XXX

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990 E. MISSION RD
FALLBROOK, CA 92028

APPROVED BY:

JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER

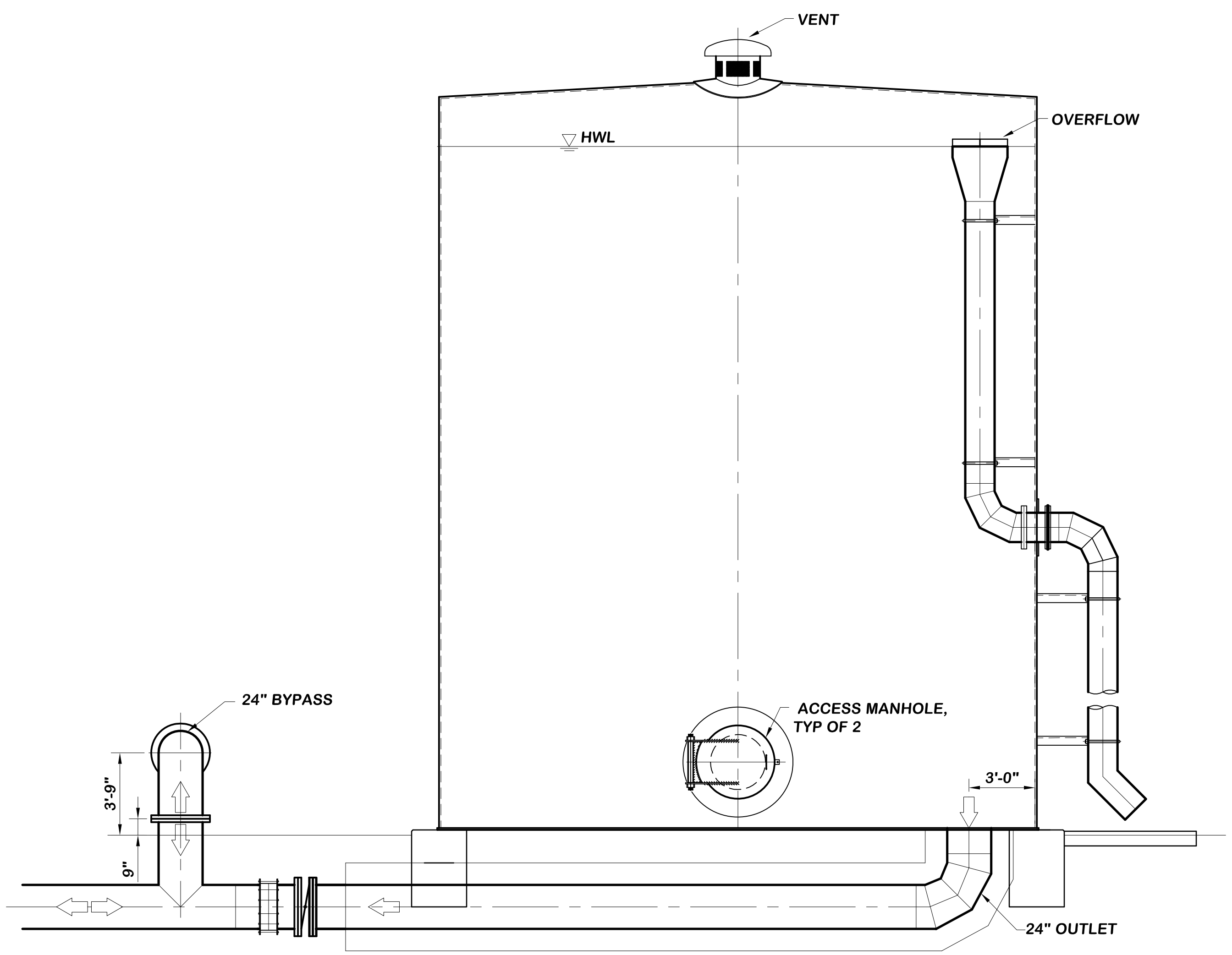
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 200 - EQUALIZATION TANK PLAN AND SECTION

DRAWING NO. 200M-1
SHEET NO. X OF XX
CLIENT JOB NO. 2744

P:\Projects\FPUD (0112)\0002 St Marg Conjunctive Use Project\CADD\MECHANICAL\200M-1-EQ-TK.dwg 10/30/2015 10:43



SECTION 2 / 200M-1

SCALE: 1/4" = 1'-0"

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE AS SHOWN
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RLG
DRAWN BY RLG
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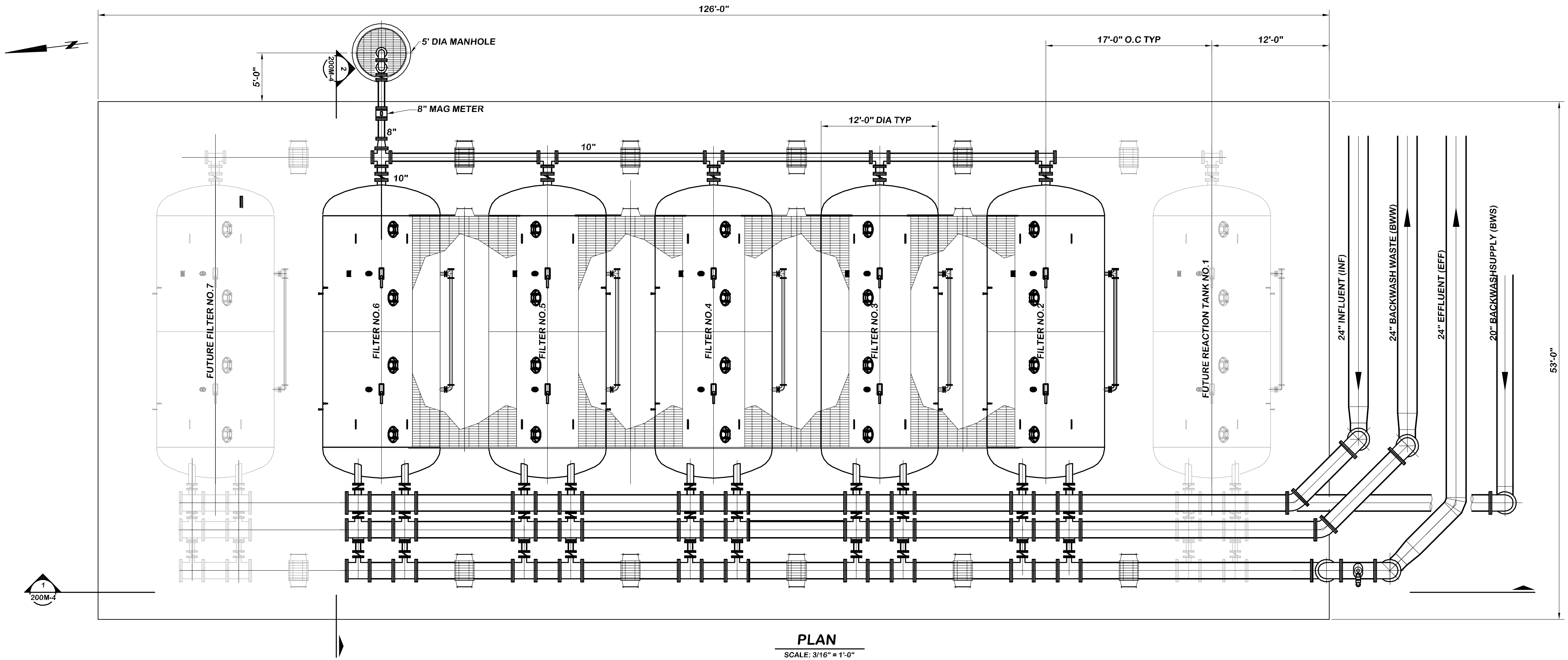
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 200 - EQUALIZATION TANK SECTIONS

DRAWING NO. 200M-2
SHEET NO. X OF XX
CLIENT JOB NO. 2744

P:\Projects\FPUD (0112)\0002 St Marg Conjunctive Use Project\CADD\MECHANICAL\200M-2-EQ-TK.dwg 10/30/2015 10:45



PLAN

SCALE: 3/16" = 1'-0"

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE AS SHOWN
DATE 10/2015
PROJECT NO. 112.FPUD.0002
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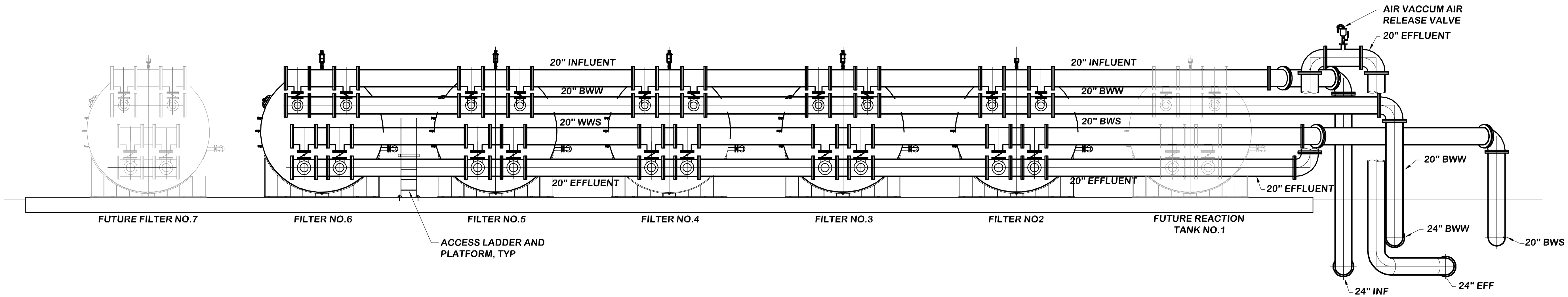
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 200 - IRON AND MANGANESE FILTRATION - PLAN

DRAWING NO. 200M-3
SHEET NO. X OF XX
CLIENT JOB NO. 2744



SECTION 1/200M-3
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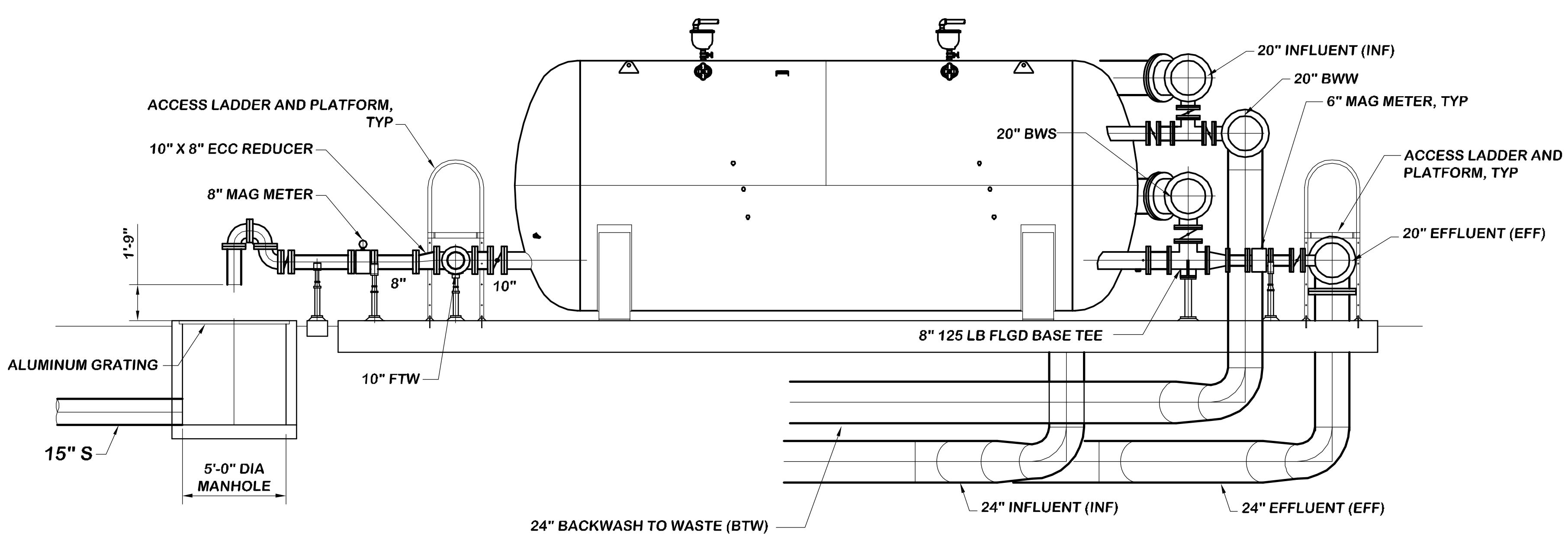

SECTION 2/200M-3
SCALE: 1/4" = 1'-0"

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE AS SHOWN
DATE 10/2015
PROJECT NO. 112.FPUD.0002
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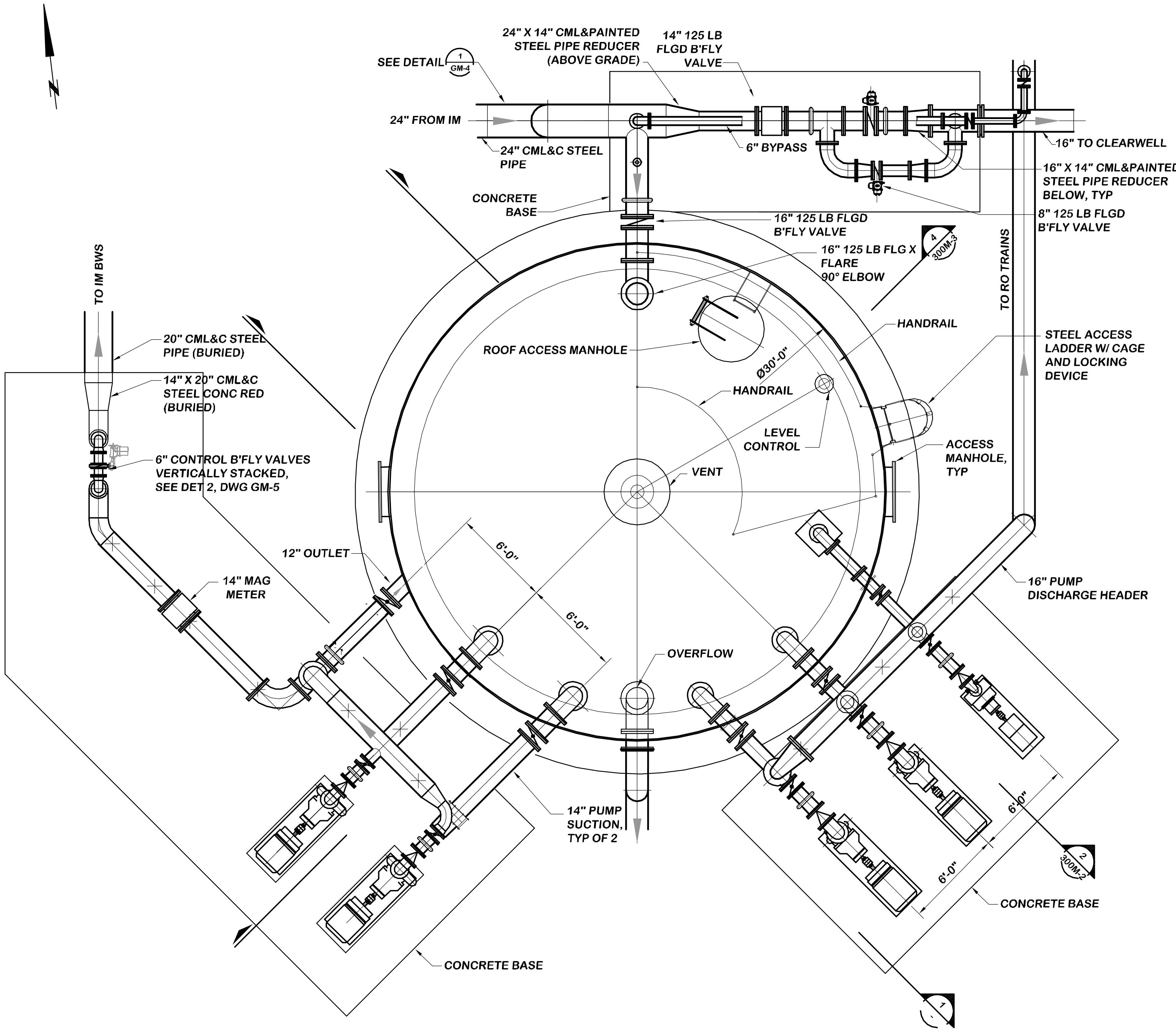
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

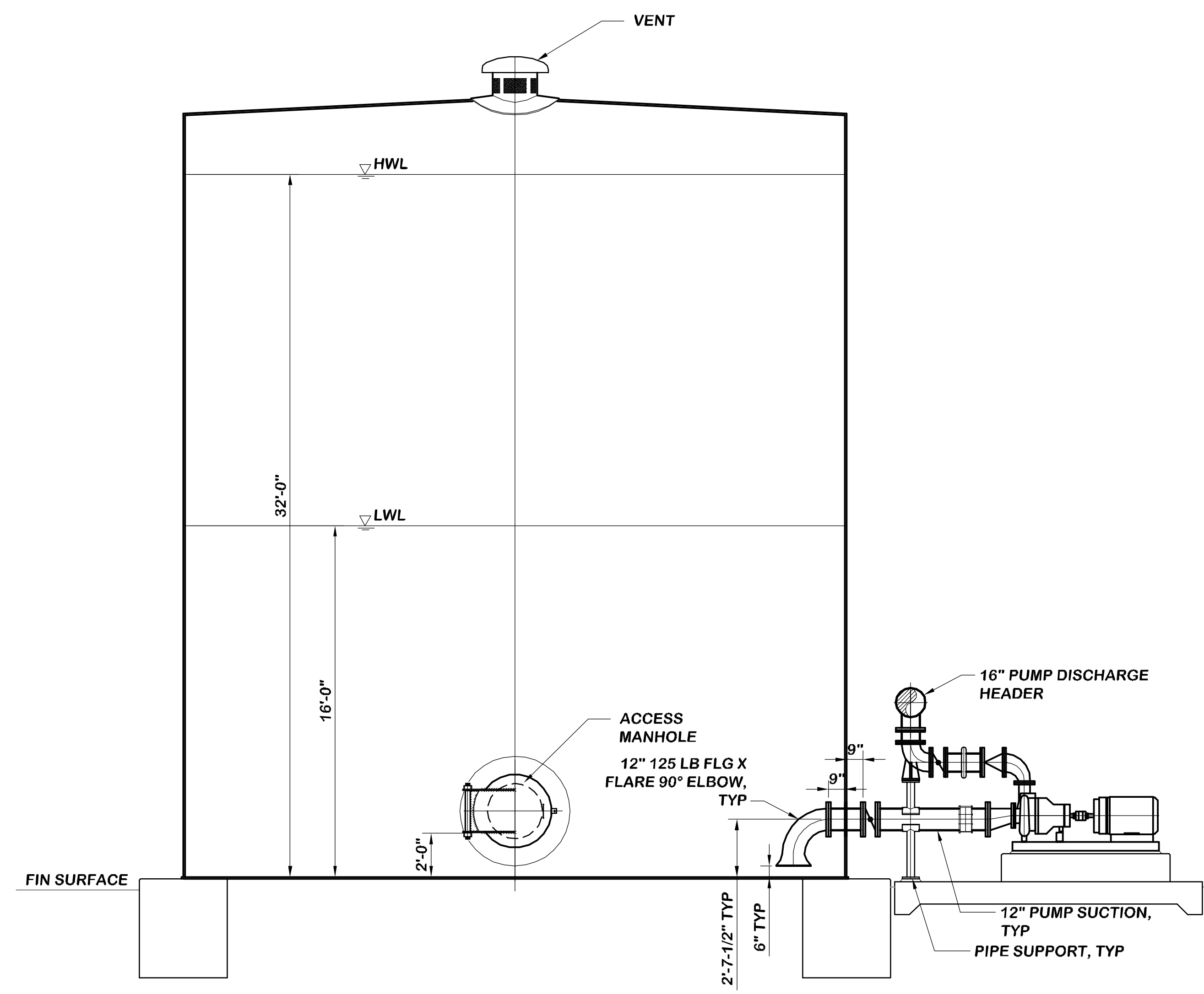
AREA 200 - IRON AND MAGANESE FILTRATION - SECTIONS

DRAWING NO. 200M-4
SHEET NO. X OF XX
CLIENT JOB NO. 2744



PLAN

SCALE: 1/4" = 1'-0"



SECTION

1 -

SCALE: 1/4" = 1'-0"

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE AS SHOWN
DATE 10/2015
PROJECT NO. 112.FPUD.0002
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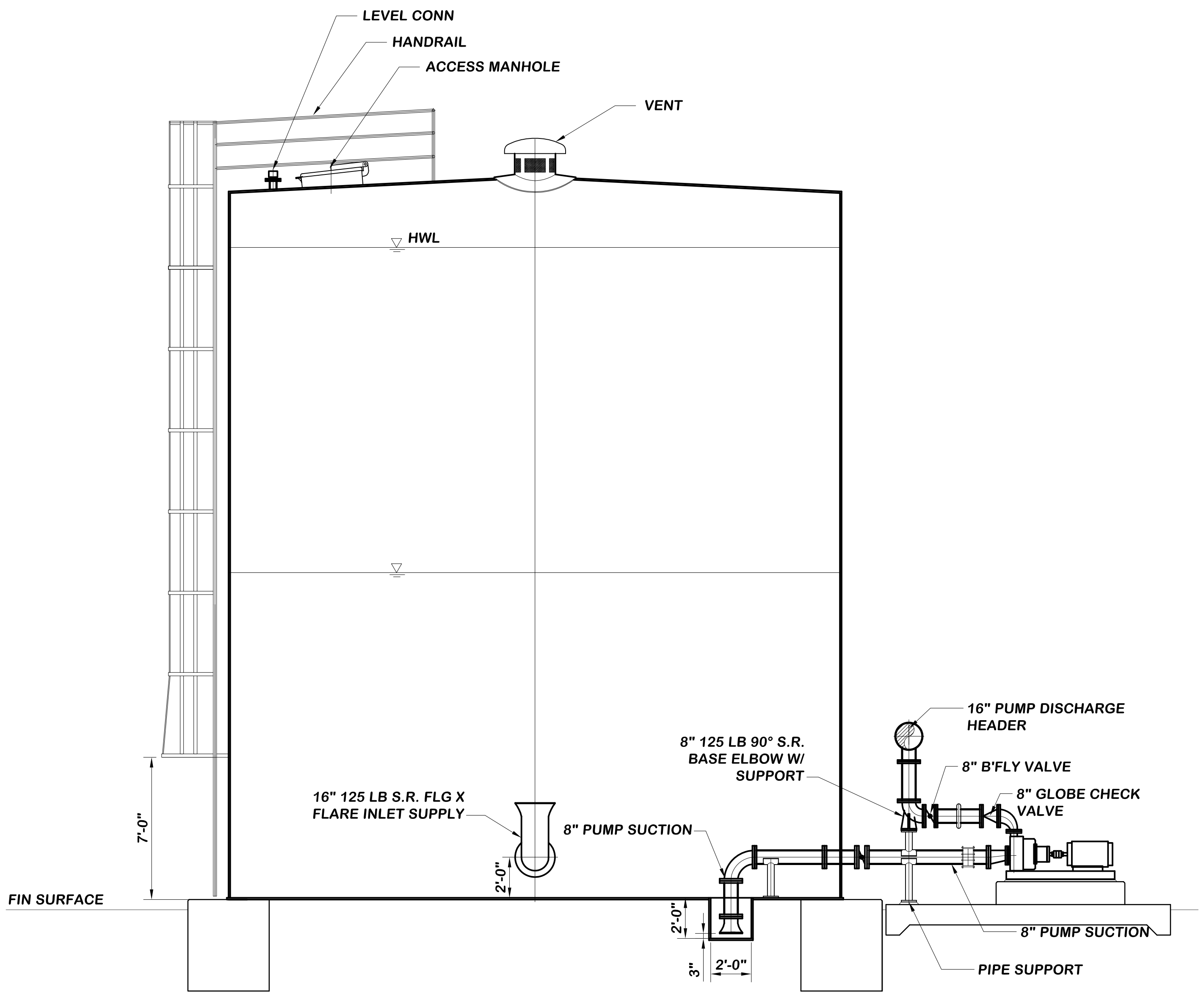
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

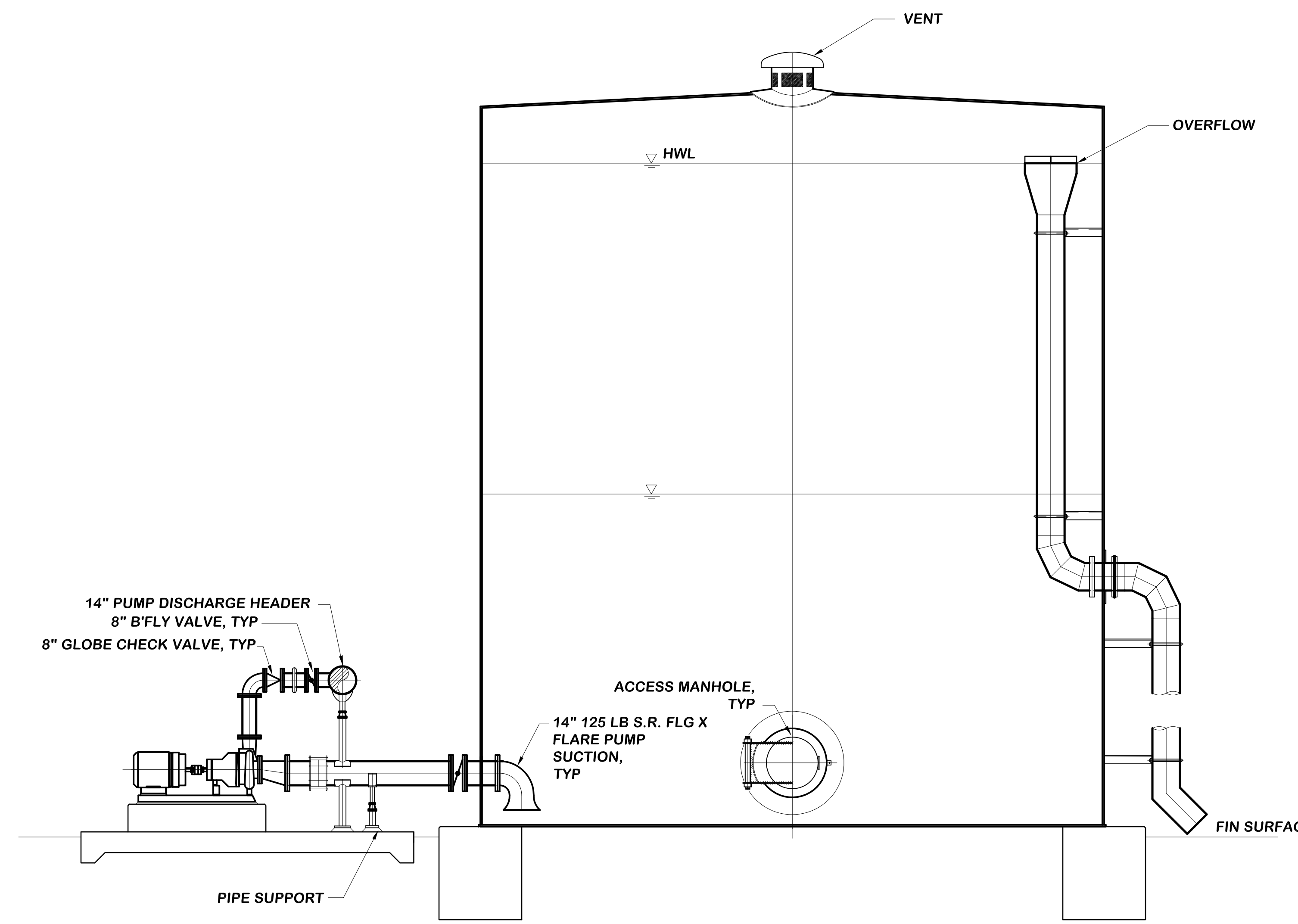
AREA 300 - RO FEED TANK AND BOOSTER PS - PLAN & SECTION

DRAWING NO. 300M-1
SHEET NO. X OF XX
CLIENT JOB NO. 2744

P:\Projects\FPUD (0112)\0002 St Marg Conjunctive Use Project\CADD\MECHANICAL\300M-1-RO-TANK.dwg 11/03/2015 13:01



SECTION 2 / 300M-1
SCALE: 1/4" = 1'-0"



SECTION 3 / 300M-1
SCALE: 1/4" = 1'-0"

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE AS SHOWN
DATE 10/2015
PROJECT NO. 112.FPUD.0002
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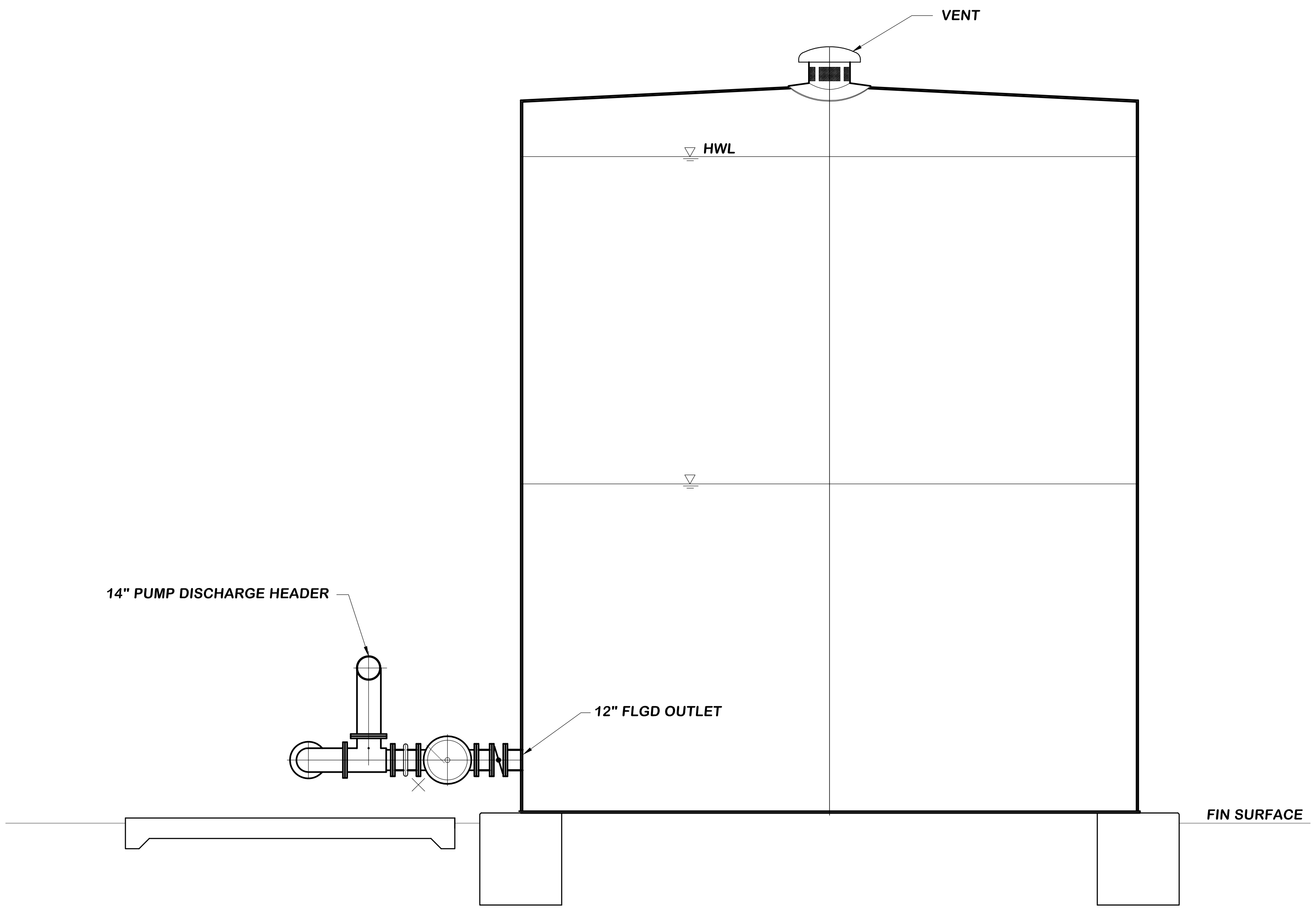
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 300 - RO FEED TANK AND BOOSTER PS - SECTIONS

DRAWING NO. 300M-2
SHEET NO. X OF XX
CLIENT JOB NO. 2744

P:\Projects\FPUD (0112)\0002 St Marg Conjunctive Use Project\CADD\MECHANICAL\300M-2-RO-TANK-SEC.dwg 10/30/2015 10:49



SECTION 4 / 300M-1

SCALE: 1/4" = 1'-0"

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE AS SHOWN
DATE 10/2015
PROJECT NO. 112.FPUD.0002
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ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 300 - RO FEED TANK AND BOOSTER PS - SECTIONS

DRAWING NO. 300M-3
SHEET NO. X OF XX
CLIENT JOB NO. 2744

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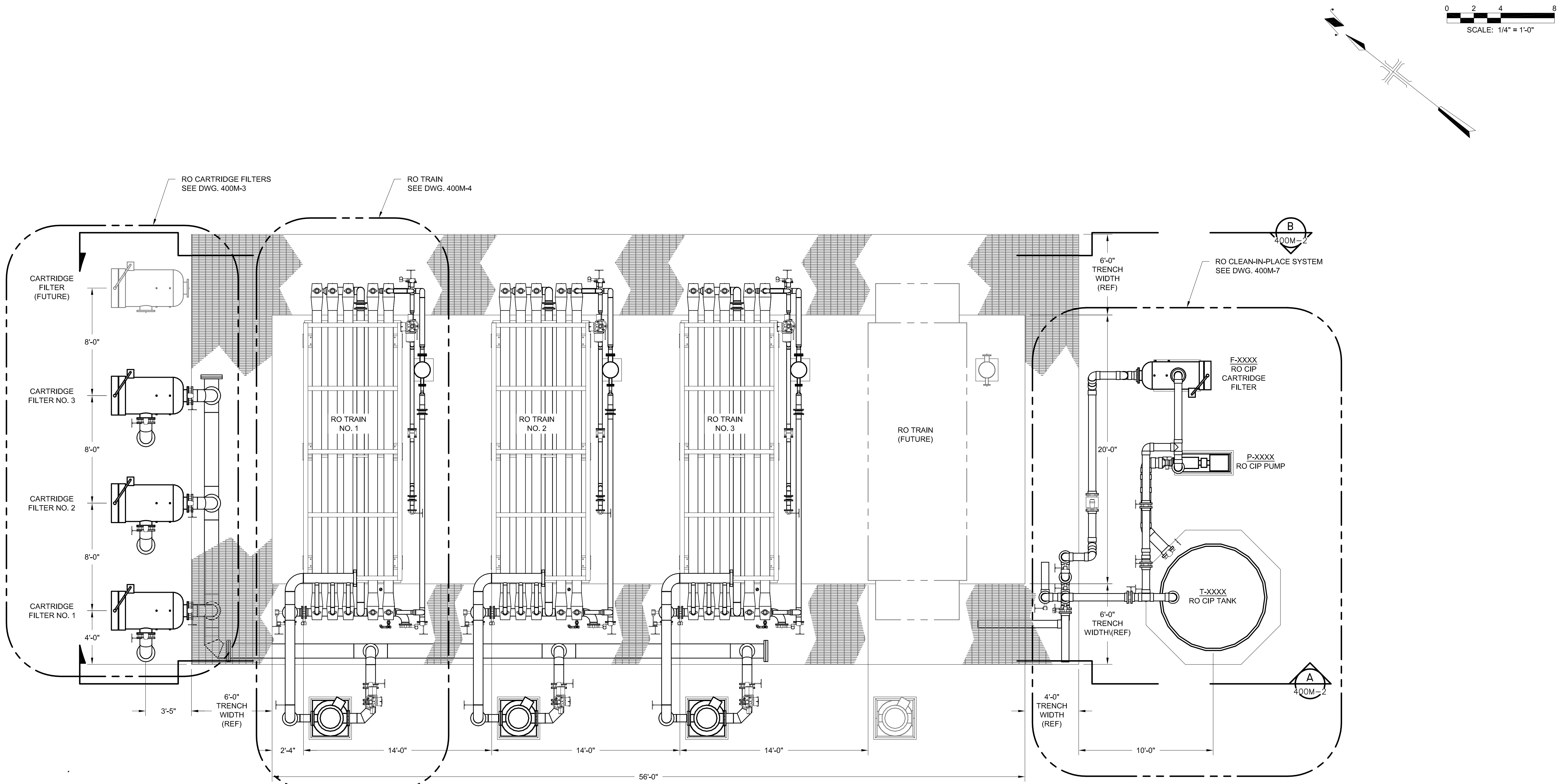

RO SYSTEM

PLAN

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE AS NOTED
DATE 06/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY AEW
DRAWN BY SAC
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SEPARATION PROCESSES, INC.
3156 LIONSHEAD AVE., SUITE 2, CARLSBAD, CA 92010
TEL: 760-400-3660 FAX: 760-400-3661

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Poway, California 92064
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990 E. MISSION RD
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ASSISTANT GENERAL MANAGER
DATE

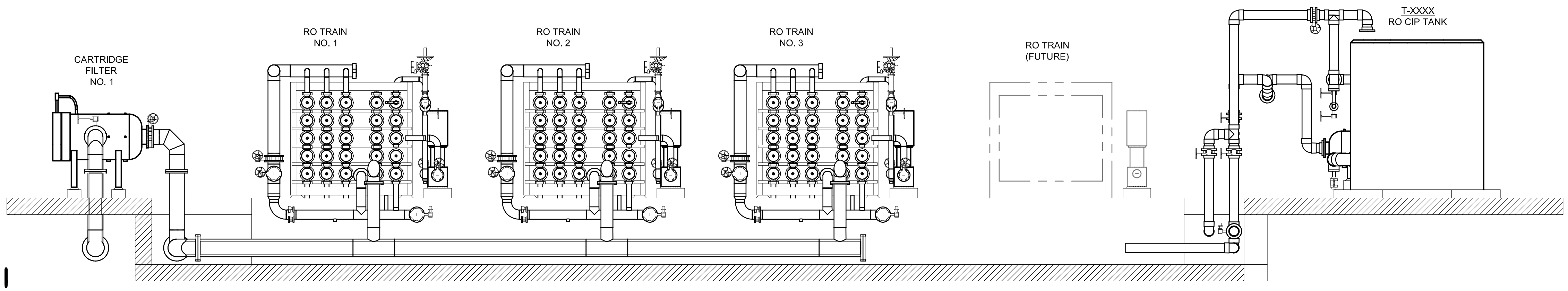
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

MECHANICAL
RO SYSTEM - PLAN

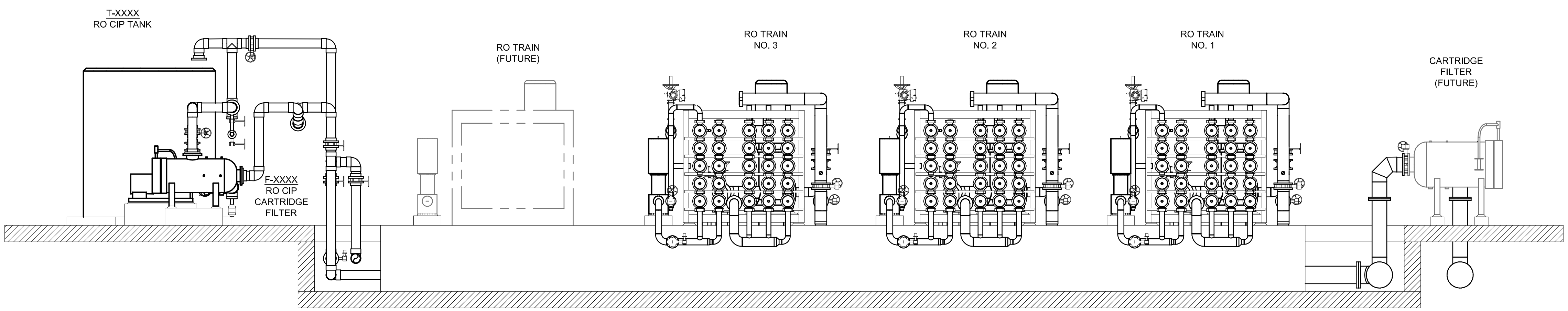
DRAWING NO. 400M-1
SHEET NO. OF XX
CLIENT JOB NO. 2744

\\SPI\CAD\CAD_Projects\2843 Fallbrook – SMCUP – IEC\07-CAD\400M-1.dwg 06/24/2015 09:29

SCALE: 1/4" = 1'-0"



RO SYSTEM
SECTION A
400M-1



RO SYSTEM
SECTION B
400M-1

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SCALE AS NOTED
DATE 06/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY AEW
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DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

MECHANICAL
RO SYSTEM - SECTIONS

DRAWING NO. 400M-2
SHEET NO. OF XX
CLIENT JOB NO. 2744

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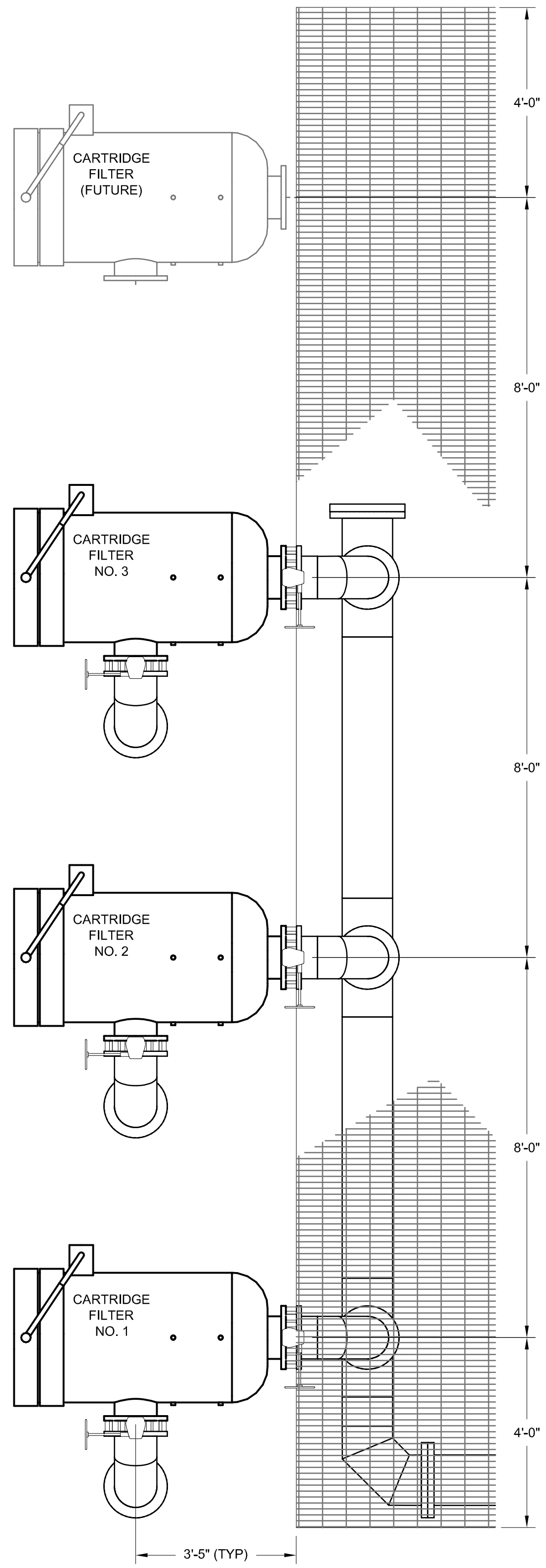
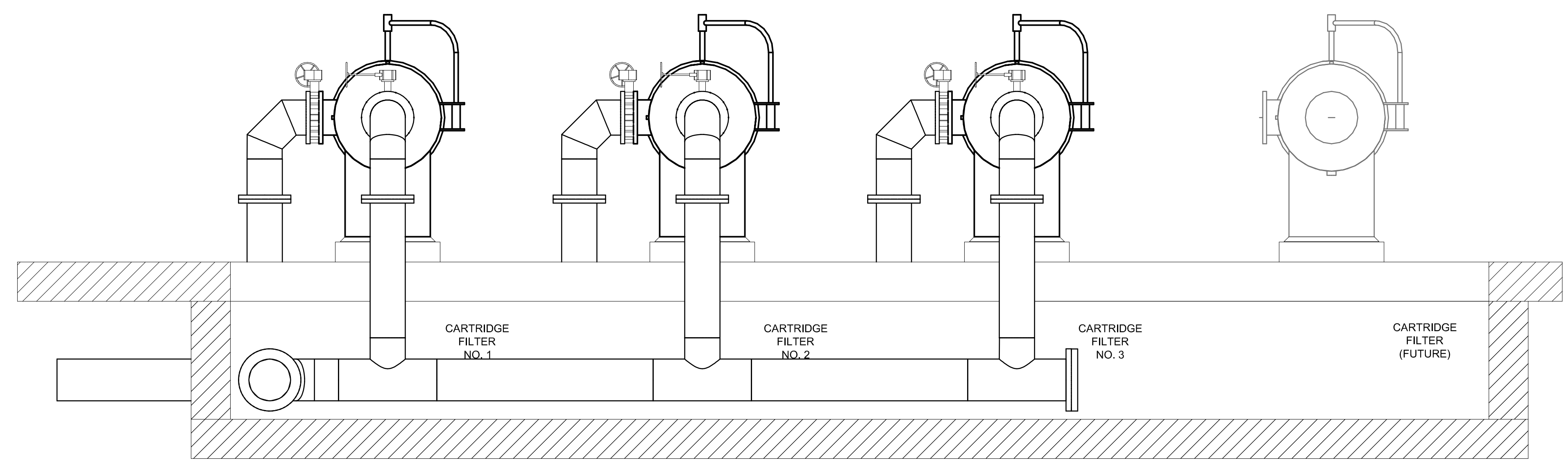


CARTRIDGE FILTERS

PLAN



CARTRIDGE FILTERS

SECTION C

SCALE: 1/2" = 1'-0"

30% SUBMITTAL

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NO.	DESCRIPTION	DATE	APPROVED

SCALE AS NOTED
DATE 06/2015
PROJECT NO. 112.FPUD.0002
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ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

MECHANICAL

CARTRIDGE FILTERS - ENLARGED PLAN AND SECTION

DRAWING NO. 400M-3
SHEET NO. OF XX
CLIENT JOB NO. 2744

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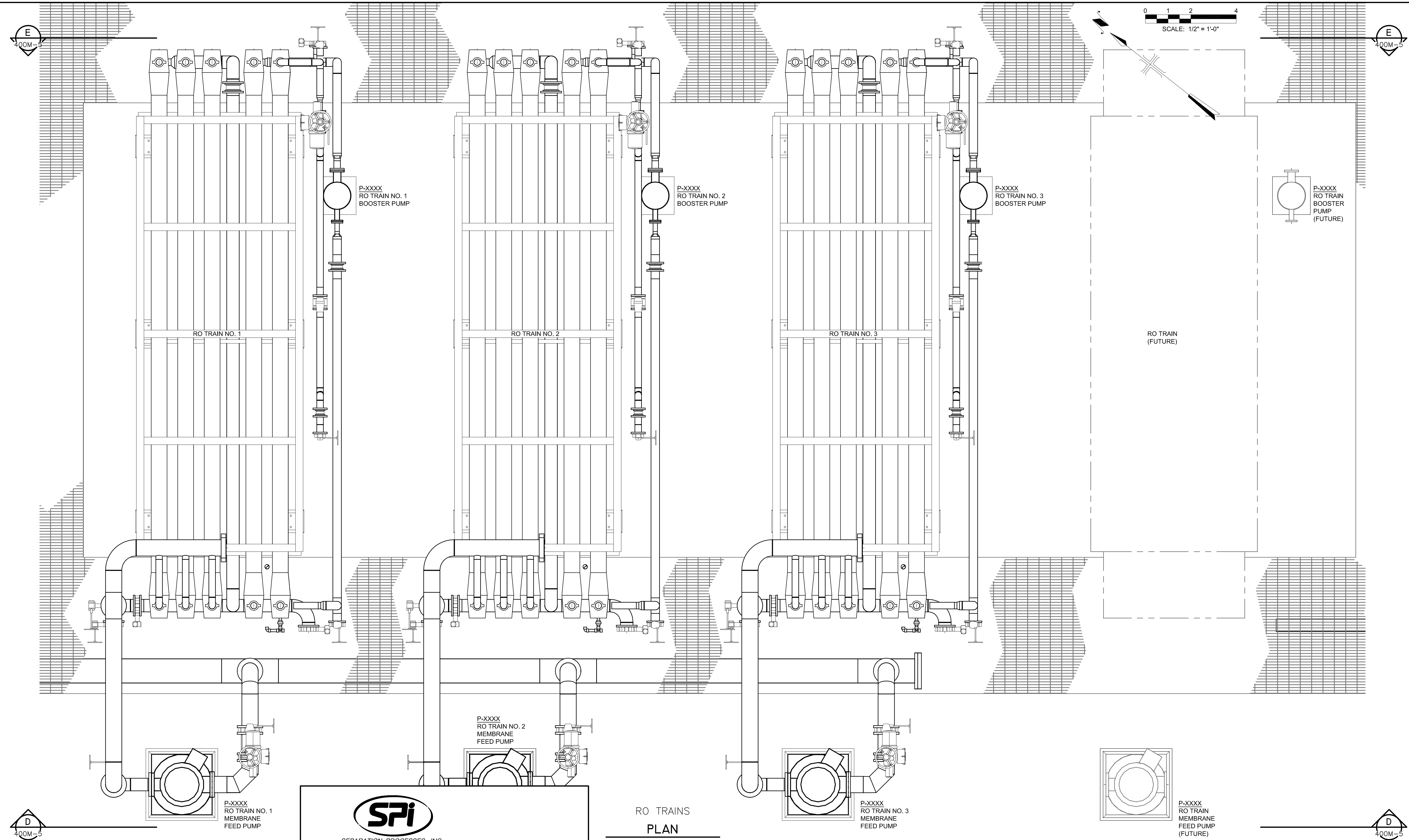

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NO.	DESCRIPTION	DATE	APPROVED

SCALE: AS NOTED
DATE: 06/2015
PROJECT NO.: 112.FPUD.0002
DESIGNED BY: AEW
DRAWN BY: SAC
CHECKED BY: XXX

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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

MECHANICAL
RO TRAINS - ENLARGED PLAN

DRAWING NO. 400M-4
SHEET NO. OF XX
CLIENT JOB NO. 2744

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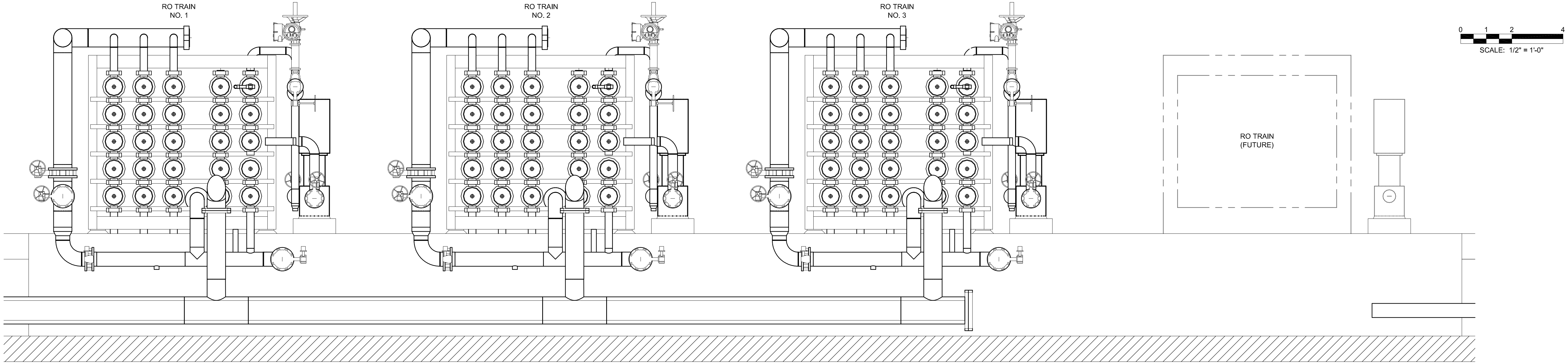
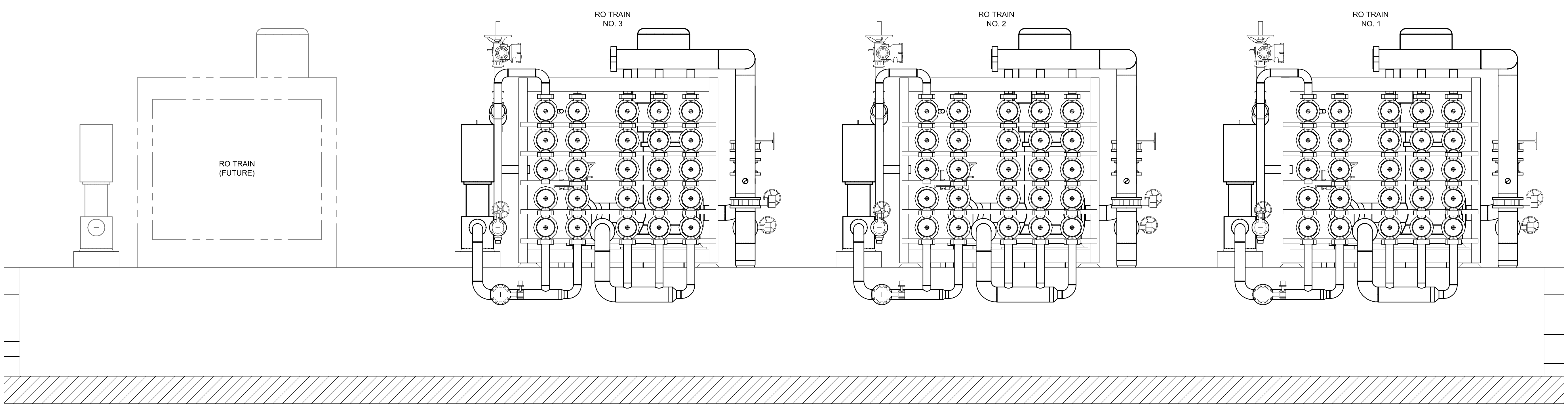


RO TRAINS
SECTION D
400M-4



RO TRAINS
SECTION E
400M-4

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SCALE: AS NOTED
DATE: 06/2015
PROJECT NO. 112.FPUD.0002
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ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

MECHANICAL
RO TRAINS - SECTIONS

DRAWING NO. 400M-5
SHEET NO. OF XX
CLIENT JOB NO. 2744

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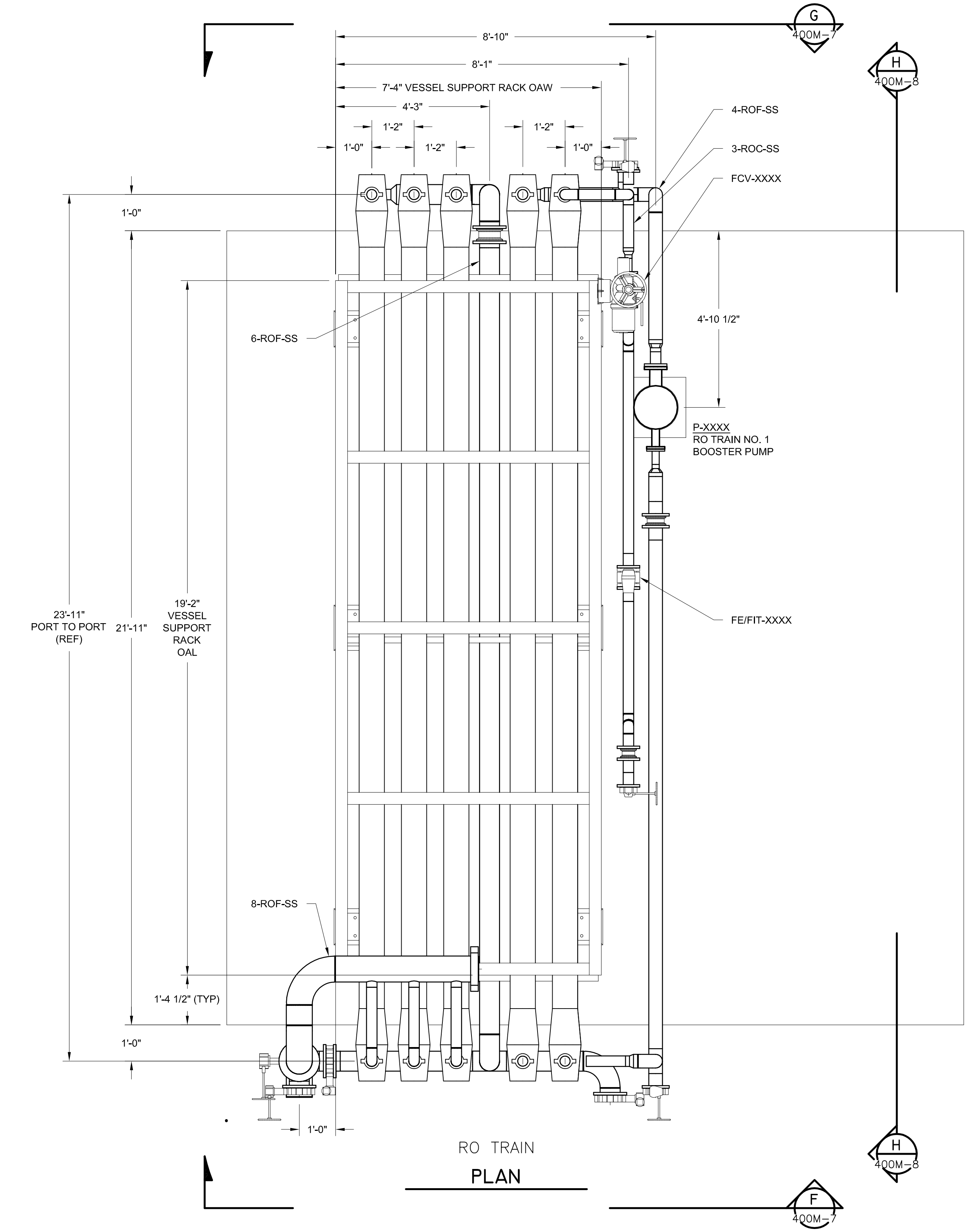

RO TRAIN

PLAN

SCALE: 1/2" = 1'-0"

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NO.	DESCRIPTION	DATE	APPROVED

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PROJECT NO. 112.FPUD.0002
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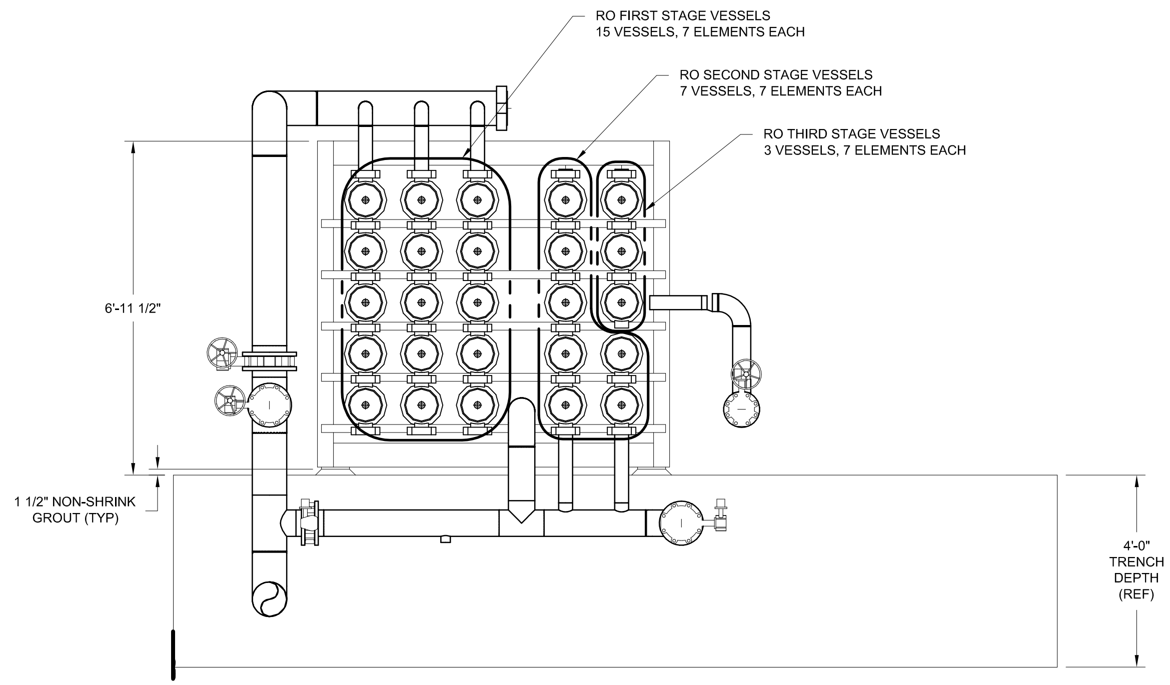
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

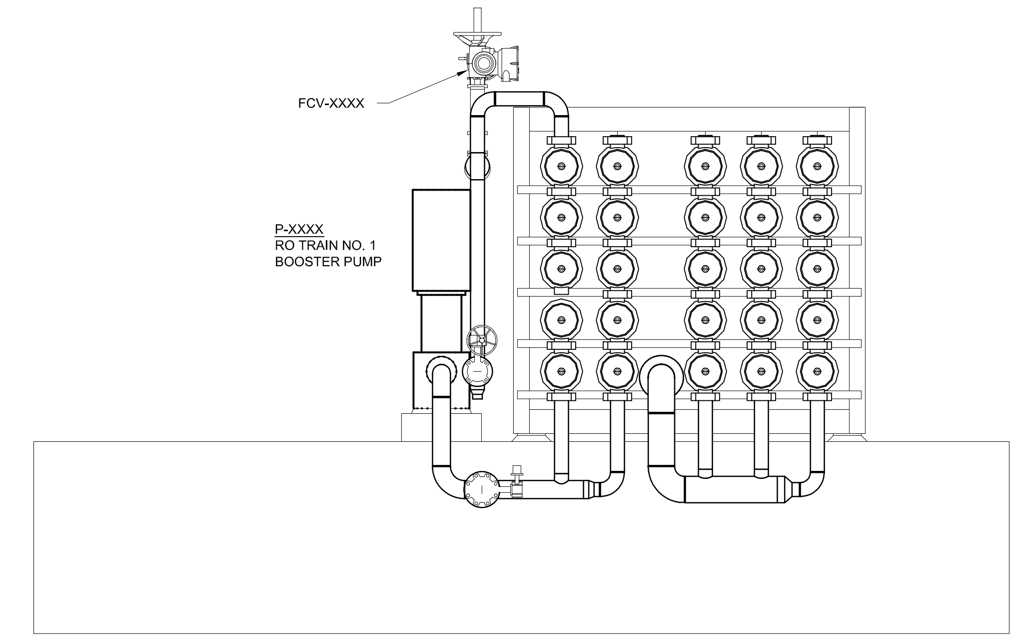
MECHANICAL
RO TRAIN - ENLARGED PLAN

DRAWING NO. 400M-6
SHEET NO. OF XX
CLIENT JOB NO. 2744

0 1 2 4
SCALE: 1/2" = 1'-0"



RO TRAIN
SECTION F
400M-6



RO TRAIN
SECTION G
400M-6

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SCALE AS NOTED
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PROJECT NO. 112.FPUD.0002
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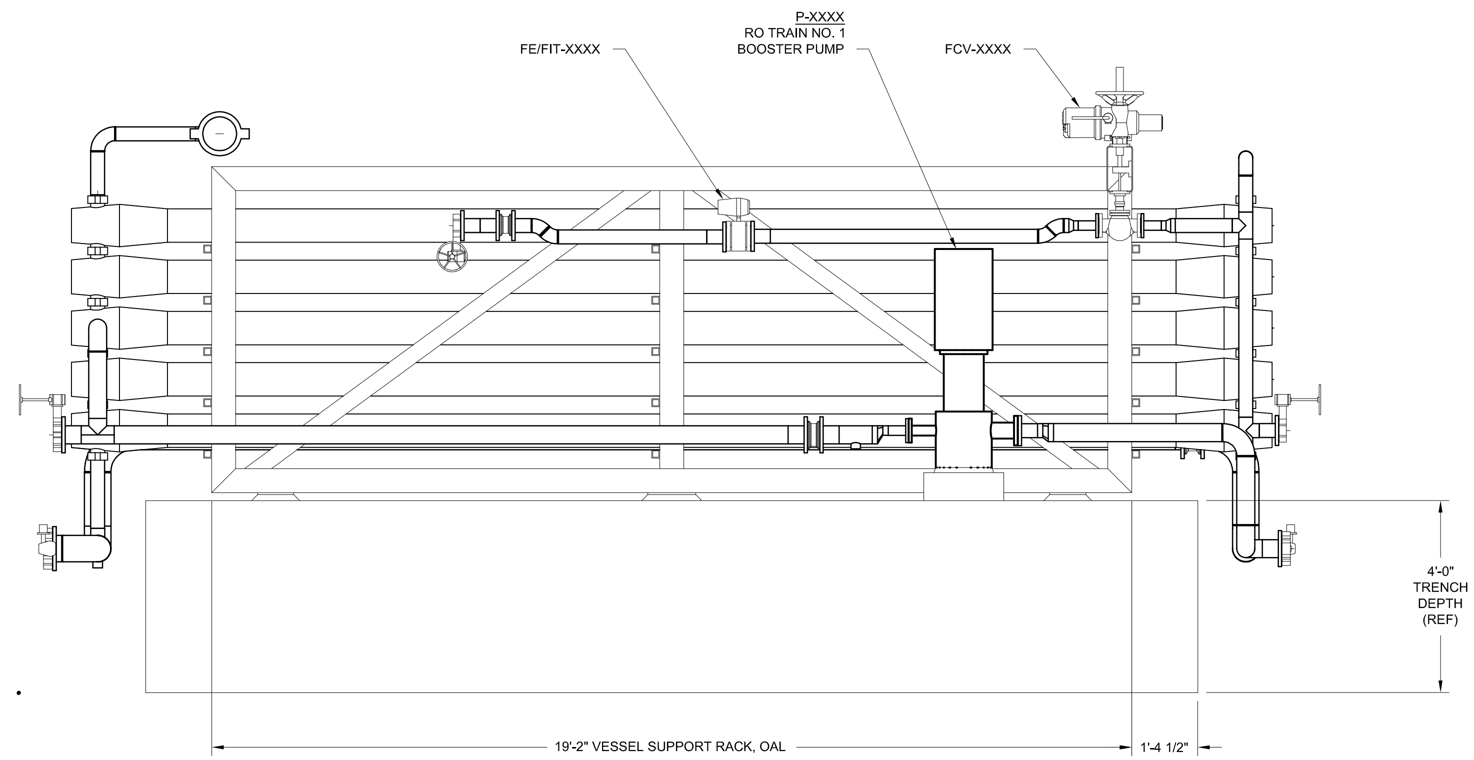
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

MECHANICAL
RO TRAIN - SECTIONS

DRAWING NO. 400M-7
SHEET NO. OF XX
CLIENT JOB NO. 2744



SCALE: 1/2" = 1'-0"

RO TRAIN
SECTION C 500M-7

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE AS NOTED
DATE 06/2015
PROJECT NO. 112.FPUD.0002
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DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES
MECHANICAL
RO TRAIN - SECTION

DRAWING NO. 400M-8
SHEET NO. OF XX
CLIENT JOB NO. 2744

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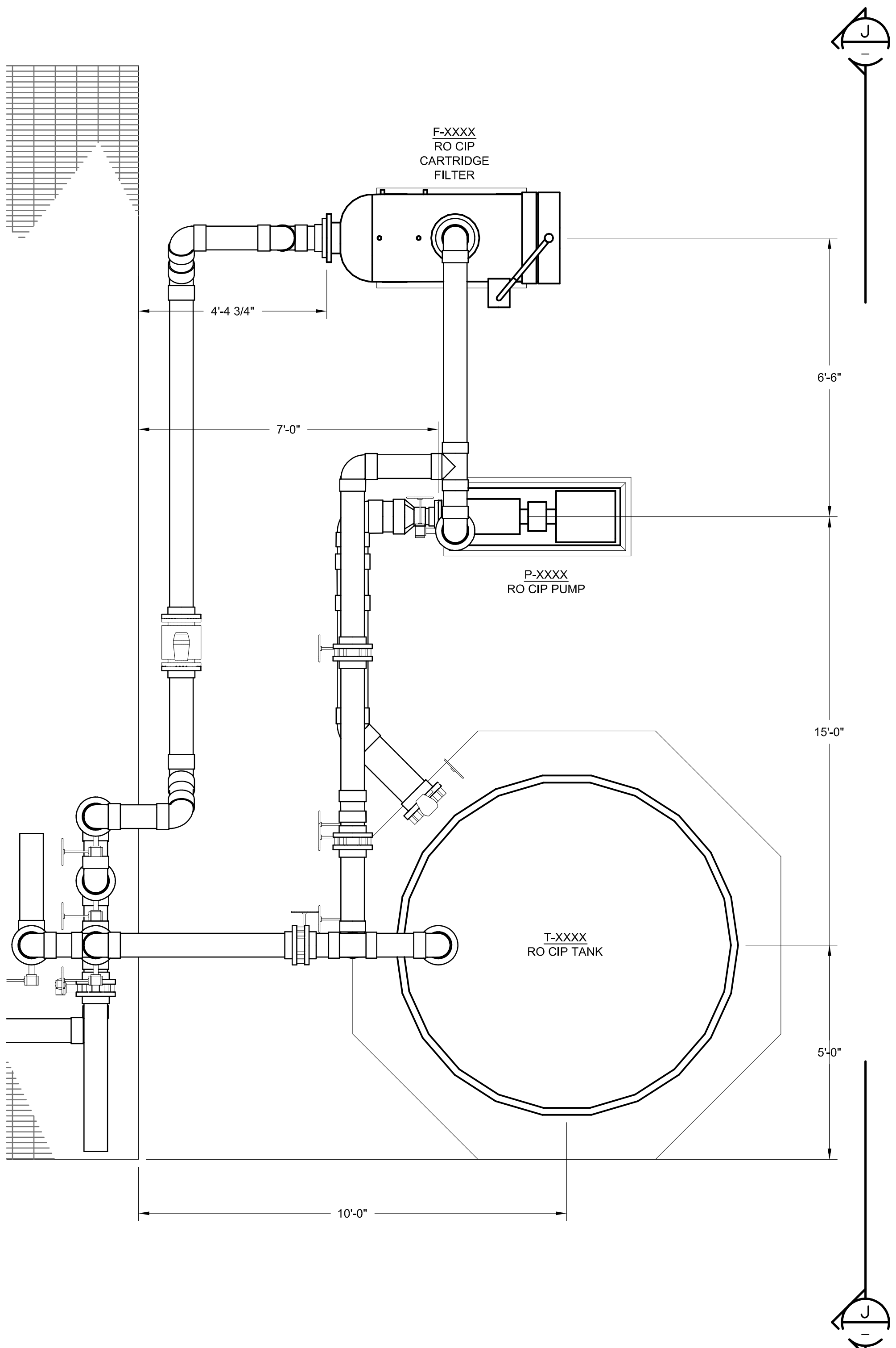
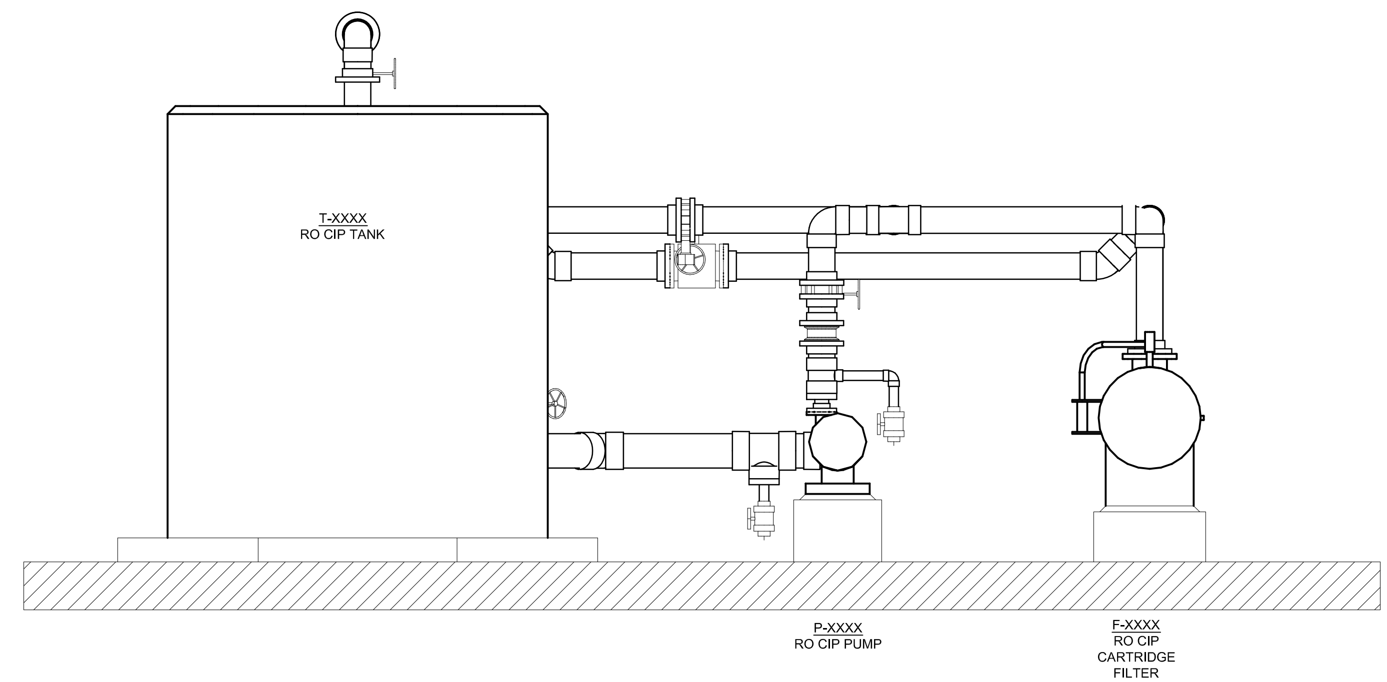


RO CIP SYSTEM

PLAN



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NO.	DESCRIPTION	DATE	APPROVED

SCALE AS NOTED
DATE 06/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY AEW
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Fallbrook Public Utility District

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ASSISTANT GENERAL MANAGER

DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

MECHANICAL

RO CIP SYSTEM - ENLARGED PLAN AND SECTION

DRAWING NO. 400M-9
SHEET NO. OF XX
CLIENT JOB NO. 2744

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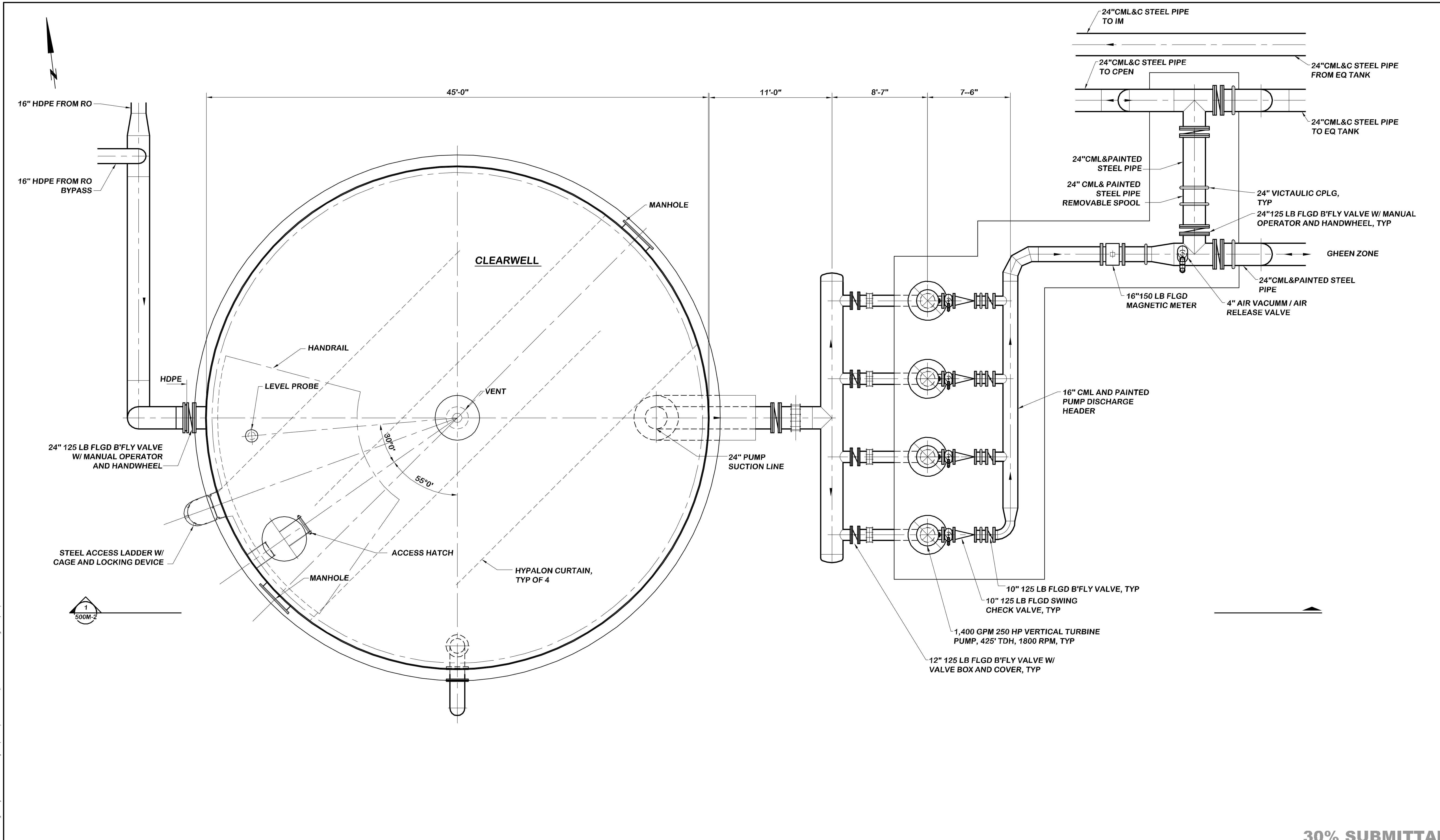


30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE AS SHOWN
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RLG
DRAWN BY RLG
CHECKED BY RK

Infrastructure ENGINEERING CORPORATION
14271 Danielson Street
Poway, California 92064
T 858.413.2400 F 858.413.2440
www.iecorporation.com

DATE

FPUD Fallbrook Public Utility District
990 E. MISSION RD
FALLBROOK, CA 92028

APPROVED BY:
JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

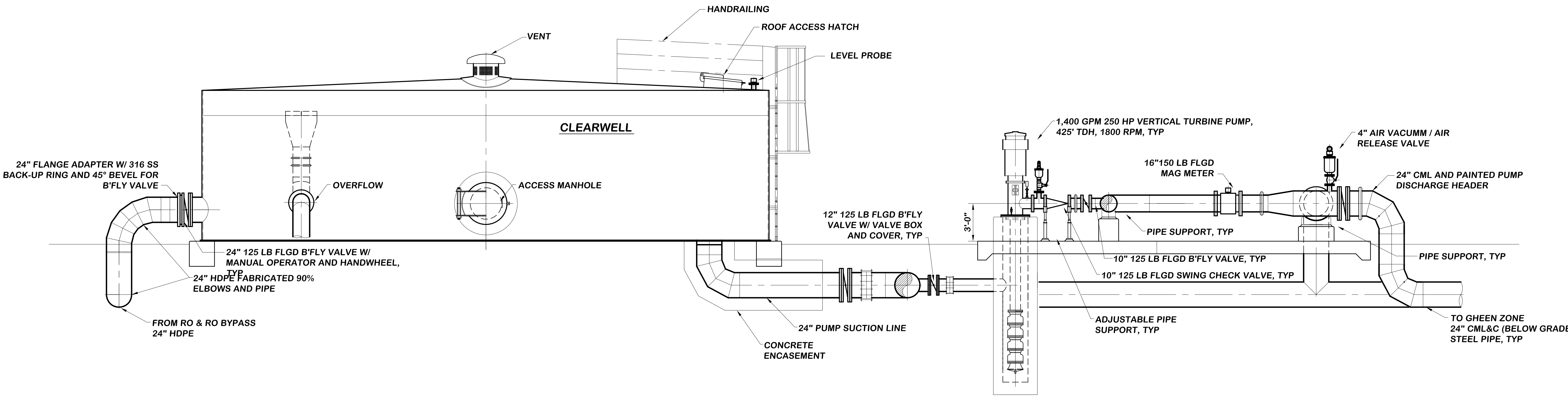
AREA 500 - CLEARWELL TANK AND PS PLAN

DRAWING NO. 500M-1
SHEET NO. X OF XX
CLIENT JOB NO. 2744

P:\Projects\FPUD (0112)\0002 St Marg Conjunctive Use Project\CADD\MECHANICAL\500M-1-CW-PS.dwg 11/03/2015 13:01

NOTE:

SEE PLAN VIEW FOR TRUE ORIENTATION OF ALL CONNECTIONS.



SECTION
SCALE: 1/4" = 1'-0"

1
500M-1

30% SUBMITTAL

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SCALE AS SHOWN
DATE 10/2015
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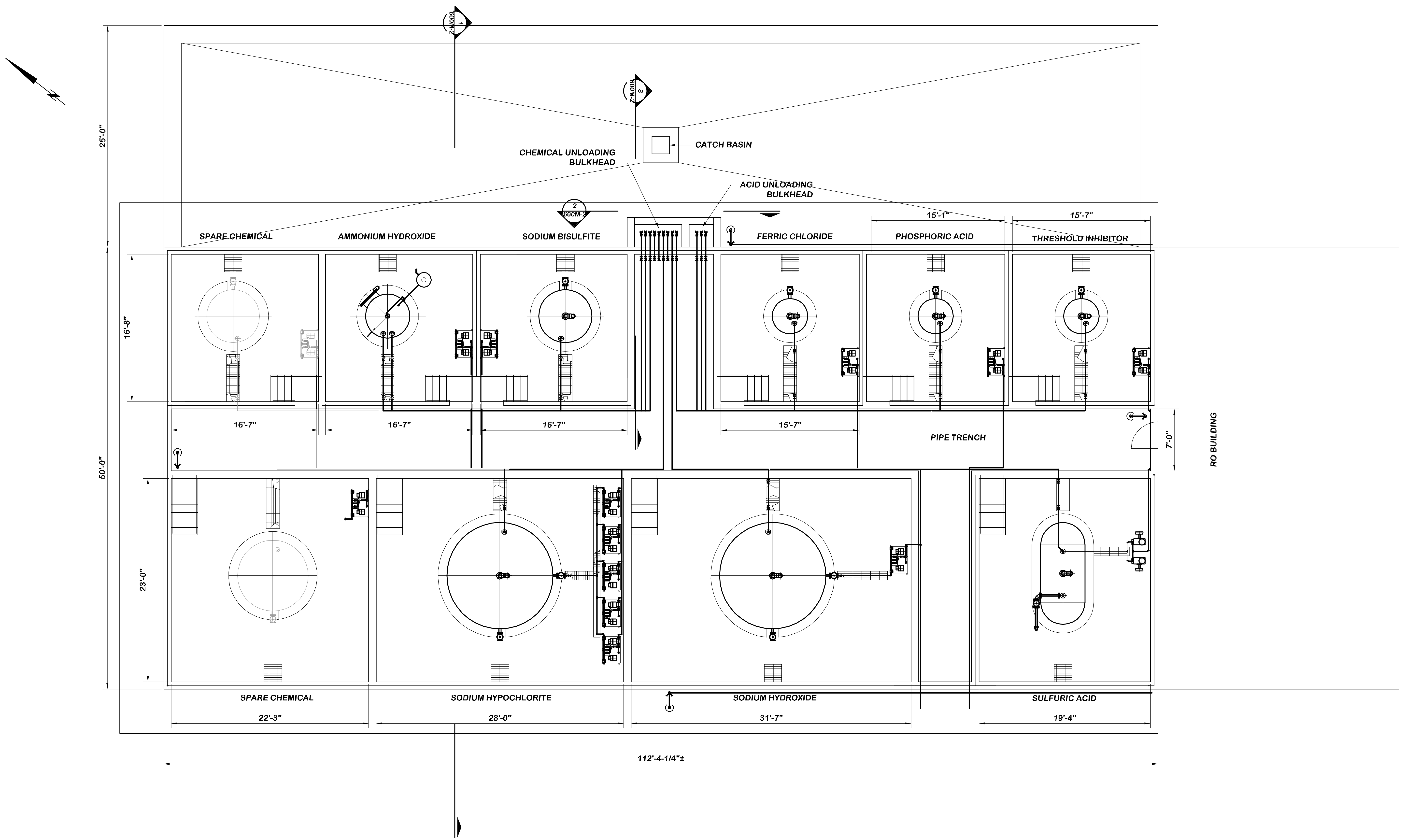
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 500 - CLEARWELL TANK AND PS SECTION

DRAWING NO. 500M-2
SHEET NO. X OF XX
CLIENT JOB NO. 2744

P:\Projects\FPUD (0112)\0002 St Marg Conjunctive Use Project\CADD\MECHANICAL\500M-2-CW-PS-SEC.dwg 10/30/2015 10:53



P:\Projects\FPUD (0112)\0002 St Marg Conjunctive Use Project\CADD\MECHANICAL\600M-1-CHEM-STOR.dwg 11/03/2015 13:12

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE 3/16" = 1'-0"
DATE 10/2015
PROJECT NO. 112.FPUD.0002
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JACK R. BEBEE, P.E.
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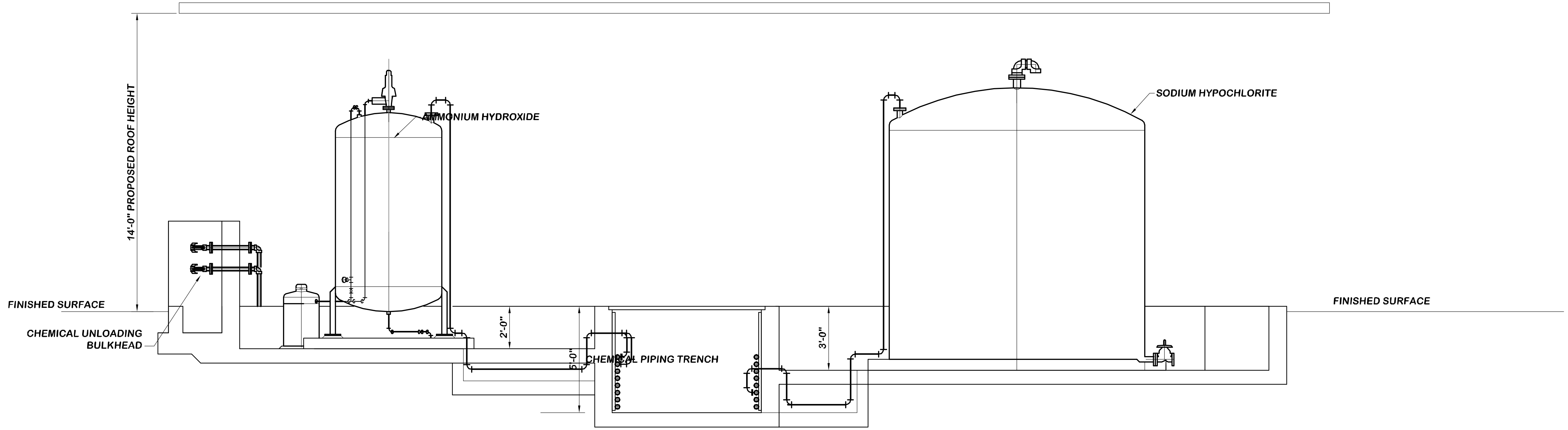
DATE

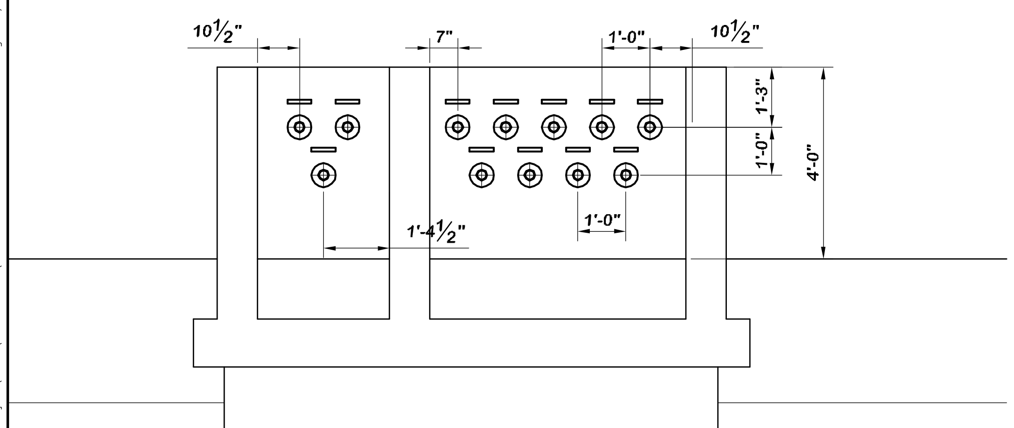
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 600 - CHEMICAL FACILITIES PLAN

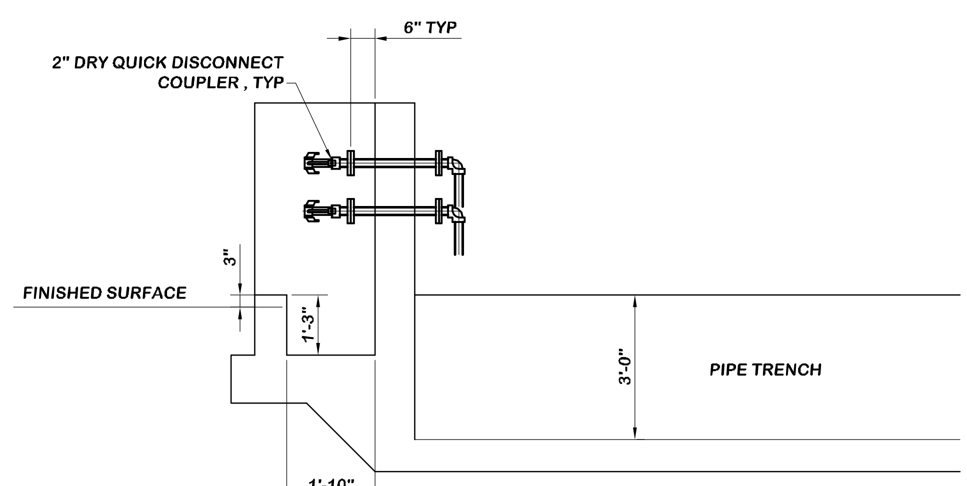
DRAWING NO. 600M-1
SHEET NO. X OF XX
CLIENT JOB NO. 2744



SECTION 1 / 600M-1
SCALE: 3/8" = 1'-0"



SECTION 2 / 600M-1
SCALE: 1/2" = 1'-0"



SECTION 3 / 600M-1
SCALE: 1/2" = 1'-0"

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE AS SHOWN
DATE 10/2015
PROJECT NO. 112.FPUD.0002
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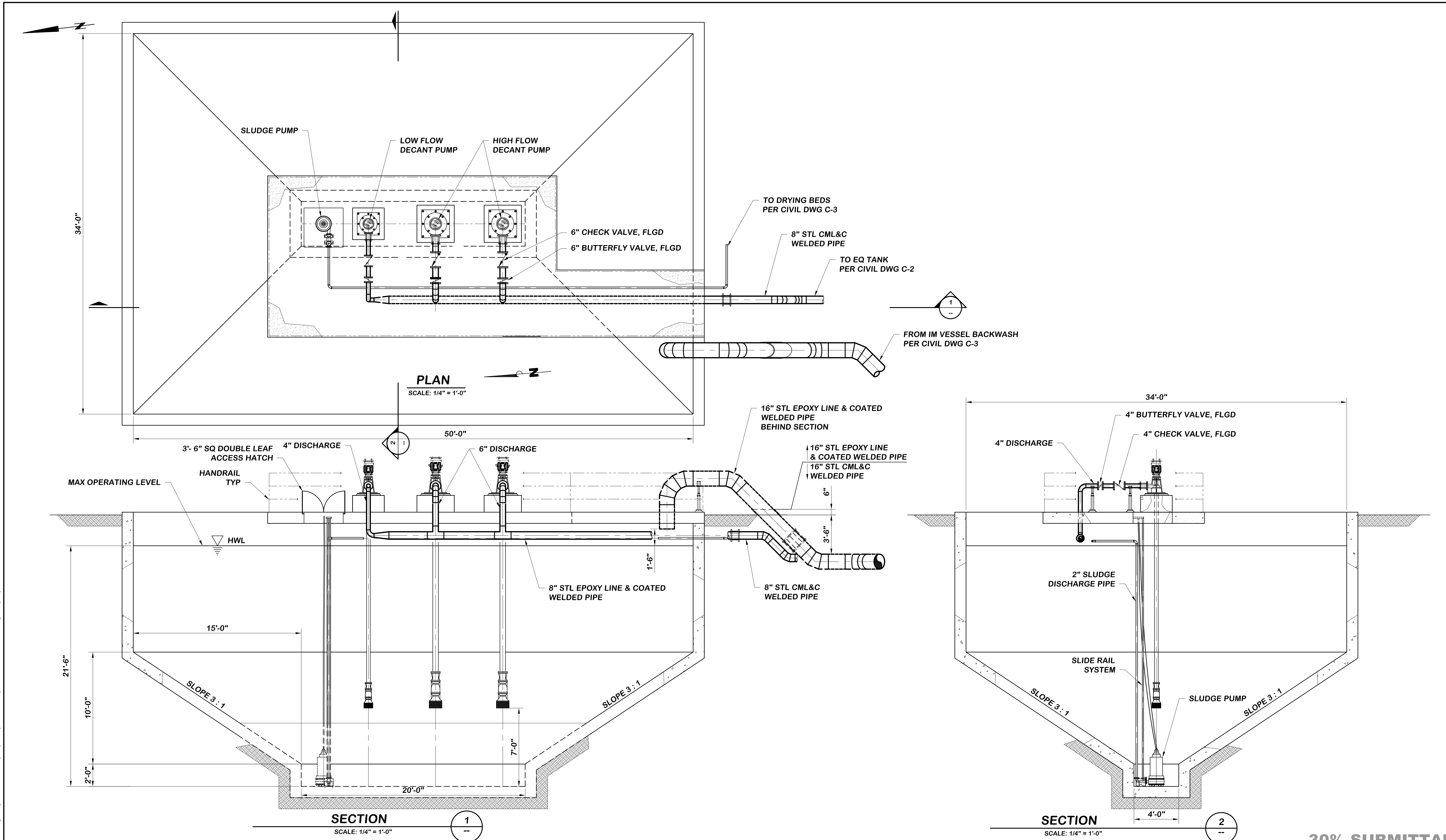
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 600 - CHEMICAL FACILITIES
SECTIONS

DRAWING NO. 600M-2
SHEET NO. X OF XX
CLIENT JOB NO. 2744

P:\Projects\FPUD (0112)\0002 St Marg Conjunctive Use Project\CADD\MECHANICAL\600M-2-CHEM-UNLOADING-SECT.dwg 11/03/2015 13:11



30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE AS SHOWN
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RM
DRAWN BY BC
CHECKED BY RK

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FPUD Fallbrook Public Utility District

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APPROVED BY:

JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER

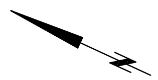
DATE

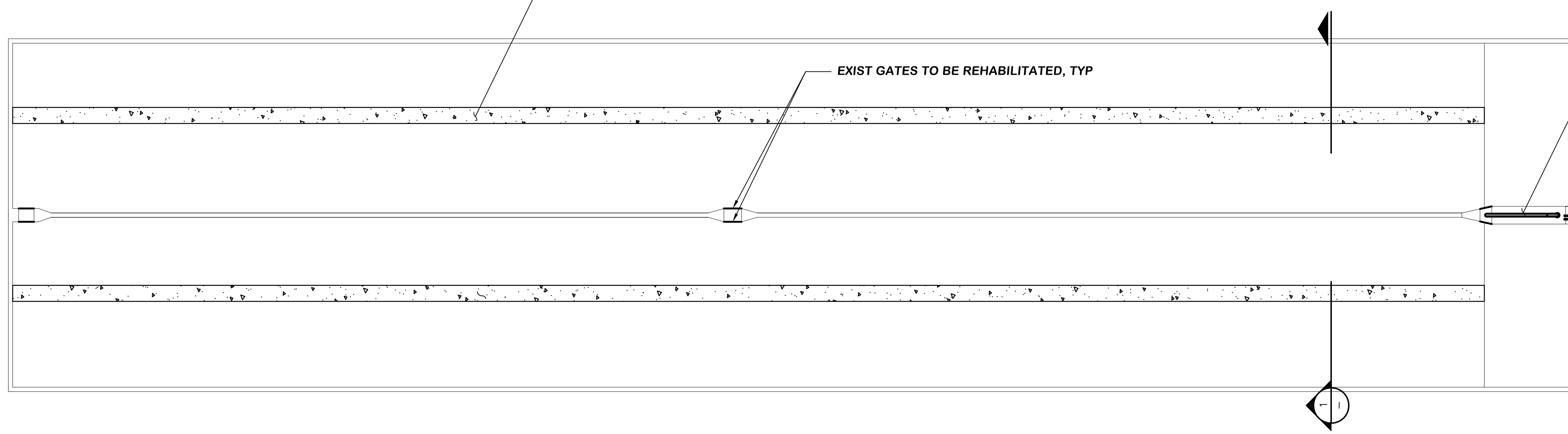
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 700 - WASTE WASHWATER STORAGE PLAN AND SECTIONS

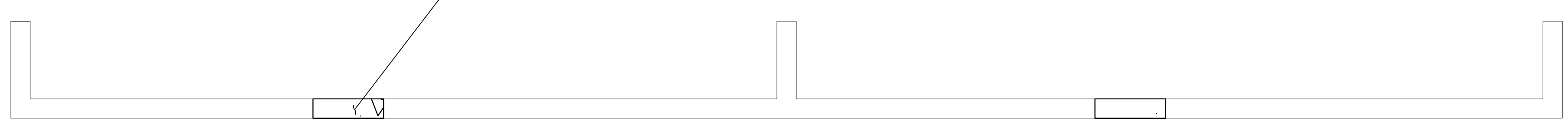
DRAWING NO. 700M-1
SHEET NO. X OF XX
CLIENT JOB NO. 2744

P:\Projects\FPUD (0112)\0002 St Marg Conjunctive Use Project\CADD\MECHANICAL\700M-1-RWT-PL-SEC.dwg 10/30/2015 10:59





DRYING BEDS PLAN
SCALE: 1/8" = 1'-0"



NOTE:
REPAIR CONCRETE WALLS AT LOCATIONS NOTED ON PLANS AND PER CONTRACTOR'S FIELD OBSERVATIONS PRIOR TO BID.

SECTION 1 / -
SCALE: 1/2" = 1'-0"

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE AS SHOWN
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RM
DRAWN BY RM
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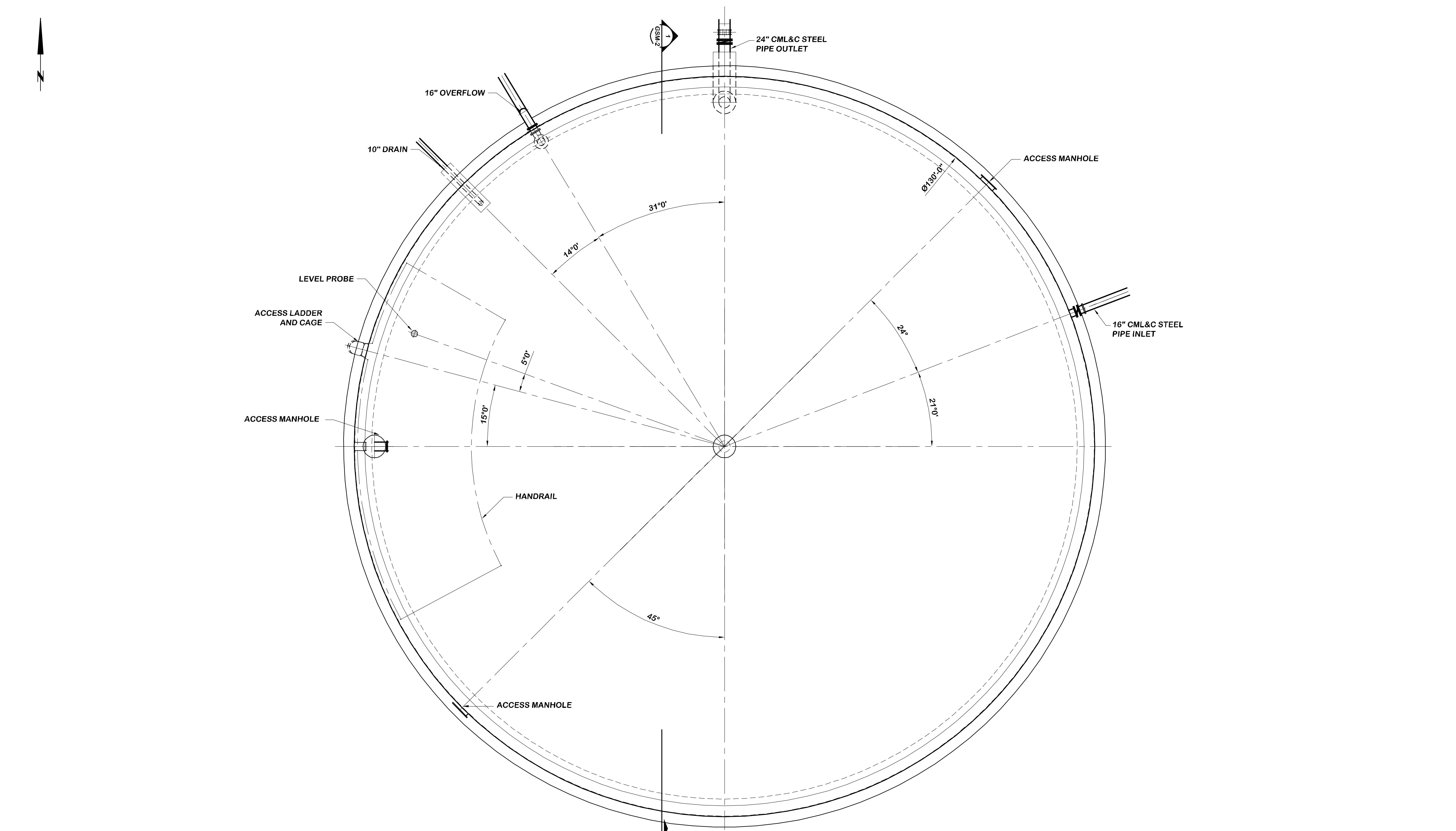
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 700 -DRYING BED MODIFICATIONS PLAN AND SECTIONS

DRAWING NO. 700M-2
SHEET NO. X OF XX
CLIENT JOB NO. 2744



30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE 1/8" = 1'-0"
DATE 10/2015
PROJECT NO. 112.FPUD.0002
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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

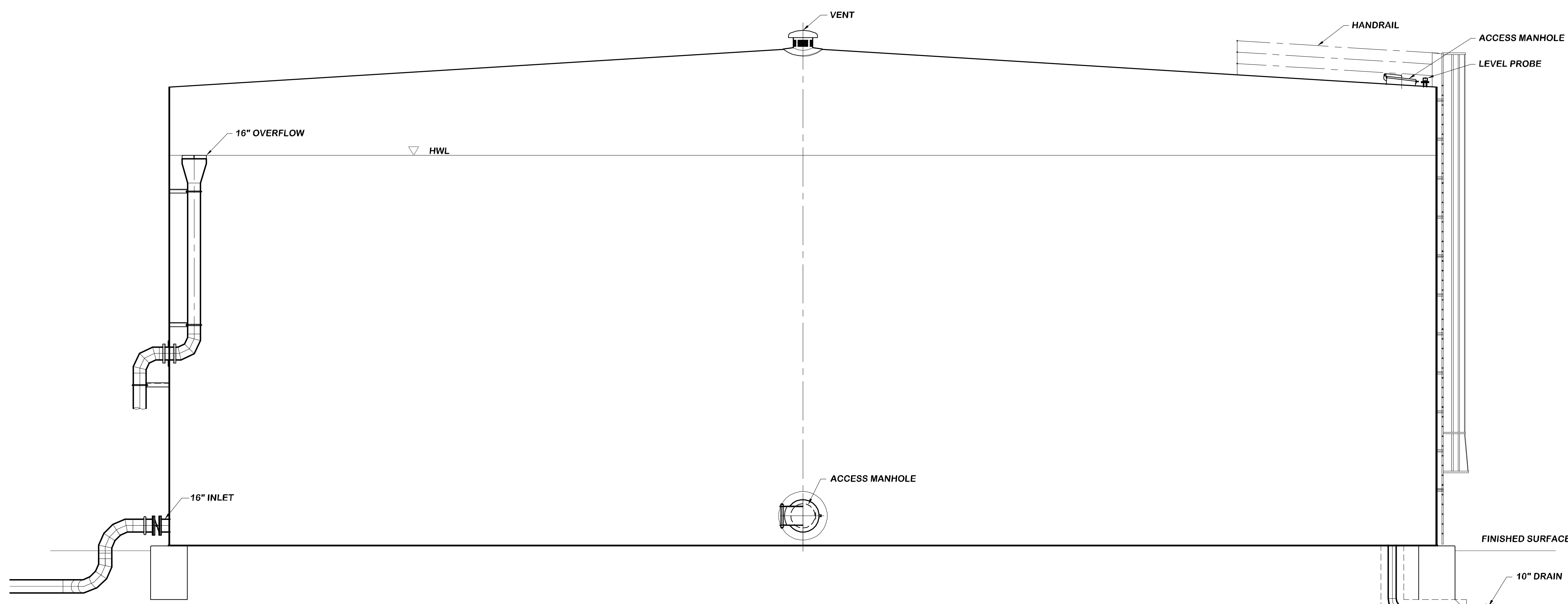
4 MG GHEEN FACILITY RESERVOIR
PLAN

DRAWING NO. GFM-1
SHEET NO. X OF XX
CLIENT JOB NO. 2744

P:\Projects\FPUD (0112)\0002 St Marg Conjunctive Use Project\CADD\MECHANICAL\GFM-1-RES-PLN.dwg 11/03/2015 13:02

NOTE:

FOR TRUE ORIENTATON OF ALL CONNECTIONS SEE DRAWING GFM-1



SECTION 1 / GSM-1

SCALE: 3/16" = 1'-0"

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

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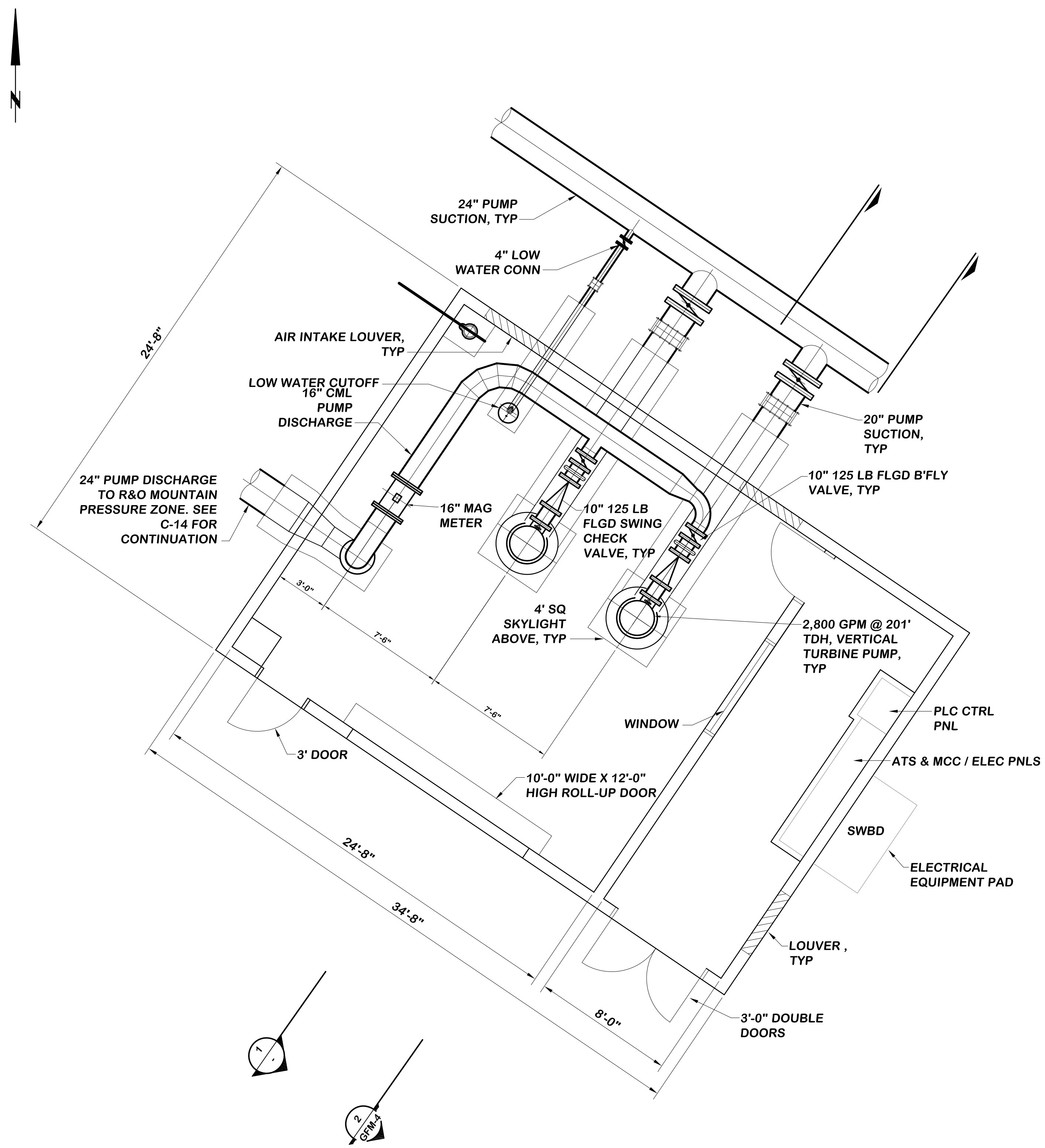
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

4 MG GHEEN FACILITY RESERVOIR SECTION

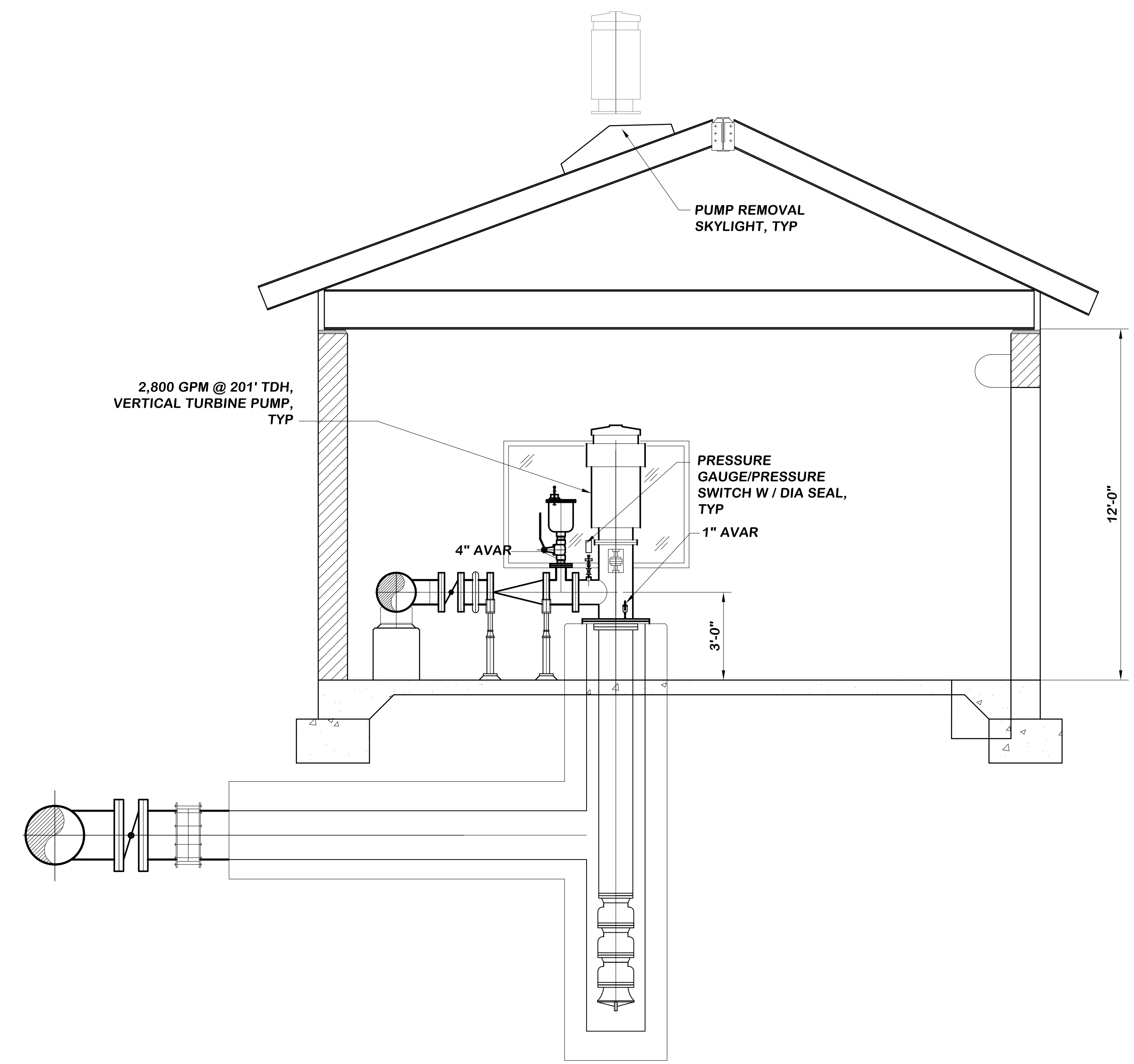
DRAWING NO. GFM-2
SHEET NO. X OF XX
CLIENT JOB NO. 2744

P:\Projects\FPUD (0112)\0002 St Marg Conjunctive Use Project\CADD\MECHANICAL\GFM-2-RES-SEC.dwg 11/03/2015 13:10



PUMP STATION PLAN

SCALE: 1/4" = 1'-0"



SECTION

1
-

SCALE: 3/8" = 1'-0"

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE AS SHOWN
DATE 10/2015
PROJECT NO. 112.FPUD.0002
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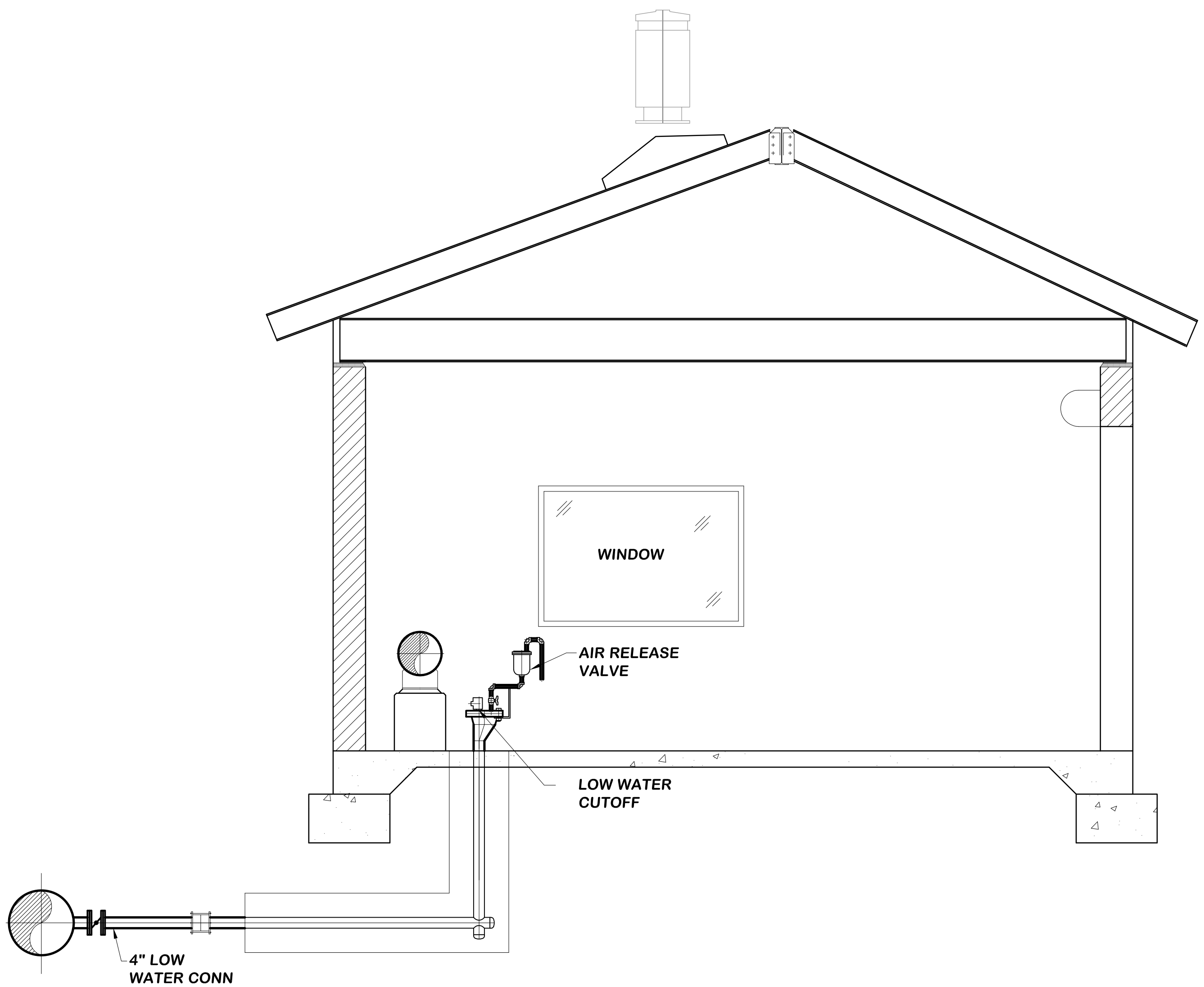
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

GHEEN FACILITY PUMP STATION PLAN AND SECTION

DRAWING NO. GFM-3
SHEET NO. X OF XX
CLIENT JOB NO. 2744

P:\Projects\FPUD (0112)\0002 St Marg Conjunctive Use Project\CADD\MECHANICAL\GFM-3-PS-PLAN.dwg 10/30/2015 11:02



SECTION (2 / GFM-3)

SCALE: 3/8" = 1'-0"

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

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DATE 10/2015
PROJECT NO. 112.FPUD.0002
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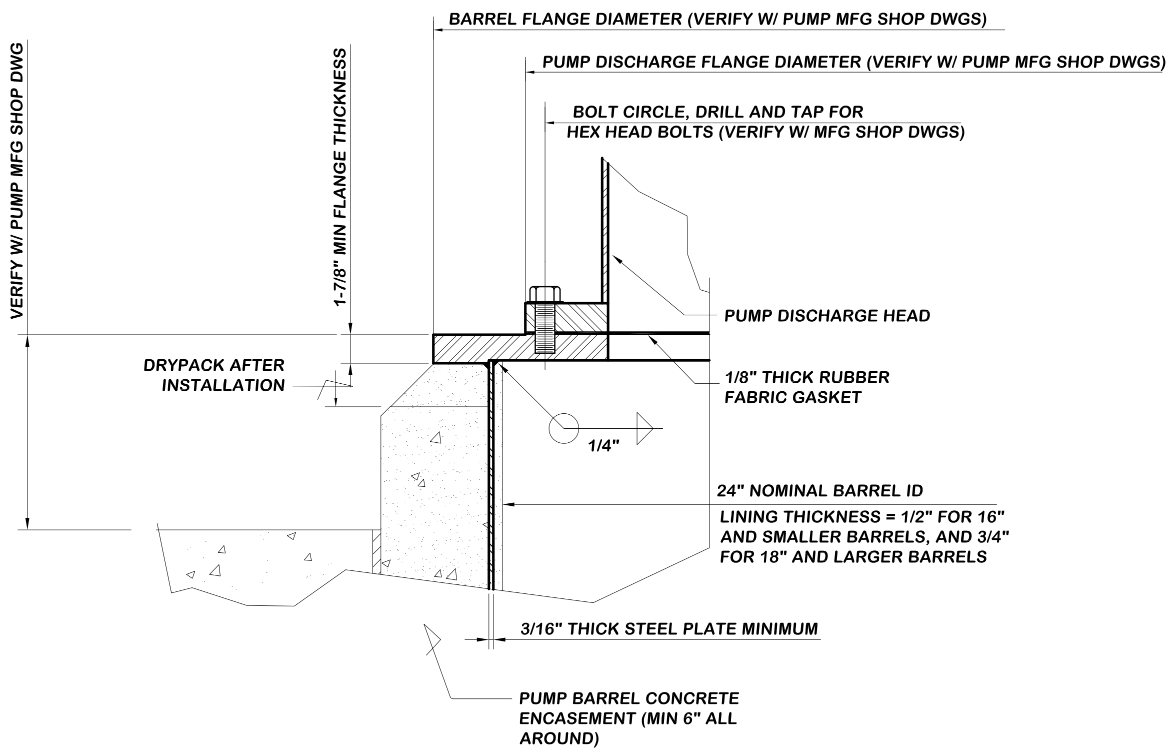
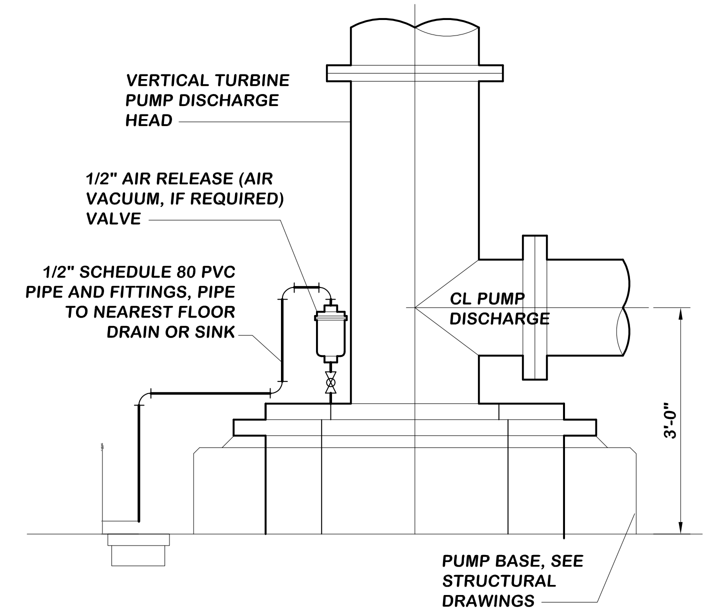
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

GHEEN FACILITY PUMP STATION SECTIONS

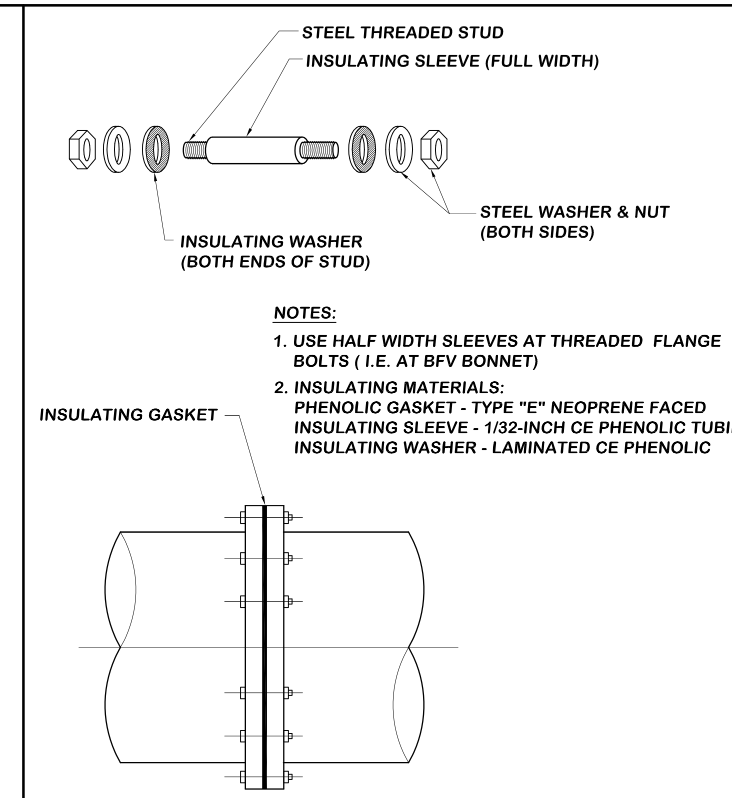
DRAWING NO. GFM-4
SHEET NO. X OF XX
CLIENT JOB NO. 2744



PUMP BARREL MOUNTING DETAIL 1 / -
N.T.S.

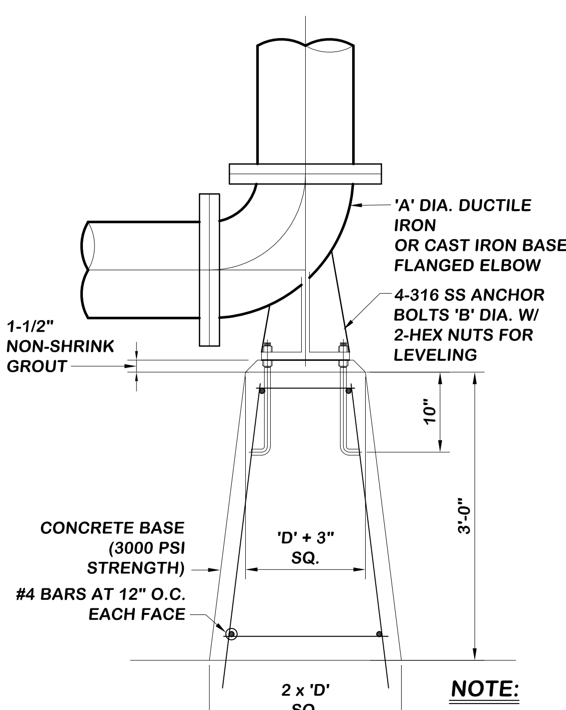


PUMP BARREL AIR VALVE 2 / -
N.T.S.



NOTES:
1. USE HALF WIDTH SLEEVES AT THREADED FLANGE BOLTS (I.E. AT BFV BONNET)
2. INSULATING MATERIALS:
PHENOLIC GASKET - TYPE "E" NEOPRENE FACED
INSULATING SLEEVE - 1/32-INCH CE PHENOLIC TUBING
INSULATING WASHER - LAMINATED CE PHENOLIC

INSULATING FLANGE SET 3 / -
N.T.S.

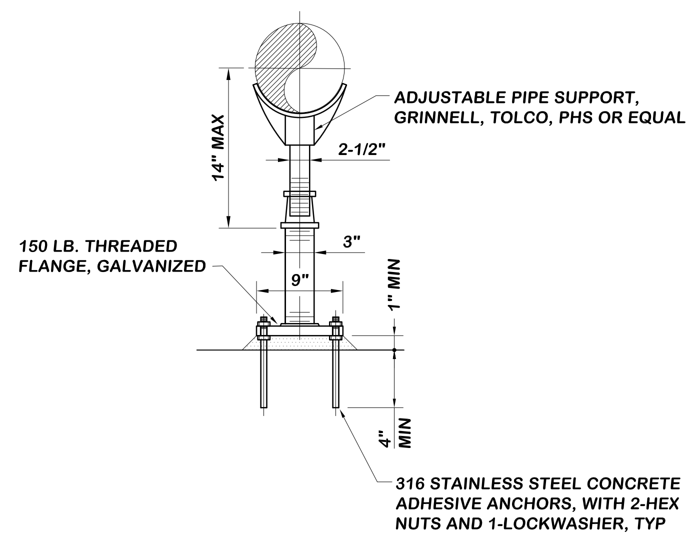


DIMS IN INCHES		LBS.
'A'	'B'	
4	5/8	9K
6	5/8	10.5K
8	5/8	13.5K
10	5/8	13.5K
12	3/4	16.5K
14	3/4	16.5K
16	3/4	16.5K
18	3/4	20.3K
20	3/4	20.3K
24	3/4	20.3K
30	7/8	24K
36	7/8	28.5K
42	1	35.3K
48	1-1/8	37.5K

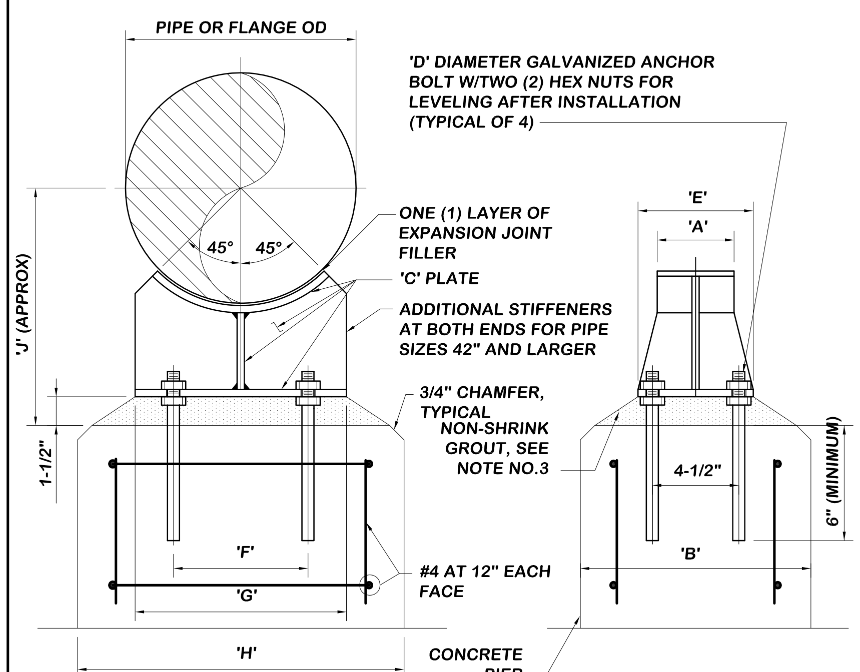
NOTE:
'D' = BASE ELBOW PLATE DIAMETER

BASE ELBOW SUPPORT 4 / -
N.T.S.

NOTE: PIPE SUPPORTS TO BE LOCATED IN PLAN AT POINTS MARKED THUS: (X).



ADJUSTABLE PIPE SUPPORT 5 / -
N.T.S.



DIMENSIONS IN INCHES													
NOMINAL PIPE SIZE						SUPPORTING							
						PIPE				FLANGE			
	'A'	'B'	'C'	'D'	'E'	'F'	'G'	'H'	'J'	'F'	'G'	'H'	'J'
6	4	12	3/8	5/8	6	4-1/2	6	12	10	6-1/2	9	16	13
8	4	12	3/8	5/8	6	5	8	13	11	7-1/2	9	16	14
10	4	12	3/8	5/8	6	6	9	15	12	9	13	18	15
12	4	12	3/8	5/8	6	7	11	17	13	10	15	20	16
14	4	12	3/8	5/8	6	8	12	17	14	11	16	21	27
16	4	12	3/8	5/8	6	9	13	19	15	12	18	24	18
18	4	12	3/8	5/8	6	10	14	20	16	13	19	24	19
20	5	12	3/8	5/8	6	10	15	21	17	15	21	26	21
22	5	12	3/8	5/8	6	12	18	24	18	16	23	28	22
24	5	12	3/8	5/8	6	13	19	24	19	16	24	30	23

NOTES:
1. WHEN SUPPORTING PIPE AND FLANGE ALTERNATELY ON THE SAME LINE, CONCRETE PIERS FOR SUPPORTS SHALL ALL HAVE THE SAME DIMENSION 'H' FOR FLANGE SUPPORT.
2. PIPE SUPPORTS TO BE LOCATED IN PLAN AT POINTS MARKED THUS: (X).
3. WHERE DIFFERENTIAL SETTLEMENT IS LIKELY TO OCCUR, OMIT GROUT AS DIRECTED BY THE ENGINEER.
4. GALVANIZE ASSEMBLY AFTER FABRICATION.

CONCRETE PIER SUPPORT 6 / -
N.T.S.

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE NTS
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RLG
DRAWN BY RLG
CHECKED BY XXX

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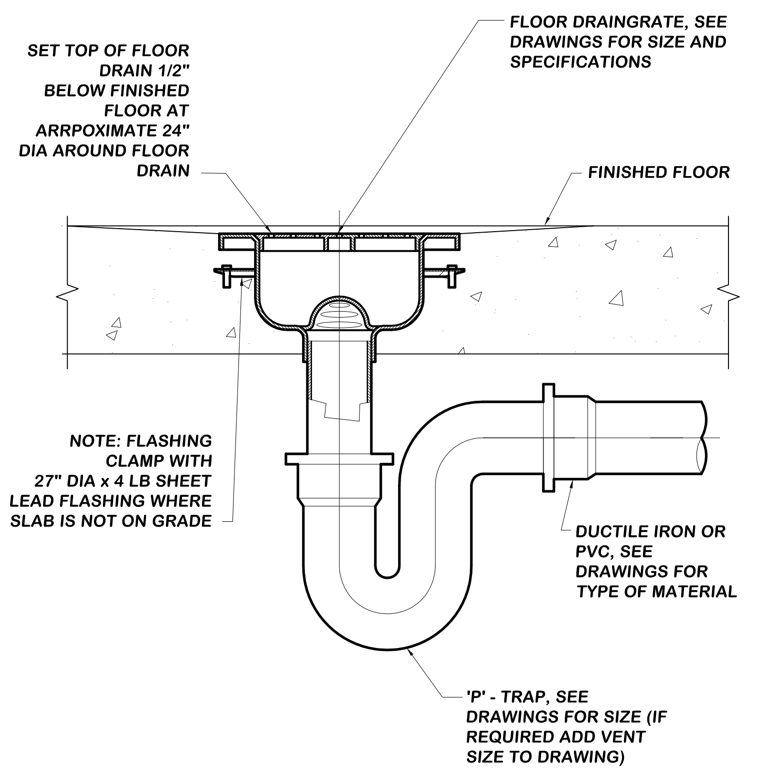
JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

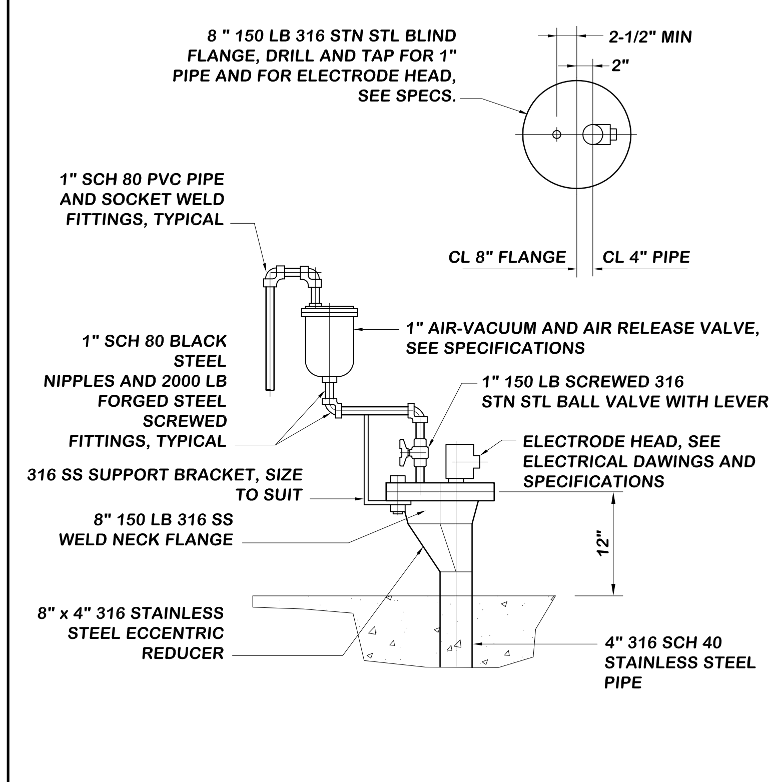
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

MISCELLANEOUS PIPING DETAILS

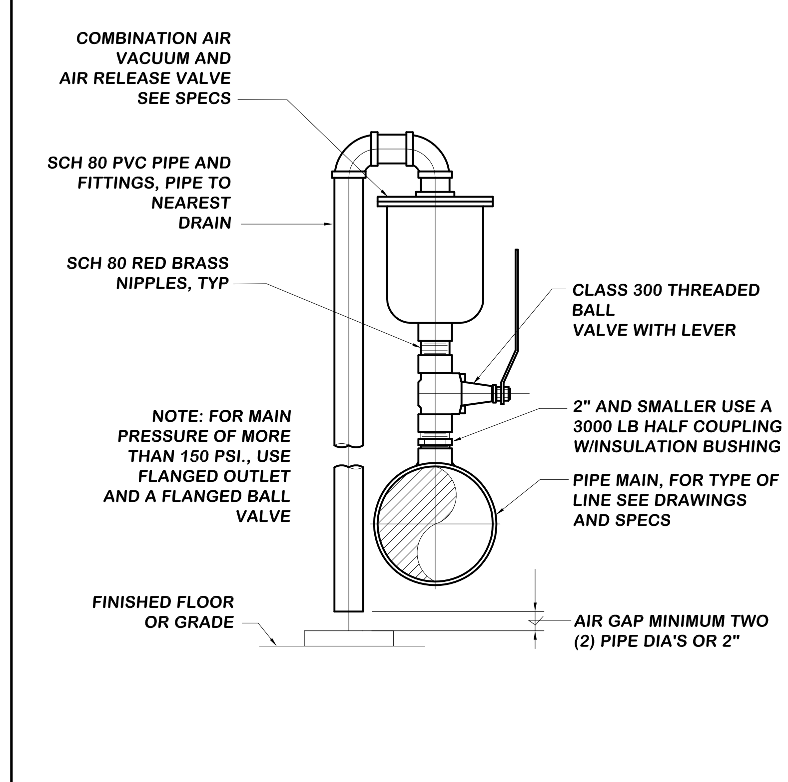
DRAWING NO. GM-1
SHEET NO. X OF XX
CLIENT JOB NO. 2744



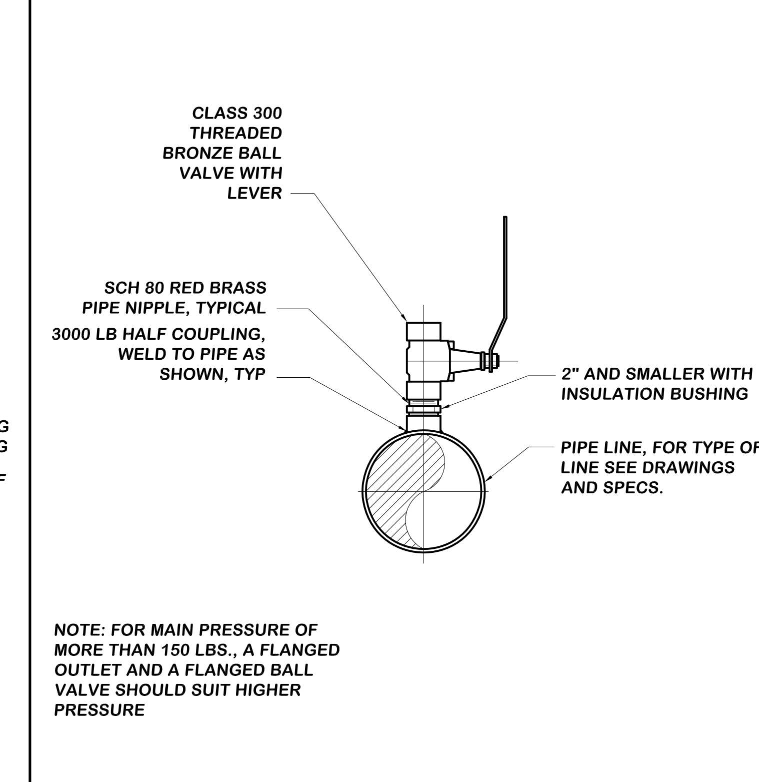
FLOOR DRAIN 1 / -
N.T.S.



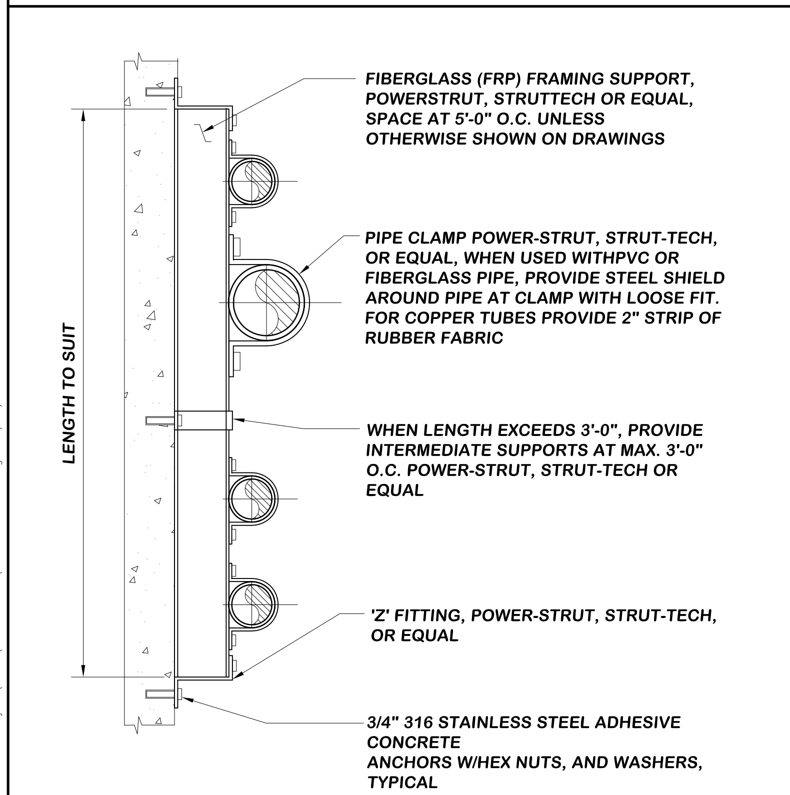
LOW WATER CUT-OFF 2 / -
N.T.S.



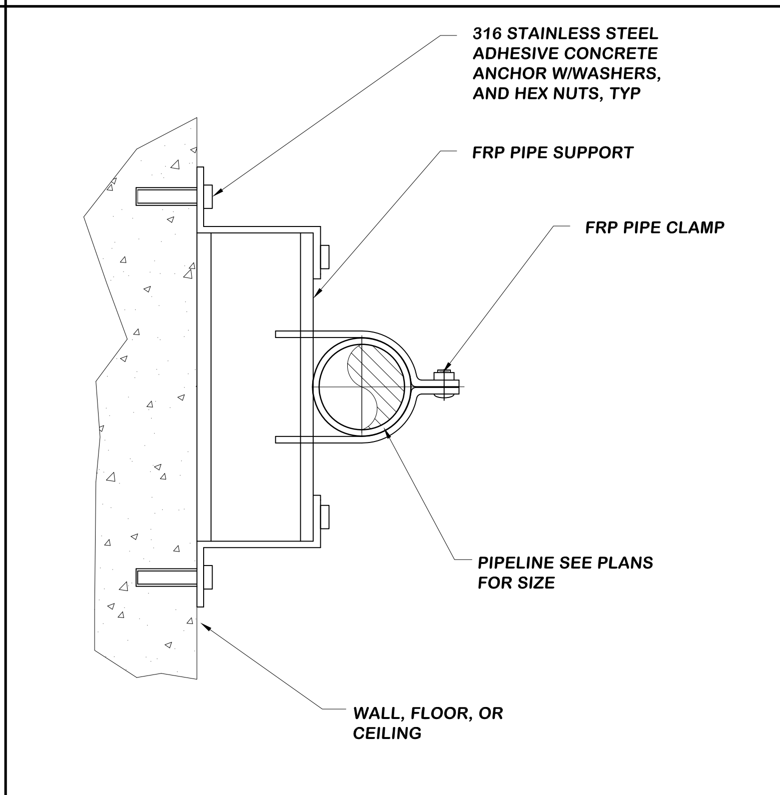
AIR RELEASE/ AIR VACCUM VALVE 3 / -
N.T.S.



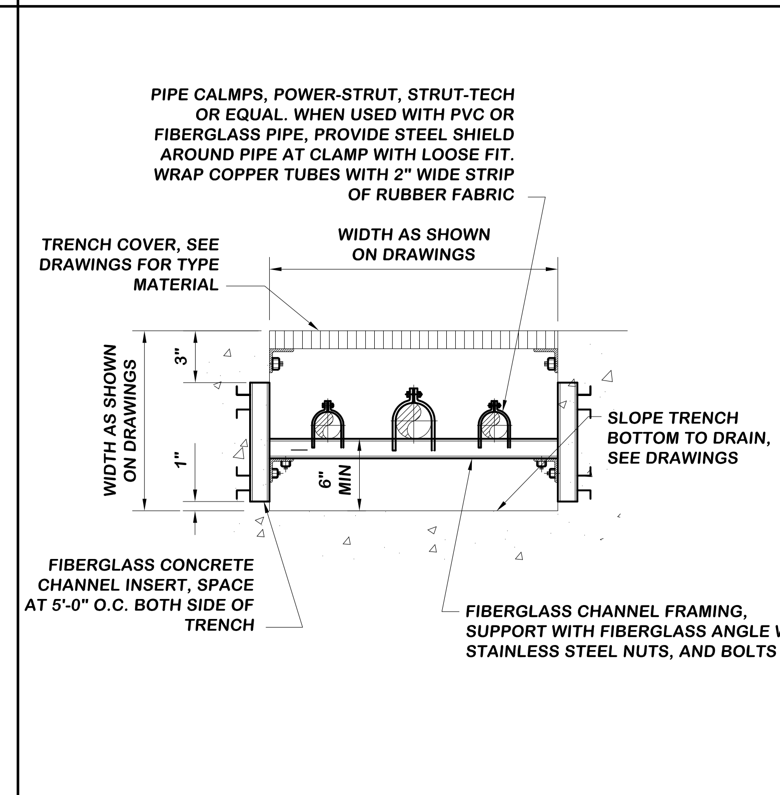
2" AND SMALLER CONN 4 / -
N.T.S.



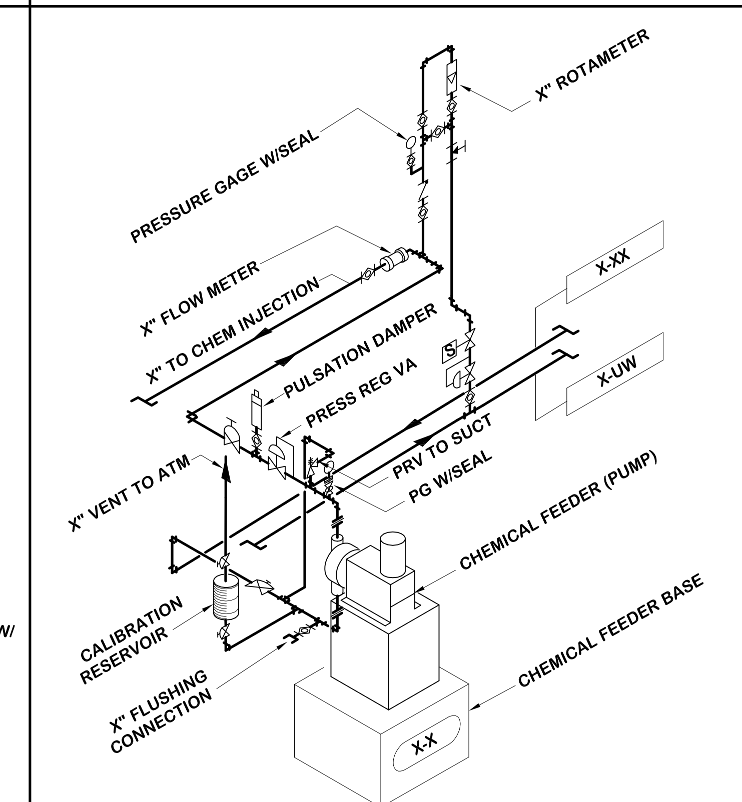
FLUSH MOUNTED BRACKET 5 / -
N.T.S.



INDIVIDUAL WALL BRACKET 6 / -
N.T.S.



PIPE TRENCH 7 / -
N.T.S.



CHEMICAL FEED PUMP ISOMETRIC 8 / -
N.T.S.

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE NTS
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PROJECT NO. 112.FPUD.0002
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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

MISCELLANEOUS MECHANICAL DETAILS

DRAWING NO. GM-2
SHEET NO. X OF XX
CLIENT JOB NO. 2744

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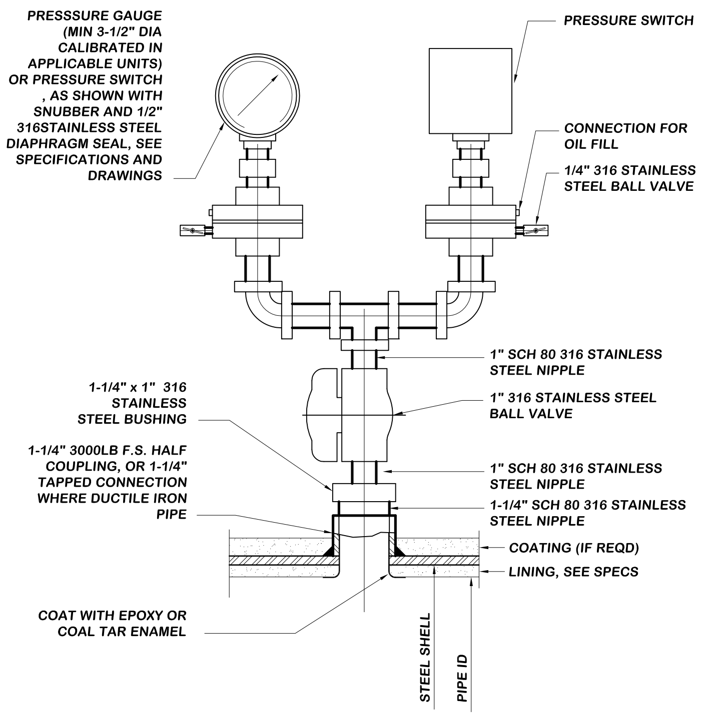
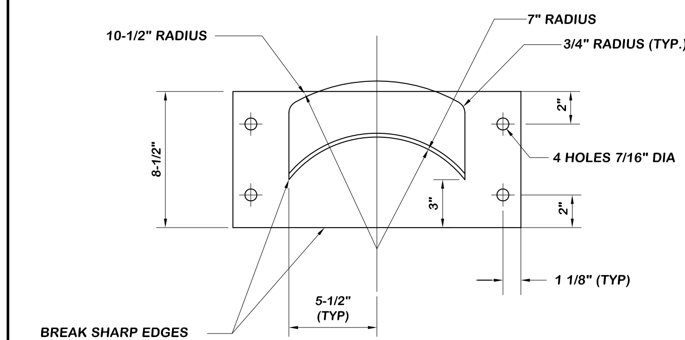


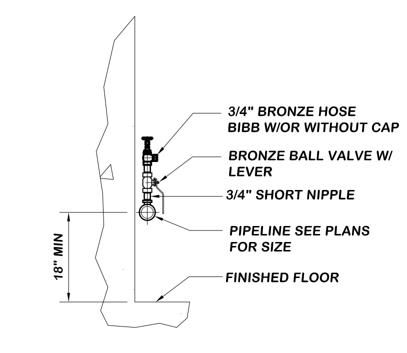
PRESSURE GAUGE & SWITCH W/ SEAL 1 -
N.T.S.

NOT USED 2 -
N.T.S.

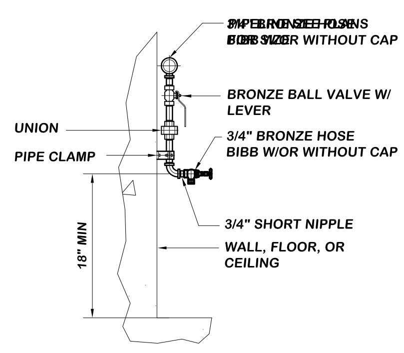


NOTE:
ALL MATERIAL TO BE 8 GAUGE GALVANIZED STEEL

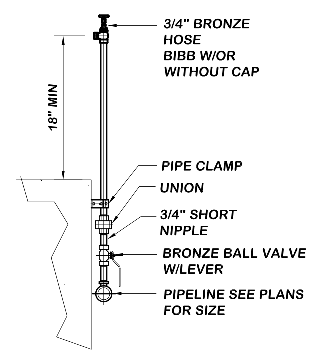
HOSE RACK 3 -
N.T.S.



HOSE BIBB - ABOVE MAIN



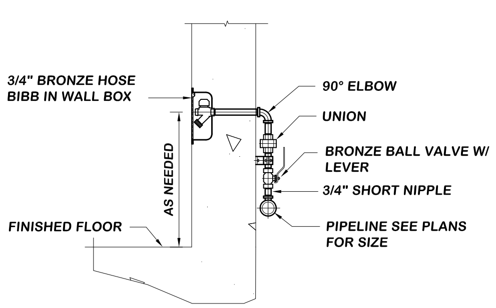
HOSE BIBB - BELOW MAIN



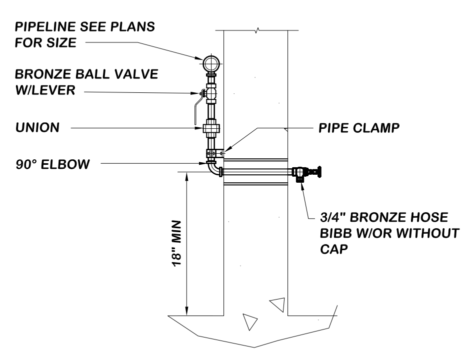
HOSE BIBB - ABOVE SLAB

NOTES:

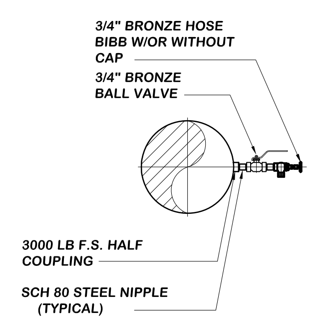
1. ALL HOSE BIBBS TO BE INDIVIDUAL SHUT-OFF VALVES (BALL OR PLUG), EXCEPT WHERE INDIVIDUALLY CONTROLLED BRANCH MAIN SERVES HOSE BIBBS ONLY.
2. FOR SIZE AND LOCATION, SEE DRAWINGS.
3. PROVIDE WARNING SIGN, WHEN USED FOR NON-POTABLE WATER.



HOSE BIBB - IN WALL BOX

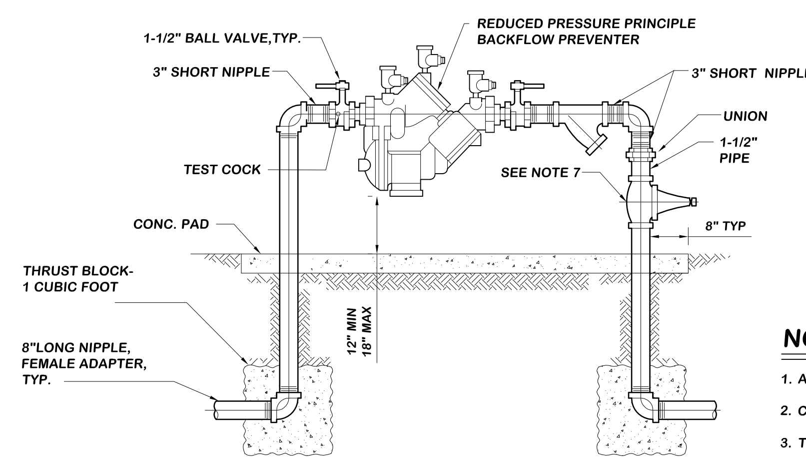


HOSE BIBB - THRU WALL



HOSE BIBB - OFF MAIN

HOSE BIBB CONNECTIONS 4 -
N.T.S.



NOTES:

1. ALL RISERS, UNIONS, ELBOWS, AND NIPPLES SHALL BE RED BRASS.
2. CLOSE NIPPLES SHALL NOT BE USED.
3. TEFLON TAPE 3/4" WIDE SHALL BE USED ON ALL THREADED CONNECTIONS.
4. CONCRETE PAD SHALL BE A MINIMUM 18" WIDE.
5. BACKFLOW PREVENTER ASSEMBLY SHALL BE TESTED UPON INSTALLATION BY CERTIFIED BACKFLOW DEVICE TESTER. CONTACTOR SHALL PROVIDE THE ENGINEER WITH WRITTEN TEST RESULTS COMPLETED BY CERTIFIED BACKFLOW TESTER PRIOR TO THE BACKFLOW PREVENTER ASSEMBLYS ACCEPTANCE BY THE OWNER
6. DISSIMILAR METALS SHALL BE SEPERATED BY AN APPROVED DIELECTRIC COUPLING.
7. PRESSURE REGULATOR, SET @ 75/85 PSI.
8. PIPING ORIENTATION SHOWN FOR REFERENCE ONLY, SEE PLANS FOR ACTURAL PIPING ORIENTATION.
9. SEE DRAWINGS FOR PRESSURE GAUGE LOCATIONS NOT SHOWN ON THIS SHEET.

REDUCED PRESSURE BACKFLOW PREVENTER 5 -
N.T.S.

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE NTS
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY RLG
DRAWN BY RLG
CHECKED BY XXX

Infrastructure ENGINEERING CORPORATION
14271 Danielson Street
Poway, California 92064
T 858.413.2400 F 858.413.2440
www.iecorporation.com

DATE

FPUD Fallbrook Public Utility District
990 E. MISSION RD
FALLBROOK, CA 92028

APPROVED BY:
JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

MISCELLANEOUS MECHANICAL DETAILS

DRAWING NO. GM-3
SHEET NO. X OF XX
CLIENT JOB NO. 2744

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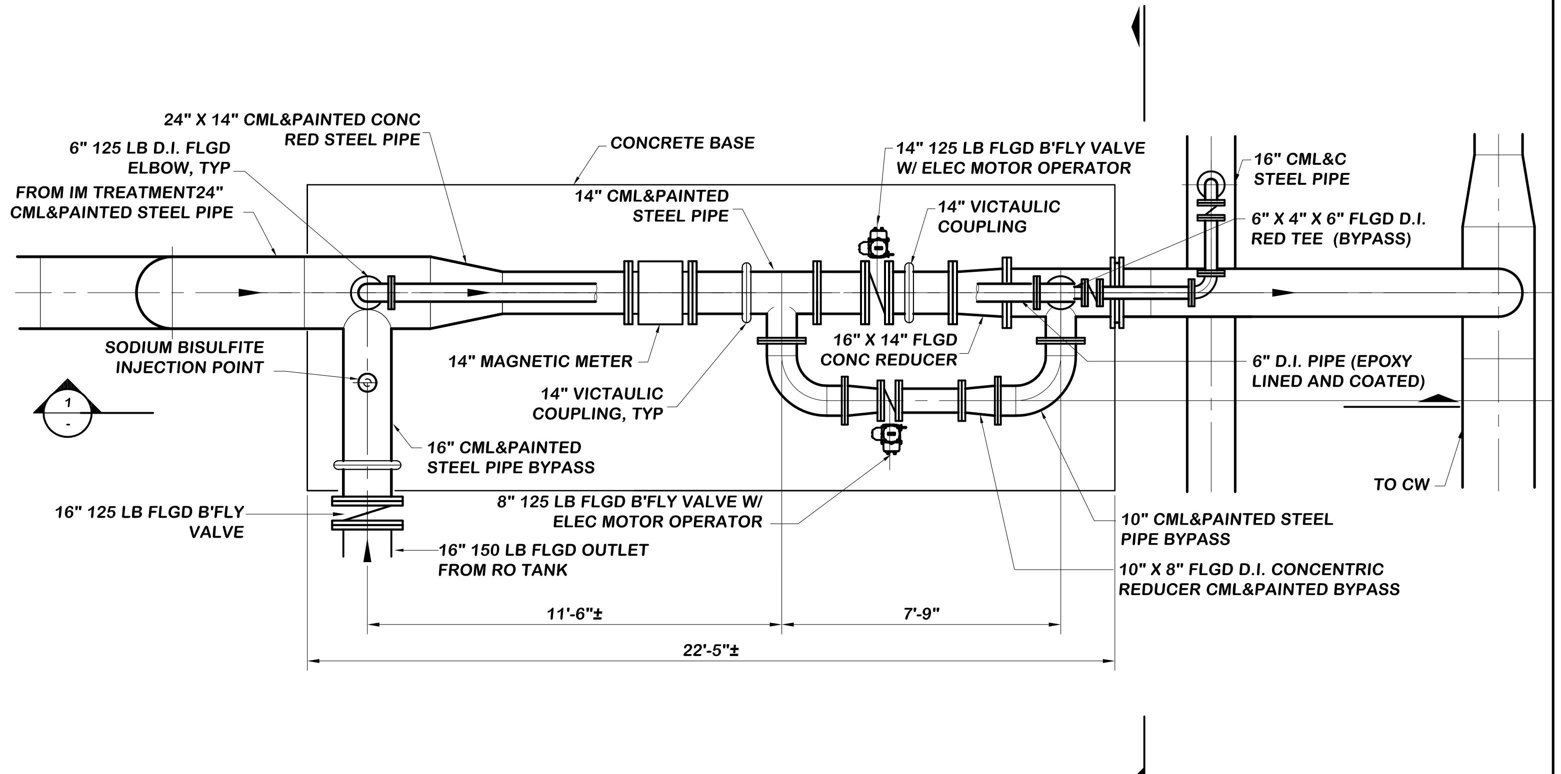
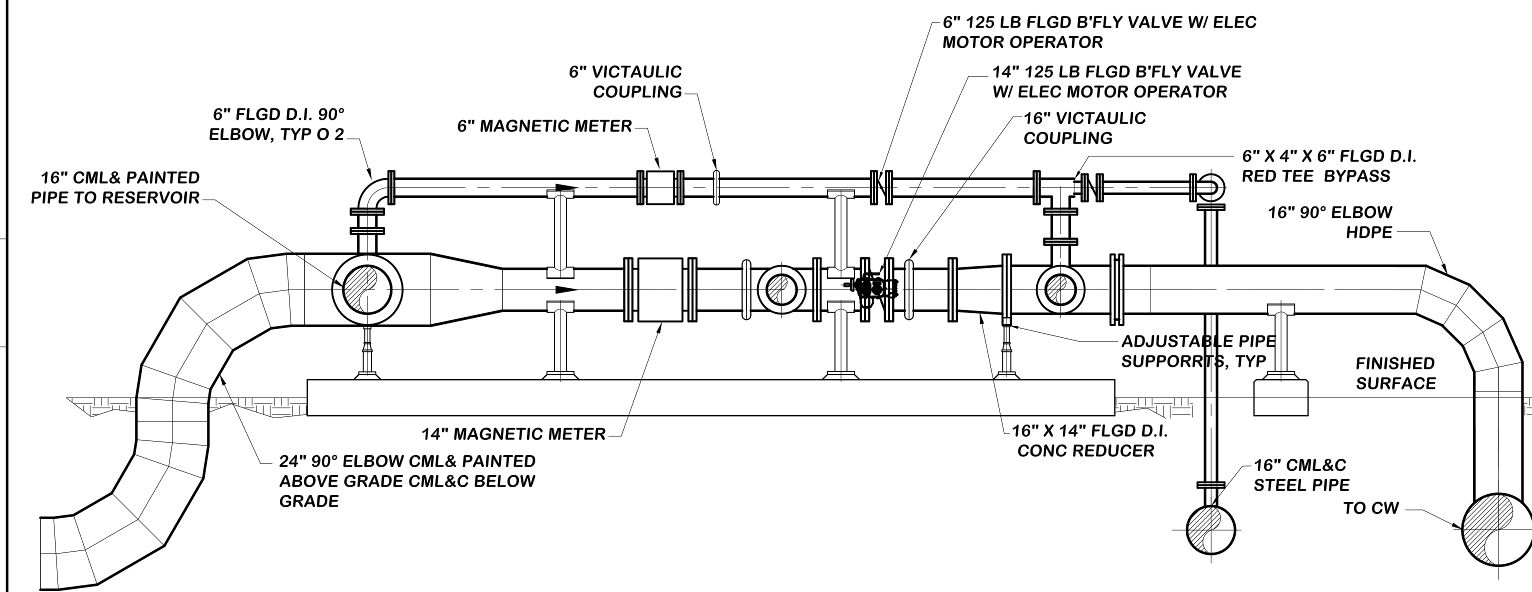


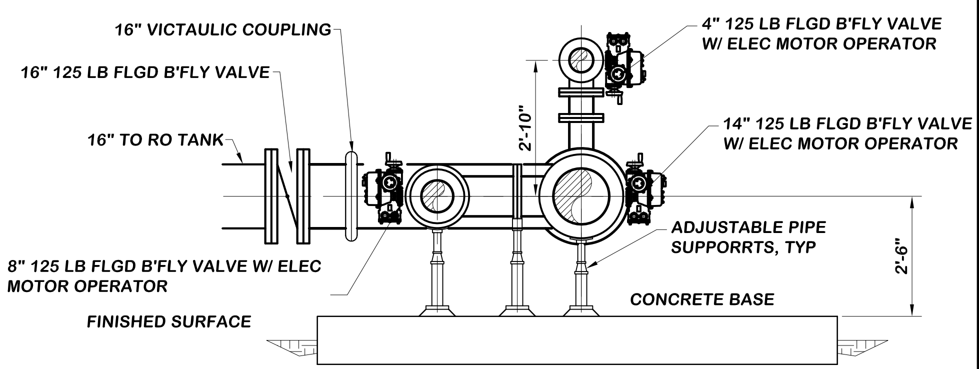
RO BYPASS PIPING DETAIL (A / -)

SCALE: 3/8" = 1'-0"



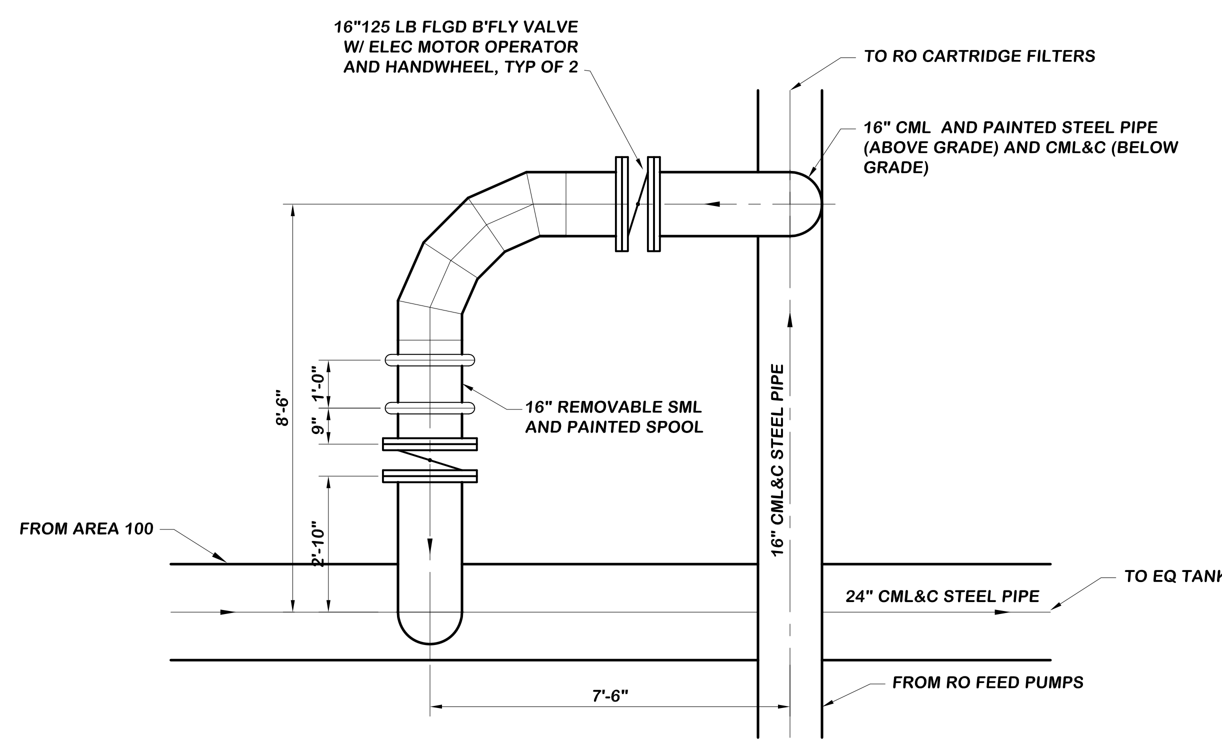
SECTION (1 / -)

SCALE: 3/8" = 1'-0"



SECTION (2 / -)

SCALE: 1/2" = 1'-0"



STARTUP IM RECIRC PIPING DETAIL (B / -)

SCALE: 1/2" = 1'-0"

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE NTS
DATE 10/2015
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DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

MISCELLANEOUS MECHANICAL DETAILS

DRAWING NO. GM-4
SHEET NO. X OF XX
CLIENT JOB NO. 2744

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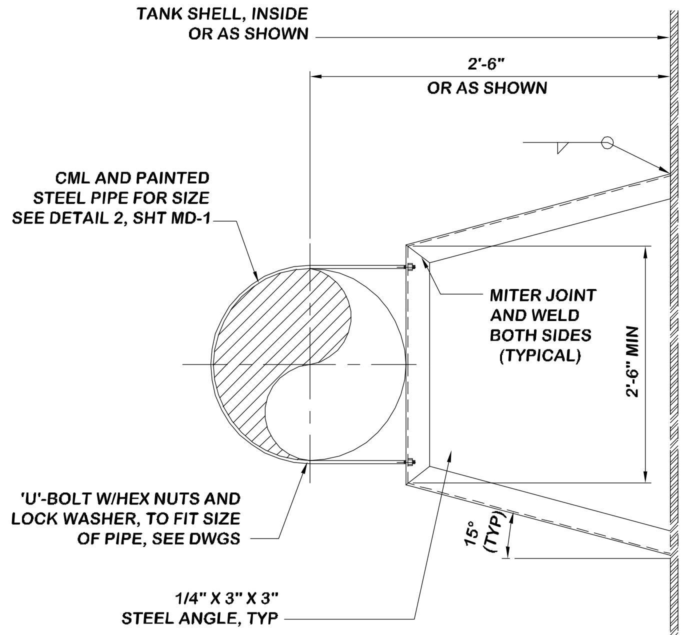
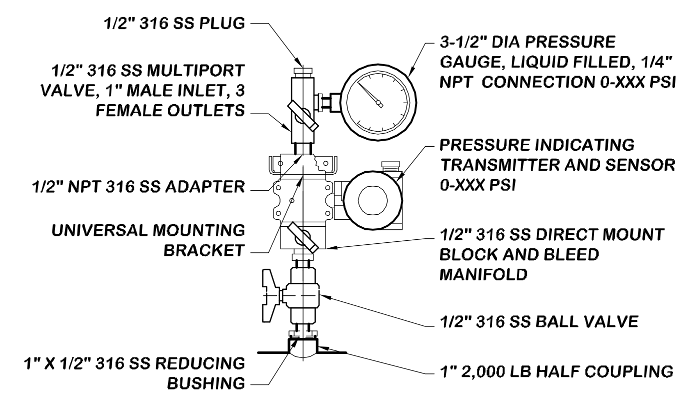


NOTES:

1. STEEL PIPE SUPPORTS SHALL BE PAINTED SAME AS INTERIOR TANK SHELL PER SPECIFICATIONS.
2. ALL BOLTS, NUTS, WASHERS, AND ALL OTHER HARDWARE SHALL BE HIGH STRENGTH STEEL.

BRACKET DETAIL 1 / -
N.T.S.

NOT USED 2 / -
N.T.S.



PRESSURE GAUGE / TRANSMITTER 3 / X
N.T.S.

NOT USED X / X
N.T.S.

NOT USED X / X
N.T.S.

NOT USED X / X
N.T.S.

NOT USED X / X
N.T.S.

NOT USED X / X
N.T.S.

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE NTS
DATE 10/2015
PROJECT NO. 112.FPUD.0002
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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

MISCELLANEOUS MECHANICAL DETAILS

DRAWING NO. GM-5
SHEET NO. X OF XX
CLIENT JOB NO. 2744

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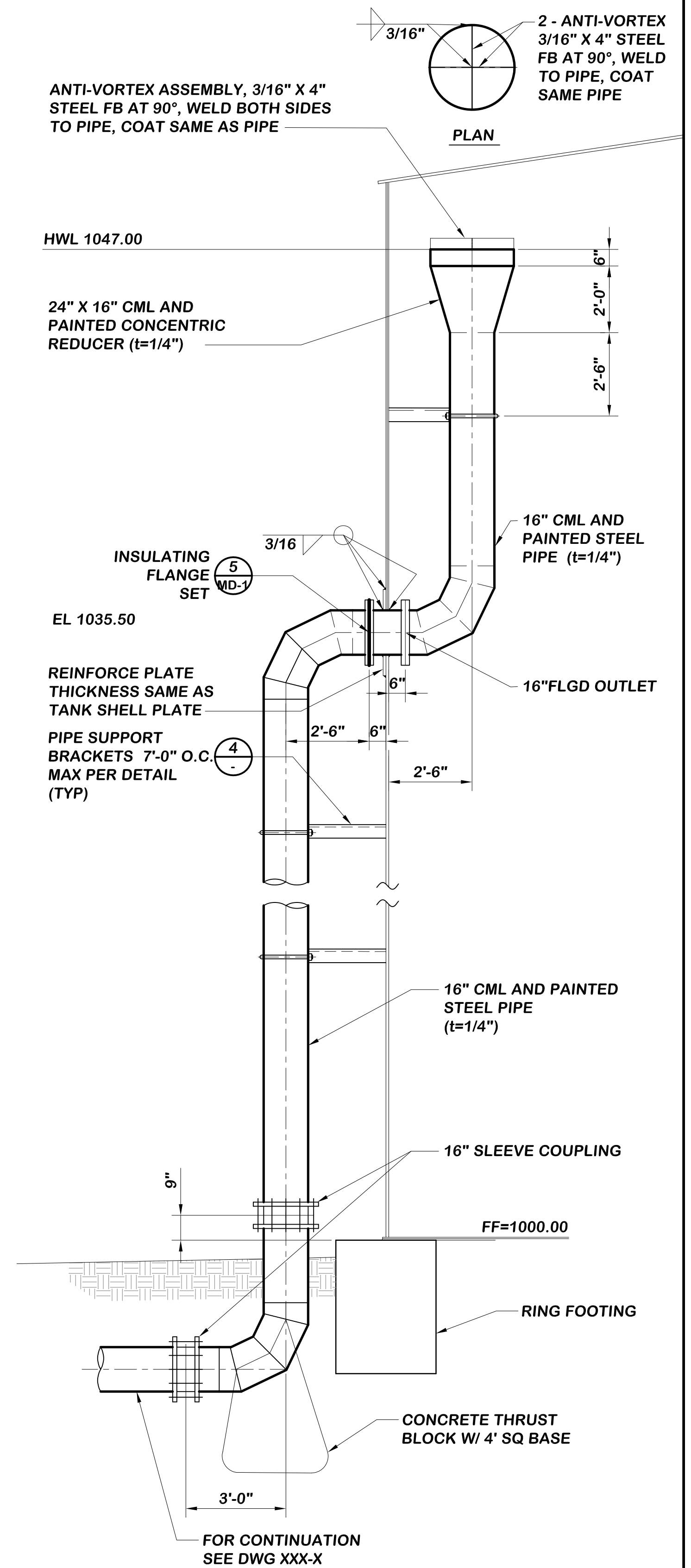
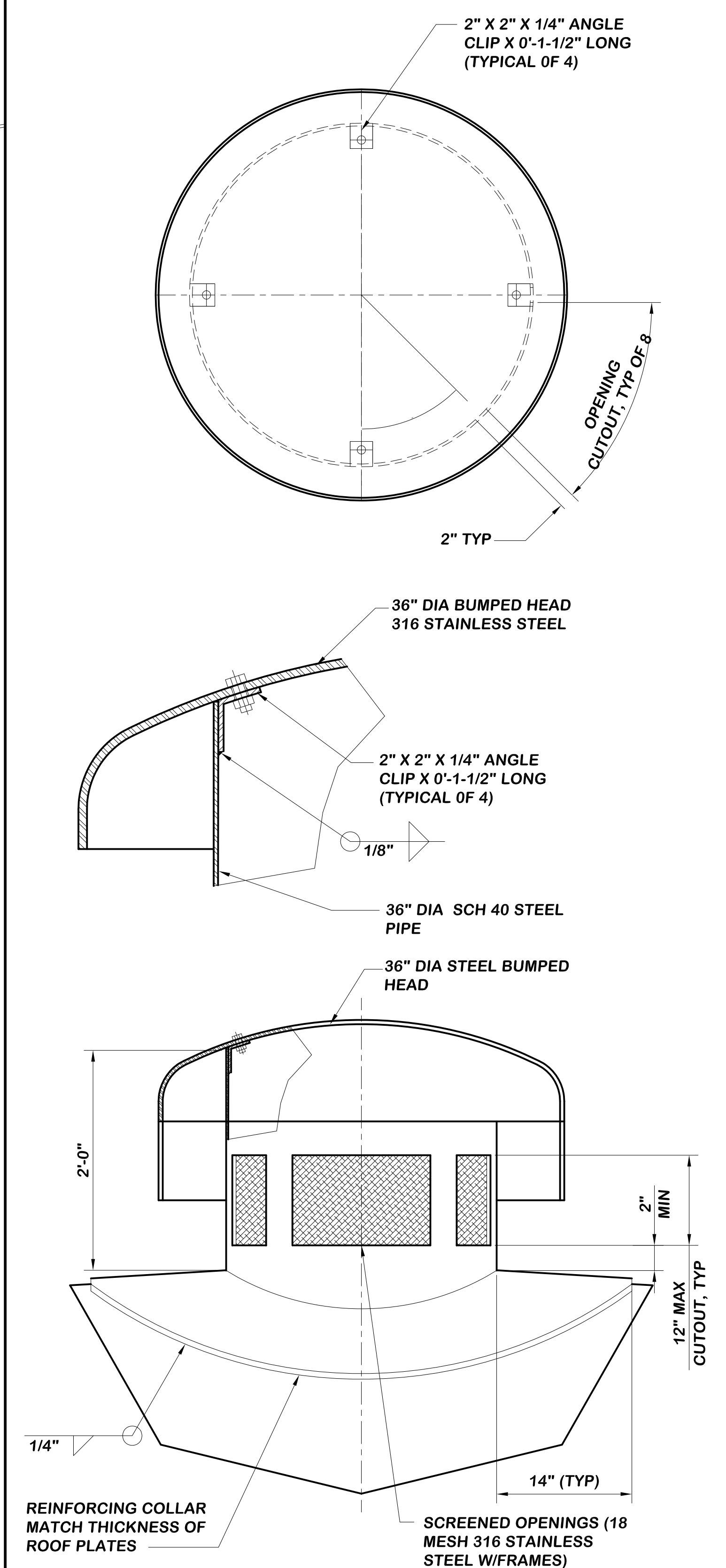


OVERFLOW DETAIL

N.T.S.

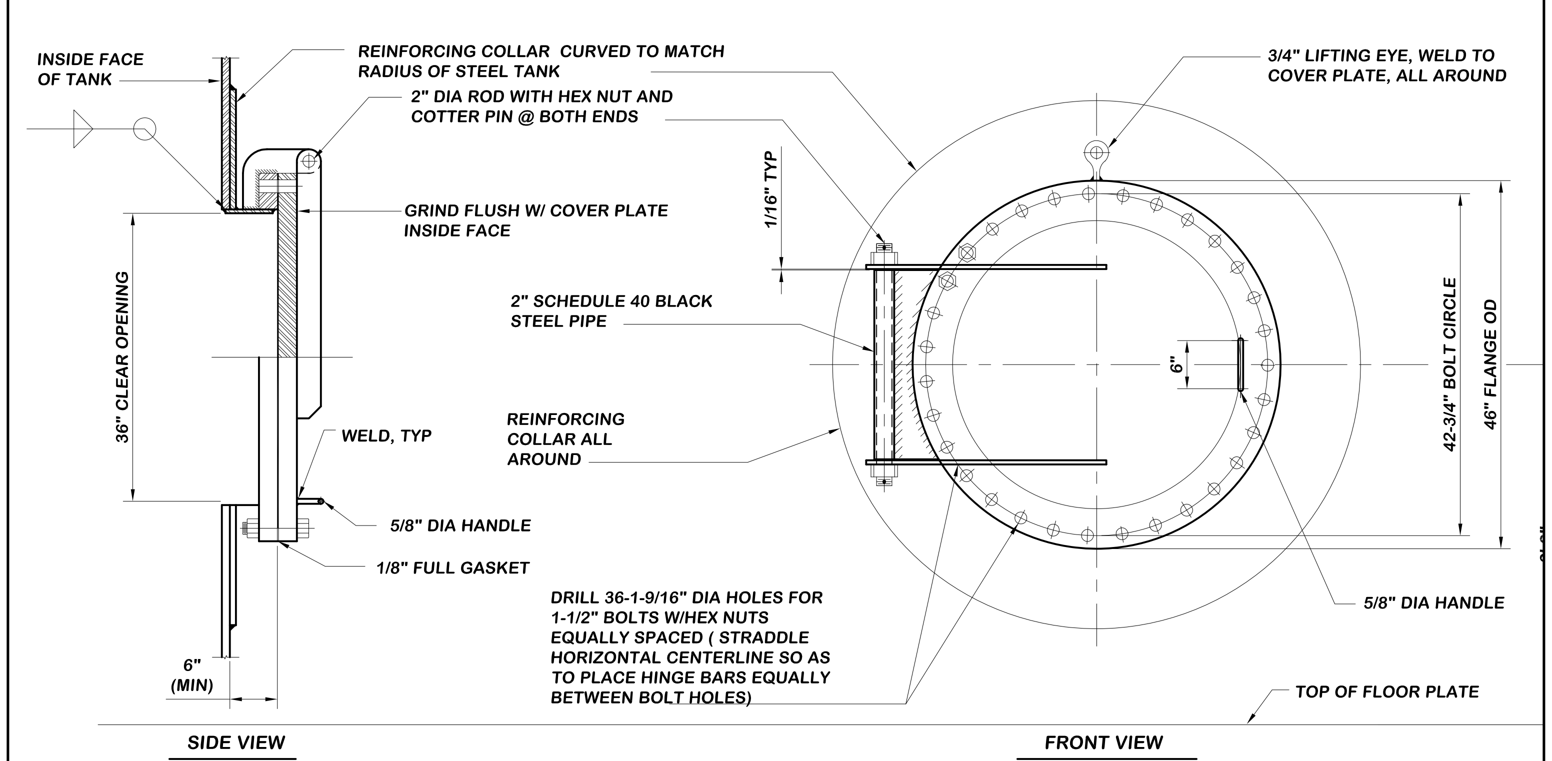
1
-



RESERVOIR VENT

VP SCALE: 1/12XP

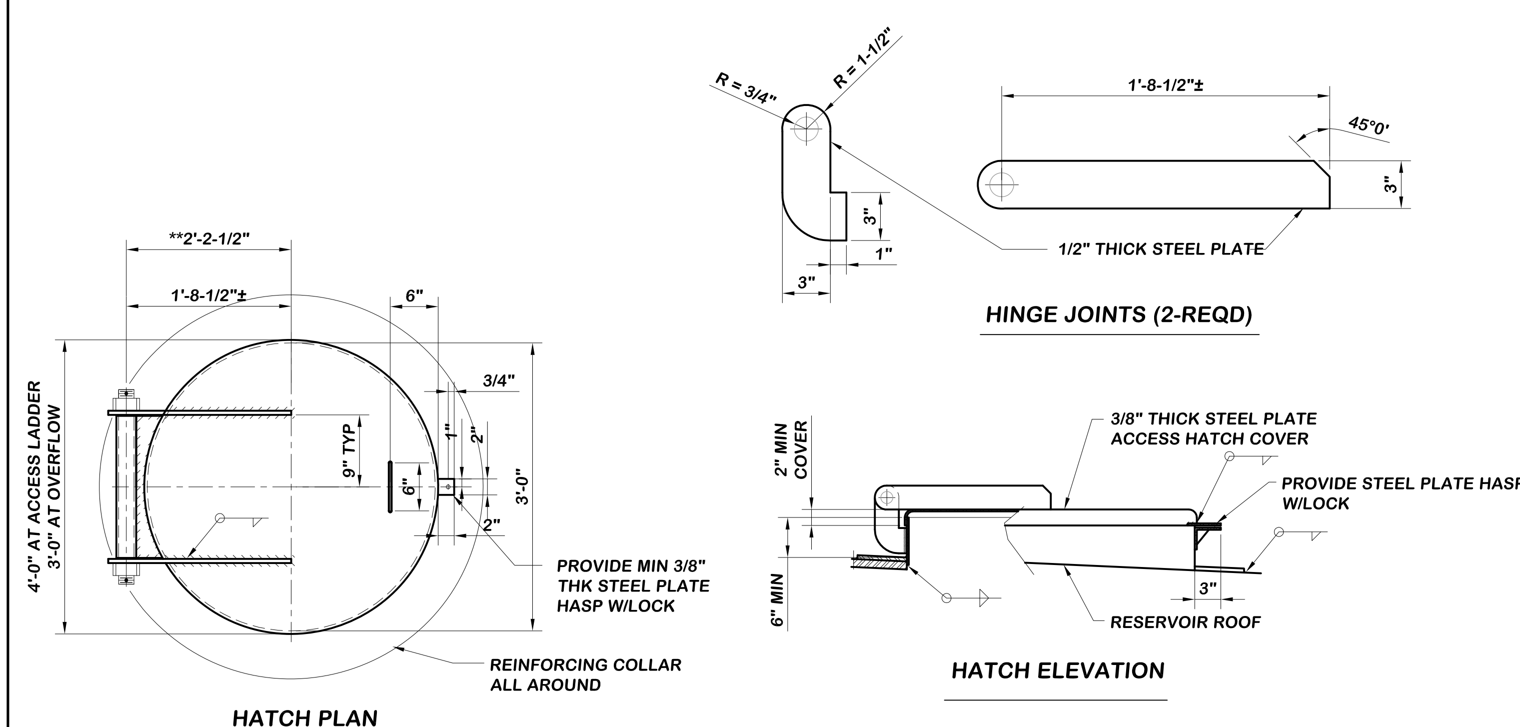
2
-



MANHOLE DETAIL

N.T.S.

3
X



ROOF ACCESS HATCH

N.T.S.

4
-

30% SUBMITTAL

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NO.	DESCRIPTION	DATE	APPROVED

SCALE	NTS
DATE	10/2015
PROJECT NO.	112.FPUD.0002
DESIGNED BY	RLG
DRAWN BY	RLG
CHECKED BY	XXX

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APPROVED BY:

JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER

DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

MISCELLANEOUS MECHANICAL DETAILS

DRAWING NO. GM-6

SHEET NO. X OF XX

CLIENT JOB NO. 2744

GENERAL STRUCTURAL NOTES

A. GENERAL

1. UNLESS DETAILED, SPECIFIED OR INDICATED OTHERWISE, CONSTRUCTION SHALL BE AS INDICATED IN THE APPLICABLE TYPICAL DETAILS AND GENERAL NOTES. TYPICAL DETAILS ARE MEANT TO APPLY EVEN THOUGH NOT REFERENCED AT SPECIFIC LOCATIONS OR IN SPECIFIC DRAWINGS.

2. STRUCTURAL DIMENSIONS CONTROLLED BY OR RELATED TO MECHANICAL OR ELECTRICAL EQUIPMENT SHALL BE VERIFIED BY THE CONTRACTOR PRIOR TO CONSTRUCTION.

3. MECHANICAL AND ELECTRICAL EQUIPMENT SUPPORTS, ANCHORAGES, OPENINGS, RECESSES AND REVEALS NOT SHOWN ON THE STRUCTURAL DRAWINGS BUT REQUIRED BY OTHER CONTRACT DRAWINGS SHALL BE PROVIDED PRIOR TO PLACING CONCRETE.

4. STRUCTURAL DRAWINGS SHALL BE USED IN COORDINATION WITH MECHANICAL, ELECTRICAL, ARCHITECTURAL, CIVIL DRAWINGS AND SHOP DRAWINGS PROVIDED BY MANUFACTURERS OF EQUIPMENT.

5. STRUCTURES HAVE BEEN DESIGNED FOR OPERATIONAL LOADS ON THE COMPLETED STRUCTURES. DURING CONSTRUCTION, THE STRUCTURES SHALL BE PROTECTED BY BRACING AND BALANCING WHEREVER EXCESSIVE CONSTRUCTION LOADS MAY OCCUR.

6. ALL EQUIPMENT ANCHORAGES SHALL BE PER THE 2010 CALIFORNIA BUILDING CODE. PRIOR TO FABRICATION AND INSTALLATION THE CONTRACTOR SHALL SUBMIT SHOP DRAWINGS AND CALCULATIONS FOR EQUIPMENT ANCHORAGES THAT HAVE BEEN STAMPED AND SIGNED BY A CIVIL ENGINEER REGISTERED IN THE STATE OF CALIFORNIA.

B. FOUNDATION DESIGN

1. FOUNDATION DESIGN IS BASED ON THE GEOTECHNICAL REPORT PREPARED BY ...

C. STRUCTURAL DESIGN

1. DESIGN IN ACCORDANCE WITH THE 2013 EDITION OF THE CALIFORNIA BUILDING CODE AND ITS LATEST SUPPLEMENTS, EXCEPT WHERE OTHER APPLICABLE CODES OR THE FOLLOWING NOTES ARE MORE RESTRICTIVE.

D. CONCRETE

1. ALL STRUCTURAL CONCRETE SHALL DEVELOP A MINIMUM COMPRESSIVE STRENGTH OF 4000 PSI IN 28 DAYS. UNLESS OTHERWISE NOTED, ALL CONCRETE CONSTRUCTION, INCLUDING BENDING OF BARS, SHALL COMPLY WITH A.C.I. CODE REQUIREMENTS FOR ENVIRONMENTAL ENGINEERING CONCRETE STRUCTURES" (A.C.I. 350-06).

2. NO BACKFILL SHALL BE PLACED AGAINST ANY STRUCTURE WALL UNTIL THE WALL HAS REACHED FULL STRENGTH AND THE CONNECTING SLABS HAVE BEEN CAST AND HAVE ALSO REACHED FULL STRENGTH.

3. ALL DETAILING, FABRICATION AND PLACING OF REINFORCING BARS, UNLESS OTHERWISE NOTED, SHALL BE IN ACCORDANCE WITH THE MANUAL OF STANDARD PRACTICE FOR DETAILING REINFORCED CONCRETE STRUCTURES A.C.I.-315, LATEST EDITION.

4. LOCATION OF ALL CONSTRUCTION JOINTS SHALL BE AS SHOWN ON THE DRAWINGS OR APPROVED BY THE ENGINEER. PLACE CONSTRUCTION JOINTS IN SLABS AND BEAMS, INCLUDING UPSET BEAMS, AT THE SAME TIME. CONSTRUCTION JOINTS AND EXPANSION JOINTS SHALL BE THOROUGHLY CLEANED FOR BOND. UNLESS SHOWN OTHERWISE, PROVIDE WATERSTOPS AT ALL CONSTRUCTION JOINTS IN WATERBEARING SLABS AND WALLS.

(CONCRETE - CONTINUED)

5. REINFORCEMENT STEEL SHALL BE DEFORMED BARS CONFORMING IN QUALITY TO THE REQUIREMENT OF THE SPECIFICATIONS FOR DEFORMED BILLET-STEEL BARS FOR CONCRETE REINFORCEMENT, ASTM DESIGNATION A-615, GRADE 60.

6. ALL WALL REINFORCEMENT AT CORNERS OR JUNCTIONS OF WALLS SHALL BE CONTINUOUS, LAPPED OR TERMINATED IN A 90 DEGREE HOOK. UNLESS SHOWN OTHERWISE ALL BARS SHALL BE DOWELED. UNLESS SHOWN OTHERWISE ALL DOWELS SHALL BE SAME SIZE AND SPACING AS THE REINFORCEMENT WHICH IS TO BE SPLICED TO THE DOWELS. DOWELS SHALL BE FIRMLY HELD IN POSITION AND SHALL NOT BE SHOVED INTO FRESHLY PLACED CONCRETE.

7. CONCRETE COVER AND REINFORCEMENT SHALL BE AS FOLLOWS:
   A. SURFACES NOT EXPOSED DIRECTLY TO GROUND, WEATHER, WATER CONDENSATION OR WATER FROM FORM REMOVAL..1 1/2"
   B. CONCRETE PLACED DIRECTLY AGAINST GROUND.......3"
   C. SURFACES EXPOSED TO GROUND, WEATHER OR WATER AFTER FORM REMOVAL...2"
   D. REINFORCEMENT SHALL BE PLACED WITHIN A TOLERANCE OF PLUS OR MINUS 1/4" OF POSITIONS SPECIFIED.

8. BAR SUPPORTS AND SPACERS SHALL BE PROVIDED IN ACCORDANCE WITH CRSI MANUAL OF STANDARD PRACTICE.

9. REINFORCING BARS AND ACCESSORIES SHALL NOT BE IN CONTACT WITH ANY PIPE, PIPE FLANGE OR METAL PARTS EMBEDDED IN CONCRETE. A MINIMUM OF 2 INCHES CLEARANCE SHALL BE PROVIDED AT ALL TIMES.

10. CONCRETE CURING COMPOUND SHALL BE IN ACCORDANCE WITH THE SPECIFICATIONS.

11. THE MINIMUM LENGTH OF LAPS FOR SPLICES SHALL BE AS GIVEN IN THE TABLE FOR CLASS "B" LAPS. PROVIDE CLASS "A" LAPS WHERE NOTED ON THE DRAWINGS OR WHERE NO MORE THAN ONE-HALF OF THE BARS ARE LAP SPLICED WITHIN A LAP LENGTH.

12. REINFORCEMENT LAPS, UNLESS OTHERWISE NOTED, SHALL SATISFY THE FOLLOWING MINIMUM REQUIREMENTS:

CONCRETE DESIGN STRENGTH = 4,000 PSI GRADE 60 REINFORCING STEEL					
BAR SIZE:	#4	#5	#6	#7	#8
LAP SPLICE LENGTH:	2'-0"	2'-6"	3'-0"	3'-6"	4'-9"

E. STRUCTURAL STEEL

1. STEEL CONSTRUCTION SHALL CONFORM TO THE SPECIFICATIONS AND STANDARDS AS CONTAINED IN THE LATEST EDITION OF THE AISC STEEL CONSTRUCTION MANUAL, INCLUDING THE COMMENTARY AND SUPPLEMENTS THERETO AS ISSUED.

2. ALL STRUCTURAL SHAPES SHALL BE OF STEEL MEETING ASTM A992. ALL STRUCTURAL BARS, PLATES AND SHEETS INDICATED ON THE DRAWING EXCEPT CONCRETE REINFORCING BARS, SHALL BE OF STEEL MEETING ASTM A36 SPECIFICATIONS.

3. PIPE COLUMNS SHALL CONFORM TO ASTM A-53, GRADE "B". STRUCTURAL TUBING SHALL CONFORM TO ASTM A-500, GRADE "B".

4. MINIMUM SIZE OF BOLTS SHALL BE 3/4-INCH DIAMETER, UNLESS OTHERWISE NOTED. ANCHOR BOLTS SHALL CONFORM TO ASTM A-307, UNLESS OTHERWISE NOTED.

F. MASONRY

1. CONCRETE BLOCK SHALL CONFORM TO ASTM C-90, GRADE N-1 FOR HOLLOW LOAD-BEARING MASONRY UNITS AND ASTM C-55 GRADE N-1 FOR HOLLOW LOAD BEARING SPLIT-FACE CONCRETE MASONRY UNITS. (f'm = 1500 PSI) ALL CELLS SHALL BE GROUTED SOLID UNLESS OTHERWISE NOTED. f'm SHALL BE VERIFIED BY "UNIT STRENGTH METHOD" PER THE CBC, 2010 EDITION, SECTION 2105.2.2.1.2

2. MORTAR SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH OF 1800 PSI AT 28 DAYS, TYPE S.

3. GROUT FOR CELLS SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH OF 3000 PSI AT 28 DAYS.

(MASONRY - CONTINUED)

4. ALL CONCRETE BLOCKS SHALL BE LAID IN RUNNING BOND UNLESS OTHERWISE SHOWN ON ARCHITECTURAL DRAWINGS.

5. ALL REINFORCING BARS SHALL BE CONTINUOUS UNLESS OTHERWISE SHOWN. LAP BARS 50 DIAMETERS AT SPLICES UNLESS OTHERWISE NOTED. STAGGER SPLICES WHERE POSSIBLE.

6. PROVIDE SPECIAL INSPECTION IN ACCORDANCE WITH THE CBC, 2010, EDITION, SECTION 1704.5.

7. 8" WALL VERTICAL REINFORCEMENT: WALL VERTICAL REINFORCEMENT SHALL BE PLACED IN THE CENTER OF GROUT, AT THE CENTER OF WALL, FULL HEIGHT. UNLESS OTHERWISE SHOWN ON PLANS, ALL 8" WALLS SHALL BE REINFORCED WITH MINIMUM VERTICAL REINFORCING AS FOLLOWS:
   1- #5 AT ALL CORNERS, INTERSECTIONS, WALL ENDS AND EACH SIDE OF JOINT
   1- #5 AT JAMBS OF OPENINGS UP TO 4'-0" WIDE
   1- #5 AT EACH END TWO JAMB CELLS OF OPENINGS 4'-1" UP TO 10'-0" WIDE
   1- #5 @ 24" AT GABLE WALLS
   1- #5 @ 48" ELSEWHERE

8. ALL DOWELS SHALL BE THE SAME SIZE AS WALL REINFORCEMENT AND SHALL LAP 50 DIAMETERS AND EXTEND INTO THE FOOTING A MINIMUM OF 24 DIAMETERS, OR EXTEND INTO THE FOOTING A MINIMUM OF 12 DIAMETERS AND HAVE A STANDARD HOOK.

9. THE BARS IN HORIZONTAL LAP SPLICES SHALL BE ALIGNED VERTICALLY AND TIED. ALIGN HORIZONTAL BARS VERTICALLY AT BENDS AND TIE. STAGGER SPLICES.

10. ALL OPENINGS SHALL HAVE A BOND BEAM AT THE TOP AND BOTTOM REINFORCED WITH 2- #5 BARS. REINFORCEMENT SHALL EXTEND 24" MINIMUM OR 50 DIAMETERS BEYOND WALL OPENINGS.

11. TYPICAL WALL HORIZONTAL REINFORCEMENT: WALL HORIZONTAL REINFORCEMENT SHALL BE 2- #5 AT TOP IN MINIMUM 8 INCHES DEEP GROUTED BOND BEAM. WALLS HIGHER THAN 12'-0" SHALL HAVE ADDITIONAL MID-HEIGHT BOND BEAM. PROVIDE LADDER TYPE #9 JOINT REINFORCING AT 16" ON CENTER. PLACE BOND BEAM BARS CONTINUOUS THROUGH JOINTS.

G. STAINLESS STEEL

1. STAINLESS STEEL SHEET AND PLATE SHALL CONFORM TO ASTM A-360. STAINLESS STEEL FASTENERS AND FITTINGS SHALL CONFORM TO ASTM A-240, TYPE 316.

H. ALUMINUM

1. WHERE ALUMINUM IS IN CONTACT WITH CONCRETE OR MASONRY SURFACES, CONTACT SURFACES SHALL BE COATED WITH HEAVY ALKALI-RESISTANT BITUMINOUS PAINT.

2. GRATING AND CHECKERED PLATE SHALL BE ALUMINUM UNLESS OTHERWISE NOTED.

J. TESTING AND SPECIAL INSPECTION

1. SPECIAL INSPECTION IS REQUIRED IN ACCORDANCE WITH THE CBC, 2013 EDITION, SECTION 1704, FOR THE FOLLOWING WORK:
   A. 4000 PSI CONCRETE
   B. REINFORCING STEEL
   C. BOLTS INSTALLED IN CONCRETE
   D. HIGH STRENGTH BOLTING
   E. MASONRY

2. A CERTIFICATE OF SATISFACTORY COMPLETION OF WORK REQUIRING SPECIAL INSPECTION MUST BE COMPLETED AND SUBMITTED TO THE FIELD INSPECTION DIVISION.

3. THE SOILS ENGINEER SHALL VERIFY THAT:
   A. SOIL CONDITIONS ARE SUBSTANTIALLY IN CONFORMANCE WITH THE SOIL INVESTIGATION REPORT.
   B. FOUNDATION EXCAVATIONS EXTEND TO PROPER DEPTH AND BEARING STRATA.

STRUCTURAL ABBREVIATIONS

AB	ANCHOR BOLT	ID	INSIDE DIAMETER
ADDL	ADDITIONAL	IN	INCH
AL	ALUMINUM		
ALT	ALTERNATE	JT	JOINT
APPROX	APPROXIMATE		
ARCH	ARCHITECTURAL	L	ANGLE, STR SHAPE
		LB	POUND
BAL	BALANCE	LL	LIVE LOAD
BLDG	BUILDING	LP, L/P	LOW POINT
BLK	BLOCK		
BM	BEAM	MAS	MASONRY
BOT	BOTTOM	MAX	MAXIMUM
BRG	BEARING	MECH	MECHANICAL
		MFR	MANUFACTURER
C	CHANNEL STR SHAPE	MH	MANHOLE
CANT'L	CANTILEVER	MID	MIDDLE
CJ	CONSTRUCTION JOINT	MIN	MINIMUM
CL	CENTERLINE, CLEAR		
CMU	CONCRETE MASONRY UNIT	N	NORTH
COL	COLUMN	NF	NEAR FACE
CONC	CONCRETE	NO	NUMBER
CONN	CONNECTION	NTS	NOT TO SCALE
CONST	CONSTRUCTION		
CONT	CONTINUOUS	OC	ON CENTER
CTR	CENTER	OD	OUTSIDE DIAMETER
		OPNG	OPENING
DET	DETAIL	OPP	OPPOSITE
DIA	DIAMETER		
DIAG	DIAGONAL	PL	PLATE
DIM	DIMENSION	PSF	POUNDS PER SQUARE FOOT
DN	DOWN		
DO	DITTO	PVC	POLYVINYL CHLORIDE
DP	DEEP		
DWG	DRAWING	R	RADIUS, RISER
		RD	ROOF DRAIN
E	EAST	REINF	REINFORCEMENT
EA	EACH	REQD	REQUIRED
EF	EACH FACE	RO	ROUGH OPENING
EJ	EXPANSION JOINT		
EL	ELEVATION	S	SOUTH
ELEC	ELECTRICAL	SECT	SECTION
ENCL	ENCLOSURE	SHT	SHEET
EQ	EQUAL	SIM	SIMILAR
EQUIP	EQUIPMENT	SPEC	SPECIFICATION
ES	EACH SIDE	SQ	SQUARE
EW	EACH WAY	SS	STAINLESS STEEL
EXST	EXISTING	STD	STANDARD
EXP	EXPANSION	STL	STEEL
EXT	EXTERIOR	STR	STRUCTURAL
		SYMM	SYMMETRICAL
FD	FLOOR DRAIN		
FDN	FOUNDATION	T	TREAD
FF	FIN FLOOR, FAR FACE	T&B	TOP AND BOTTOM
FIN	FINISH	TOC	TOP OF CONCRETE
FLR	FLOOR	THK	THICK
FRP	FIBERGLASS REINFORCED PLASTIC	T/	TOP OF
		TYP	TYPICAL
FT	FOOT		
FTG	FOOTING	UON	UNLESS OTHERWISE NOTED
GA	GAUGE		
GALV	GALVANIZE	VERT	VERTICAL
GB	GRADE BEAM		
GRTG	GRATING	W	WIDE FLANGE STR SHAPE, WIDTH, WEST
HORIZ	HORIZONTAL		
HP, H/P	HIGH POINT	w/	WITH
HS	HIGH STRENGTH		
HVAC	HEATING, VENTILATING & AIR CONDITIONING		

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San Diego, California 92127
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SCALE AS SHOWN
DATE 06/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY HIW
DRAWN BY JEN
CHECKED BY SP

Infrastructure ENGINEERING CORPORATION
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www.iecorporation.com

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FALLBROOK, CA 92028

APPROVED BY:

JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

GENERAL STRUCTURAL NOTES AND ABBREVIATIONS

DRAWING NO. GS-1
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

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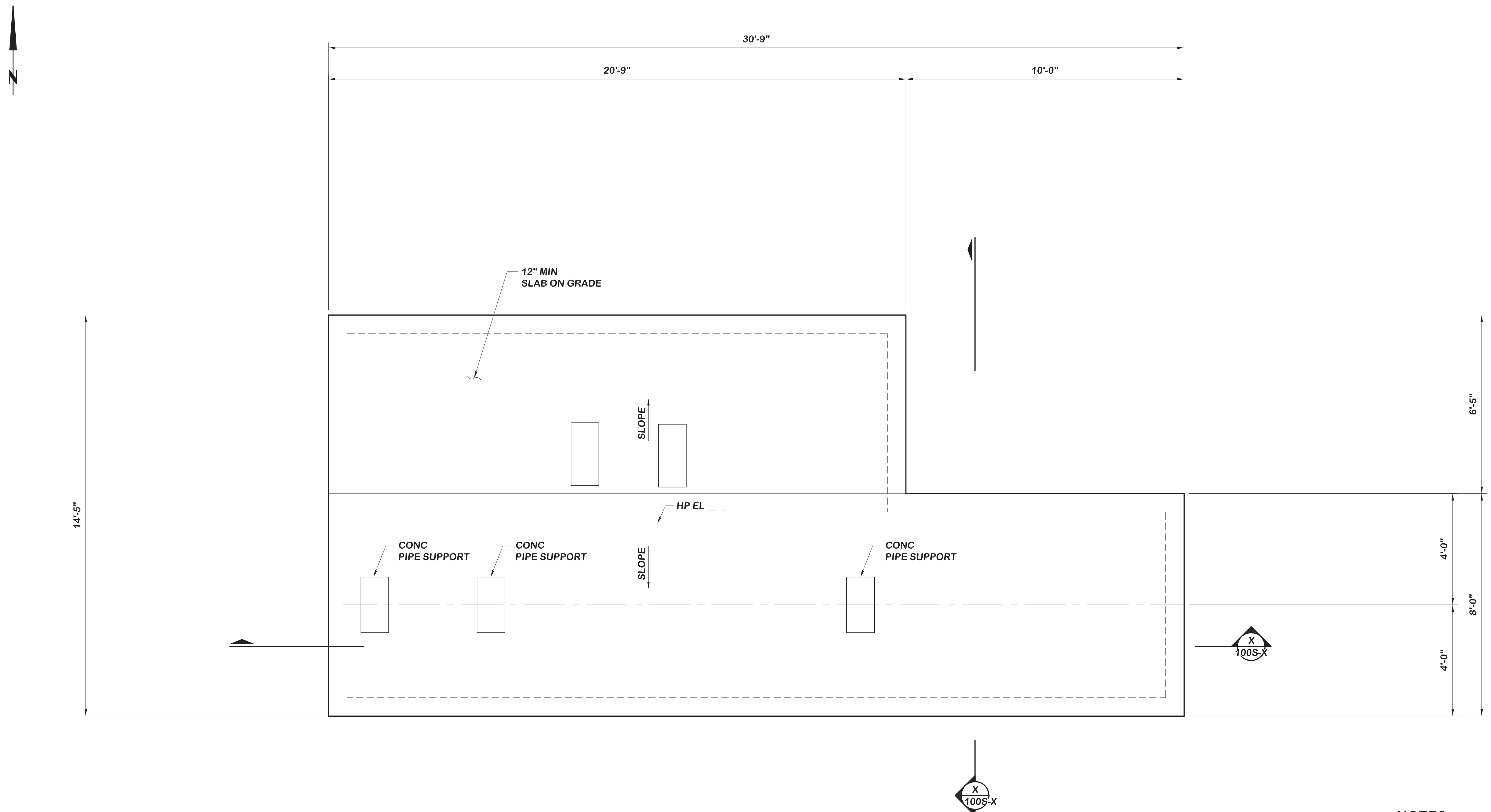

SLAB PLAN

SCALE: 1/2" = 1'-0"

NOTES:

1. REFER TO SHEET GS-1 FOR GENERAL STRUCTURAL NOTES AND STRUCTURAL ABBREVIATIONS.
2. REFER TO SHEETS GS-2 THROUGH GS-5 FOR TYPICAL STRUCTURAL DETAILS.
3. REFER TO MECHANICAL DRAWINGS FOR ALL DIMENSIONS AND OPENINGS NOT SHOWN.
4. REFER TO MECHANICAL DRAWINGS FOR LOCATIONS OF PIPE PENETRATIONS AND RELATED OPENINGS.

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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 100 - INLET METER AND FCF VAULT PLAN

DRAWING NO. 100S-1
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

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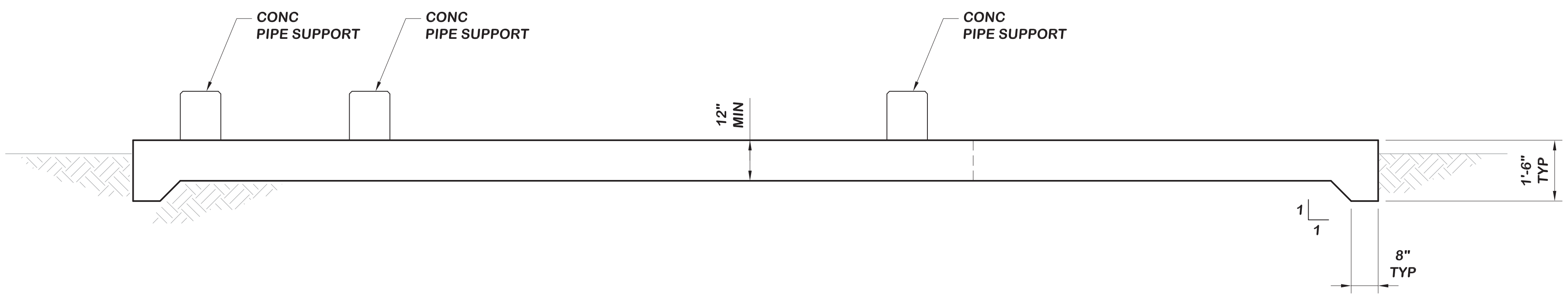
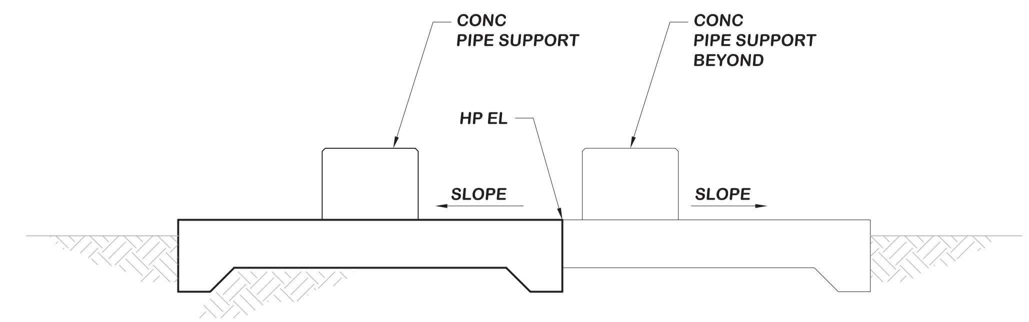


SECTION A
100S-1
SCALE: 1/2" = 1'-0"



SECTION B
100S-1
SCALE: 1/2" = 1'-0"

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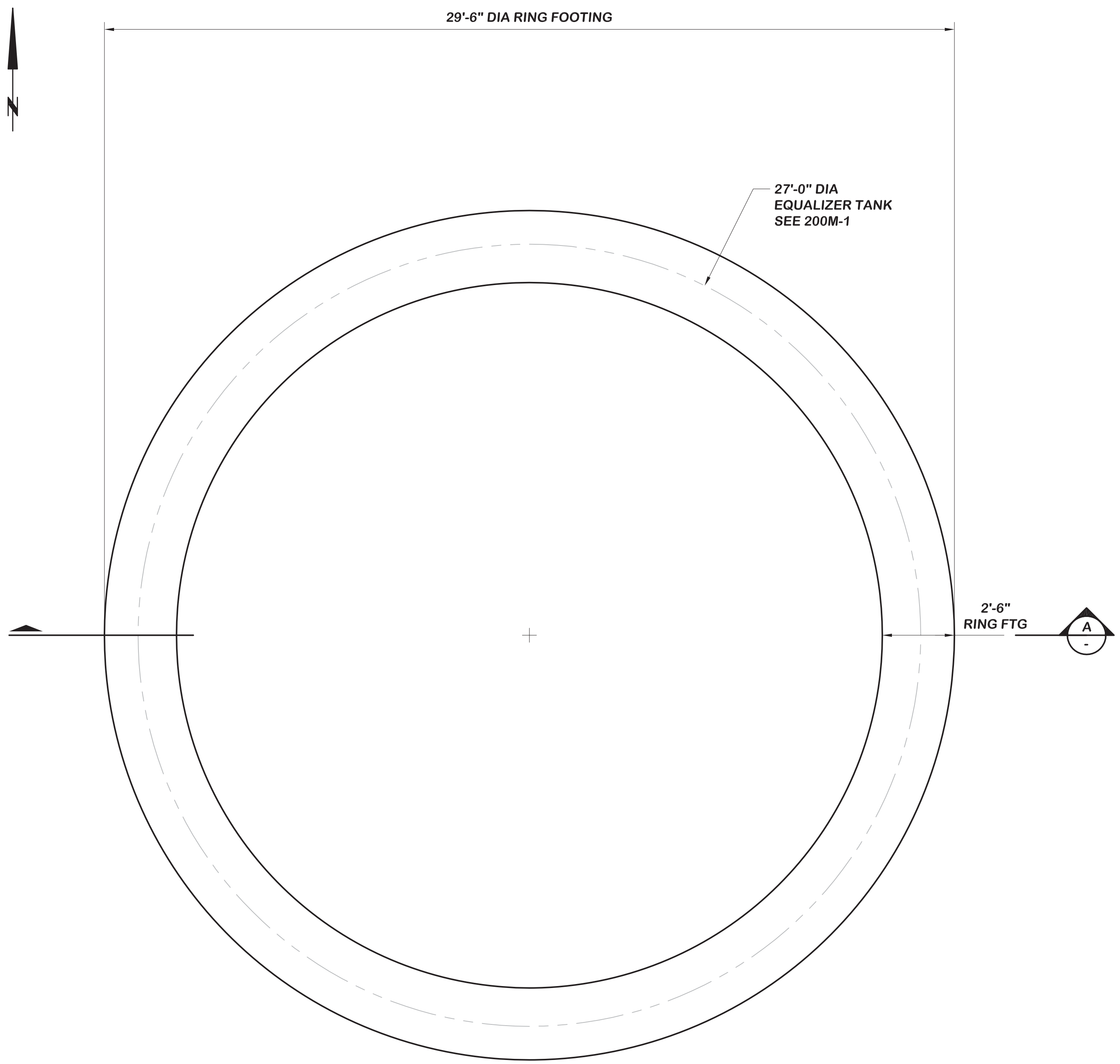
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

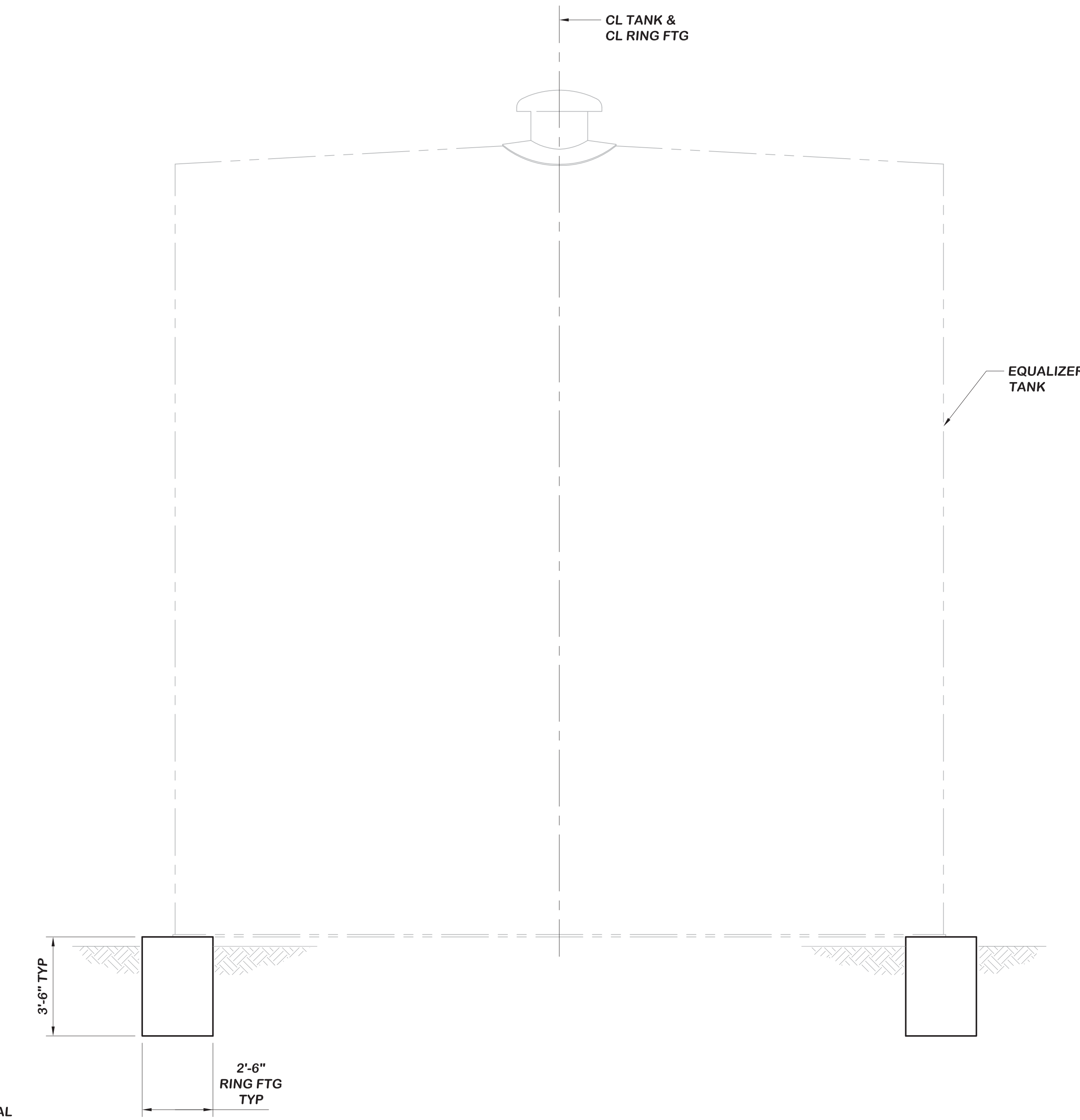
AREA 100 - RETURN FCF SECTIONS & DETAILS

DRAWING NO. 100S-2
SHEET NO. XX OF XX
CLIENT JOB NO. 2744



TANK FOOTING PLAN

SCALE: 3/8" = 1'-0"



SECTION A -

SCALE: 3/8" = 1'-0"

NOTES:

1. REFER TO SHEET GS-1 FOR GENERAL STRUCTURAL NOTES AND STRUCTURAL ABBREVIATIONS.
2. REFER TO SHEETS GS-2 THROUGH GS-5 FOR TYPICAL STRUCTURAL DETAILS.
3. REFER TO MECHANICAL DRAWINGS FOR ALL DIMENSIONS AND OPENINGS NOT SHOWN.
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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 200 - EQUALIZATION TANK PLAN AND SECTION

DRAWING NO. 200S-1
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

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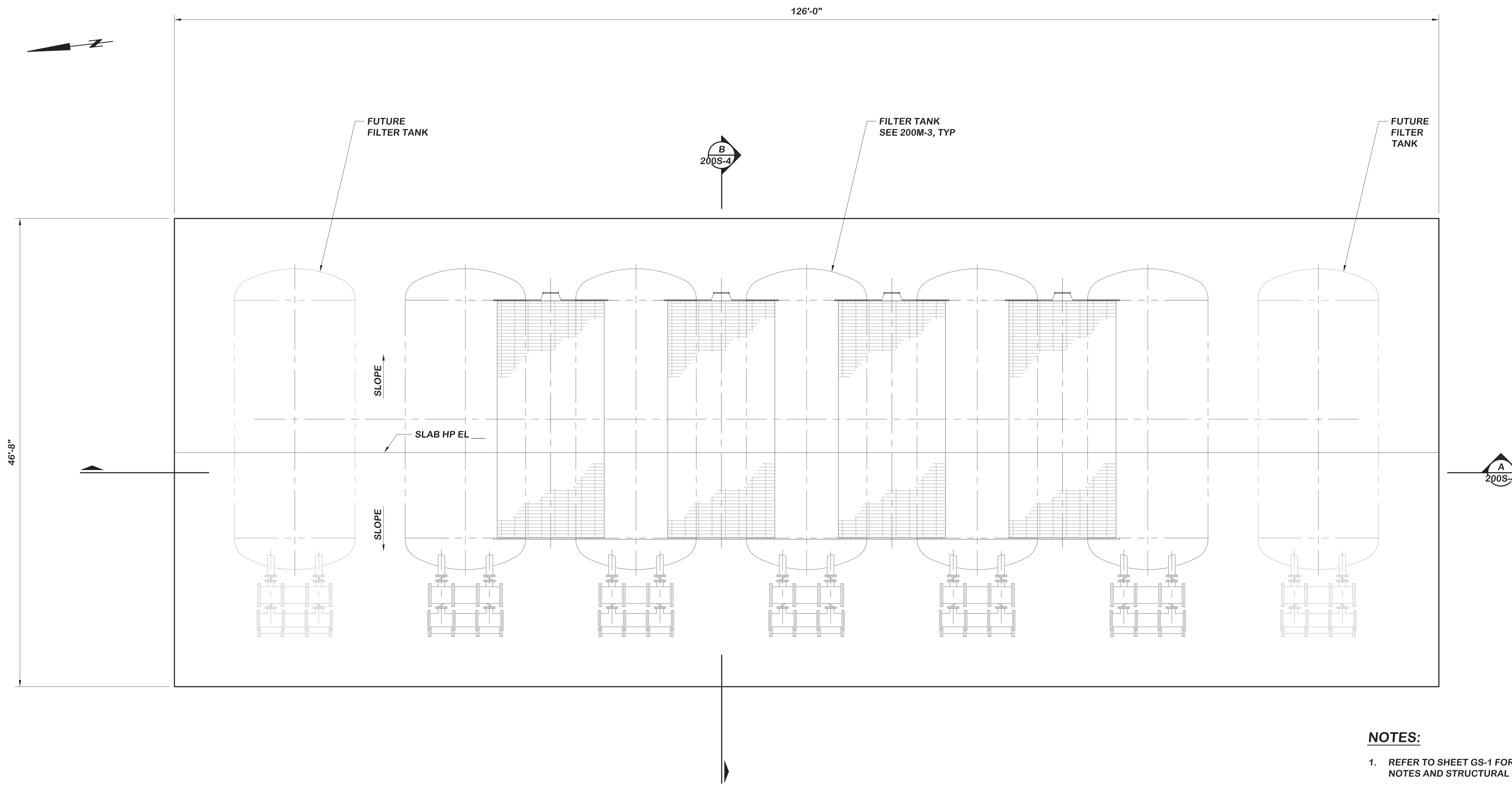

SLAB PLAN

SCALE: 3/16" = 1'-0"

NOTES:

1. REFER TO SHEET GS-1 FOR GENERAL STRUCTURAL NOTES AND STRUCTURAL ABBREVIATIONS.
2. REFER TO SHEETS GS-2 THROUGH GS-5 FOR TYPICAL STRUCTURAL DETAILS.
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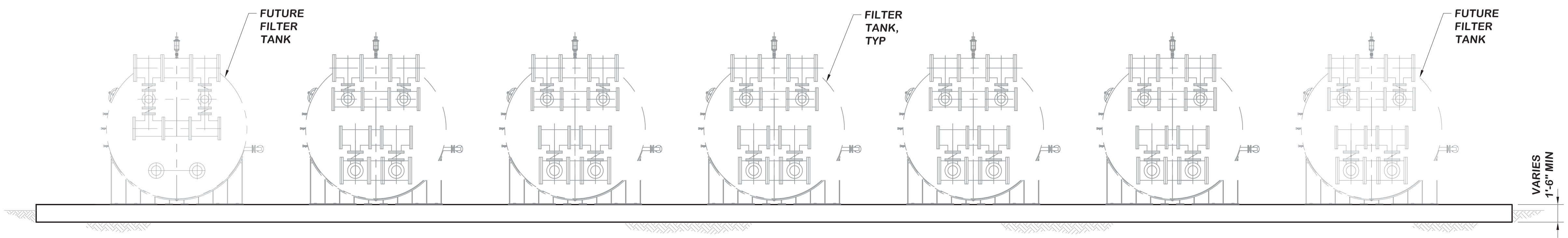
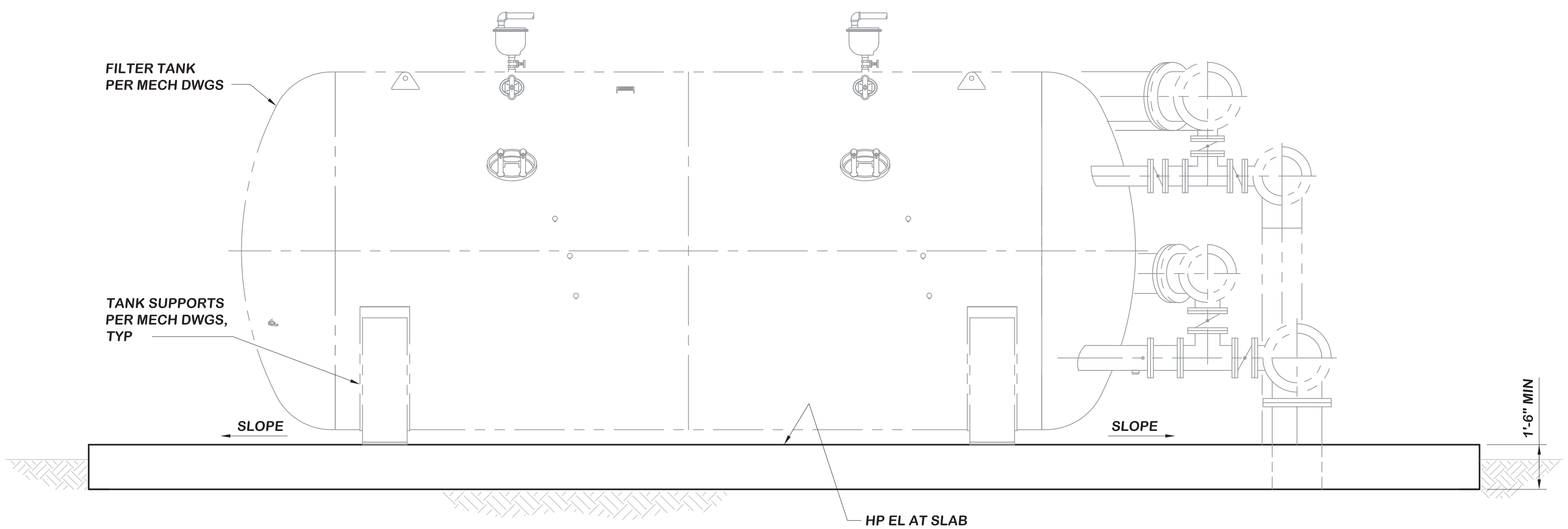
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 200 - IRON AND MANGANESE FILTRATION SLAB PLAN

DRAWING NO. 200S-3
SHEET NO. XX OF XX
CLIENT JOB NO. 2744



SECTION A 200S-3
SCALE: 3/16" = 1'-0"



SECTION B 200S-3
SCALE: 3/8" = 1'-0"

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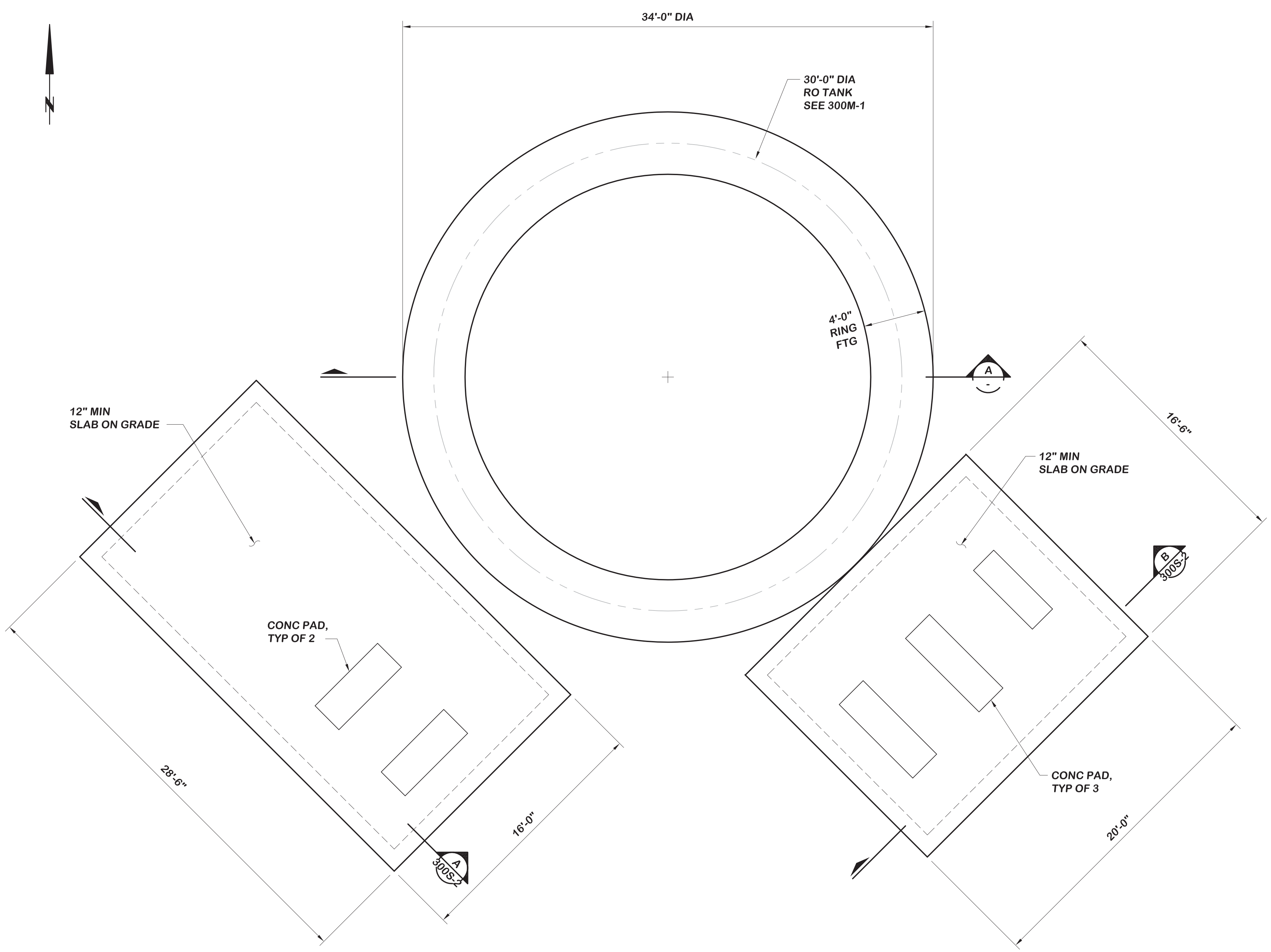
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

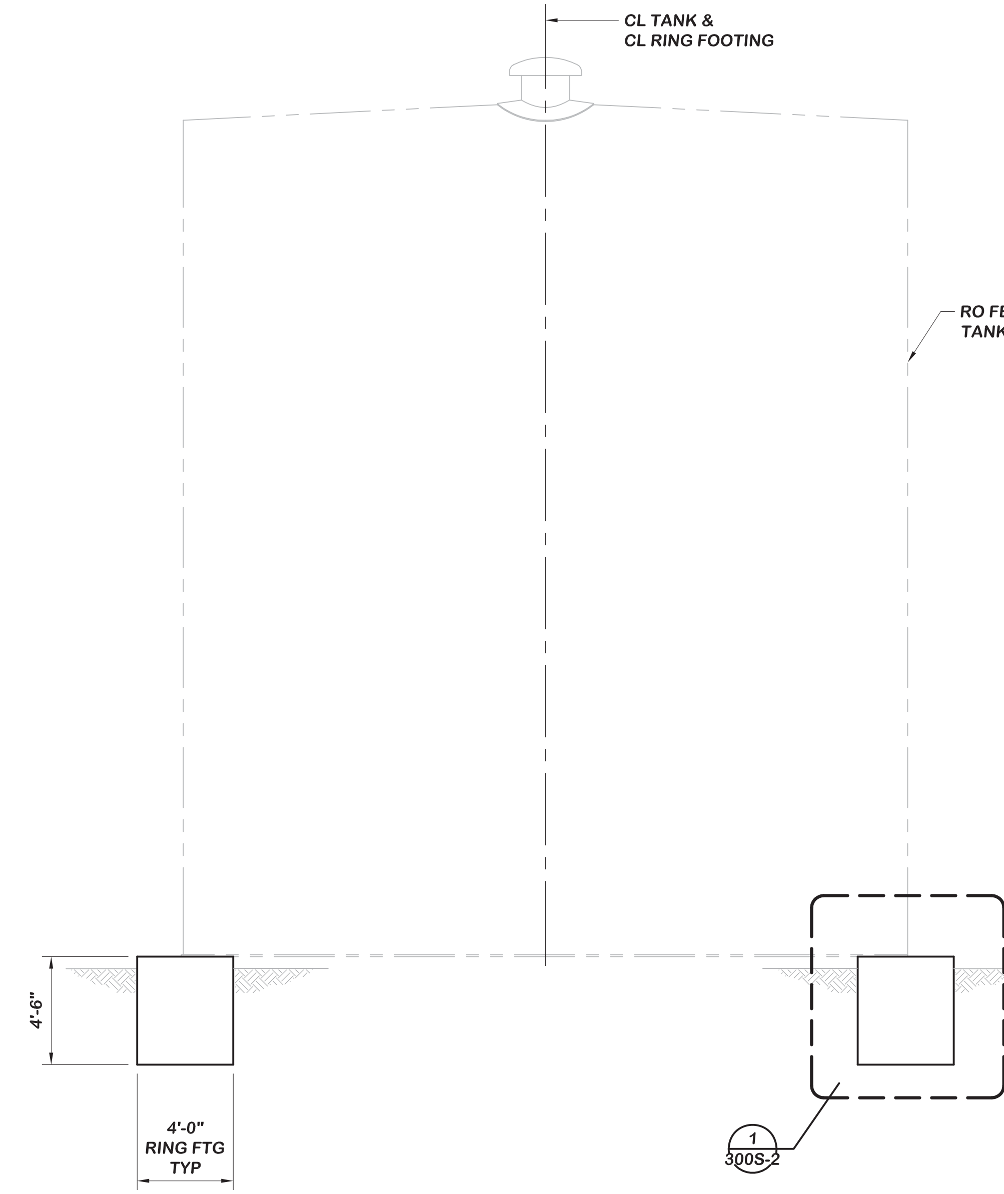
AREA 200 - IRON AND MANGANESE FILTRATION
SLAB SECTIONS AND DETAILS

DRAWING NO. 200S-4
SHEET NO. XX OF XX
CLIENT JOB NO. 2744



TANK FOOTING AND PUMP STATION SLABS PLAN

SCALE: 1/4" = 1'-0"



SECTION A

SCALE: 1/4" = 1'-0"

NOTES:

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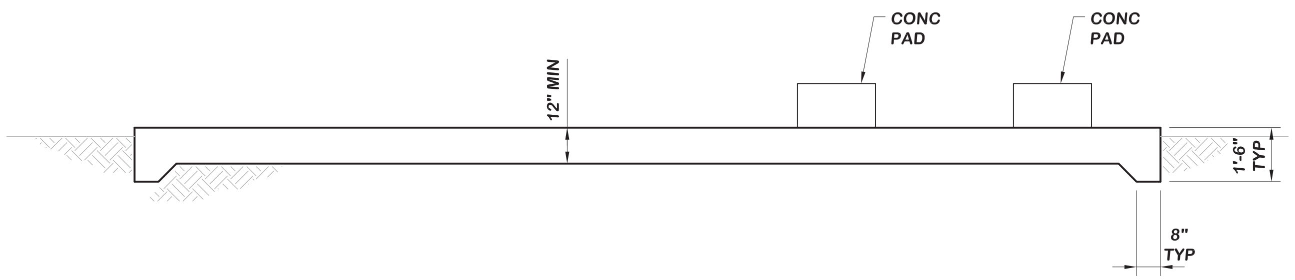
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

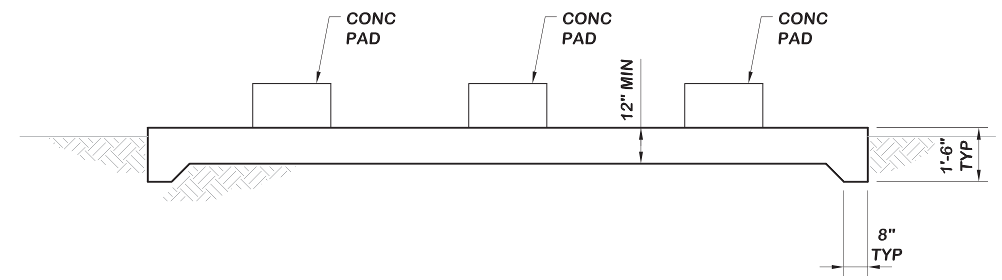
AREA 300 - RO FEED TANK AND BOOSTER PUMP STATION, PLAN AND SECTION

DRAWING NO. 300S-1
SHEET NO. XX OF XX
CLIENT JOB NO. 2744



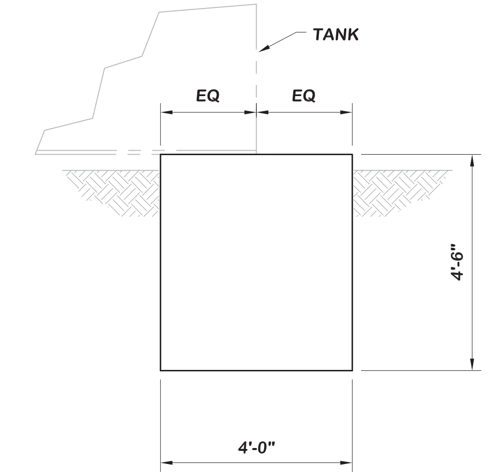
SECTION A / 300S-1

SCALE: 3/8" = 1'-0"



SECTION B / 300S-1

SCALE: 3/8" = 1'-0"



DETAIL 1 / -

SCALE: 1/2" = 1'-0"

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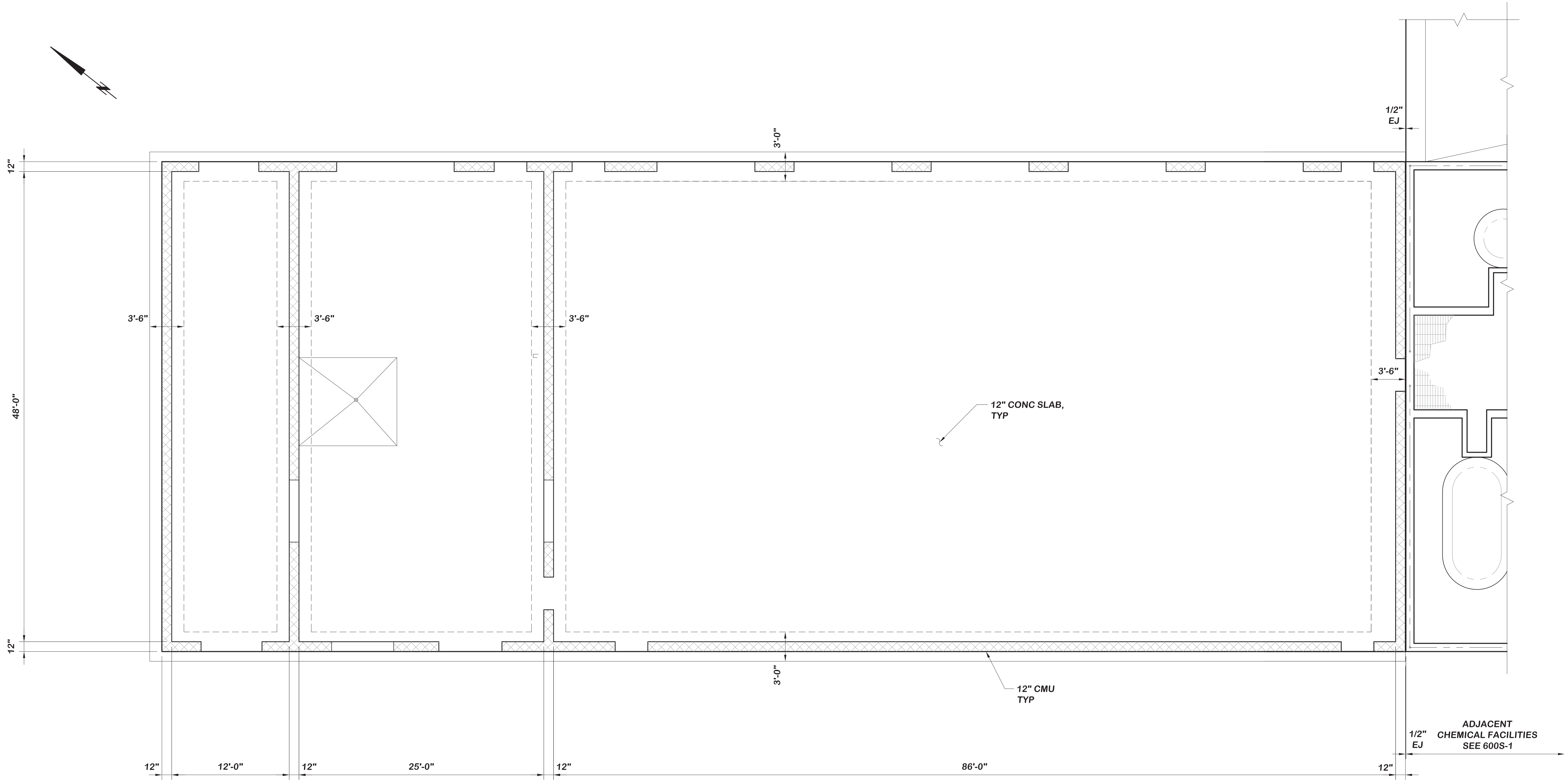
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 300 - RO FEED TANK AND BOOSTER PUMP STATION SECTIONS AND DETAILS

DRAWING NO. 300S-2
SHEET NO. XX OF XX
CLIENT JOB NO. 2744



FOUNDATION PLAN

SCALE: 3/16" = 1'-0"

NOTES:

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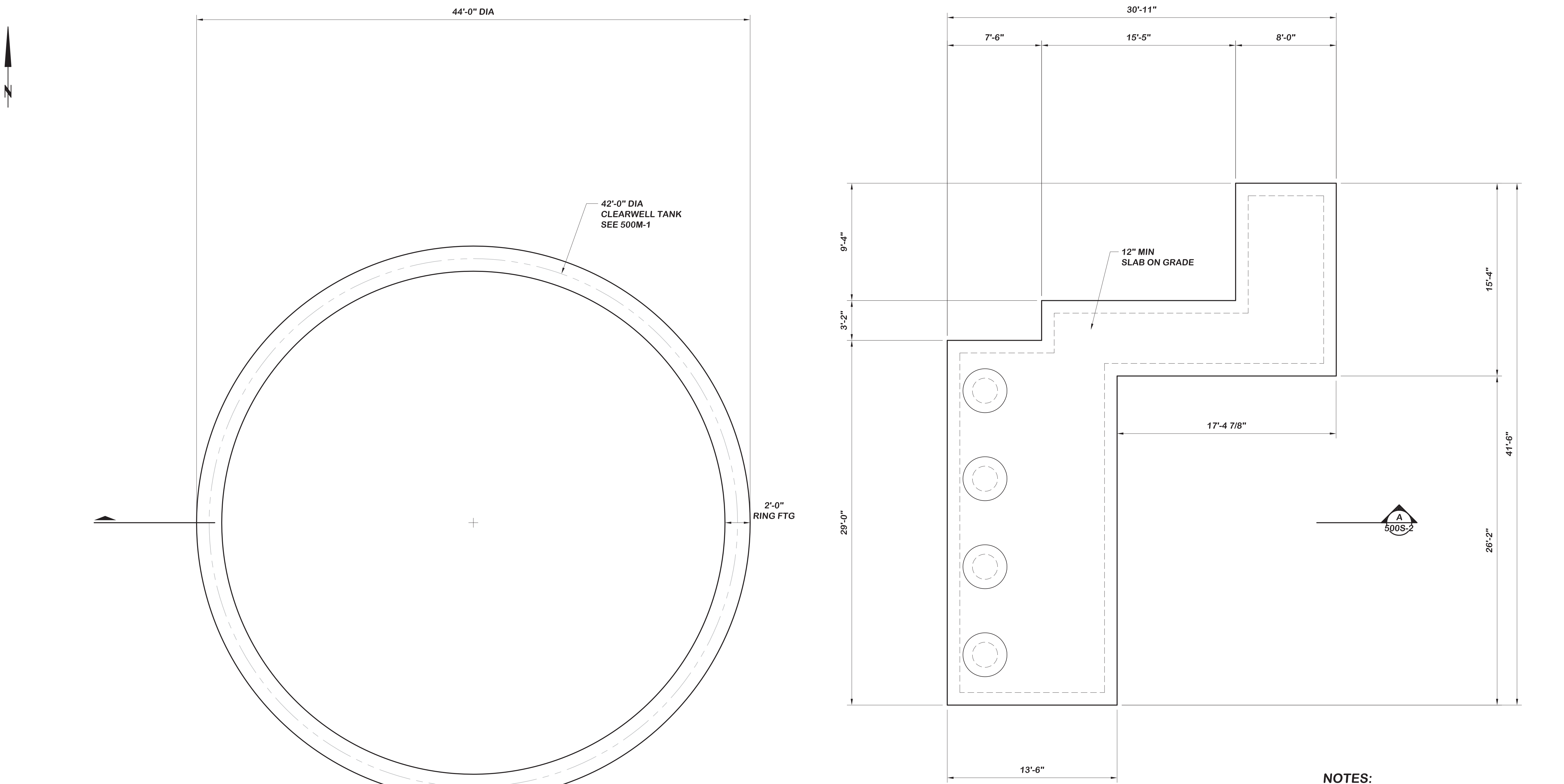
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 400 - RO BUILDING FOUNDATION PLAN

DRAWING NO. 400S-1
SHEET NO. XX OF XX
CLIENT JOB NO. 2744



TANK FOOTING AND PUMP STATION SLAB PLAN

SCALE: 1/4" = 1'-0"

NOTES:

1. REFER TO SHEET GS-1 FOR GENERAL STRUCTURAL NOTES AND STRUCTURAL ABBREVIATIONS.
2. REFER TO SHEETS GS-2 THROUGH GS-5 FOR TYPICAL STRUCTURAL DETAILS.
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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 500 - CLEARWELL TANK AND PUMP STATION, TANK FOOTING AND SLAB PLAN

DRAWING NO. 500S-1
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

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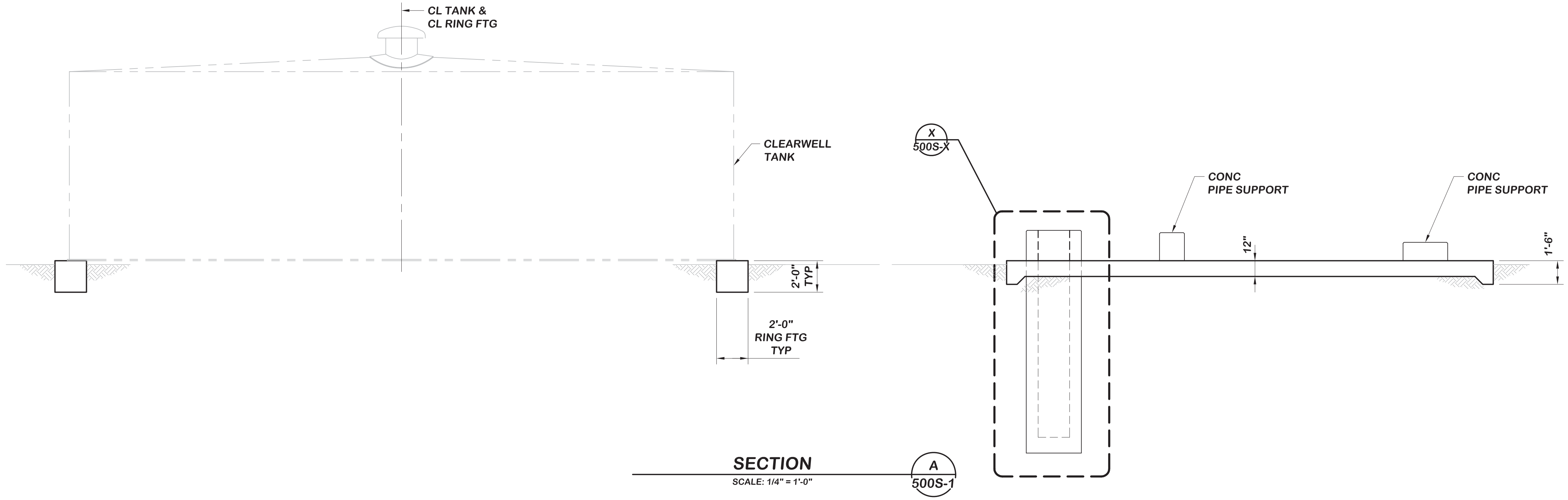

SECTION A / 500S-1

SCALE: 1/4" = 1'-0"

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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 500 - CLEARWELL TANK AND PUMP STATION SECTION

DRAWING NO. 500S-2
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

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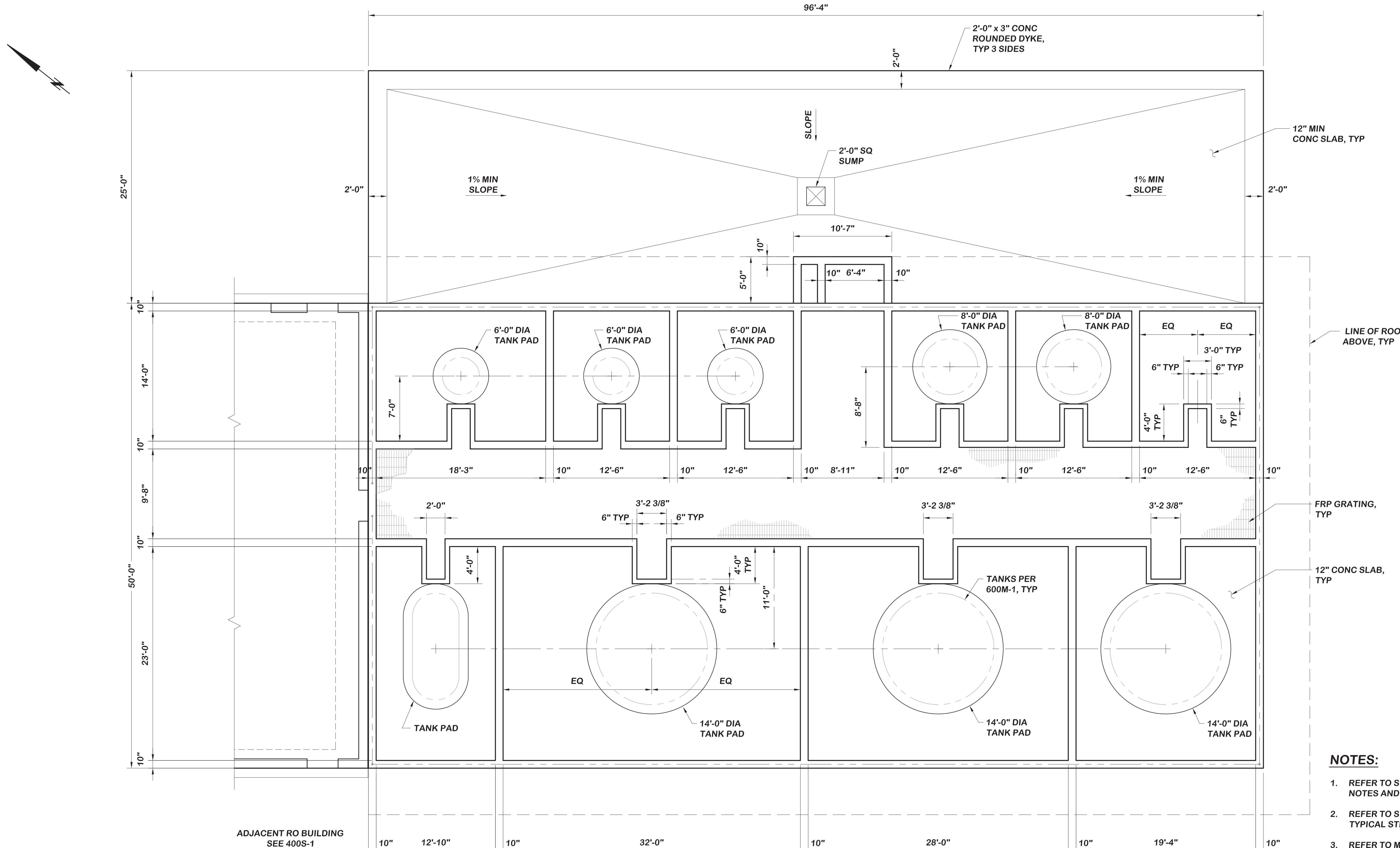

CONTAINMENT PLAN

SCALE: 3/16" = 1'-0"

NOTES:

1. REFER TO SHEET GS-1 FOR GENERAL STRUCTURAL NOTES AND STRUCTURAL ABBREVIATIONS.
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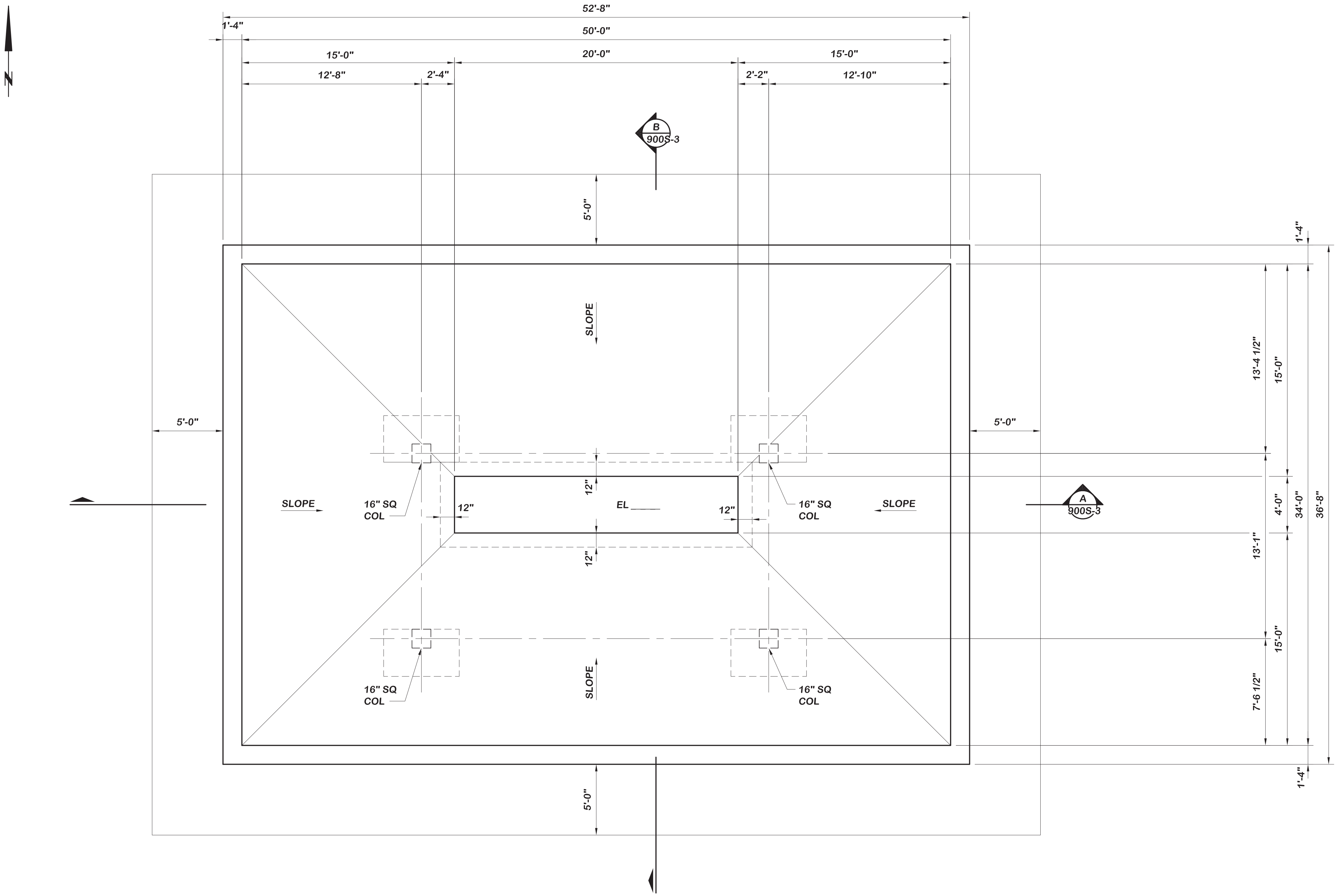
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 600 - CHEMICAL FACILITIES CONTAINMENT PLAN

DRAWING NO. 600S-1
SHEET NO. XX OF XX
CLIENT JOB NO. 2744



BOTTOM PLAN

SCALE: 1/4" = 1'-0"

NOTES:

1. REFER TO SHEET GS-1 FOR GENERAL STRUCTURAL NOTES AND STRUCTURAL ABBREVIATIONS.
2. REFER TO SHEETS GS-2 THROUGH GS-5 FOR TYPICAL STRUCTURAL DETAILS.
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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 700 - WASTE WASHWATER STORAGE BOTTOM PLAN

DRAWING NO. 700S-1
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

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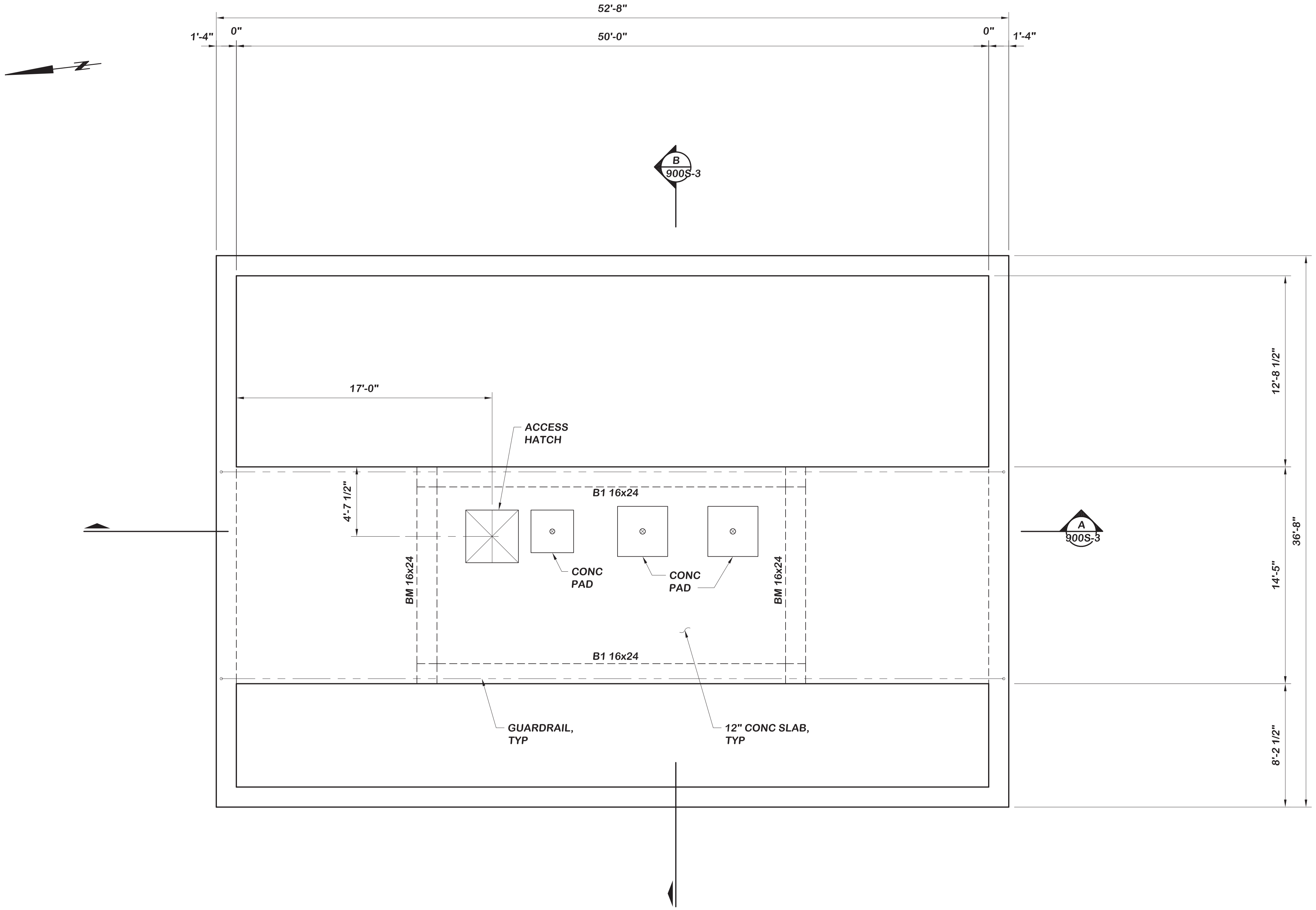

TOP PLAN

SCALE: 1/4" = 1'-0"

NOTES:

1. REFER TO SHEET GS-1 FOR GENERAL STRUCTURAL NOTES AND STRUCTURAL ABBREVIATIONS.
2. REFER TO SHEETS GS-2 THROUGH GS-5 FOR TYPICAL STRUCTURAL DETAILS.
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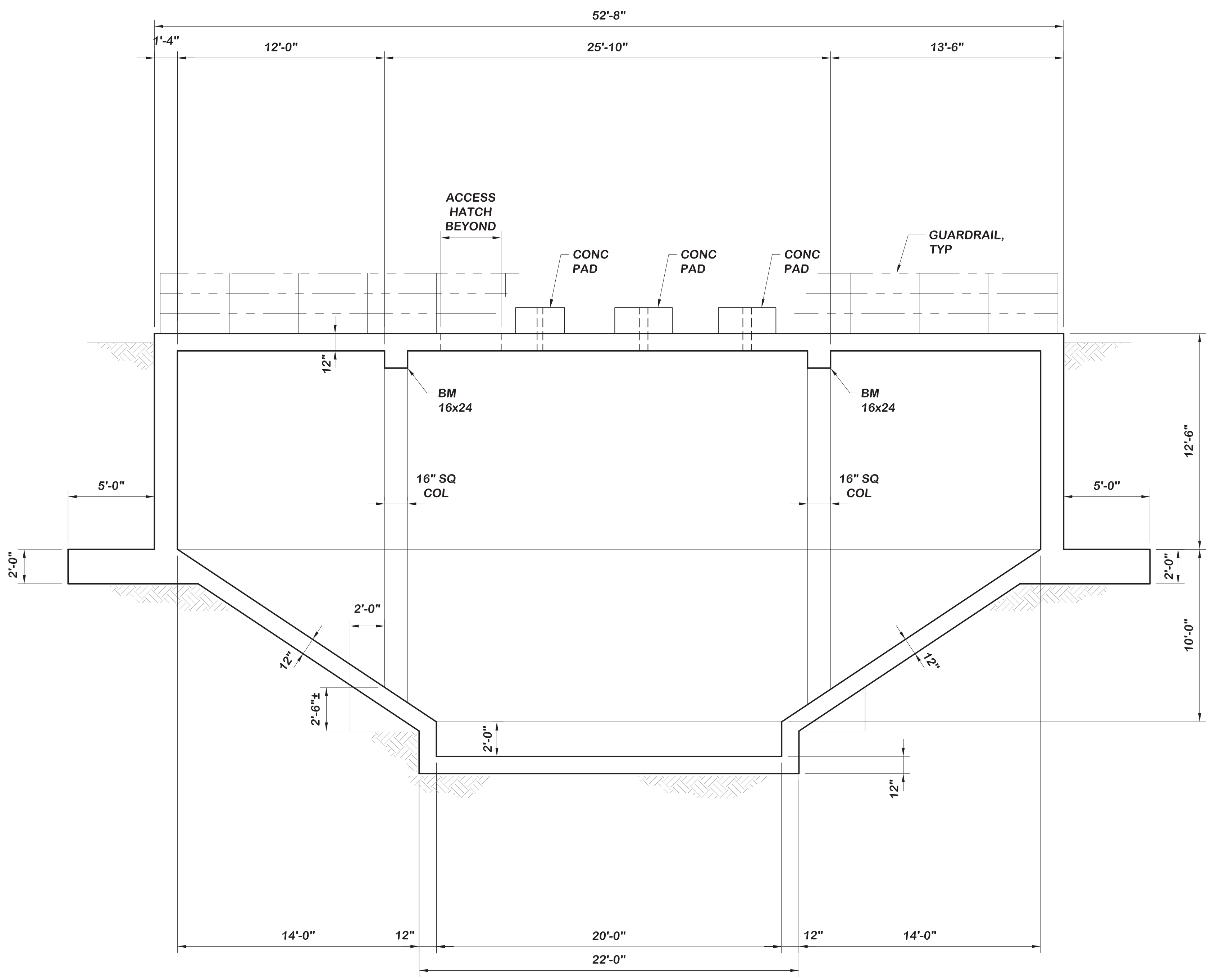
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

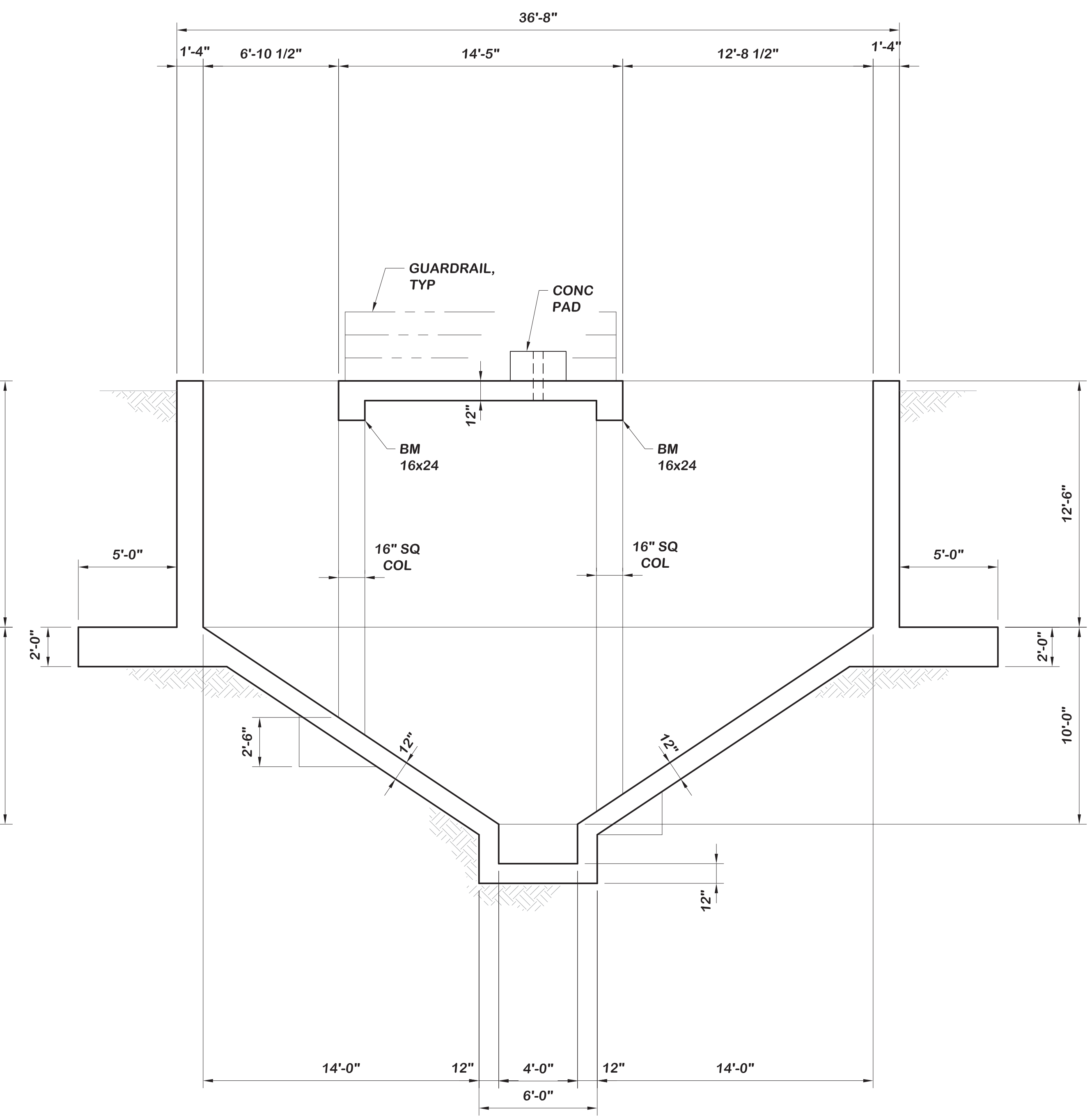
AREA 700 - WASTE WASHWATER STORAGE
TOP PLAN

DRAWING NO. 700S-2
SHEET NO. XX OF XX
CLIENT JOB NO. 2744



SECTION A/900S-1 A/900S-2

SCALE: 3/8" = 1'-0"



SECTION B/900S-1 B/900S-2

SCALE: 3/8" = 1'-0"

Beyaz & Patel
16935 West Bernardo Drive, Ste 100
San Diego, California 92127
(858) 451-0374

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE AS SHOWN
DATE 06/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY HIW
DRAWN BY JEN
CHECKED BY SP

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www.iecorporation.com

DATE

Fallbrook Public Utility District
990 E. MISSION RD
FALLBROOK, CA 92028

APPROVED BY:

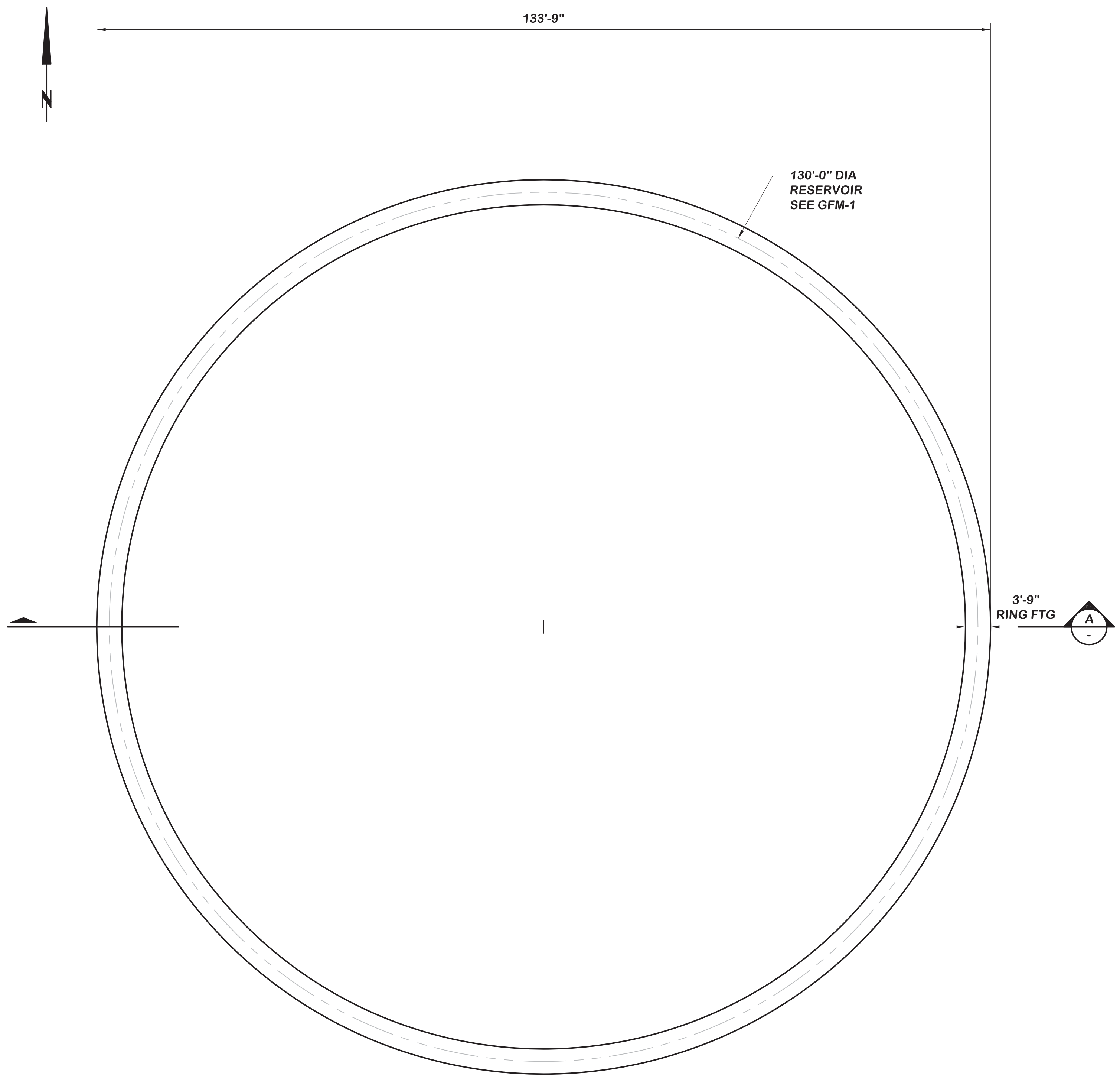
JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 700 - WASTE WASHWATER STORAGE SECTIONS

DRAWING NO. 700S-3
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

R:\CAD\71CAD\TG_Projects\7115\0515010-Santa Margarita-SMCUP\Dwgs\Structural\900S-03-RWT-XS.dwg 06/24/2015 11:28



RESERVOIR PLAN

SCALE: 3/32" = 1'-0"

SECTION

SCALE: 3/32" = 1'-0"

A
GFS-1

NOTES:

1. REFER TO SHEET GS-1 FOR GENERAL STRUCTURAL NOTES AND STRUCTURAL ABBREVIATIONS.
2. REFER TO SHEETS GS-2 THROUGH GS-5 FOR TYPICAL STRUCTURAL DETAILS.
3. REFER TO MECHANICAL DRAWINGS FOR ALL DIMENSIONS AND OPENINGS NOT SHOWN.
4. REFER TO MECHANICAL DRAWINGS FOR LOCATIONS OF PIPE PENETRATIONS AND RELATED OPENINGS.

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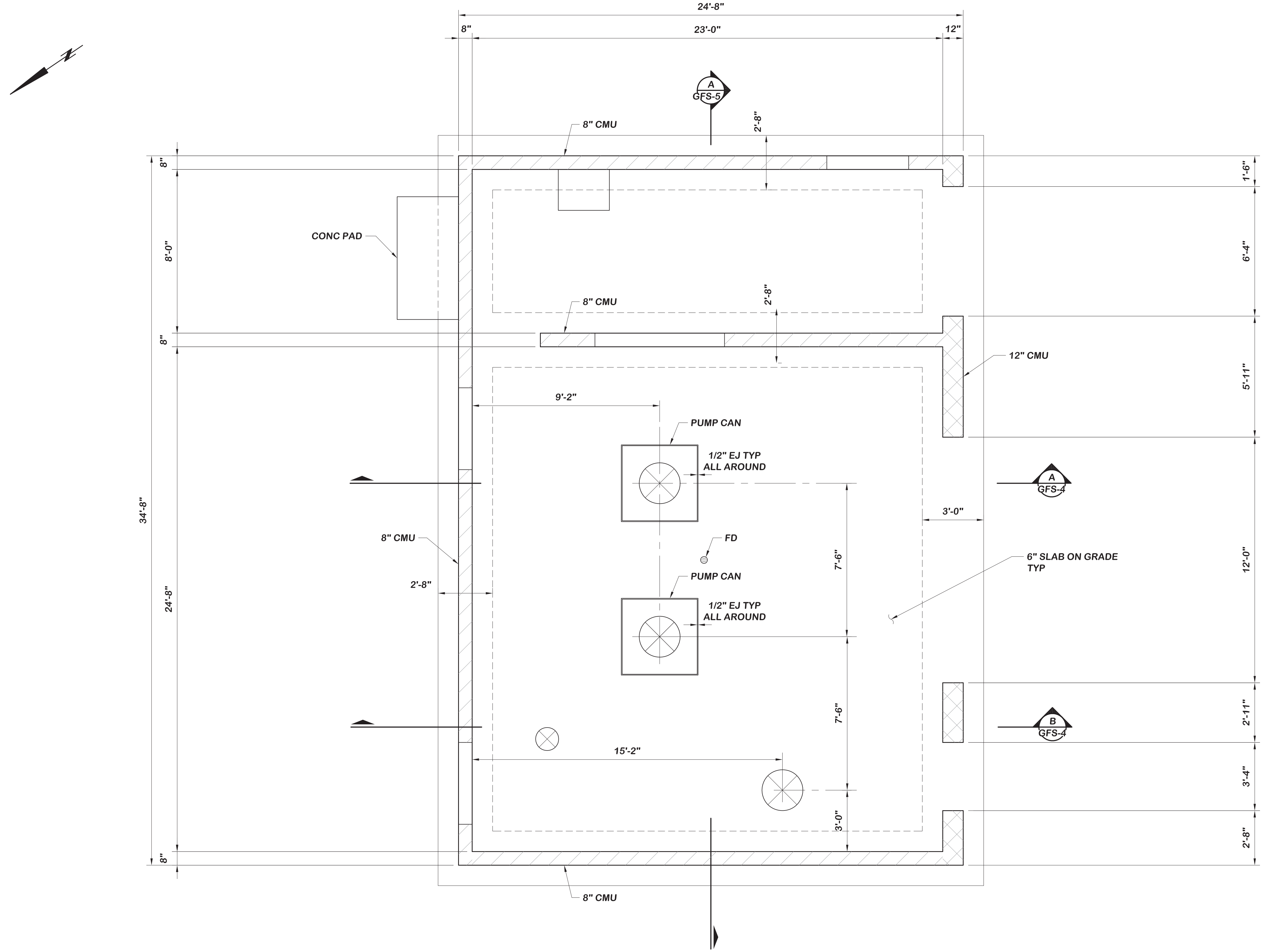
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

GHEEN FACILITY
RESERVOIR PLAN AND SECTION

DRAWING NO. GFS-1
SHEET NO. XX OF XX
CLIENT JOB NO. 2744



FOUNDATION PLAN

SCALE: 3/8" = 1'-0"

NOTES:

1. REFER TO SHEET GS-1 FOR GENERAL STRUCTURAL NOTES AND STRUCTURAL ABBREVIATIONS.
2. REFER TO SHEETS GS-2 THROUGH GS-5 FOR TYPICAL STRUCTURAL DETAILS.
3. REFER TO MECHANICAL DRAWINGS FOR ALL DIMENSIONS AND OPENINGS NOT SHOWN.
4. REFER TO MECHANICAL DRAWINGS FOR LOCATIONS OF PIPE PENETRATIONS AND RELATED OPENINGS.

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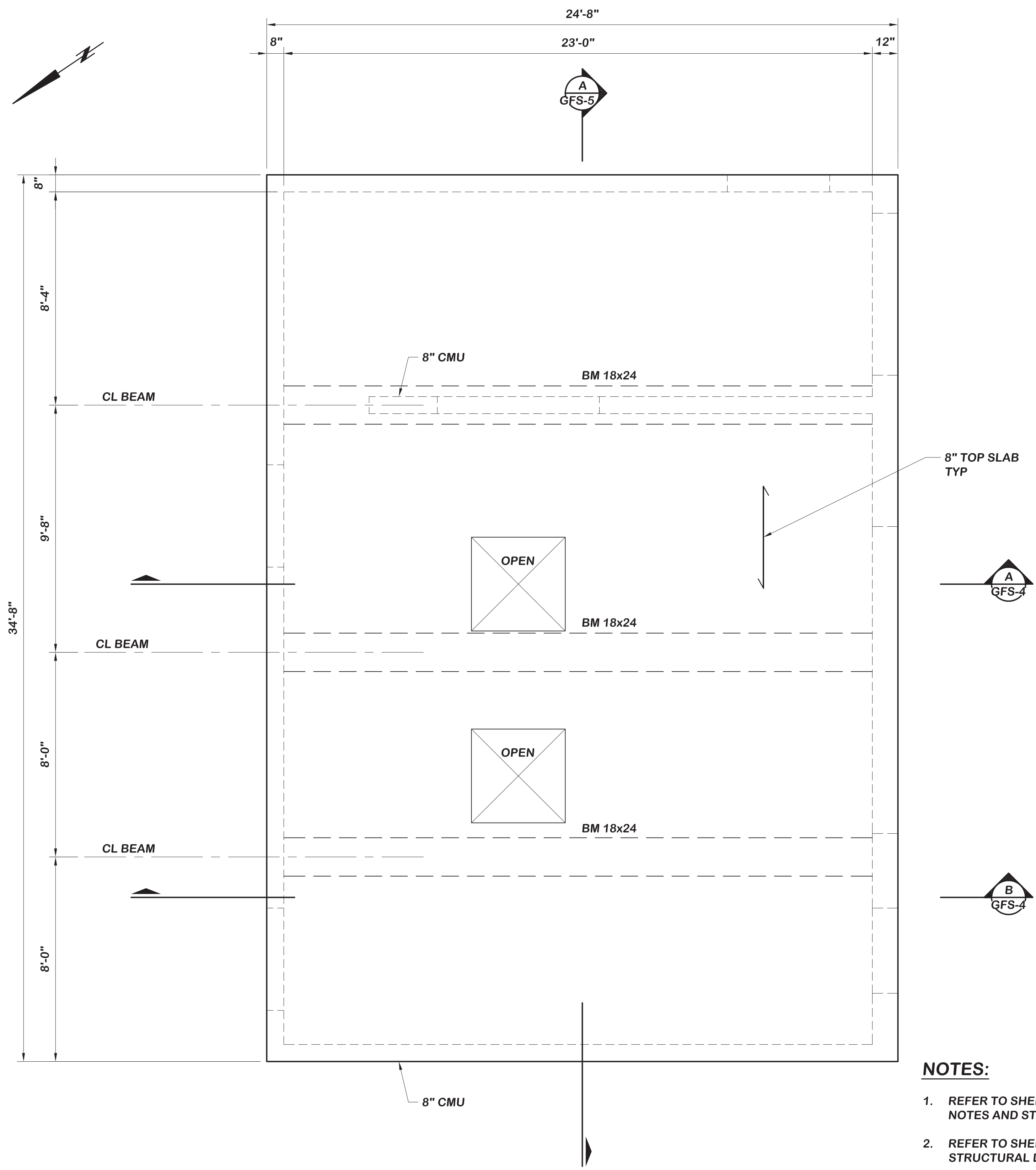
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

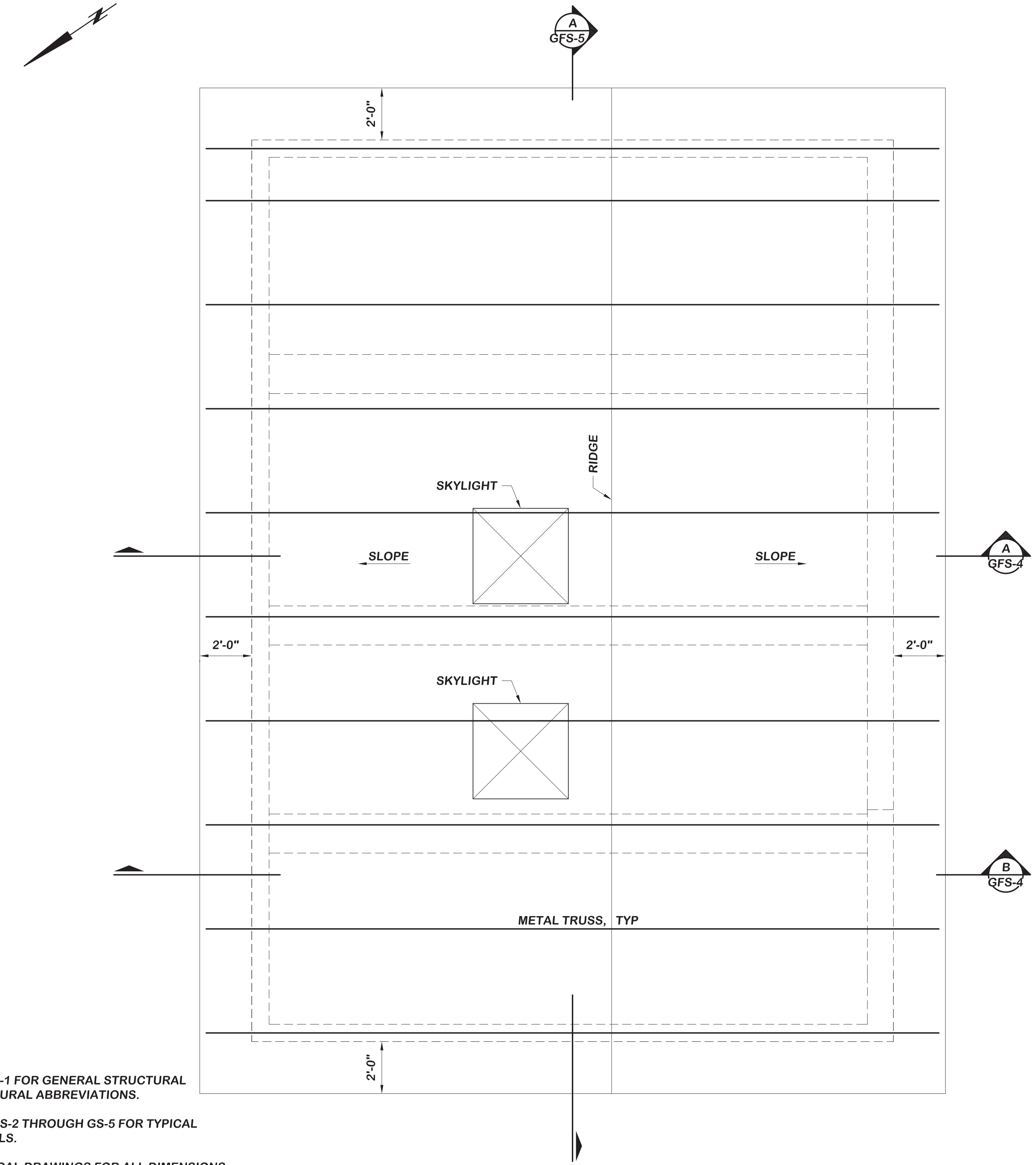
GHEEN FACILITY PUMP STATION FOUNDATION PLAN

DRAWING NO. GFS-2
SHEET NO. XX OF XX
CLIENT JOB NO. 2744



TOP SLAB PLAN

SCALE: 3/8" = 1'-0"



ROOF FRAMING PLAN

SCALE: 3/8" = 1'-0"

NOTES:

1. REFER TO SHEET GS-1 FOR GENERAL STRUCTURAL NOTES AND STRUCTURAL ABBREVIATIONS.
2. REFER TO SHEETS GS-2 THROUGH GS-5 FOR TYPICAL STRUCTURAL DETAILS.
3. REFER TO MECHANICAL DRAWINGS FOR ALL DIMENSIONS AND OPENINGS NOT SHOWN.
4. REFER TO MECHANICAL DRAWINGS FOR LOCATIONS OF PIPE PENETRATIONS AND RELATED OPENINGS.

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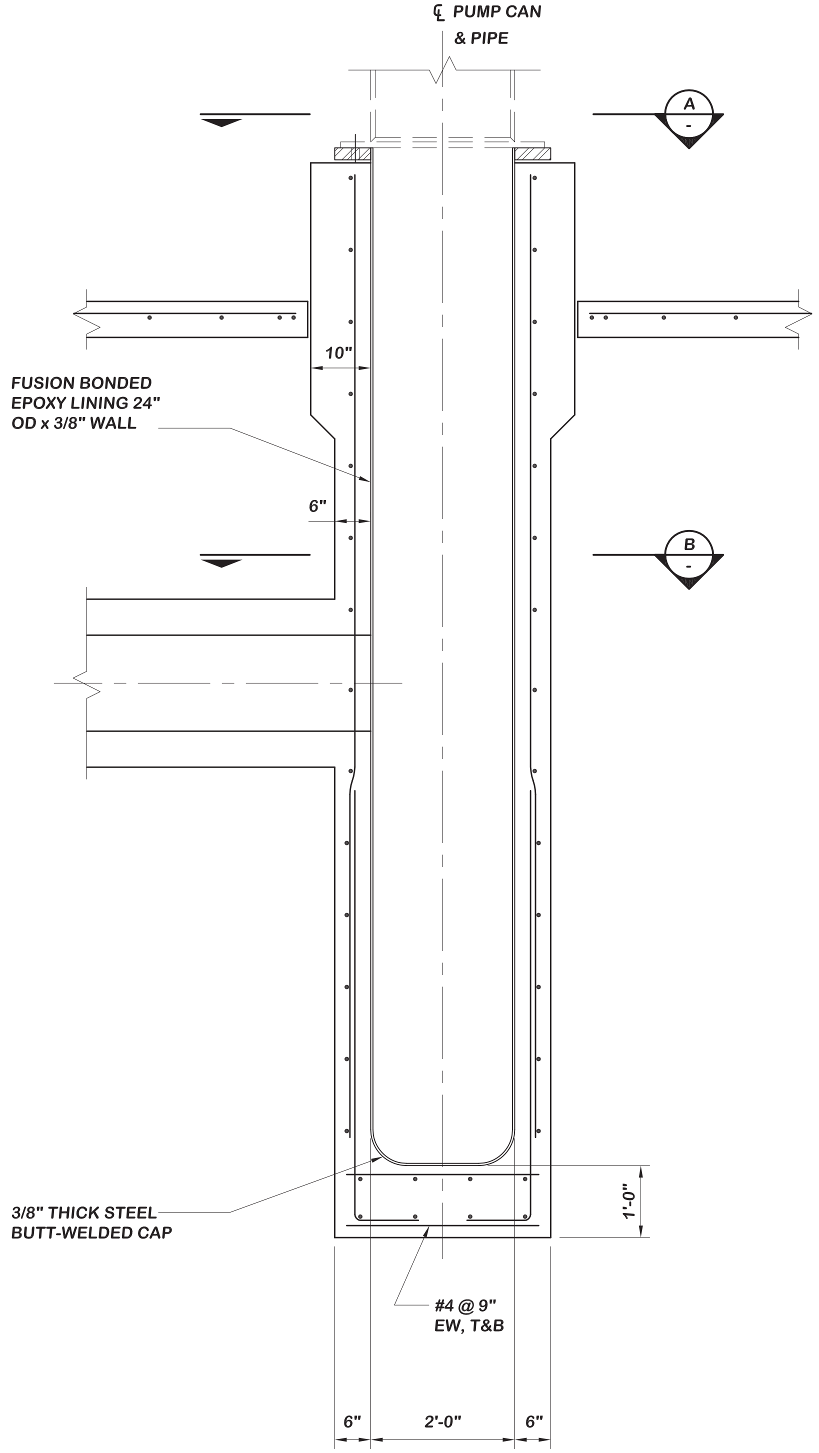
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

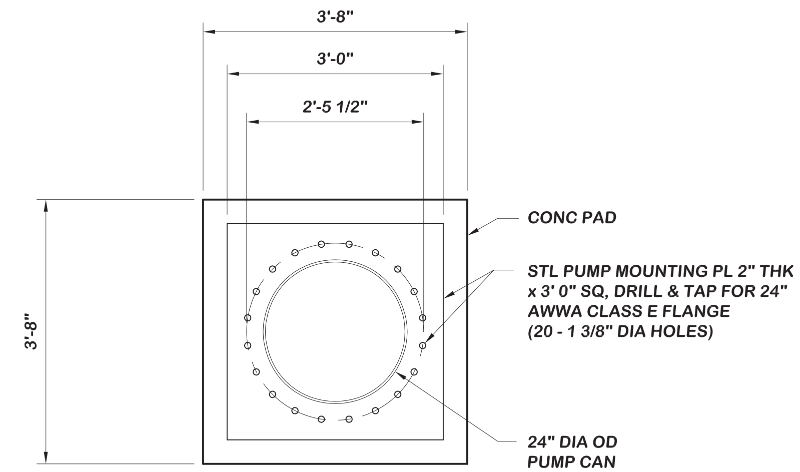
GHEEN FACILITY PUMP STATION
TOP SLAB PLAN AND ROOF FRAMING PLAN

DRAWING NO. GFS-3
SHEET NO. XX OF XX
CLIENT JOB NO. 2744



PUMP MOUNTING PLATE - PLAN VIEW

DETAIL 1 / GFS-4
SCALE: 3/4" = 1'-0"

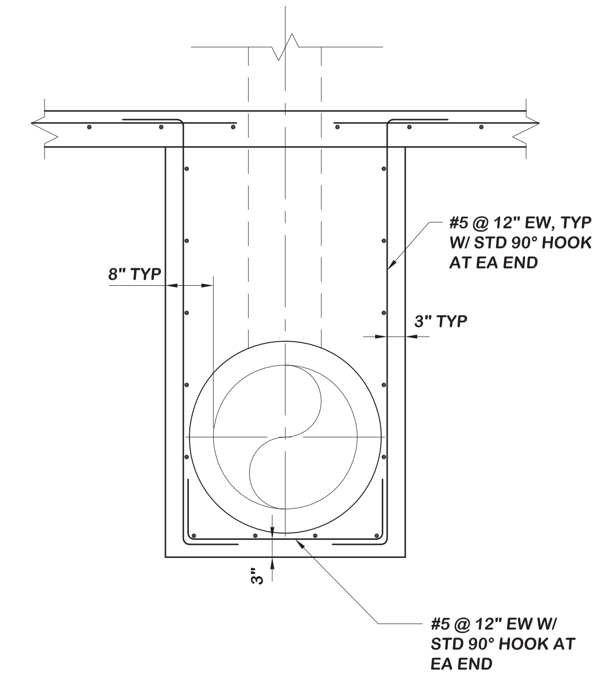


NOTES:

1. HOLES FOR BOLTS: DRILL & TAP TO STRADDLE CENTERLINE OF PLATE AS SHOWN.
2. STEEL PLATE SHALL BE CARBON STEEL CONFORMING TO ASTM A181, GRADE I.

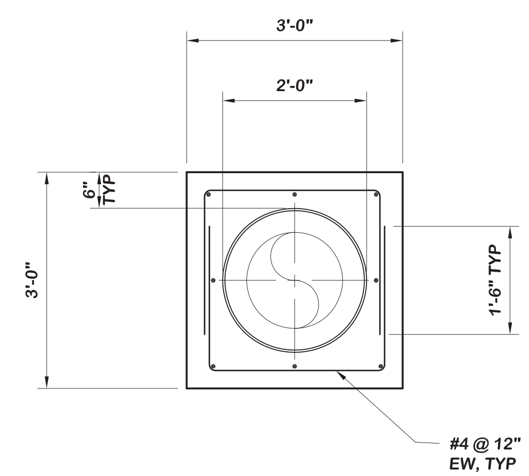
PUMP MOUNTING PLATE - PLAN VIEW

SECTION A / -
SCALE: 3/4" = 1'-0"

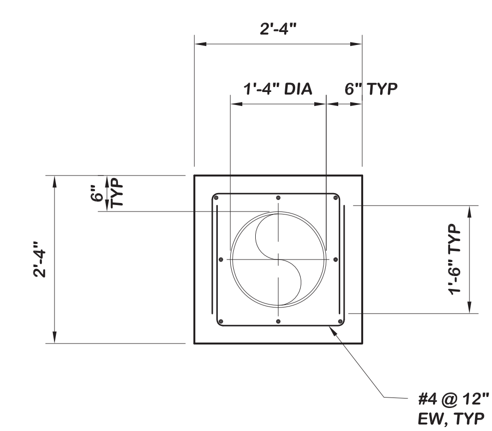


CONCRETE ENCASED PIPE

SECTION B / -
SCALE: 3/4" = 1'-0"



SECTION C / -
SCALE: 3/4" = 1'-0"



SECTION D / GFS-4
SCALE: 3/4" = 1'-0"

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ASSISTANT GENERAL MANAGER
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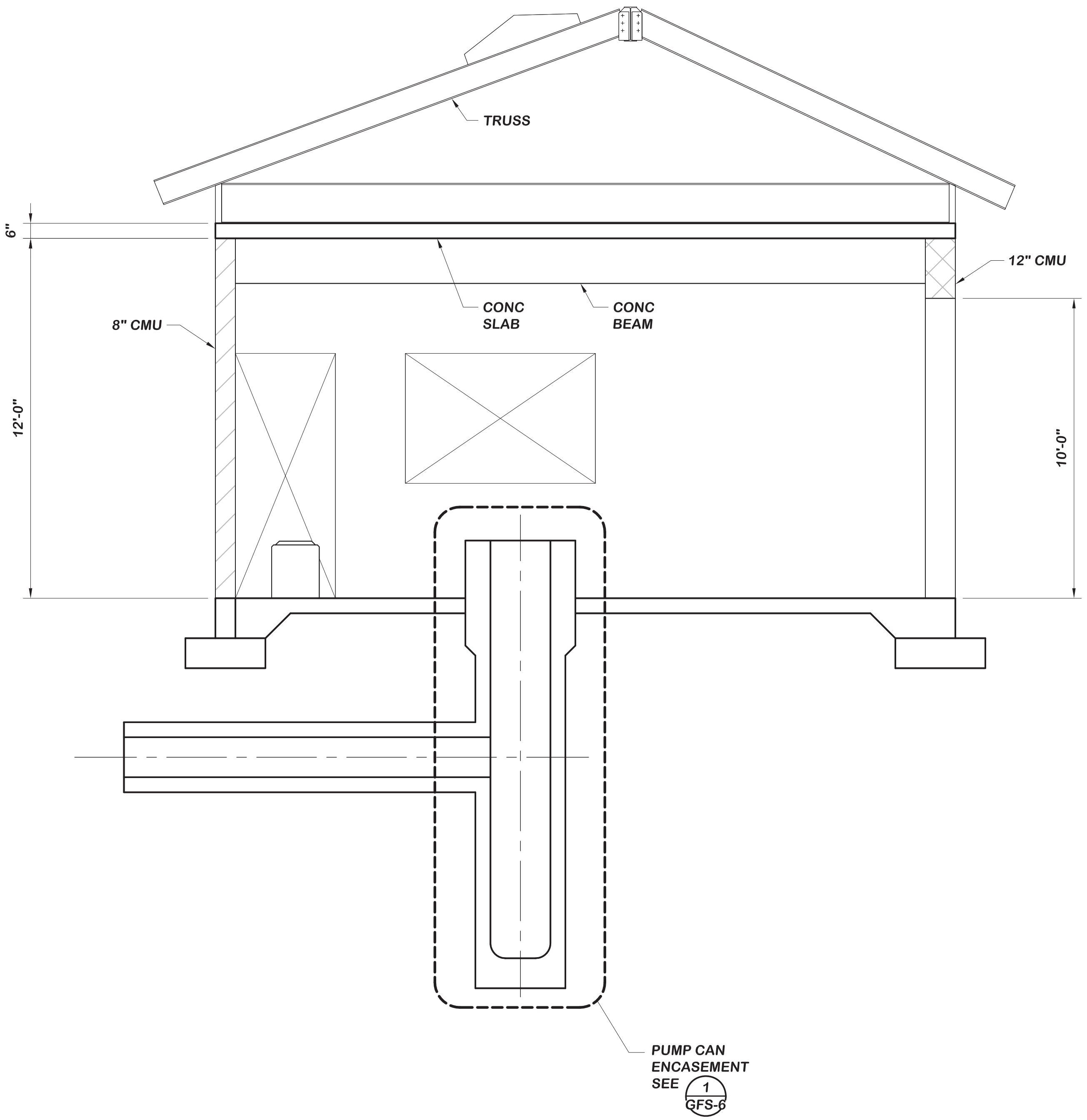
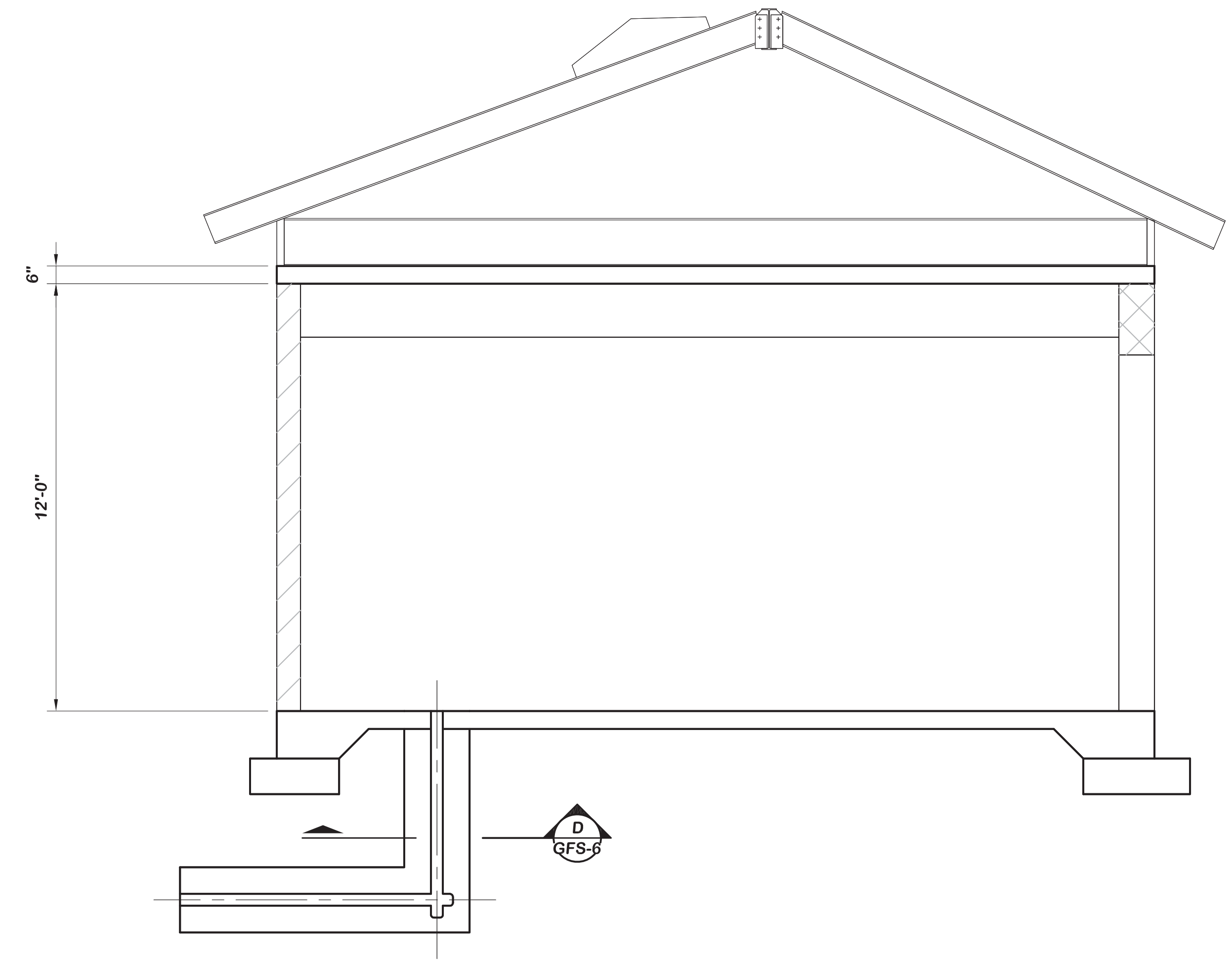
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

GHEEN FACILITY PUMP STATION
PUMP ENCASEMENT SECTIONS AND DETAILS

DRAWING NO. GFS-6
SHEET NO. XX OF XX
CLIENT JOB NO. 2744



SECTION A/GFS-2 A/GFS-3
SCALE: 3/8" = 1'-0"



SECTION B/GFS-2 B/GFS-3
SCALE: 3/8" = 1'-0"

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE N.T.S.
DATE 06/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY HIW
DRAWN BY DU
CHECKED BY SP

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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

GHEEN FACILITY PUMP STATION SECTIONS

DRAWING NO. GFS-4
SHEET NO. X OF XX
CLIENT JOB NO. 2744

CONDUIT PLAN	SINGLE LINE DIAGRAM	SCHEMATIC DIAGRAM	DESCRIPTION
	50A 3P		CIRCUIT BREAKER. UPPER NUMBER IS TRIP RATING. LOWER NUMBER IS NUMBER OF POLES
			THREE POSITION SWITCH. MAINTAINED CONTACT FUNCTION MAY VARY AS NOTED ON DIAGRAMS. CENTER POSITION IS OFF
			TWO POSITION SWITCH. MAINTAINED CONTACT FUNCTION MAY VARY AS NOTED ON DIAGRAMS
			MOMENTARY CONTACT PUSHBUTTON. FUNCTION MAY VARY AS NOTED ON DIAGRAMS
LOS		LOS	MOMENTARY CONTACT PUSHBUTTON WITH PROVISION FOR LOCKOUT.
			LOCKABLE DISCONNECT SWITCH. RATING AND DETAILS AS NOTED ON DRAWINGS.
ZS			LIMIT SWITCH. NORMALLY OPEN
ZS			LIMIT SWITCH. NORMALLY CLOSED
		NOTO	TIME DELAY RELAY CONTACT. OFF DELAY, NORMALLY OPEN, TIME OPEN
		NCTC	TIME DELAY RELAY CONTACT. OFF DELAY, NORMALLY CLOSED, TIME CLOSED
		NOTC	TIME DELAY RELAY CONTACT. ON DELAY, NORMALLY OPEN, TIME CLOSED
		NCTO	TIME DELAY RELAY CONTACT. ON DELAY, NORMALLY CLOSED, TIME OPEN
SOV			SOLENOID OPERATED VALVE
			MOTOR CONTROL CENTER DRAWOUT STABS
	2		MOTOR STARTER WITH THERMAL OVERLOADS. NUMBER INDICATES NEMA SIZE
		OL	MOTOR OVERLOAD CONTACT
2	2	2	MOTOR, NUMBER INDICATES HORSEPOWER
		R	INDICATING LIGHT, PUSH-TO-TEST. LETTER INDICATES COLOR. R=RED B=BLUE G=GREEN A=AMBER W=WHITE
		M	CONTACTOR OR RELAY COIL. LETTER OR NUMBER IS DESIGNATION
		M	NORMALLY CLOSED CONTACT. LETTER OR NUMBER IS DESIGNATION
		M	NORMALLY OPEN CONTACT. LETTER OR NUMBER IS DESIGNATION
		RTM	RUNNING TIME METER, NON-RESETTABLE
	20A	5A	FUSE, NUMBER INDICATES RATING
			CONTROL TRANSFORMER. RATING AS NOTED ON DRAWINGS OR AS REQUIRED BASED ON LOAD SERVED.
	KW		KILOWATT METER
PS			PRESSURE SWITCH. CONTACT ACTION AS NOTED ON DRAWINGS

CONDUIT PLAN	SINGLE LINE DIAGRAM	SCHEMATIC DIAGRAM	DESCRIPTION
T			POWER TRANSFORMER. RATINGS AS NOTED ON DRAWINGS
			DUPLEX RECEPTACLE. 20A, SPEC GRADE GROUNDING TYPE. UNLESS OTHERWISE NOTED ON DRAWINGS.
			TELEPHONE OUTLET
J			JUNCTION BOX OR CONDUIT FITTING AS NOTED OR REQUIRED. (SHOWN WITH CONDUIT TURNING UP)
LS			LEVEL SWITCH, CONTACT ACTION AS NOTED ON DRAWINGS
			CONTROL PANEL OR EQUIPMENT AS NOTED
FS			FLOW SWITCH, CONTACT ACTION AS NOTED ON DRAWINGS
$			FLUSH TOGGLE SWITCH, SINGLE POLE, SINGLE THROW
$3			FLUSH TOGGLE SWITCH, THREE WAY
			FLUORESCENT FIXTURE. SEE LIGHTING SCHEDULE.
			LIGHTING FIXTURE, WALL MOUNTED SEE LIGHTING SCHEDULE
PB			MH-MANHOLE PB-PULLBOX HH-HANDHOLE OR AS NOTED ON DRAWINGS
T			TELEPHONE CONDUIT. SIZE AS NOTED
G			GROUNDING GRID OR GROUNDING CONDUCTOR SIZE AS REQUIRED OR AS NOTED ON DRAWINGS
G			GROUND PIGTAIL. SIZE AS NOTED ON DRAWINGS
G			EXOTHERMIC GROUND CONNECTION
G			BOLTED GROUND CONNECTION
			CONDUIT BENDING UP
			CONDUIT BENDING DOWN
			UNDERGROUND OR CONCEALED CONDUIT, 1" MINIMUM
			EXPOSED CONDUIT, 3/4" MINIMUM.
PB1 1,3,5			HOMERUN CONDUIT WITH 3 CONDUCTORS, NEUTRAL AND GROUND, CIRCUITS 1,3,5 PANEL PB1, NO HASHMARKS INDICATE 2 CONDUCTORS AND GROUND
			DRIVEN GROUND ROD/TEST WELL 3/4" X 10' Cu CLAD STEEL
			PANELBOARD OR AS NOTED ON DRAWING
			LIQUIDTIGHT FLEXIBLE CONDUIT
XXX	XXX		CONDUIT NUMBER 'XXX', REFER TO CONDUIT SCHEDULE FOR DESCRIPTION

CONDUIT PLAN	SINGLE LINE DIAGRAM	SCHEMATIC DIAGRAM	DESCRIPTION
$M			MANUAL MOTOR STARTER
			GROUND
			HEATER, RATING AS NOTED ON DRAWING
			HORN OR AUDIBLE SIGNAL
∅	∅	∅	PHASE
			TERMINAL, INTERNAL WIRING
			TERMINAL, FIELD WIRING
DS			DOOR SWITCH
			CONDUIT STUB OUT
F XX	XX		DISCONNECT SWITCH, F = FUSED NF = NON-FUSED XX = AMP RATING
		T	TELEMETRY INPUT POINT
		P	PLC INPUT POINT AT RTU

STANDARD ABBREVIATIONS

A	AMPERES
AC	ALTERNATING CURRENT
AF	AMPERE FRAME
AFC	ABOVE FINISHED CONCRETE
AFF	ABOVE FINISHED FLOOR
AFG	ABOVE FINISHED GRADE
AT	AMPERE TRIP
ATS	AUTOMATIC TRANSFER SWITCH
AUX	AUXILIARY
AUTO	AUTOMATIC
AWG	AMERICAN WIRE GAUGE
BC	BARE COPPER
BD	BOARD
BKR	BREAKER
C	CONDUIT
CAB	CABINET
CB	CIRCUIT BREAKER
CKT	CIRCUIT
CLG	CEILING
C.O.	CONDUIT ONLY
COMPT	COMPARTMENT
COND	CONDUCTOR
CONT	CONTROL
CONTD	CONTINUED
CPT	CONTROL POWER TRANSFORMER
CP	CONTROL PANEL
CT	CURRENT TRANSFORMER
CU	COPPER
CR	CONTROL RELAY
DC	DIRECT CURRENT
DISC	DISCONNECT
DISC SW	DISCONNECT SWITCH
DPDT	DOUBLE POLE DOUBLE THROW
DPST	DOUBLE POLE SINGLE THROW
DWG	DRAWING
DS	DOOR SWITCH
EL,ELEV	ELEVATION
EMT	ELECTRICAL METALLIC TUBING
EO	ELECTRICALLY OPERATED
EXIST	EXISTING
FBO	FURNISHED BY OWNER
FDR	FEEDER
FIN	FINISHED
FLA	FULL LOAD AMPS
FLEX	FLEXIBLE
FM	FLOW METER
FS	FLOW SWITCH
FT OR '	FEET OR FOOT
FT	FLOW TRANSMITTER
FUT	FUTURE
FVNR	FULL VOLTAGE NON REVERSING
GALV	GALVANIZED
GD	GAS DETECTORS
GFI	GROUND FAULT INTERRUPTER
GFP	GROUND FAULT PROTECTION
GND OR G	GROUND
HH	HANDHOLE
HOA	HAND/OFF/AUTO
HTR	HEATER
IC	INTERRUPTING CURRENT
IN OR "	INCHES OR INCH
IND	INDICATING
INST	INSTANTANEOUS
INSTR	INSTRUMENT
INTLK	INTERLOCK
JB OR J	JUNCTION BOX, CONDULET OR FITTING AS REQUIRED BY NEC. UNLESS OTHERWISE NOTED
KW	KILOWATTS
LCL	LONG CONTINUOUS LOAD
LCP	LOCAL CONTROL PANEL
LEV	LEVEL
LIM	LIMIT
LR	LOCAL/REMOTE
LOS	LOCKOUT STOP STATION
LS	LEVEL OR LIMIT SWITCH
LSIG	LONG TIME, SHORT TIME, INSTANTANEOUS AND GROUND FAULT ADJUSTMENTS
LT	LIGHT
LTG	LIGHTING
LV	LOW VOLTAGE
MA	MILLIAMPERE
MAINT	MAINTAINED
MAN	MANUAL
MAX	MAXIMUM
MC	MAINTAINED CONTACT
MCC	MOTOR CONTROL CENTER
MCM	THOUSAND CIRCULAR MILS
MCP	MOTOR CIRCUIT PROTECTOR
MH	MANHOLE
MIN	MINIMUM OR MINUTE
MLO	MAIN LUGS ONLY
MOV	MOTOR OPERATED VALVE ACTUATOR
MSB	MAIN SWITCHBOARD
MTG	MOUNTING
MTR	MOTOR
N	NEUTRAL
NA	NON-AUTOMATIC
NC	NORMALLY CLOSED
NCIO	NORMALLY CLOSED, INSTANTANEOUS OPEN
NCTC	NORMALLY CLOSED, TIME CLOSE
NCTO	NORMALLY CLOSE, TIME OPEN
NEC	NATIONAL ELECTRIC CODE
NIC	NOT IN CONTRACT
No	NUMBER
NO	NORMALLY OPEN
NOIC	NORMALLY OPEN, INSTANTANEOUS CLOSE
NOTC	NORMALLY OPEN, TIME CLOSE
NOTO	NORMALLY OPEN, TIME OPEN
NP	NAMEPLATE
NTS	NOT TO SCALE
OL	OVERLOAD
OTT	OVERTEMP SWITCH
PB	PUSHBUTTON
PB	PULLBOX
PC	PHOTOCELL
PCV	PUMP CONTROL VALVE
PMR	POWER MONITOR RELAY
PNL	PANEL
POS	POSITION
PR	PAIR
PRI	PRIMARY
PS	PRESSURE SWITCH
PT	POTENTIAL TRANSFORMER
PVC	POLYVINYL CHLORIDE
PVC/RGS	PVC JACKETED RIGID GALVANIZED STEEL CONDUIT
PW	PART WINDING
RECEP	RECEPTACLE
RCP	REMOTE CONTROL PANEL
RGS	RIGID GALVANIZED STEEL CONDUIT
RTU	REMOTE TERMINAL UNIT
RVAT	REDUCED VOLTAGE AUTO TRANSFORMER
RVYD	REDUCED VOLTAGE WYE DELTA
SCE	SOUTHERN CALIFORNIA EDISON
SEC	SECONDARY
SEL	SELECTOR
SP	SPARE
SPEC	SPECIFICATION
SPDT	SINGLE POLE DOUBLE THROW
SPST	SINGLE POLE SINGLE THROW
SS	STAINLESS STEEL
SSRV	SOLID STATE REDUCED VOLTAGE STARTER
ST	SHUNT TRIP
STA	STATION
STL	STEEL
STP	SHIELDED TWISTED PAIR
STR	STARTER
STT	SHIELDED TWISTED TRIPLET
SV	SOLENOID VALVE
SW	SWITCH
SWBD	SWITCHBOARD
TB	TERMINAL BOX
TEL	TELEPHONE
TEMP	TEMPERATURE
TERM	TERMINAL
TM	TELEMETRY
TS	TEMPERATURE SWITCH
TS2W	TWO SPEED TWO WINDING
TVSS	TRANSIENT VOLTAGE SURGE SUPPRESSOR
TW/SH	TWISTED SHIELDED
TYP	TYPICAL
UG	UNDERGROUND
UON	UNLESS OTHERWISE NOTED
V	VOLTS
W	WATTS
W/	WITH
W/O	WITHOUT
WP	WEATHERPROOF
XFMR	TRANSFORMER
XP	EXPLOSION PROOF
ZS	POSITION SWITCH OR LIMIT SWITCH
3W	THREE WIRE
4W	FOUR WIRE

MPA MORAES/PHAM & ASSOCIATES
CONSULTING ELECTRICAL ENGINEERS
2131 PALOMAR AIRPORT RD., STE. 120
CARLSBAD CA. 92011
(760) 431-7177

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE NONE
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY TAA
DRAWN BY AH
CHECKED BY TAA

Infrastructure ENGINEERING CORPORATION
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FPUD Fallbrook Public Utility District
990 E. MISSION RD
FALLBROOK, CA 92028

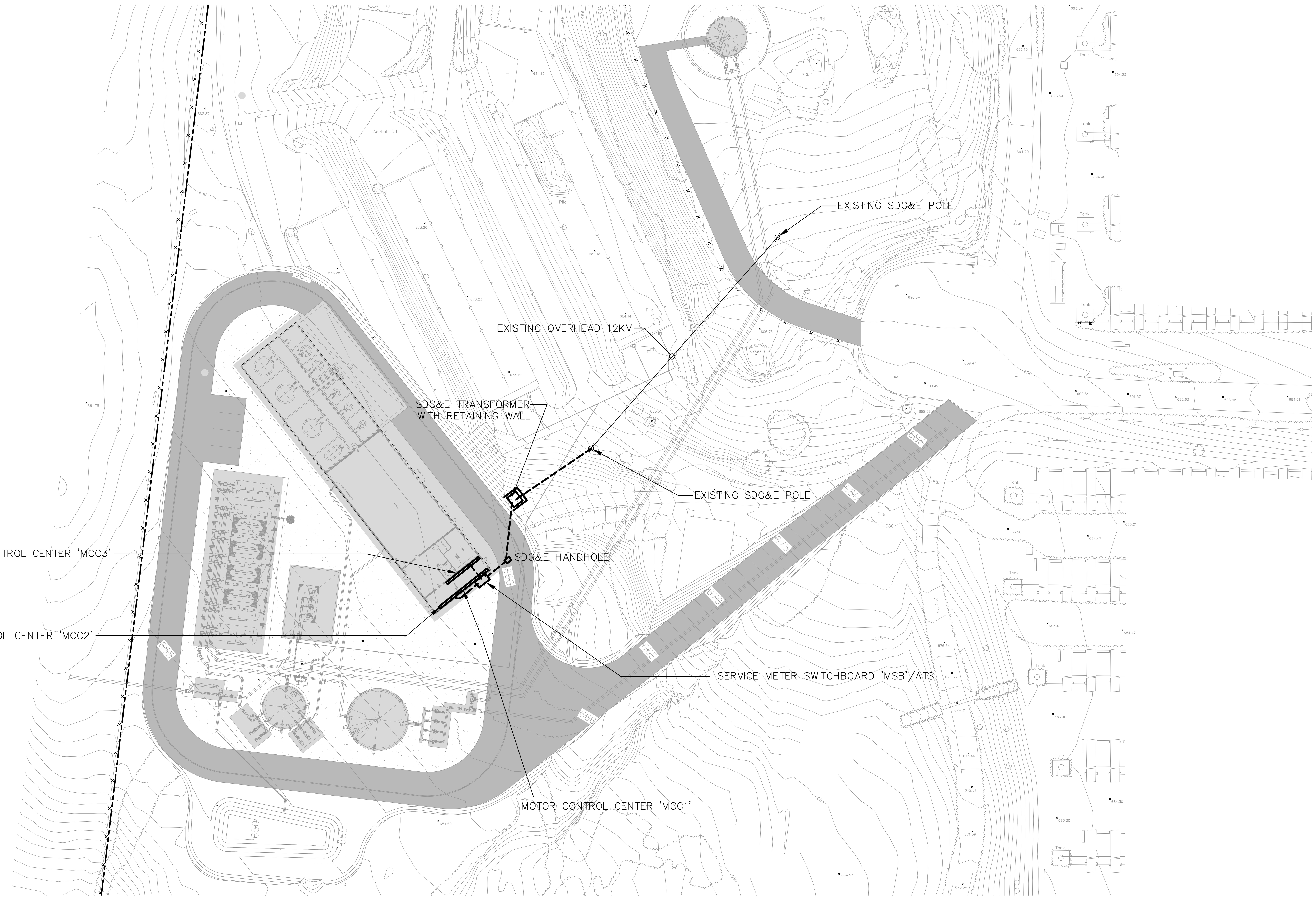
APPROVED BY:

JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

STANDARD ELECTRICAL SYMBOLS AND ABBREVIATIONS

DRAWING NO. E-1
SHEET NO. X OF XX
CLIENT JOB NO. 2744



ELECTRICAL SITE PLAN

SCALE: 1" = 40'-0"

GRAPHIC SCALE

0 40' 80'

SCALE: 1" = 40'

30% SUBMITTAL

MPA MORAES/PHAM & ASSOCIATES
CONSULTING ELECTRICAL ENGINEERS
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CARLSBAD CA. 92011 (760) 431-7177

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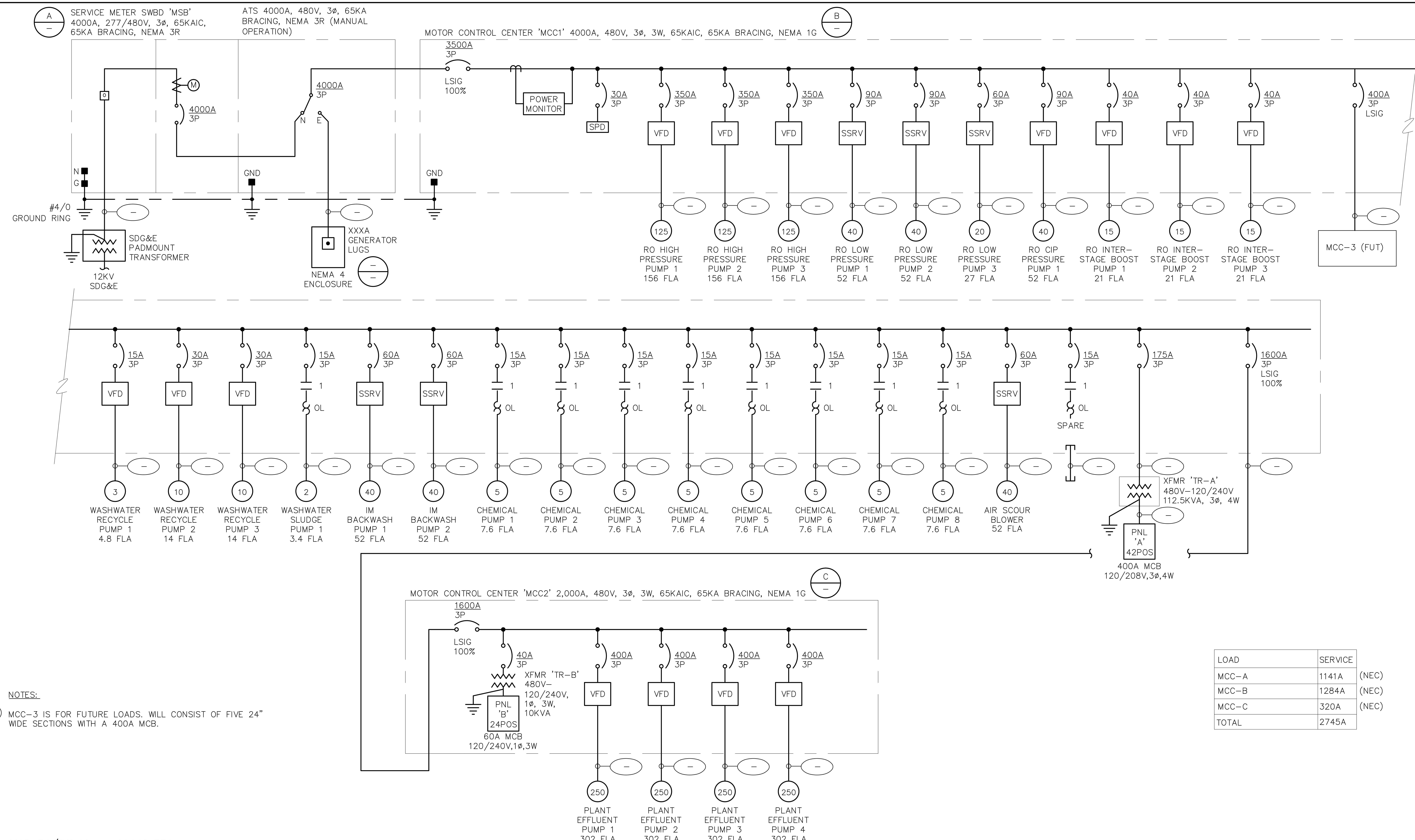
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

PLANT ELECTRICAL SITE PLAN

DRAWING NO. E-2
SHEET NO. X OF XX
CLIENT JOB NO. 2744



NOTES:

1. MCC-3 IS FOR FUTURE LOADS. WILL CONSIST OF FIVE 24" WIDE SECTIONS WITH A 400A MCB.

LOAD	SERVICE	
MCC-A	1141A	(NEC)
MCC-B	1284A	(NEC)
MCC-C	320A	(NEC)
TOTAL	2745A	

SINGLE LINE DIAGRAM – WTP

30% SUBMITTAL

MORAES/PHAM & ASSOCIATES
CONSULTING ELECTRICAL ENGINEERS
2131 PALOMAR AIRPORT RD., STE. 120
CARLSBAD CA. 92011
(760) 431-7177

NO.	DESCRIPTION	DATE	APPROVED

SCALE NONE
DATE 10/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY TAA
DRAWN BY AH
CHECKED BY TAA

Infrastructure ENGINEERING CORPORATION
14271 Danielson Street
Poway, California 92064
T 858.413.2400 F 858.413.2440
www.iecorporation.com

DATE

FPUD Fallbrook Public Utility District
990 E. MISSION RD
FALLBROOK, CA 92028

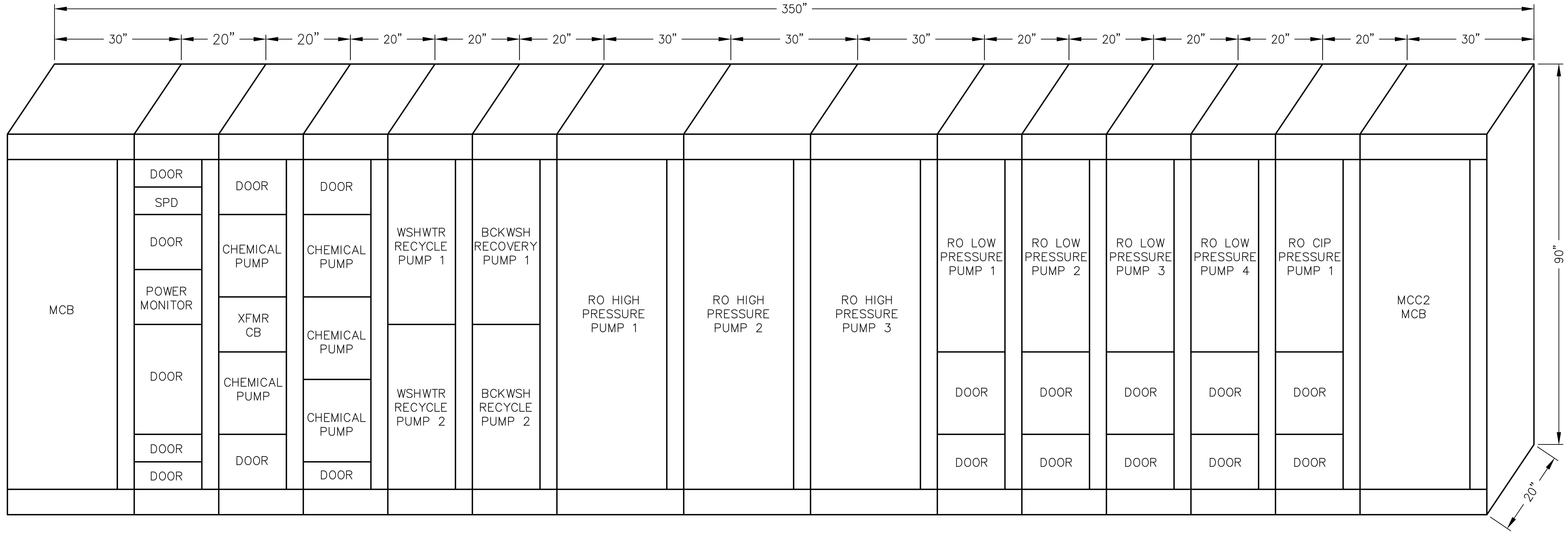
APPROVED BY:

JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

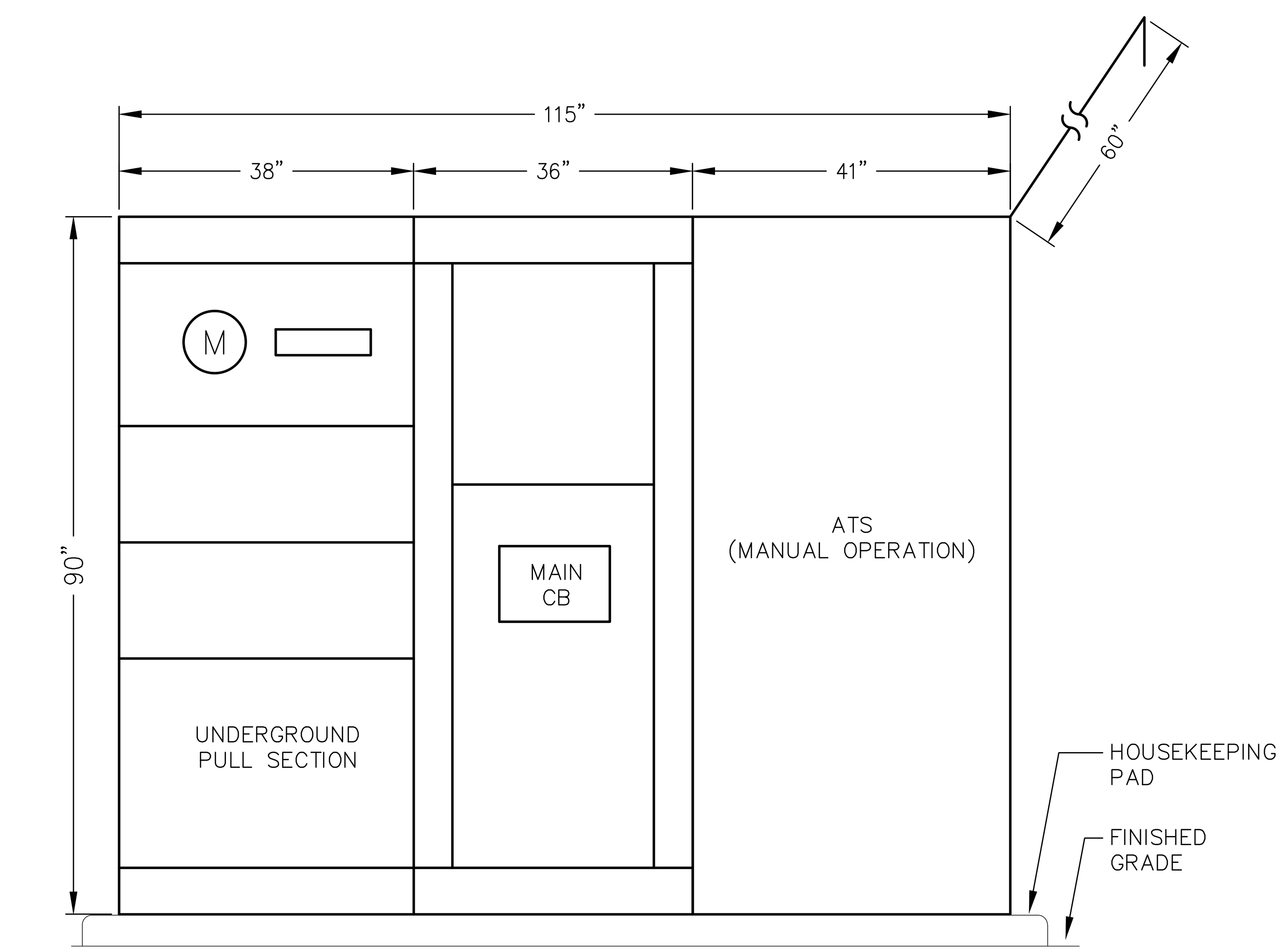
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

PLANT SINGLE LINE DIAGRAM

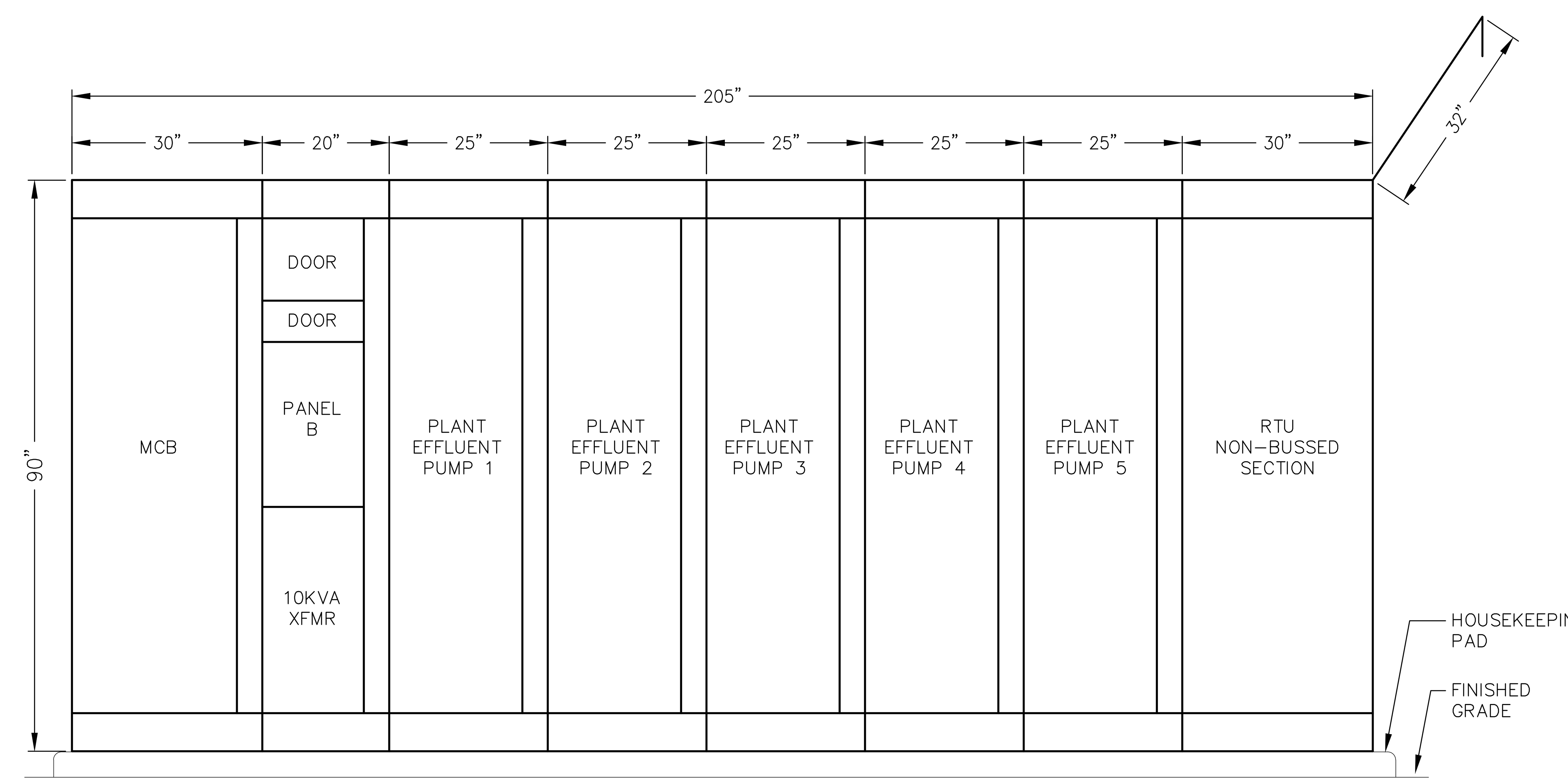
DRAWING NO. E-3
SHEET NO. X OF XX
CLIENT JOB NO. 2744



B – MCC1 ELEVATION (NEMA 1G) – WTP
NOT TO SCALE



A – SERVICE METER SWBD 'MSB' (NEMA 3R) – WTP
NOT TO SCALE



C – MCC2 ELEVATION (NEMA 3R) – WTP
NOT TO SCALE

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE NONE
DATE 06/2015
PROJECT NO. 112.FPUD.0002
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DATE

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ASSISTANT GENERAL MANAGER
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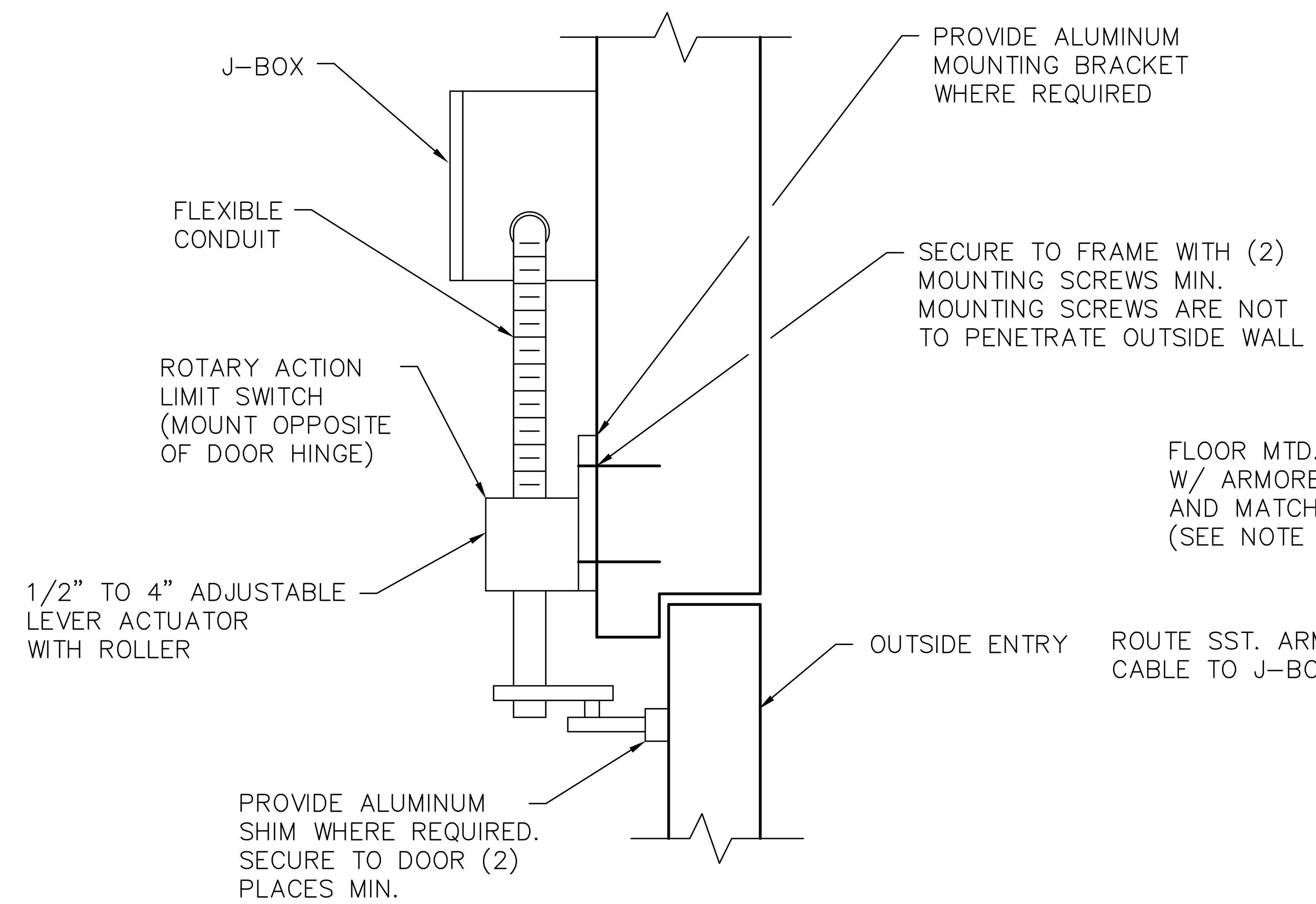
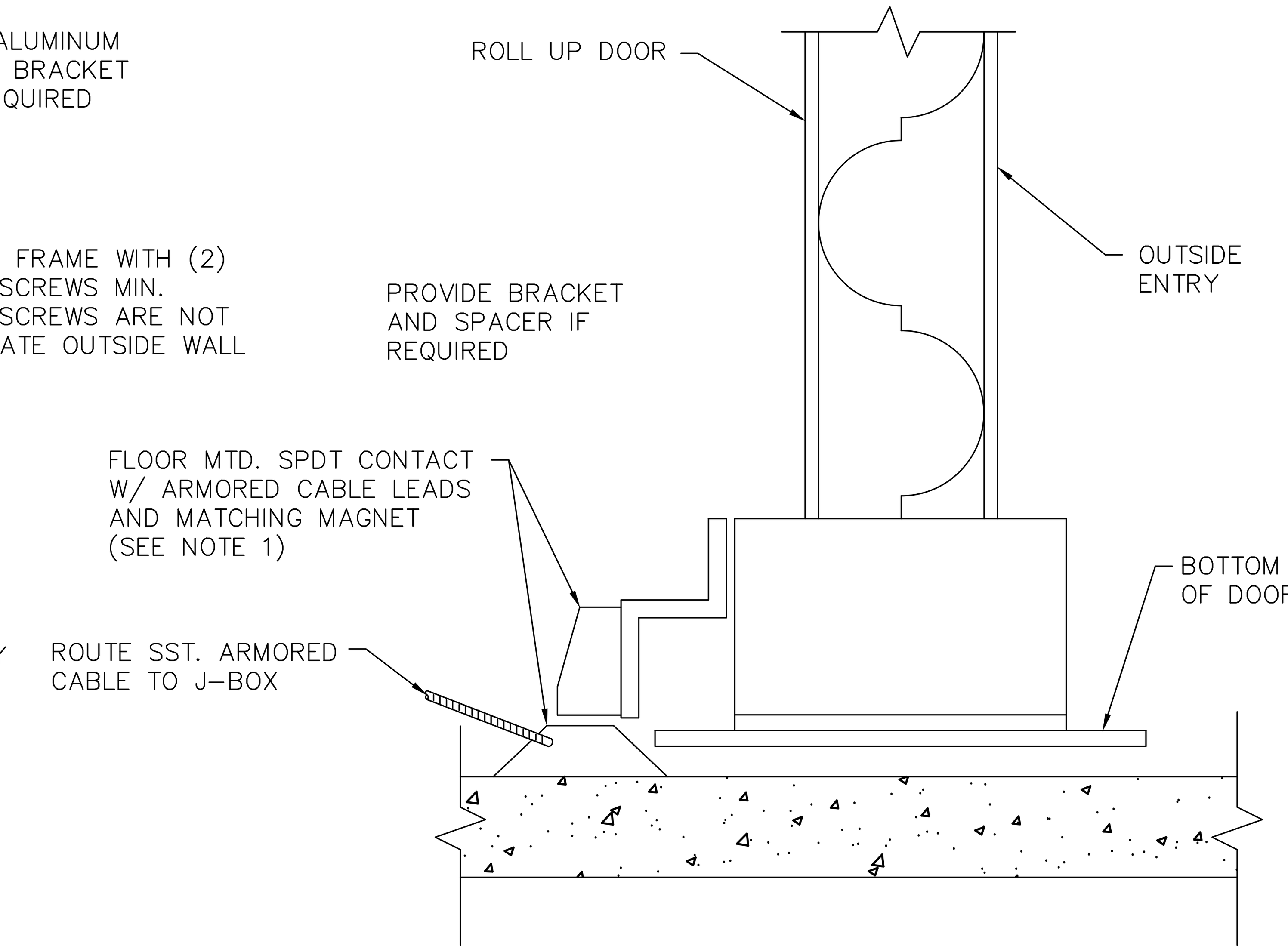
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES
PLANT ELEVATIONS

DRAWING NO. E–4
SHEET NO. X OF XX
CLIENT JOB NO. 2744



ENTRY DOOR

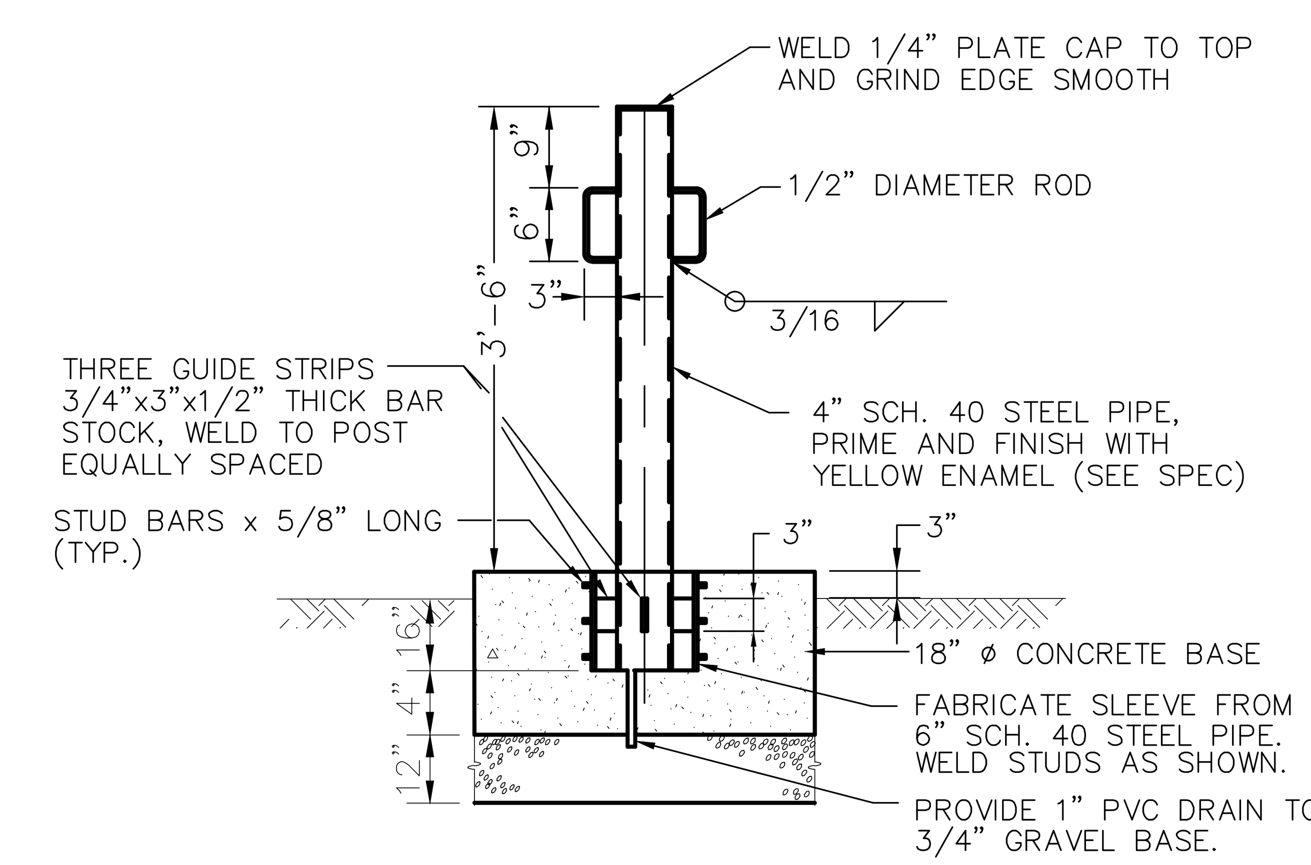
NOTE:
ACTUTATE SWITCH WHEN DOOR OPENS AT 15° MAX.



ROLL UP DOOR

NOTE 1:
SWITCH ACTIVATES WHEN DOOR OPENS. PROVIDE PROPER GAP PER MANUFACTURER'S SPECIFICATIONS.

DOOR ENTRY SWITCHES
N.T.S.



REMOVABLE GUARD POST DETAIL
N.T.S.

30% SUBMITTAL

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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

DETAILS 1

DRAWING NO. E-5
SHEET NO. X OF XX
CLIENT JOB NO. 2744

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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

DETAILS 2

DRAWING NO. E-6
SHEET NO. X OF XX
CLIENT JOB NO. 2744

CONDUIT		FROM	TO	CABLE			VOLTAGE		REMARKS
NO.	SIZE			QTY.	SIZE	GND. *			
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*–ONE GROUND CONDUCTOR PER CONDUIT

CONDUIT		FROM	TO	CABLE			VOLTAGE		REMARKS
NO.	SIZE			QTY.	SIZE	GND. *			
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ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

SCHEDULES 1

DRAWING NO. E-7
SHEET NO. X OF XX
CLIENT JOB NO. 2744

CONDUIT		FROM	TO	CABLE			VOLTAGE		REMARKS	CONDUIT		FROM	TO	CABLE			VOLTAGE		REMARKS
NO.	SIZE			QTY.	SIZE	GND. *				NO.	SIZE			QTY.	SIZE	GND. *			
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*–ONE GROUND CONDUCTOR PER CONDUIT

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(760) 431-7177

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ASSISTANT GENERAL MANAGER

DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

SCHEDULES 2

DRAWING NO. E–8
SHEET NO. X OF XX
CLIENT JOB NO. 2744

CONDUIT		FROM	TO	CABLE			VOLTAGE		REMARKS
NO.	SIZE			QTY.	SIZE	GND. *			
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*–ONE GROUND CONDUCTOR PER CONDUIT

CONDUIT		FROM	TO	CABLE			VOLTAGE		REMARKS
NO.	SIZE			QTY.	SIZE	GND. *			
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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

SCHEDULES 3

DRAWING NO. E-9
SHEET NO. X OF XX
CLIENT JOB NO. 2744

CONDUIT		FROM	TO	CABLE			VOLTAGE		REMARKS
NO.	SIZE			QTY.	SIZE	GND. *			
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*–ONE GROUND CONDUCTOR PER CONDUIT

PANEL 'A'

MOUNTING SURFACE — 120/208V VOLT — 3ø PHASE — 4W WIRE — MAIN 400A — 10,000 A.I.C. SYM. — BUS 400A

LOCATION	WATTAGE ØA	WATTAGE ØB	WATTAGE ØC	REC	LTG	POLE	BKR	CKT NO.	ØA ØB ØC	CKT NO.	BKR	POLE	LTG	REC	WATTAGE ØA	WATTAGE ØB	WATTAGE ØC	LOCATION
								1		2								
								3		4								
								5		6								
								7		8								
								9		10								
								11		12								
								13		14								
								15		16								
								17		18								
								19		20								
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								23		24								
								25		26								
								27		28								
								29		30								
								31		32								
								33		34								
								35		36								
								37		38								
								39		40								
								41		42								
									WATTS/LINE									

ØA= ØB= ØC=

TOTAL WATTS= AMPS/LINE= LCL AMPS=

LIGHTING FIXTURE SCHEDULE

SYMBOL	TAG	DESCRIPTION	FIXTURE WATTS / VOLTAGE	LAMP TYPE / NO. OF LAMPS / WATTS	MOUNTING	MANUFACTURER / CATALOG NO.
	A					
	B					
	C					
	D					
	E					

PANEL 'B'

MOUNTING MCC — 120/240V VOLT — 1ø PHASE — 3W WIRE — MAIN 60 — 10,000 A.I.C. SYM. — BUS 100

LOCATION	WATTAGE ØA	WATTAGE ØB	REC	LTG	POLE	BKR	CKT NO.	ØA ØB	CKT NO.	BKR	POLE	LTG	REC	WATTAGE ØA	WATTAGE ØB	LOCATION
							1		2							
							3		4							
							5		6							
							7		8							
							9		10							
							11		12							
							13		14							
							15		16							
							17		18							
							19		20							
							21		22							
							23		24							
								WATTS/LINE								

ØA= ØB=

TOTAL WATTS= AMPS/LINE= LCL AMPS=

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APPROVED BY:

JACK R. BEBEE, P.E.
ASSISTANT GENERAL MANAGER
DATE

SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

SCHEDULES 4

DRAWING NO. E-10
SHEET NO. X OF XX
CLIENT JOB NO. 2744

30% SUBMITTAL

NO.	DESCRIPTION	DATE	APPROVED

SCALE AS SHOWN
DATE 06/2015
PROJECT NO. 112.FPUD.0002
DESIGNED BY TAA
DRAWN BY AH
CHECKED BY TAA

Infrastructure
ENGINEERING CORPORATION
14271 Danielson Street
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T 858.413.2400 F 858.413.2440
www.iecorporation.com

DATE

FPUD
Fallbrook Public Utility District
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FALLBROOK, CA 92028

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ASSISTANT GENERAL MANAGER
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SANTA MARGARITA CONJUNCTIVE USE
PROJECT FACILITIES

SITE LIGHTING PLAN

DRAWING NO. E-11
SHEET NO. X OF XX
CLIENT JOB NO. 2744

30% SUBMITTAL

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SANTA MARGARITA CONJUNCTIVE USE
PROJECT FACILITIES

OPERATIONS BLDG LIGHTING PLAN

DRAWING NO. E-12
SHEET NO. X OF XX
CLIENT JOB NO. 2744

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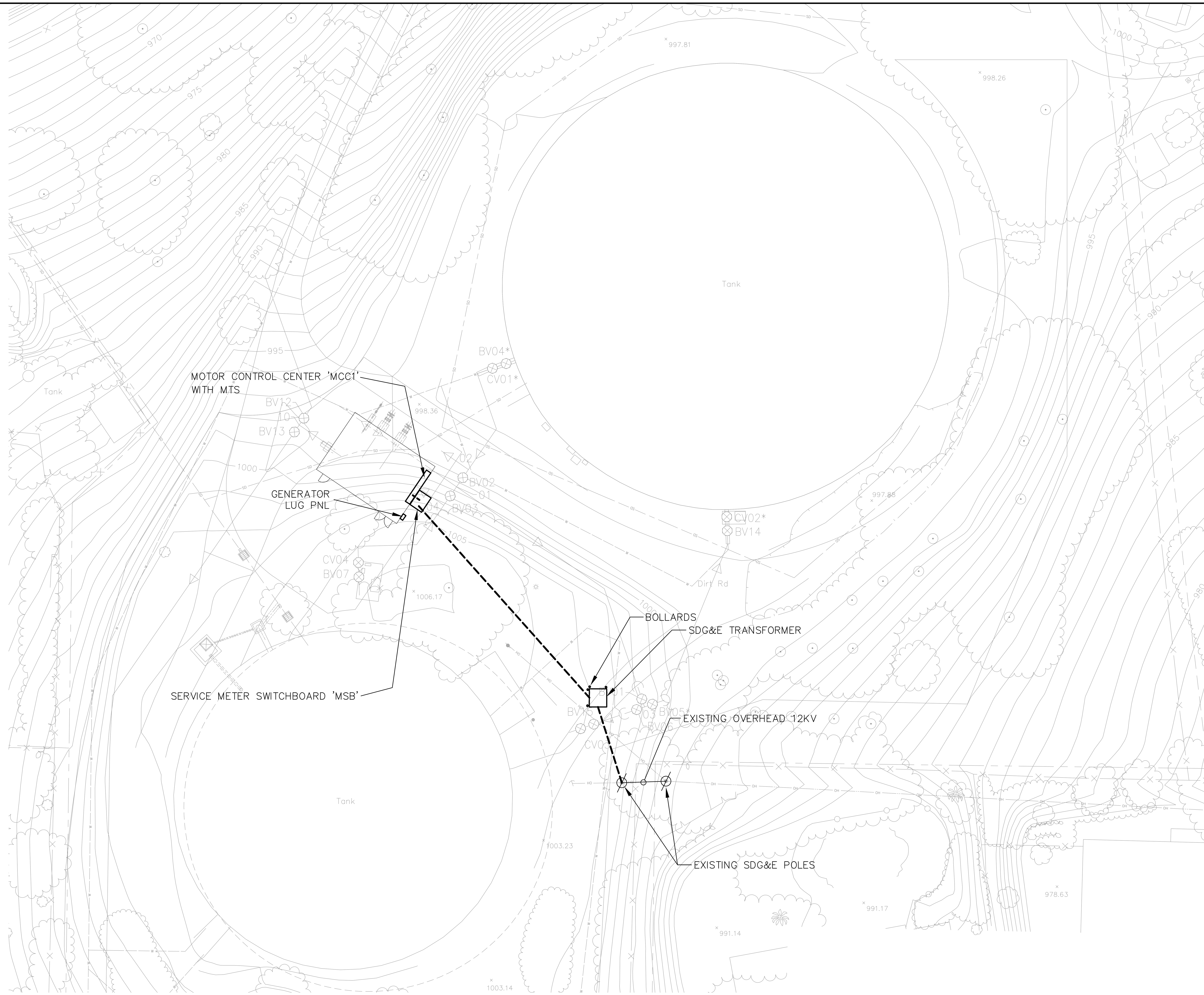
SANTA MARGARITA CONJUNCTIVE USE
PROJECT FACILITIES

OPERATIONS BLDG POWER AND SIGNAL PLAN

DRAWING NO. E-13
SHEET NO. X OF XX
CLIENT JOB NO. 2744



ELECTRICAL SITE PLAN
SCALE: 1" = 20'–0"

GRAPHIC SCALE
0 20' 40'
SCALE: 1" = 20'

30% SUBMITTAL

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2131 PALOMAR AIRPORT RD., STE. 120
CARLSBAD CA. 92011
(760) 431-7177

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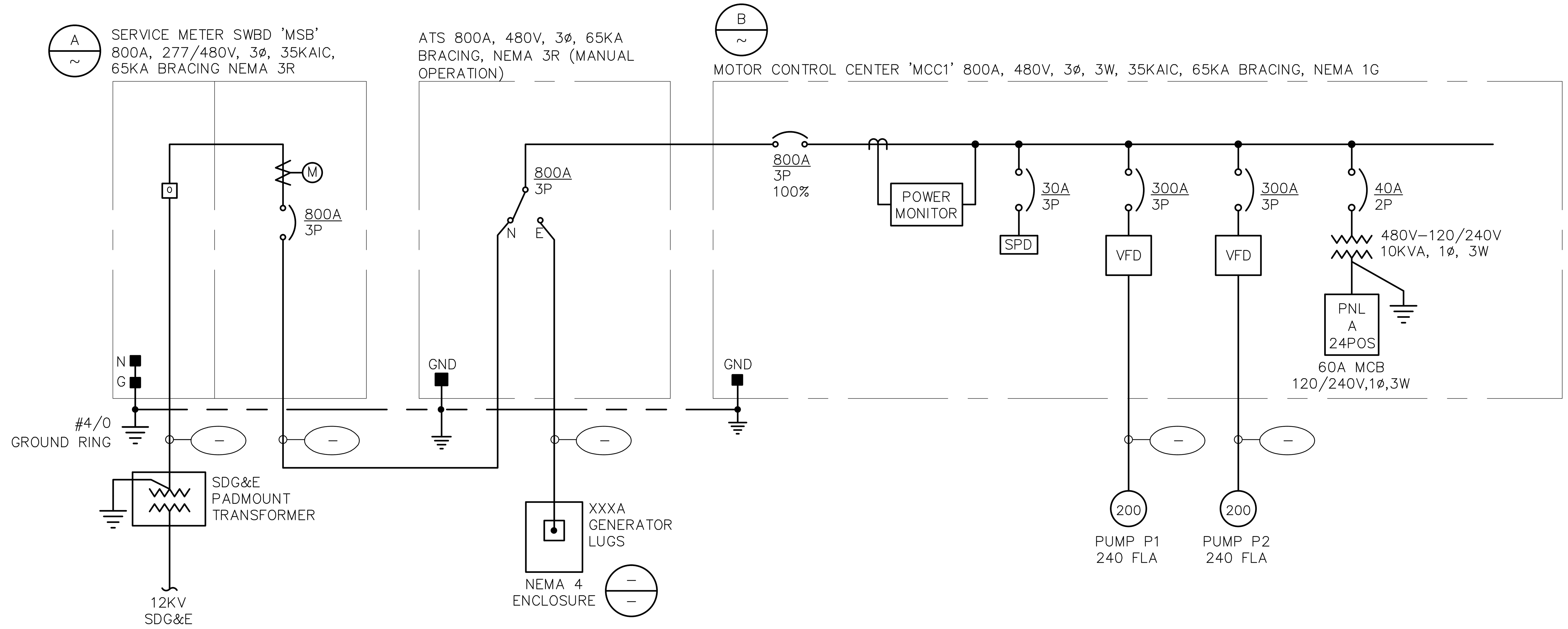
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

GHEEN ELECTRICAL SITE PLAN

DRAWING NO. GFE-1
SHEET NO. X OF XX
CLIENT JOB NO. 2744

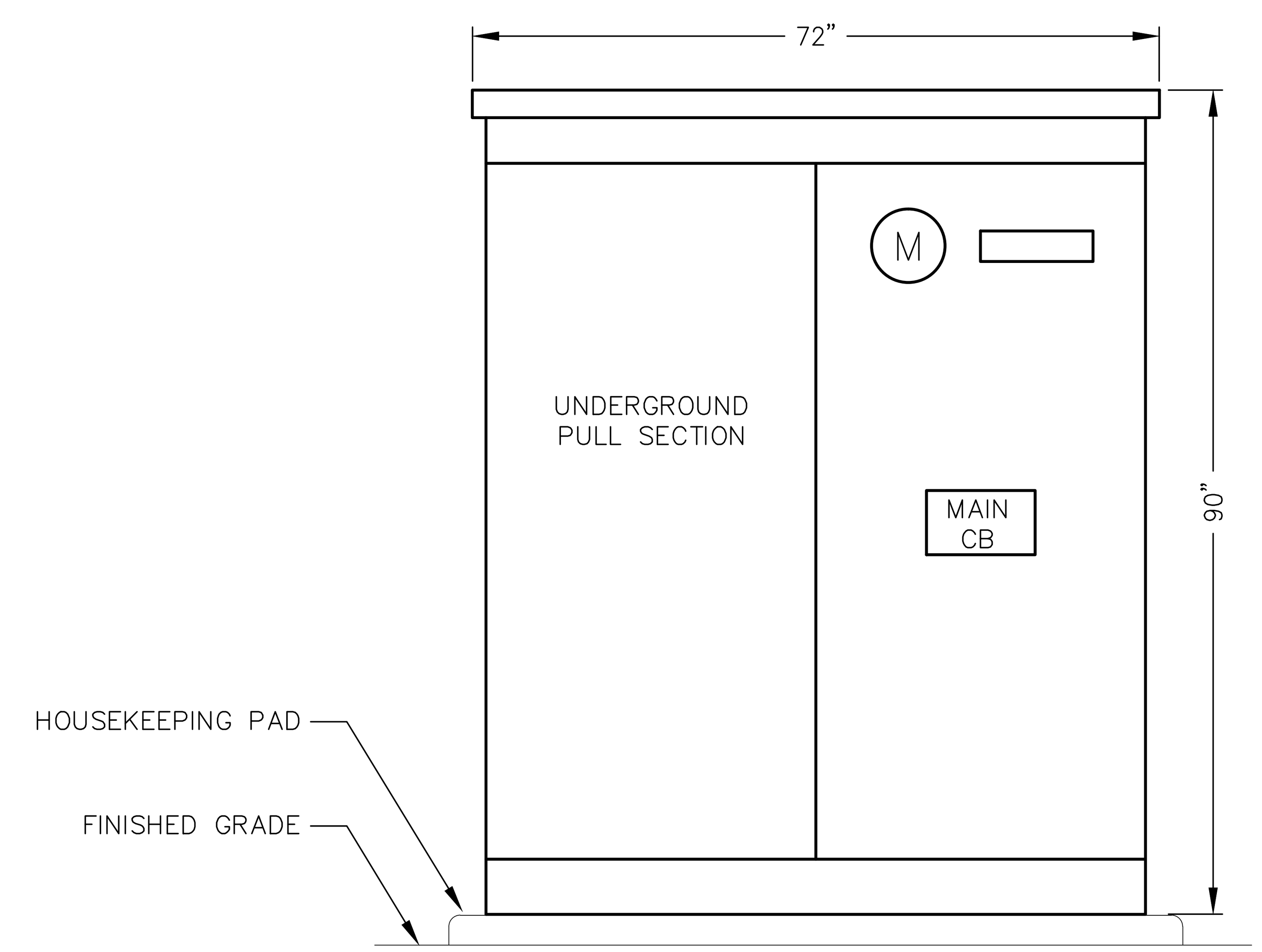


LOAD CALC (CONNECTED)	
1 @ 200HP	240A
1 @ 200HP	240A
PANEL A 10KVA	20A
25% LARGEST MOTOR	60A
	560A @ 480V, 3ø

NOTES:

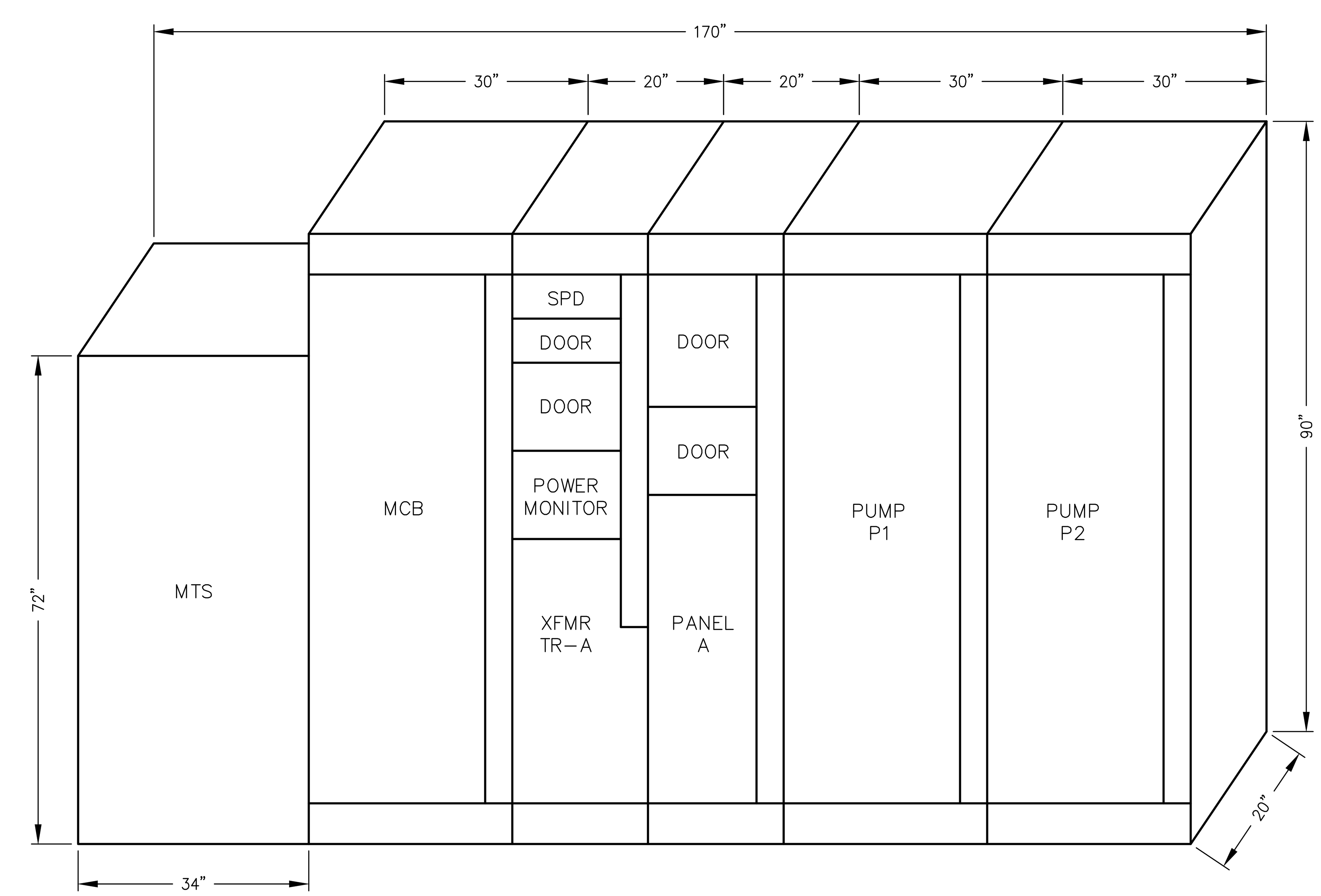
1. X.

SINGLE LINE DIAGRAM – GHEEN RESERVOIR



A – SERVICE METER SWBD 'MSB' (NEMA 3R) – GHEEN RESERVOIR

NOT TO SCALE



B – MCC1 ELEVATION (NEMA 1G) – GHEEN RESERVOIR

NOT TO SCALE

30% SUBMITTAL

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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

GHEEN SINGLE LINE DIAGRAM AND ELEVATIONS

DRAWING NO. GFE-2
SHEET NO. X OF XX
CLIENT JOB NO. 2744

	PRIMARY LOCATION (b)NORMALLY ACCESSIBLE TO OPERATOR	FIELD MOUNT	AUXILIARY LOCATION (b)NORMALLY ACCESSIBLE TO OPERATOR
DISCRETE INSTRUMENTS	LCP		LCP
SHARED DISPLAY, SHARED CONTROL	LCP		LCP
COMPUTER FUNCTION	LCP		LCP
PROGRAMMABLE LOGIC CONTROL	LCP		LCP

DESIGNATIONS SUCH AS 100 (LOCAL CONTROL BOARD NO. 100), 200 (LOCAL CONTROL BOARD NO.200), ETC., ARE USED WHEN NECESSARY TO SPECIFY INSTRUMENT OR FUNCTION LOCATION.

NORMALLY INACCESSIBLE OR BEHIND-THE-PANEL DEVICES OR FUNCTIONS ARE DEPICTED BY USING THE SAME SYMBOLS BUT WITH DASHED HORIZONTAL BARS, I.E.

SINGLE INSTRUMENT OR OTHER COMPONENT HAVING MULTIPLE FUNCTIONS

(XXX) SOFTWARE OR LOGIC RESIDENT IN DISTRIBUTED CONTROL SYSTEM (DCS) AT PROGRAMMABLE LOGIC CONTROLLER (PLC) XXX. SEE ASSOCIATED LOGIC DIAGRAMS.

(XXX) PANEL MOUNTED PILOT LIGHT WITH PANEL NUMBER DESIGNATION(i.e. XXX = 100, 200, ETC.).

FY * INSTRUMENT PANEL MOUNTED WITH COMPUTING OR CONVERTING FUNCTION

CONVERT */*

E – VOLTAGE
I – CURRENT
P – PNEUMATIC
A – ANALOG
B – BINARY
H – HYDRAULIC
O – ELECTROMAGNETIC, SONIC
R – RESISTANCE (ELECT.)
D – DIGITAL
PF – PULSE FREQUENCY

COMPUTE *

SUMMING	Σ	AVERAGING	Σ/n
SUBTRACTOR	–	RATIO	1:1
MULTIPLYING	X	DIFFERENCE	Δ
DIVIDING	÷	HIGH SELECTING	>
ROOT EXTRACTION	√	LOW SELECTING	<
PROPORTIONAL	P	INTEGRAL	I
DERIVATIVE	R		

ISA FUNCTION IDENTIFICATION TABLE

	FIRST-LETTER		SUCCEEDING-LETTERS		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER, COMBUSTION				
C	CONDUCTIVITY			CONTROL	CLOSED
D	DENSITY	DIFFERENTIAL			
E	VOLTAGE		SENSOR (PRIMARY ELEMENT)		
F	FLOW RATE	RATIO (FRACTION)			
G	GAGE		GLASS, VIEWING DEVICE		
H	HAND				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT		LOW
M	MOTOR, MOISTURE	MOMENTARY			MIDDLE, INTERMEDIATE
N	TORQUE		ISOLATE	ISOLATOR	
O	USER SPECIFIED		ORIFICE, RESTRICTION		OPEN
P	PRESSURE, VACUUM		POINT (TEST) CONNECTION		
Q	QUANTITY	INTEGRATE, TOTALIZE			
R	RADIATION		RECORD		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER, LOUVER	
W	WEIGHT, FORCE		WELL		
X	RUN	X AXIS		COMPUTE, CONVERT	
Y	EVENT, STATE OR PRESENCE	Y AXIS		DRIVER, ACTUATOR, FINAL	
Z	POSITION, DIMENSION	Z AXIS		CONTROL ELEMENT	

TYPICAL FORMAT:

TIC–1	–	INSTRUMENT IDENTIFICATION OR TAG NUMBER
TIC	–	FUNCTIONAL IDENTIFICATION
T	–	FIRST–LETTER
IC	–	SUCCEEDING–LETTER(S)
1	–	LOOP NUMBER

FIRST LETTER — SUCCEEDING LETTER — SUCCEEDING LETTER — TIC 1 — INSTRUMENT LOOP NUMBER — (INSTRUMENT SYMBOLS)

EXPANDED FORMAT:

10–PAH–1A — TAG NUMBER
10 — OPTIONAL PREFIX
A — OPTIONAL SUFFIX

I UNDEFINED INTERLOCK DEVICE

(XXX) DESIGNATIONS OF CONTROL FUNCTIONS ASSOCIATED INSTRUMENT OR OTHER COMPONENTS.

AC –	AUTO/CLOSE	OO –	ON/OFF
AHC –	AUTO/HOLD/CLOSE	OCA –	OPEN/CLOSE/AUTO
AM –	AUTO/MANUAL	OSC –	OPEN/STOP/CLOSED
C –	CLOSE	POT –	POTENTIOMETER
DEV –	DEVIATION	RST –	RESET
ES –	EMERGENCY STOP	RL –	RAISE/LOWER
HOA –	HAND/OFF/AUTO	RSL –	RAISE/STOP/LOWER
HOR –	HAND/OFF/REMOTE	SD –	SHUTDOWN
LOS –	LOCKOUT STOP	SEL –	SELECT
LR –	LOCAL/REMOTE	SP –	SET POINT
N.C. –	NORMALLY CLOSED	SR –	START/RESET
N.O. –	NORMALLY OPEN	SS –	STOP/START
MOA –	MANUAL/OFF/AUTO	WA	WARNING ALARM
O –	OPEN		
OL –	OVERLOAD (MOTOR)		

INPUT/OUTPUT INTERFACE SYMBOLS

= DIGITAL OUTPUT = ANALOG OUTPUT

= DIGITAL INPUT = ANALOG INPUT

LINE SYMBOLS

PROCESS LINE (1)
INSTRUMENT OR CONNECTION TO PROCESS
ELECTRIC SIGNAL
PF ELECTRIC PULSE FREQUENCY SIGNAL (0–100 CYCLE/SEC., 0–150 PULSE/MIN., etc.)
PD ELECTRIC PULSE DURATION SIGNAL (15 SEC., 3/12 SEC = 0 %, etc.)
PNEUMATIC SYMBOL (2)
HYDRAULIC SYMBOL
CAPILLARY TUBE
ELECTROMAGNETIC OR SONIC SIGNAL (3)
INTERNAL SYSTEM LINK (SOFTWARE OR DATA LINK)
MECHANICAL LINK
CONNECTING LINES
FIELD INSTRUMENT/ DEVICE
CONTINUED IN OTHER AREA

SYMBOLS

GATE VALVE
THREE WAY VALVE
PLUG VALVE
BALL VALVE
BUTTERFLY VALVE
CHECK VALVE
DOUBLE FLAP CHECK VALVE
NEEDLE VALVE
BALANCING VALVE
GLOBE VALVE
AIR RELEASE VALVE
PRESSURE RELEASE VALVE
VACUUM RELIEF VALVE
PRESSURE REDUCING VALVE BACK PRESSURE REGULATING VALVE
VALVE WITH DIAPHRAGM OPERATOR
SV SOLENOID VALVE
M VALVE WITH MOTOR OPERATOR
VALVE WITH PISTON OPERATOR
VALVE WITH PRESSURE BALANCED OPERATOR
QUICK COUPLER
PINCH VALVE
BALL CHECK VALVE

DEVICE SYMBOLS

MANUAL SAMPLER
INJECTOR
FILTER
D DRAIN
MANUAL AIR VENT
BLIND FLANGE CAP OR PLUG
STRAINER
LI/LT XXXX ULTRA SONIC LEVEL SENSOR
LI/LT XXXX CAPACITANCE LEVEL PROBE
ORIFICE PLATE
DIAPHRAGM SEAL
LSH XXXX LEVEL FLOAT SWITCH
WATER SURFACE ELEVATION
REDUCER OR INCREASER
FLAP GATE
SLIDE GATE
CHEMICAL DIFFUSER
PULSATION DAMPER
STATIC MIXER
CC CALIBRATION CHAMBER
FIT XXXX M ELECTROMAGMETER FLOW METER
ROTOMETER
THERMOMETER
LEVEL PRESSURE TRANSDUCER

MECHANICAL EQUIPMENT SYMBOLS

CENTRIFUGAL BLOWER
VERTICAL TURBINE PUMP
CENTRIFUGAL PUMP
M MOTOR
PROPELLER FLOW METER
PERISTALTIC PUMP
CHEMICAL METERING PUMP
TANK
MIXER OR FLOCCULATOR
TELESCOPING VALVE
SAMPLE PUMP
OPEN VENT

30% SUBMITTAL

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CONSULTING ELECTRICAL ENGINEERS
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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

P&ID INSTRUMENTATION LEGEND

DRAWING NO. GI-1
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 100 P&ID
GROUND WATER SUPPLY & GHEEN RETURN

DRAWING NO. 100I-1
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

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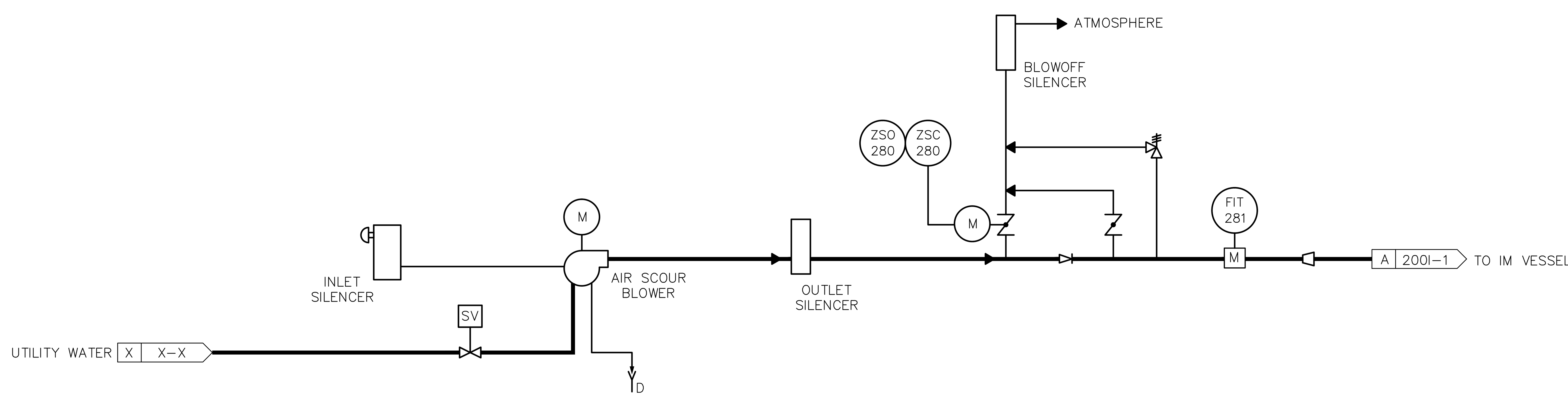
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 200 P&ID
EQUALIZATION TANK AND IM TREATMENT

DRAWING NO. 200I-1
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

SCADA

PLC



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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 200 P&ID AIR SCOUR SYSTEM

DRAWING NO. 200I-2
SHEET NO. XX OF XX
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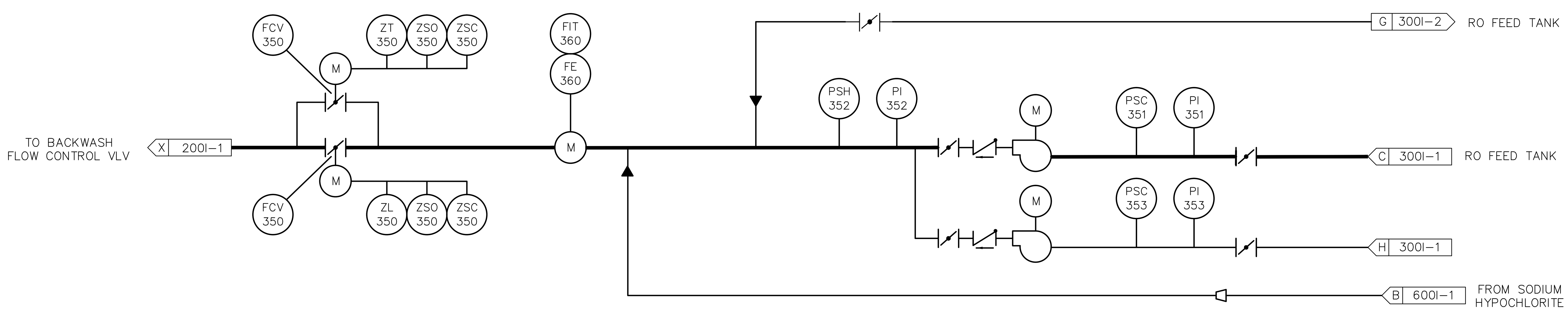
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 300 P&ID
RO FEED TANK AND IM TREATED WATER BY-PASS

DRAWING NO. 300I-1
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

SCADA

PLC



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DESIGNED BY RK
DRAWN BY TS
CHECKED BY RM

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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 300 P&ID
IM BACKWASH WATER SUPPLY

DRAWING NO. 300I-2
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 400 P&ID
RO CARTRIDGE FILTERS

DRAWING NO. 400I-1
SHEET NO. X OF XX
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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 400 P&ID
RO TRAINS OVERVIEW

DRAWING NO. 400I-2
SHEET NO. X OF XX
CLIENT JOB NO. 2744

NOTES:
(UNLESS OTHERWISE SPECIFIED)

1. ALL EQUIPMENT, VALVES, PIPING AND OTHER COMPONENTS ON THIS DRAWING NOTED AS WITHIN RO TRAIN LIMITS ARE A PART OF RO TRAIN NO. 1. RO TRAIN NO. 2 AND 3 ARE DUPLICATES OF RO TRAIN NO. 1.

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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 400 P&ID
RO TRAIN DETAIL - I (RO FEED PUMPING)

DRAWING NO. 400I-3
SHEET NO. X OF XX
CLIENT JOB NO. 2744

1. ALL EQUIPMENT, VALVES, PIPING AND OTHER COMPONENTS ON THIS DRAWING NOTED AS WITHIN RO TRAIN LIMITS ARE A PART OF RO TRAIN NO. 1. RO TRAIN NO. 2 AND 3 ARE DUPLICATES OF RO TRAIN NO. 1.

2. RO VESSEL PERMEATE SAMPLE VALVES,ONE PER VESSEL THIS STAGE.

30% SUBMITTAL

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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 400 P&ID
RO TRAIN DETAIL - II (RO VESSELS I)

DRAWING NO. 400I-4
SHEET NO. X OF XX
CLIENT JOB NO. 2744

1. ALL EQUIPMENT, VALVES, PIPING AND OTHER COMPONENTS ON THIS DRAWING NOTED AS WITHIN RO TRAIN LIMITS ARE A PART OF RO TRAIN NO. 1. RO TRAIN NO. 2 AND 3 ARE DUPLICATES OF RO TRAIN NO. 1.

2. RO VESSEL PERMEATE SAMPLE VALVES,ONE PER VESSEL THIS STAGE.

30% SUBMITTAL

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DATE 10/2015
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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 400 P&ID
RO TRAIN DETAIL - III (RO VESSELS II)

DRAWING NO. 400I-5
SHEET NO. X OF XX
CLIENT JOB NO. 2744

NOTES:
(UNLESS OTHERWISE SPECIFIED)

1. ALL EQUIPMENT, VALVES, PIPING AND OTHER COMPONENTS ON THIS DRAWING NOTED AS WITHIN RO TRAIN LIMITS ARE A PART OF RO TRAIN NO. 1. RO TRAIN NO. 2 AND 3 ARE DUPLICATES OF RO TRAIN NO. 1.

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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 400 P&ID
RO TRAIN DETAIL - IV (RO CONCENTRATE)

DRAWING NO. 400I-6
SHEET NO. X OF XX
CLIENT JOB NO. 2744

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AREA 400 P&ID
RO TRAIN DETAIL - V (RO PERMEATE)

DRAWING NO. 400I-7
SHEET NO. X OF XX
CLIENT JOB NO. 2744

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AREA 400 P&ID
RO CLEAN-IN-PLACE SYSTEM

DRAWING NO. 400I-8
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

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AREA 500 P & ID
CLEARWELL AND PRODUCT WATER PUMP STATION

DRAWING NO. 500I-1
SHEET NO. X OF XX
CLIENT JOB NO. 2744

SCADA

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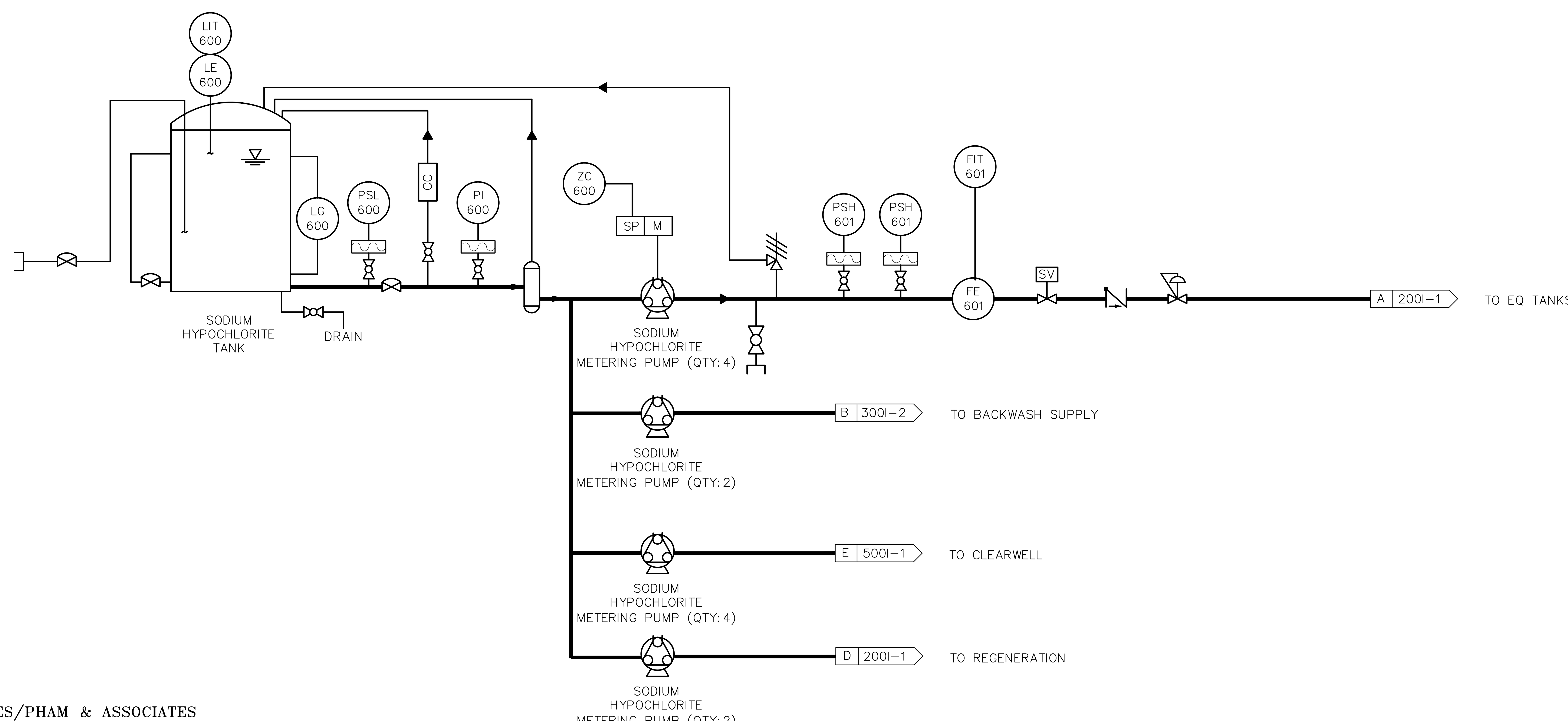

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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 600 P&ID
SODIUM HYPOCHLORITE HANDLING FACILITIES

DRAWING NO. 600I-1
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 600 P&ID
SODIUM BISULFITE HANDLING FACILITIES

DRAWING NO. 600I-2
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 600 P&ID
AQUA AMMONIA HANDLING FACILITIES

DRAWING NO. 600I-3
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 600 P&ID
SODIUM HYDROXIDE HANDLING FACILITIES

DRAWING NO. 600I-4
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 600 P&ID
PHOSPHORIC ACID HANDLING FACILITIES

DRAWING NO. 600I-5
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 600 P&ID
FERRIC CHLORIDE HANDLING FACILITIES

DRAWING NO. 600I-6
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

PROCESS AND INSTRUMENTATION DIAGRAM
SULFURIC ACID FEED SYSTEM

DRAWING NO. 600I-7
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 600 P&ID
THRESHOLD INHIBITOR FEED SYSTEM

DRAWING NO. 600I-8
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

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DRAWN BY TS
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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

AREA 700 WASTE WASHWATER AND RECOVERY

DRAWING NO. 700I-1
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

GHEEN FACILITY P&ID STATION PLAN

DRAWING NO. GFI-1
SHEET NO. XX OF XX
CLIENT JOB NO. 2744

NOTES:

1. X.

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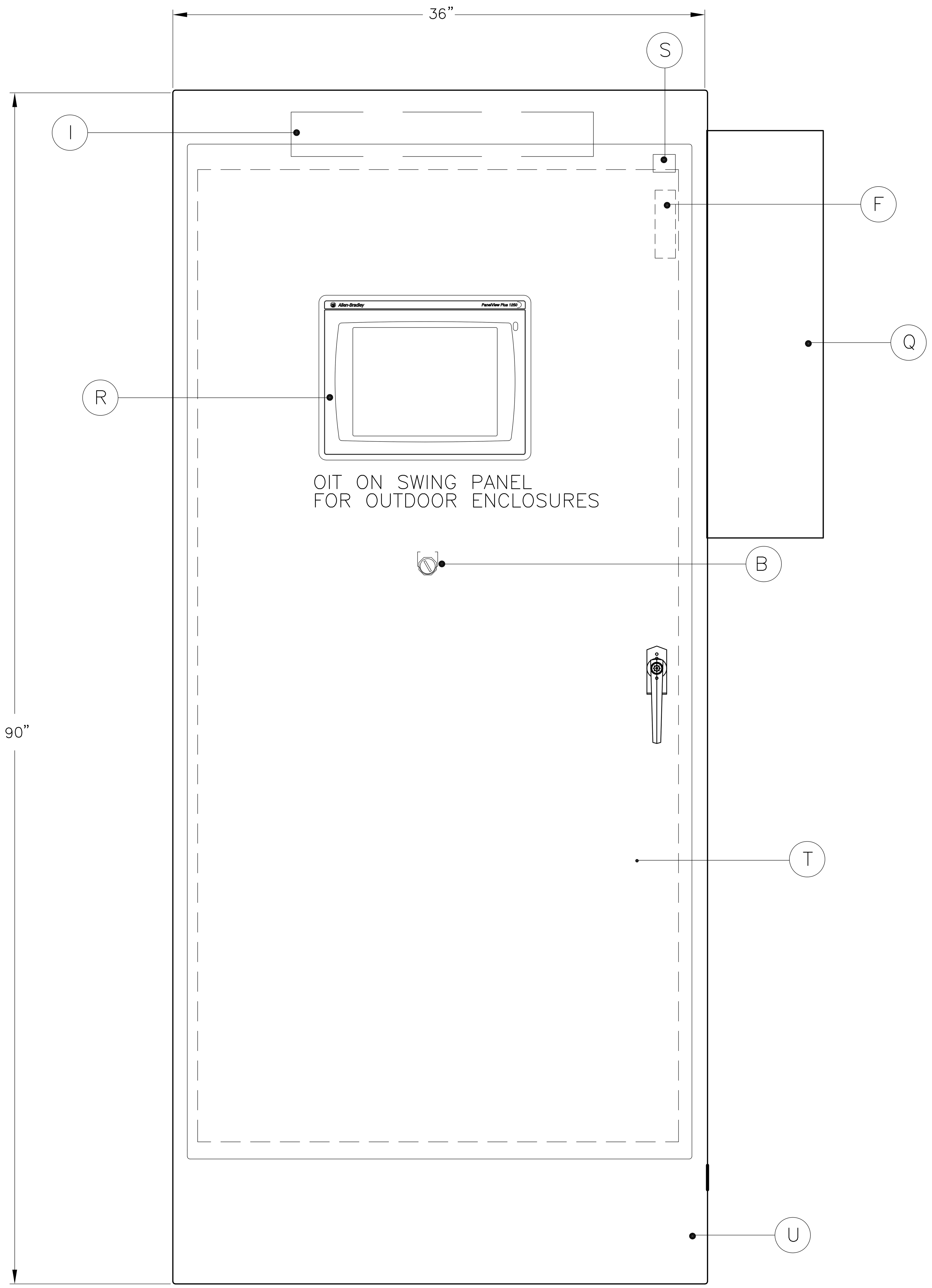
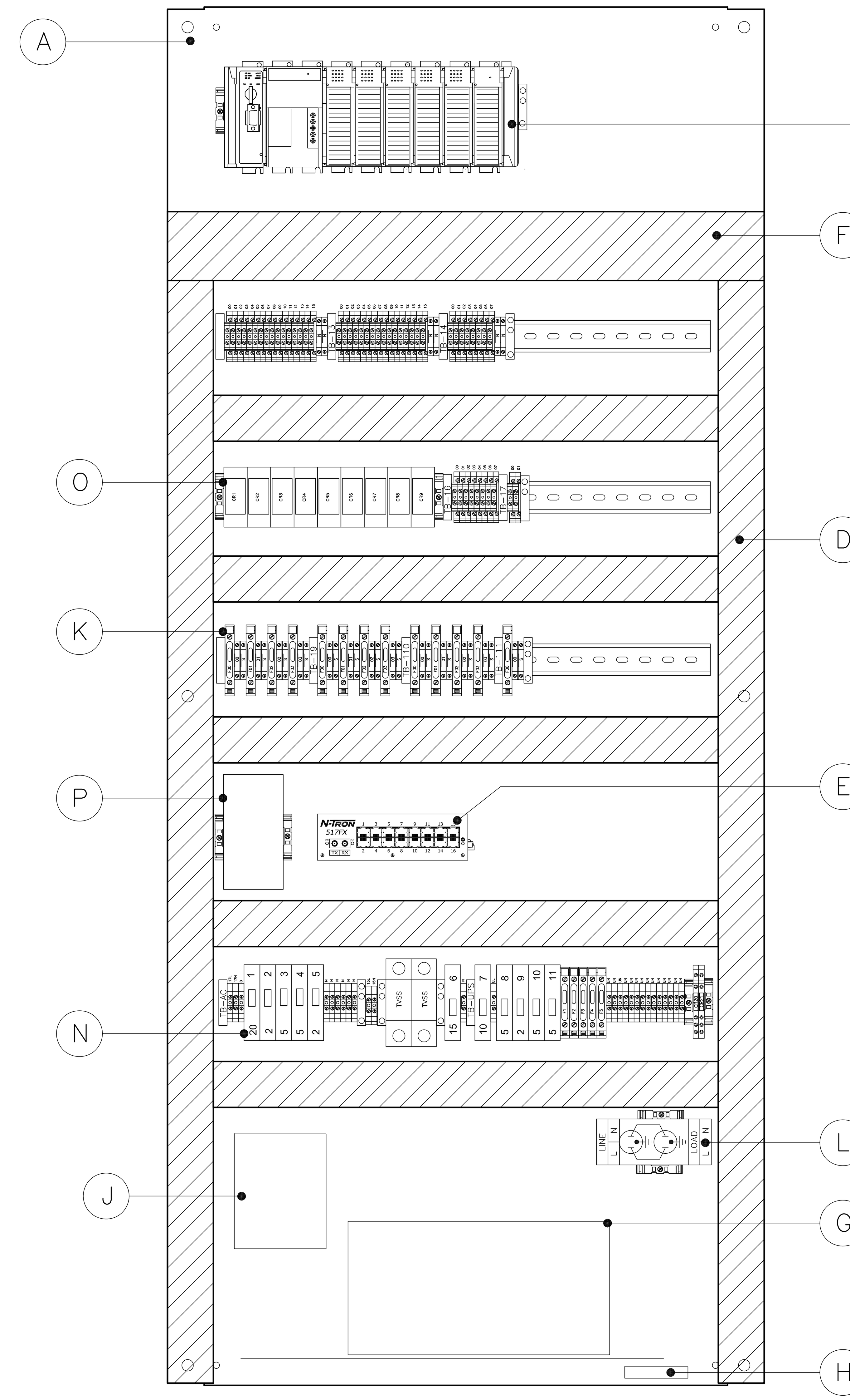
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

NETWORK DIAGRAM

DRAWING NO. **N-1**
SHEET NO. **X** OF **XX**
CLIENT JOB NO. **2744**



CONTROL PANEL FRONT ELEVATION



CONTROL PANEL BACKPANEL DETAIL

EQUIPMENT LIST	
ITEM	DESCRIPTION
A	BACKPANEL
B	INTRUSION OVER RIDE KEYSWITCH
C	PLC
D	WIREDUCT
E	ETHERNET SWITCH
F	INTRUSION SWITCH
G	UPS
H	GROUND BAR
I	PANEL LIGHT
J	HEATER
K	FUSE TERMINALS
L	RECEPTACLES GFI
M	TERMINALS
N	CIRCUIT BREAKER
O	RELAYS
P	POWER SUPPLY, 24VDC
Q	AIR CONDITIONER
R	OIT
S	LIGHT SWITCH
T	SWING PANEL
U	ENCLOSURE 90"X36"X24" N4X

PANEL MUST BE UL508A CERTIFIED

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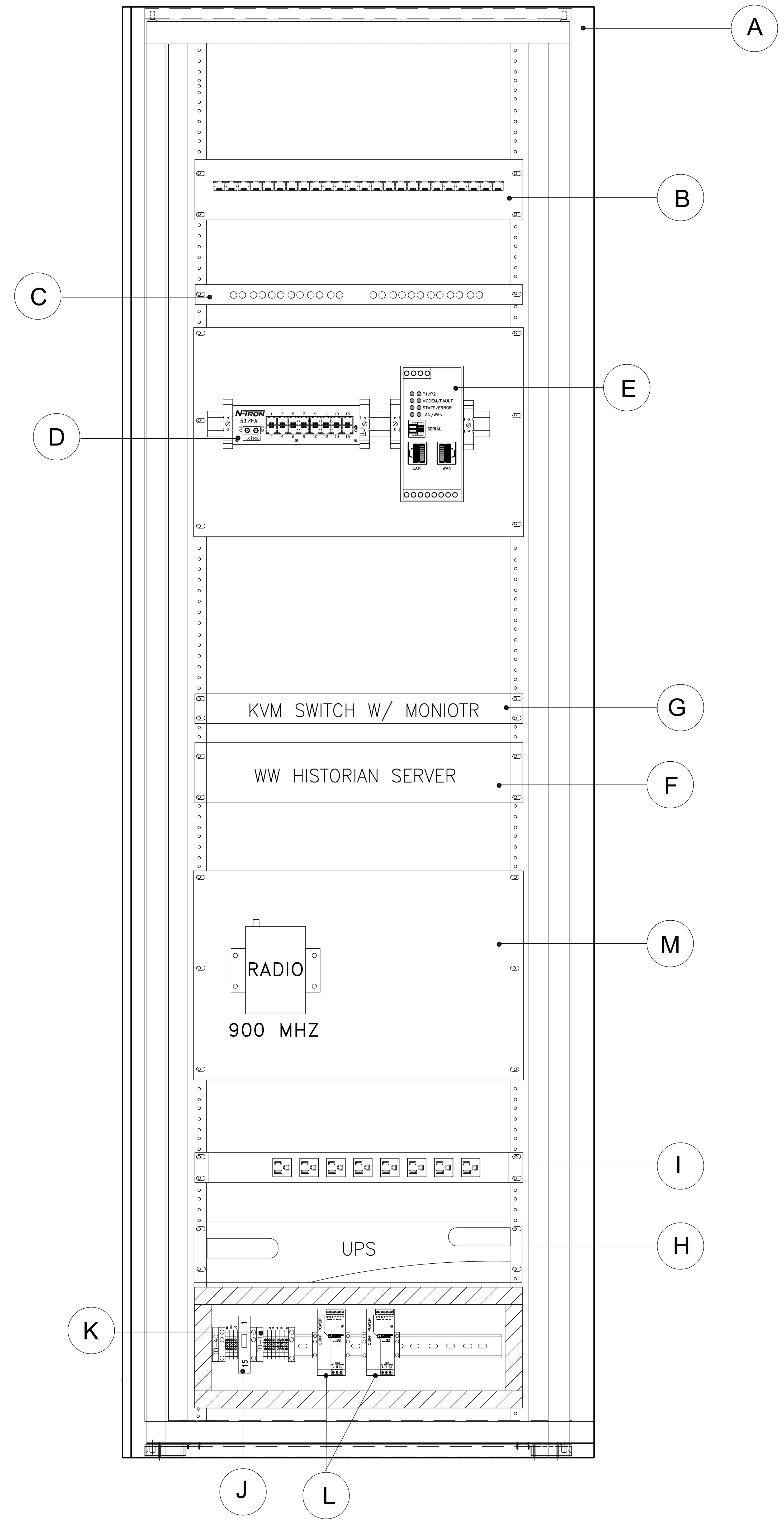
SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

CP LAYOUT

DRAWING NO. N-2
SHEET NO. X OF XX
CLIENT JOB NO. 2744



SERVER RACK FRONT ELEVATION

EQUIPMENT LIST	
ITEM	DESCRIPTION
A	19" ENCLOSED RACK
B	COPPER PATCH PANE;L
C	FIBER OPTIC PATCH PANEL
D	ETHERNET SWITCH
E	ETHERNET ROUTER
F	SERVER (WW HISTORIAN)
G	KVM W/ MONITOR
H	UPS
I	120VAC POWER STRIP
J	CIRCUIT BREAKER
K	SINGLE LEVEL TERMINAL BLOCKS
L	REDUNDANT 24VDC POWER SUPPLY
M	SCADA RADIO

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SANTA MARGARITA CONJUNCTIVE USE PROJECT FACILITIES

SERVER RACK

DRAWING NO. N-3
SHEET NO. X OF XX
CLIENT JOB NO. 2744

APPENDIX B

TECHNICAL MEMORANDUM NO. 1

TECHNICAL MEMORANDUM NO. 1 (TM 1)

Santa Margarita Conjunctive Use Project Facilities Predesign
for the Fallbrook Public Utility District

Draft Date: February 12, 2015
Final Date: August 28, 2015

Authors: John D. Kenny, P.E.

Reviewers: Céline C. Trussell, P.E., BCEE
R. Rhodes Trussell, Ph.D., P.E., BCEE

Job Number: 126.001

Subject: Raw Water Quality Characterization for the Fallbrook Public Utility District's Santa Margarita River Conjunctive Use Project Facilities

EXECUTIVE SUMMARY

The purpose of this Technical Memorandum (TM) is to summarize the quality of the water to be supplied to the new Santa Margarita River Conjunctive Use Project (SMRCUP) facilities, to recommend an assumed water quality for the design of those facilities, and to determine if additional water quality data, sampling, or testing is required.

A comprehensive summary of the estimated quality of water to be supplied to the new facilities (referred to as raw water quality) is shown in Table 2.1 through Table 2.3 in the body of the TM. A refined raw water quality summary of key constituents related to design is shown in Table ES.1, below in the Executive Summary (ES).

The new SMRCUP facilities will receive groundwater from existing and new wells located on Marine Corps Base Camp Pendleton (MCBCP). The raw water quality summary presented Table ES.1 was developed from water quality samples collected from the existing wells. An evaluation of the raw water quality shows that all water quality constituents with Primary Maximum Contaminant Levels (pMCLs) and Notification Levels (NL) are well below their respective limits. On the other hand, several constituents with Secondary Maximum Contaminant Levels (sMCLs) exceed their Recommended Levels. These constituents include iron, manganese, total dissolved solids (TDS), color, and conductivity, and they may require treatment (treatment processes to be recommended after water quality goals are developed in TM 2).

Table ES.1 – Estimated SMRCUP raw water quality for key constituents

Parameter	Units	Regulatory Limit	Water quality		
			Min	Avg	Max
General water quality parameters					
Alkalinity as $CaCO_3$	mg/L	--	170	199	223
Calcium	mg/L	--	80	89	94
Magnesium	mg/L	--	31	37	68
pH	--	--	7.1	7.4	7.9
Potassium	mg/L	--	2.5	3.6	5.6
Silica	mg/L	--	24.0	27.2	30.0
Sodium	mg/L	--	95	115	132
Total Organic Carbon (TOC)	mg/L	--	1.4	2.0	6.4
Constituents with Primary Maximum Contaminant Levels					
Aluminum	µg/L	1000	ND	ND	ND
Barium	µg/L	1000	ND	59	140
Fluoride	mg/L	2	0.1	0.4	0.7
Nitrate as NO_3	mg/L	45	0.4	1.6	4.0
Constituents with Secondary Maximum Contaminant Levels					
Aluminum	µg/L	200	ND	ND	ND
Chloride	mg/L	250 Recommended 500 Upper	145	161	173
Color - Apparent	color units	15	ND	5	18
Conductivity (EC)	µS/cm	900 Recommended 1600 Upper	1030	1230	1317
Iron	µg/L	300	11	101	317
Manganese	µg/L	50	199	283	494
Odor	TON	3	ND	0.3	1.7
Sulfate	mg/L	250 Recommended 500 Upper	63	186	208
Total Dissolved Solids (TDS)	mg/L	500 Recommended 1000 Upper	690	748	821
Turbidity	NTU	5	0.06	0.76	2.6
Constituents with Notification Levels					
Boron	µg/L	1000	41	137	191

In order to determine the necessity of iron and manganese (IM) and reverse osmosis (RO) treatment, and to subsequently design these processes, an assumed raw water quality is required (referred to as design water quality). A comprehensive, albeit preliminary, design water quality summary for IM and RO treatment is presented in Table 3.1 through Table 3.3, in the body of the TM (Separation Processes Inc will further refine the RO design water quality). An abbreviated design summary for key constituents that can determine the necessity of IM and RO treatment is shown in Table

ES.2. The design water quality will be compared against product water quality goals to determine the required treatment (water quality goals will be presented in TM 2).

This evaluation of the available raw water quality data shows that sufficient information is available for the evaluation and design of treatment processes for the SMRCUP with the exception that Disinfection By-Product formation is recommend:

The additional sampling, testing and analysis is not expected to delay the project and inclusion of the resulting data will allow for the development of final raw water quality characterization and final design water quality summary.

Table ES.2 – Design water quality for IM and RO processes

Parameter	Units	Design water quality
IM Process		
Iron	µg/L	10 min 400 max
Manganese	µg/L	500
RO Process		
Chloride	mg/L	165
Total Dissolved Solids (TDS)	mg/L	750

1 BACKGROUND

1.1 INTRODUCTION

The Fallbrook Public Utilities District (FPUD) is in the process of designing treatment and distribution facilities for the Santa Margarita River Conjunctive Use Project (SMRCUP) that will receive a blend of groundwater from existing and new groundwater wells located on Marine Corps Base Camp Pendleton (MCBCP)[1]. The goal of this Technical Memorandum (TM 1) is to characterize the raw water quality of this new source water, to recommend feedwater quality values to be used in the predesign (also known as design water quality), and to evaluate if further water quality sampling or testing is needed. Two subsequent TMs will present treated water quality goal recommendations for the new treatment plant and distribution system (TM 2) and a review of treatment plant alternatives to meet those goals (TM 3).

1.2 GROUNDWATER BASIN WELL CONFIGURATION

The SMRCUP utilizes aquifers underlying MCBCP for storage of diverted and infiltrated Santa Margarita River (SMR) water. Groundwater wells in the Upper Ysidora and Chappo Sub-Basins feed into a common header, which supplies the stored groundwater to MCBCP iron and manganese treatment plant IM-24 that subsequently feeds P-113, a reverse osmosis plant (also known as Haybarn Canyon AWTP). The new SMRCUP facilities will also draw from this same header, such that both IM-24/P-113 and the new SMRCUP facilities will treat the same water source. In addition to the existing wells, new wells will be added to the well field to meet the additional demand that the new SMRCUP facilities impose on the common header. The location of the existing wells and the proposed wells is shown in Figure 1.1.

[1] Conjunctive use is the temporary storage of water in a groundwater aquifer through intentional recharge and subsequent extraction for later use (CA Water Code).

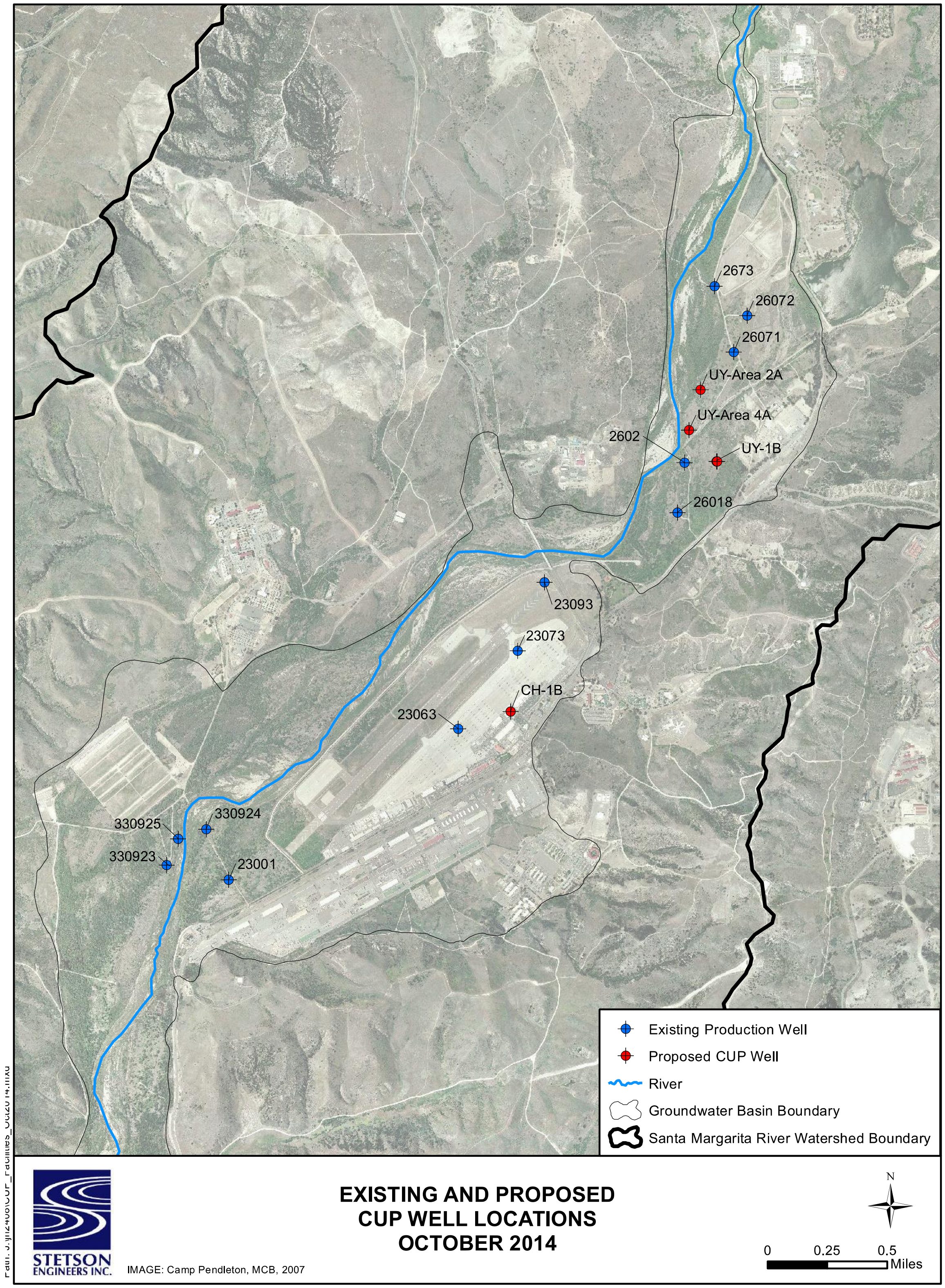

Figure 1.1 – MCBCP SMRCUP well locations

1.3 GROUNDWATER REGULATORY CLASSIFICATION

The draft agreement between MCBCP and the FPUD states that the SMRCUP water supplied to the new facilities will be qualified as groundwater (*i.e.*, not groundwater under the direct influence of surface water). The effect of this classification is that FPUD will only have to demonstrate 4-log (99.99%) virus removal/inactivation at the new plant, as opposed to the greater disinfection requirements for groundwaters under the direct influence of surface waters (greater than or equal to 4-log virus removal/inactivation, greater than or equal to 3-log *giardia* removal/inactivation, and greater than or equal to 2-log *cryptosporidium* removal/inactivation).

The groundwater classification presumes that there is not a significant occurrence of large pathogens in the groundwater (*e.g.*, *cryptosporidium*, *giardia*), and that the groundwater is not subject to significant and rapid shifts in water quality characteristics due to changes in the water quality of the SMR (*e.g.*, with respect to turbidity, conductivity, pH). Consequently, groundwater has lower pathogen removal and/or inactivation requirements compared to groundwater under the direct influence of surface water (purveyors of groundwater are required to conduct either triggered source water monitoring or demonstrate 4-log virus removal/inactivation).

1.4 SOURCES OF WATER QUALITY DATA

The following sources of water quality data were available for the raw water characterization:

- Wellhead water quality data from 2001 to 2010, and 2013, sampled from the wells that supply groundwater to IM-24/P-113 on MCBCP, and
- A summary of wellhead water quality data from 2008 to 2011, reported in the Environmental Impact Report (USMC, 2014).

Summaries of these water quality data, their relation to regulatory limits, and a discussion of their relevance to design are presented in the following section.

2 RAW WATER QUALITY CHARACTERIZATION

2.1 RAW WATER QUALITY SUMMARY

Given that the SMRCUP facilities will receive the same water as IM-24/P-113, the ideal water quality source would be samples collected from the IM-24 influent; however, these data were not available for review. Further, well flow data were only available for a small fraction of sampling events (two out of 23); thus, a flow-weighted average of the water quality samples would severely reduce the amount of available water quality data that could be included in the analysis. In the absence of the flow data, the best available method for estimating the blended water quality is to assume that the well flows are equal and to calculate a simple average of water quality samples taken during each sampling event (the sampling events were conducted quarterly, or yearly, over a period of several weeks; this averaging method is referred to as a simple average throughout the TM). As such, an estimate of the source water quality was developed through simple averages of the sampling events. This method of estimating the source water quality was also compared to flow-weighted estimates of the source water quality, for periods of time when flow data was available (indicated as flow-weighted average in this TM). The estimated source water quality from the simple-average analysis is presented in this section, with a comparison between the flow-weighted average and the simple average presented in a later section. The comparison demonstrated that the results from the simple average were satisfactory, enabling a summary of data over the entire period of record, including periods where flow data were not available.

Wellhead sampling was conducted on a quarterly basis from 2001 through 2005 and on a yearly basis in 2006 to 2010, and 2013, yielding approximately 26 sets of water quality results per well. The 2001 to 2003 sampling included some microbiological constituents (total coliform, *E. coli*, and heterotrophic plate counts), general water quality parameters (*e.g.*, major anions and cations, pH), inorganic chemicals with regulatory limits, disinfection by-products (DBPs), radionuclides and 1,2,3-trichloropropane (TCP), but did not include other organic chemicals. The 2004 to 2010, and 2013 wellhead sampling did contain several organic chemicals, such as synthetic organic chemicals (SOCs) and volatile organic chemicals (VOCs) with regulatory limits. A summary of all sampled water quality parameters, including TCP, but excluding other organic chemicals, is presented in Table 2.1. Organic chemicals that were detected during the 2004 to 2010, and 2013, wellhead sampling are shown in Table 2.2 (excluding TCP), while the organic chemicals that were not detected are listed in Table 2.3. An expanded summary of the water quality parameters is presented in the appendix, including the 5^{th}, 10^{th}, 50^{th}, 90^{th}, and 95^{th} percentiles of the simple averages, as well as the individual wellhead samples.

The estimated raw water quality summary tables include relevant regulatory or health-based advisory levels for reference. Primary Maximum Contaminant Levels (pMCLs), Secondary Maximum Contaminant Levels (sMCLs), and Notification Levels (NLs) are shown when applicable. For detected organic chemicals with no regulatory limit, Risk Based Action Levels (RBALs) were developed using an approach developed by the National Academy of Science (NAS, 2012). This approach uses reference doses (RfDs) published by the EPA. These RfDs are based on No- or Lowest-Observed-Adverse-Effect-Levels (NOAELs or LOAELs), developed from human or animal studies, with several uncertainty factors to compensate for assumptions (*e.g.*, uncertainty based on differences between humans and the animal test specifies, differences in human population sensitivity, lack of data). In the absence of formal criteria for drinking water concentrations, these RBALs can provide guidance on the health-risk posed by chemicals.

The estimate of the source water quality presented in Table 2.1 through Table 2.3 are based on water quality samples collected from the wells that provided groundwater to IM-24/P-113 from 2001 to 2007 (USBR, 2013) and also samples collected from wells in 2008 to 2010 and 2013. The exception is that data from well 2202 was excluded due to detections of TCP[2], following the assumption that MCBCP removes wells from service when TCP is detected and only returns them to service if TCP becomes undetectable. Water quality data from 2001 to 2010 represents samples from 14 wells, while water quality samples from 2013 represent 8 wells. The Division of Drinking Water (DDW) Water Quality Analyses Database indicates that well 2671 has been destroyed. Further, flow data from 2009 to 2014 and the 2013 water quality sampling indicate that well 2603 may have been removed from service (in addition to 2202) and that new wells may have been brought online in recent years (23001, 23093, 26018, 2602, 26071, 26073, and 330924). Limited water quality data is available from these new wells, although water quality sampling data from wells 2602, 26071 and 26018 were included in the 2013 sampling. All wells except for well 2202 were included in the water quality characterization, as the exact make-up of the well field that will supply the new facilities is subject to change.

In total, the sampling from 2001 to 2010, and 2013, includes water quality information for all of the relevant, regulated constituents, namely, the following:

- Microbiological contaminants with pMCLs,
- Inorganic chemicals with pMCLs,
- Radionuclides with pMCLs,
- One disinfection by-product (DPB): trihalomethanes (THMs),
- Synthetic organic chemicals (SOCs) with pMCLs,
- Volatile organic chemicals (VOCs) with pMCLs, and
- Constituents with sMCLs.

Samples were not collected for DBPs other than THMs (haloacetic acids, bromate, chlorite), nor constituents with Maximum Residual Disinfectant Levels (MRDLs). The raw water has not yet been treated with a chemical oxidant; thus, it is appropriate to not measure for DBPs and MRDLs.

The estimated blended source water quality presented in Table 2.1 assumes that the well flow is equal between the wells and comparison with flow-weighted averages where flow data are available shows that this approach is reasonable. However, during operation of the well field some wells may be taken offline or online, as needed for service, and well production rates may differ between the wells. Deviations from equal well flow may impact the estimated blended water quality for constituents whose concentration varies between wells. Expected deviations from the estimated raw water

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[2] Sanitation and Radiation Laboratories (SRL) method reporting limit of the method of 0.005 μg/L

quality obtained from simple averages are discussed subsequently in the report, when well flow data and flow-weighted averages are presented.

As mentioned previously, new wells will be required to meet the additional demand of the new SMRCUP facilities. Stetson Engineers, Inc., the engineering firm that performed aquifer hydraulic modeling for MCBCP to support the SMRCUP, anticipates that the placement of the new wells and the increased production will not change the water quality significantly (Stetson, 2014).

Table 2.1 – Summary of estimated SMRCUP source water quality, based on wellhead water quality samples from 2001 to 2010, and 2013[1]

Parameter	Units	Regulatory Limit	Min	Avg	Max	No.[6]
Microbiological parameters						
Coliform	P (1) / A (0)	--	0%	1%	9%	194
E. Coli	P / A	TT[2]	A	A	A	194
Heterotrophic Plate Count	CFU/100mL	--	1	24	84	194
General water quality parameters						
Aggressive Index	--	--	11	12	13	225
Alkalinity as $CaCO_3$	mg/L	--	170	199	223	225
Bicarbonate alkalinity	mg/L	--	42	210	256	225
Calcium	mg/L	--	80	89	94	229
Carbonate alkalinity	mg/L	--	ND[2]	0.0	0.9	246
Dissolved Inorganic Carbon (DIC) as C[3]	mg/L	--	--	52	--	--
Magnesium	mg/L	--	31	37	68	229
pH	--	--	7.1	7.4	7.9	255
Potassium	mg/L	--	2.5	3.6	5.6	229
Sodium	mg/L	--	95	115	132	229
Silica[4]	mg/L	--	24.0	27.2	30.0	9
Strontium[4]	mg/L	--	0.55	0.58	0.7	8
Temperature[4]	°C	--	18.1	21.3	23.2	8
Total Hardness	mg/L	--	328	369	390	229
Total Organic Carbon (TOC)	mg/L	--	1.4	2.0	6.4[12]	256
Constituents with Primary Maximum Contaminant Levels (pMCLs)						
Inorganic chemicals						
Aluminum	µg/L	1,000	ND	ND	ND	255
Antimony	µg/L	6	ND	0.02	0.30	255
Arsenic	µg/L	10	ND	1	3	255
Asbestos	MFL	7	ND	ND	ND	84
Barium (2004-2010, 2013)	µg/L	1,000	ND	59	140	134
Beryllium	µg/L	4	ND	0.01	0.25	263
Cadmium	µg/L	5	ND	ND	ND	255
Chromium	µg/L	50	ND	0.01	0.18	255
Cyanide	µg/L	150	ND	ND	ND	214
Fluoride	mg/L	2	0.1	0.4	0.7	229
Hexavalent chromium[5]	µg/L	10	ND	ND	ND	6
Mercury	µg/L	2	ND	ND	ND	255
Nickel	µg/L	100	ND	1	12	255
Nitrate + Nitrite as N	µg/L	10,000	89	380	820	202
Nitrate as NO_3	mg/L	45	0.4	1.6	4.0	238
Nitrite as N	µg/L	1,000	ND	3	63	258
Perchlorate	µg/L	6	ND	ND	ND	13
Selenium	µg/L	50	ND	0.3	4	255
Thallium	µg/L	2	ND	ND	ND	255
Radionuclides						
Gross Alpha	pCi/L	15	ND	3	5	301
Gross Beta	pCi/L	50	ND	2	3	157

Parameter	Units	Regulatory Limit	Min	Avg	Max	No.[6]
Radium 226	pCi/L	5 (Ra226 +Ra228)	ND	0.2	0.5	107
Radium 228	pCi/L		ND	0.9	3.1	98
Strontium 90	pCi/L	8	ND	0.1	0.6	157
Tritium (2004-2009)[7]	pCi/L	20,000	-17	110	343	82
Uranium	pCi/L	20	1	2	4	93
Volatile organic chemicals (VOCs)						
Cis-1,2-Dichloroethene (Cis-1,2-Dichloroethylene) (2004-2010, 2013)[8]	µg/L	6	ND	0.0	0.05	148
Dichloromethane (methylene chloride) (2004-2010, 2013)	µg/L	5	ND	0.01	0.08	129
Trichloroethylene (TCE) (2004-2010, 2013)[9]	µg/L	5	ND	0.08	0.87	134
Non-volatile synthetic organic chemicals (SOCs)						
Pentachlorophenol (PCP) (2005, 2008-2010, 2013)	µg/L	1	ND	0.01	0.07	37
Disinfection by-products (DPBs)						
Total Trihalomethanes (THMs)	µg/L	80	ND	0.1	0.8	247
Constituents with Action Levels (ALs)						
Copper	µg/L	1,300	ND	4	82	255
Lead	µg/L	15	ND	0.1	1.1	255
Constituents with Secondary Maximum Contaminant Levels (sMCLs)						
Aluminum	µg/L	200	ND	ND	ND	255
Chloride	mg/L	250 Rec 500 Upper	145	161	173	229
Color – Apparent	color units	15	ND	5	18	251
Conductivity (EC)	µS/cm	900 Rec 1,600 Upper	1,030	1,230	1,317	225
Copper	µg/L	1,000	ND	4	82	255
Foaming Agents (MBAS)	mg/L	0.5	ND	0.003	0.007	93
Iron	µg/L	300	11	101	317	274
Manganese	µg/L	50	199	283	494	262
Odor	TON	3	ND	0.3	1.7	227
Silver	µg/L	100	ND	ND	ND	255
Sulfate	mg/L	250 Rec 500 Upper	63	186	208	229
Total Dissolved Solids (TDS)	mg/L	500 Rec 1,000 Upper	690	748	821	229
Turbidity	NTU	5	0.06	0.76	2.6	244
Zinc	µg/L	5,000	ND	2	29	254
Constituents with Notification Levels (NLs)						
1,2,3-TCP (1997-2008, 2013)[10]	µg/L	0.005	ND	0.000	0.001	388
Boron	µg/L	1,000	41	137	191	162
Carbon Disulfide[11]	µg/L	160	0.00	0.00	0.02	45
Vanadium	µg/L	50	2	5	10	167

[1] Including wells 2301 (currently monitoring well), 23063, 23073, 2393, 26018, 2602, 2603, 2671 (destroyed), 26071, 26072, 2673, 330923, 330925, and 33924 (currently a monitoring well); excluding well

2202 due to continued TCP detections; averaging calculations performed assuming non-detect values were presented at a concentration of zero.
[2] TT = treatment technique; ND = below the method reporting limit
[3] Calculated for average water quality, assuming a temperature of 20 degrees Celsius
[4] Includes eight samples collected from wells 23001, 23063, 23073, 23093, 2602, 26072, 330924, and 330925 from 5/20/15 through 5/21/15, with offline wells undergoing flushing prior to sampling
[5] Samples collected in November and December 2014, analyzed using method 218.6, and accessed through the DDW Water Quality Analyses Database Files
[6] Number of individual wellhead samples; the number of sampling events is shown in the appendix
[7] Tritium counting error ranged from 117 to 216
[8] One of the two samples with detectable concentrations was J-flagged, indicating that the detected value was between the Method Detection Limit (MDL) and the Method Reporting Limit (MRL) and that the flagged value was an estimate
[9] All four detections were in well 26018 with the highest concentration detected at 2.6 µg/L
[10] Detections of 0.005, 0.003, and 0.006 µg/L in 2003 and 2004 from well 330923 were included in the analysis, although it is assumed that MCBCP would have removed this well from service after the first detection
[11] The one sampled with a detectable concentration was J-flagged (see note 7)
[12] High TOC values in three of the 13 wells during this sampling event, with the three high wells having multiple samples collected from some wells on the same day (*e.g.*, five samples), which is unusual for this dataset (typically only one sample per well per day is collected), and which might indicate that sampling was occurring during a flushing test; further, some individual sample TOC concentrations were as high as 44.2 mg/L, indicating possible error; lab notes are unavailable; the second highest TOC value (after 6.4 mg/L) was 3.4 mg/L, which appears free of well testing (did not include multiple samples per well per day), and for which the highest individual well sample (prior to blending) was 5.3 mg/L.

Table 2.2 – Organic chemicals detected in 2004 to 2010, and 2013 wellhead samples

Parameter	Unit	Risk based action level or action level	Detected value	No. of detections	No. of non-detections
2,4,5-T	µg/L	70[a] (RBAL)	0.109	1	13
Chloromethane	µg/L	28[a] (RBAL)	0.2 – 0.8	2	142
Methane	mg/L	10-28[b] (AL)	3 – 8.8	4	2

[a] Risk Based Action Levels (RBALs) based on the EPA reference dose (RfD) of 0.01 and 0.004 mg/kg/day for 2,4,5-T and chloromethane, respectively, assuming 2L/day, 70 kg, and 20% relative source contribution
[b] Action level (AL) based on explosive concerns; well vents recommended at 10 mg/L (DOI 2001)

Table 2.3 – Organic chemicals not detected during 2004 to 2010, and 2013 wellhead sampling

Parameter	Method	Parameter	Method	Parameter	Method
1,1-DICHLOROETHANE	524.2	ALDICARB	531.2	ENDRIN	505
1,1-DICHLOROPROPENE	524.2	ALDICARB SULFONE	531.2	ETHYL TERT-BUTYL ETHER	524.2
1,1,1-TRICHLOROETHANE	524.2	ALDICARB SULFOXIDE	531.2	ETHYLBENZENE	524.2
1,1,1,2-TETRACHLOROETHANE	524.2	ALDRIN	505	GLYPHOSATE	547
1,1,2-TRICHLORO-1,2,2-TRICHFLUOROETHANE	524.2	AROCLOR-1016	505	HEPTACHLOR	505
1,1,2-TRICHLOROETHANE	524.2	AROCLOR-1221	505	HEPTACHLOR EPOXIDE	505
1,1,2,2-TETRACHLOROETHANE	524.2	AROCLOR-1232	505	HEXACHLOROBENZENE	525.2
1,2-DIBROMOETHANE	551.1	AROCLOR-1242	505	HEXACHLOROBUTADIENE	524.2
1,2-DICHLOROBENZENE	524.2	AROCLOR-1248	505	HEXACHLOROCYCLOPENTADIENE	525.2
1,2-DICHLOROETHANE	524.2	AROCLOR-1254	505	ISOPROPYL ETHER	524.2
1,1-DICHLOROETHANE	524.2	AROCLOR-1260	505	ISOPROPYLBENZENE	524.2
1,1-DICHLOROETHENE	524.2	ASBESTOS	100.2	LINDANE	505
1,1-DICHLOROPROPENE	524.2	ATRAZINE	525.2	M,P-XYLENES	524.2
1,1,1-TRICHLOROETHANE	524.2	BAYGON	531.2	METHIOCARB	531.2
1,1,1,2-TETRACHLOROETHANE	524.2	BENTAZON	515.4	METHOMYL	531.2
1,1,2-TRICHLOROETHANE	524.2	BENZENE	524.2	METHOXYCHLOR	505
1,1,2,2-TETRACHLOROETHANE	524.2	BENZO[A]PYRENE	525.2	METHYL TERT-BUTYL ETHER	524.2
1,2-DIBROMOETHANE	551	BIS(2-ETHYLHEXYL)ADIPATE	525.2	METHYLENE CHLORIDE	524.2
1,2-DICHLOROBENZENE	524.2	BIS(2-ETHYLHEXYL)PHTHALATE	525.2	MOLINATE	525.2
1,2-DICHLOROETHANE	524.2	BROMOBENZENE	524.2	N-BUTYLBENZENE	524.2
1,2-DICHLOROPROPANE	524.2	BROMOCHLOROMETHANE	524.2	NAPHTHALENE	524.2
1,2,3-TRICHLOROBENZENE	524.2	BROMOETHANE	524.2	O-XYLENE	524.2
1,2,3-TRICHLOROPROPANE	524.2	BROMOMETHANE	524.2	OXAMYL	531.2
1,2,4-TRICHLOROBENZENE	524.2	CARBARYL	531.2	PARAQUAT DICHLORIDE	549.2
1,2,4-TRIMETHYLBENZENE	524.2	CARBOFURAN	531.2	PCB (TOTAL)	505
1,3-DICHLOROBENZENE	524.2	CARBON TETRACHLORIDE	524.2	PICLORAM	515.4
1,3-DICHLOROPROPANE	524.2	CHLORDANE	505	PROPYLBENZENE	524.2
1,3-DICHLOROPROPENE, TOTAL	524.2	CHLOROBENZENE	524.2	SEC-BUTYLBENZENE	524.2
1,3,5-TRIMETHYLBENZENE	524.2	CHLOROETHANE	524.2	SILVEX	515.4
1,4-DICHLOROBENZENE	524.2	CHLORTHAL	515.4	SIMAZINE	525.2
1,4-DIOXANE	522	CHROMIUM, TOTAL	200.8	STYRENE	524.2
2-BUTANONE	524.2	CIS-1,3-DICHLOROPROPENE	524.2	T-AMYL METHYL ETHER	524.2
2-CHLOROTOLUENE	524.2	DALAPON	515.4	TERT-BUTYLBENZENE	524.2
2,2-DICHLOROPROPANE	524.2	DCPA MONO-ACID DEGRADATE	515.4	TETRACHLOROETHENE	524.2
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	1613	DIBROMOCHLOROMETHANE	524.2	THIOBENCARB	525.2
2,4-D	515.4	DIBROMOCHLOROPROPANE	551	TOLUENE	524.2
2,4-DB	515.4	DIBROMOMETHANE	524.2	TOXAPHENE	505
3-HYDROXYCARBOFURAN	531.2	DICAMBA	515.4	TRANS-1,2-DICHLOROETHENE	524.2
3,5-DICHLOROBENZOIC ACID	515.4	DICHLORODIFLUOROMETHANE	524.2	TRANS-1,3-DICHLOROPROPENE	524.2
4-CHLOROTOLUENE	524.2	DICHLOROPROP	515.4	TRICHLOROETHENE	524.2
4-ISOPROPYLTOLUENE	524.2	DIELDRIN	505	TRICHLOROFLUOROMETHANE	524.2
4-METHYL-2-PENTANONE	524.2	DINOSEB	515.4	URANIUM 238	200.8
ACIFLUORFEN	515.4	DIQUAT	549.2	VINYL CHLORIDE	524.2
ALACHLOR	505	ENDOTHALL	548.1	XYLENES, TOTAL	524.2

Many of the sampled constituents never exceeded a regulatory limit or health-based advisory level in any of the samples, including individual wellhead samples (individual wellhead samples have more variability than the simple averages, where the effect of high concentrations might be balanced by low concentrations in the averaged samples). The following sections list the parameters that exceeded regulatory and health-based advisory levels. In these sections, the regulatory limits are compared to the maximum simple average of the samples, to the maximum of the individual wellhead samples, and to the 95th percentile of the individual wellhead samples. Although the maximum individual wellhead values are not good indicators of the maximum blended wellhead water quality, their examination can elucidate the proximity to which the blended water might approach regulatory or health-based limits when multiple wells are taken offline.

2.2 CONSTITUENTS WITH PRIMARY MAXIMUM CONTAMINANT LEVELS

Although maximum samples for some individual wellheads exceeded pMCLs for Arsenic, Fluoride and Nickel, examination of the remainder of the data suggests that the blended raw water quality is well below regulatory MCLs. During the 2001-2010, and 2013, wellhead sampling, the maximum individual wellhead samples (not the blended estimate through simple averages) exceeded the pMCL for the following parameters (see appendix for maximum values for individual wellhead samples):

- Arsenic,
- Fluoride, and
- Nickel.

However, the 95th percentile of individual wellhead samples and the maximum simple average did not exceed the pMCL, indicating that those samples that exceeded the pMCL are rare (see appendix for 95th percentiles of individual wellhead samples). The individual wellhead 95th percentile sample and the maximum simple average for arsenic and nickel were approximately an order of magnitude below the pMCL; for fluoride they were less than half of the pMCL.

Three other constituents were within an order of magnitude in the maximum estimated raw water quality (trichloroethylene, uranium, gross alpha, and radium 226 plus radium 228); however, again, in all cases the maximum simple average was approximately half of the pMCL, or less. Three volatile organic chemicals (VOCs) and one non-volatile synthetic organic chemical (SOC) were detected in individual wells: cis-1,2-dichloroethene (cis-1,2-DCE), dichloromethane (methylene chloride), trichloroethylene (TCE), and pentachlorophenol (PCP), with the latter being the SOC. Cis-1,2-DCE and dichloromethane were almost an order of magnitude below the pMCL in the individual wells where they were measured. Blending with the other wells brings their concentrations even further below their pMCLs. TCE and PCP were about half of their pMCLs in the wells where they were detected. Blending with several wells would drop the concentration further below the pMCLs (*e.g.*, blending with six other wells of equal flow would drop both concentrations more than order of magnitude below their pMCLs). Lastly, hexavalent chromium, a recently regulated constituent, appears to be well below the MCL in the blended raw water. Direct sampling for hexavalent chromium in 2014 yielded all non-detects (EPA method 218.6), and recent total chromium sampling (EPA method 200.8), results in a maximum simple average of 0.14 µg/L, which is well below the hexavalent chromium pMCL of 10 µg/L (total chromium includes any hexavalent chromium that may be present). Thus, no constituent with a pMCL is expected to be present at a concentration greater than its pMCL in the raw water for the SMRCUP facilities.

2.3 CONSTITUENTS WITH SECONDARY MAXIMUM CONTAMINANT LEVELS

Several constituents with sMCLs exceed their recommended aesthetic (*i.e.*, not health-based) limits on average or at the maximum value in the estimated raw water quality. These constituents would require treatment (*e.g.*, IM and RO treatment) to reliably produce a water quality that meets the Recommended sMCLs; however, treatment requirements are dependent on water quality goals, which will be developed in TM 2. All constituents with Upper sMCL were always less than the Upper sMCL in the estimated raw water.

Conductivity, manganese, and TDS exceeded their respective sMCL or Recommended sMCL on average in the estimated raw water. Color and iron exceeded the sMCL in the maximum estimated raw water blend. Chloride, odor, sulfate, and turbidity were within an order of magnitude of their sMCL or Recommended sMCL for their maximum estimated raw water quality. All of these constituents are well removed through a combination of IM and RO treatment. Thus, if IM and RO treatment is included for select constituents (*e.g.*, iron, manganese, chloride and TDS), they will also remove these other constituents with sMCLs well.

2.4 CONSTITUENTS WITH NOTIFICATION LEVELS

Of the parameters measured with NLs, TCP was the only constituent where at least one sample exceeded the NL. TCP has only been detected in three of the groundwater wells that IM-24/P-113 utilizes, and, further, it is assumed that MCBCP removes any well from service when TCP is detected and only returns the well to service if TCP is undetectable. Five detections of TCP (in wells 330923 and 33924 from 2003 to 2004) were included in the raw water quality blended analysis, although some of these detections were likely found in samples collected from the well after the wells were taken out of service. Despite including these detections, the maximum raw water quality estimate for TCP was well below the NL (0.001 µg/L, compared to the NL of 0.005 µg/L).

The maximum simple average of the wellhead samples for boron and vanadium were within an order of magnitude of their NLs (191 µg/L compared to the NL of 1,000 µg/L for boron, and 10 µg/L compared to the NL of 50 µg/L for vanadium); however, both of these blended estimates were less than half of the NL. These constituents (boron, vanadium, and TCP) are thus not expected to exceed their NLs in the raw water supplied to the new SMRCUP facilities. Nevertheless, it is assumed that both FPUD and MCBCP will continue to watch for 1,2,3-TCP in the remaining wells as DDW Plans to promulgate a pMCL this year (DDW, 2014).

2.5 ORGANIC CHEMICALS WITHOUT REGULATORY OR HEALTH-BASED ADVISORY LEVELS

Three organic chemicals without regulatory or health-based advisory levels were detected in one well: 2,4,5-T, chloromethane, and methane. In the absence of formal criteria for drinking water concentrations (*i.e.*, pMCLs, NLs), Risk Based Action Levels

(RBALs) were developed using the reference doses (RfDs) to evaluate the potential health risk of 2,4,5-T and chloromethane, as mentioned earlier. A search was conducted for methane reference levels, and an action level with respect to explosives obtained from the Department of Interior (DOI) Office of Surface Mining Reclamation and Enforcement (OSMRE), developed for coal mining areas. 2,4,5-T and chloromethane measured concentrations were more than order of magnitude below their RBALs in this one well, indicating that they will be even less concentrated in the blended source water. Methane was detected near the more conservative range of the action level in one well. The number of methane samples is small (6 samples total), which may indicate sampling related to specific drilling activities on MCBCP. Well vents can be provided if methane levels reach the action level. Blending would further reduce any remaining, dissolved methane concentrations. In summary, these organic chemicals are expected to be present at concentrations well below a level of concern.

2.6 PROCESS DESIGN CONSIDERATIONS

The treatment processes for the new SMRCUP facilities have not yet been selected (the treatment processes are subject of TM 3) nor have the treatment goals, for which the treatment system will be designed, been developed yet (the goals are the subject of TM 2). Thus, exact design considerations cannot be presented here; however, general design considerations for facilities similar to IM-24 and P-113 are discussed below. In this regard, several aspects of treatment design for the new SMRCUP facilities may be affected by the source water quality, including the following:

- Iron and manganese (IM) removal system,
- Waste washwater recovery,
- IM washwater reclamation system,
- Reverse osmosis (RO) sizing,
- RO recovery and pretreatment,
- Disinfection, and
- Product water stabilization.

IM treatment may be employed to reduce the high concentrations of manganese, and iron, to lower concentrations. The design of IM systems is a function of maximum expected concentrations of iron and manganese; however, their concentrations do not need to be precisely known, in the range of iron and manganese levels observed, as typical IM systems achieve removals in excess of what are typically required. After dissolved manganese is removed in the filters, the backwash water is typically sent to a reclaim system, where manganese and iron particulates are settled. The ease of settling manganese particulates is a function of the iron particulate concentration in the washwater, and thus the minimum concentration of iron is also important for design. The minimum concentration of iron in this water is lower than typical, relative to the manganese concentrations, and Trussell Technologies has observed poor settling of manganese particulate in MCBCP IM plants back in 2008. If a washwater recovery system is used in the design, the ability to add iron-based coagulant (*e.g.*, ferric chloride) may be included in the design to ensure proper settling.

RO may be employed to reduce the concentration of chloride, TDS, conductivity, sodium, and other dissolved species. The size of the RO system will depend on the water quality goals for specific constituents (*e.g.*, chloride) relative to their concentrations in the source water, including the distribution of these concentrations and the averaging period of the goal (*e.g.*, annual average). The maximum recovery of the RO is limited by the deposition of precipitates present or formed from constituents in the feed water on the membrane surface (such as silica or calcium carbonate). Anti-scalant (also known as anti-foulants or threshold inhibitors) and/or pH adjustment may increase the recovery of the RO. Separation Processes Inc (SPI) will be examining these issues further.

The dissolved inorganic carbon (DIC) concentration in the source water is high, which will increase copper solubility in household plumbing through the formation of complexes with the copper ion. The North MCBCP system experienced copper concentrations in excess of the AL in consumer taps and in response implemented a Corrosion Control Treatment (CCT) to reduce the concentrations, including orthophosphate addition. The South MCBCP System, where the SMRCUP wells are located, has lower concentrations of DIC and has also observed elevated concentrations of copper in consumer taps, but below the AL of 1,300 µg/L. The design of the new facilities will thus consider the ability to add orthophosphate.

The total organic carbon (TOC) concentration is high for a groundwater. Although groundwaters typically do not form DBPs in excess of the regulatory limits, the high TOC concentrations may lead to higher DBP formation for the new SMRCUP facilities. The proposed bench-scale Simulated Distribution System (SBS) would determine the extent of the DBP formation for the new facilities.

The design of product stabilization chemical systems and the clearwell capacity would also be based on water quality considerations, including pH, temperature, alkalinity, calcium concentration, and the effect of RO treatment system on these parameters. Blending of the RO and the RO by-pass (*i.e.*, the fraction of the IM effluent that is not treated by the RO) is a common solution.

2.7 FLOW-WEIGHTED AVERAGES VERSUS SIMPLE AVERAGES

The “average” water quality presented in Table 2.1 is a simple average of the quality in all of the wells in the system for which there are data for each sampling event. This sort of simple average, in essence, assumes equal flow between the wells. Well flow data is not available during most of the time period when water quality samples were collected, and thus it is not possible to directly check this assumption for most of the water quality samples; however, recent well flow data is available, and this data can be used to check the well flow during recent water quality sampling. The distribution of production between the wells from 2009 to 2014 is shown in Figure 2.1 and a trend of the monthly well production is shown in Figure 2.2. These figures show unequal well flows over this time period, and significant variation in production between wells. The difference between the assumption of equal well flow (simple averages) and correcting for unequal well flow (Flow-weighted averages) could increase when the water quality varies significantly from one well to the next. In the operating practice on MCBCMP, wells are brought on- and offline as needed according to their need for mechanical repair (MCBCP, 2014), suggesting that flow-weighted averaging may be justified. This variation highlights the difficulty of estimating the current and future blended water quality to a high degree of precision for water quality parameters that vary significantly between wells.

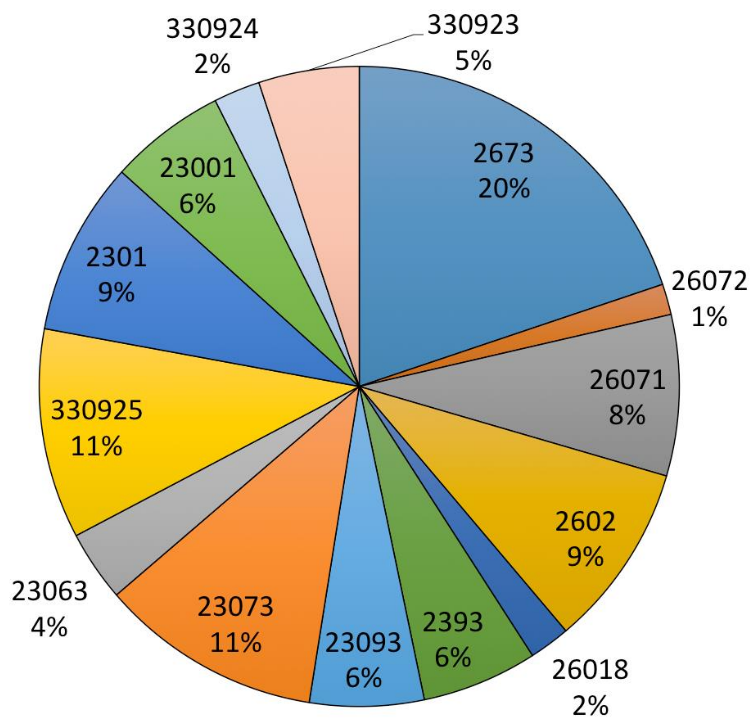

Figure 2.1 – Distribution of total well production, October 2009 to September 2014

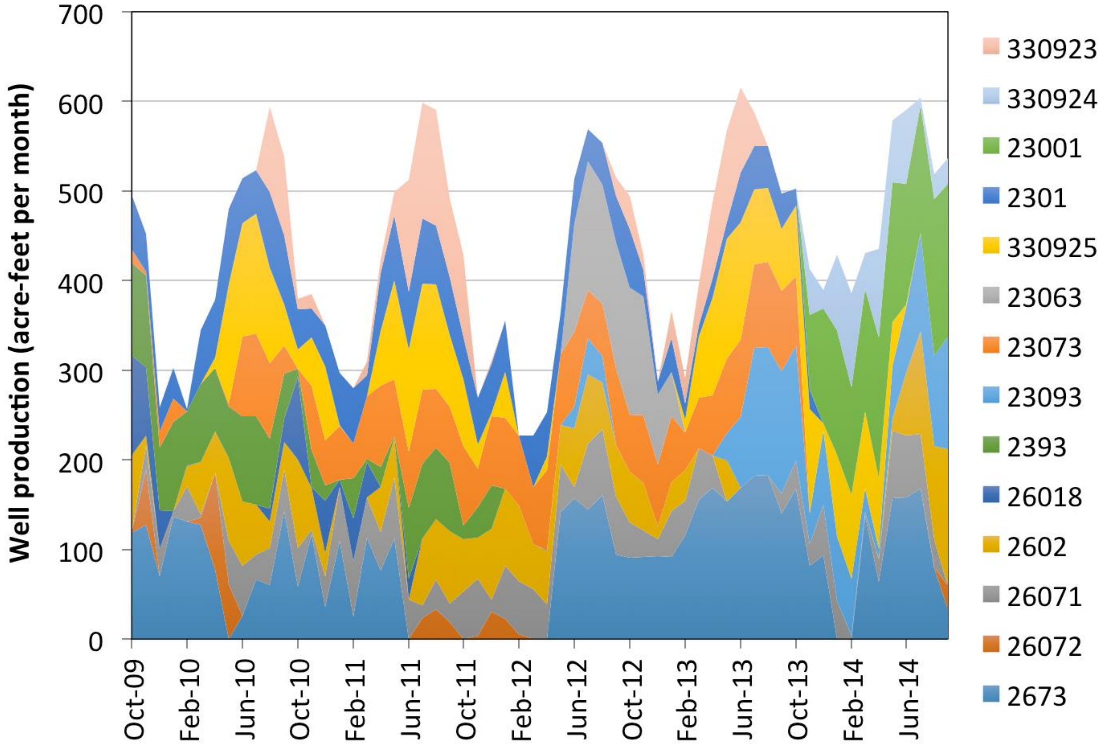

Figure 2.2 – Monthly well production, October 2009 to September 2014

The error yielded by the equal flow assumption (simple average versus flow-weighted average), and its significance, was checked for two time periods (April 2010 and April to May 2013), where both monthly well flow production and individual wellhead water quality sample data are available. In Table 2.4 and Table 2.5 the flow-weighted average is compared to the simple average. The comparison shows that the simple average is similar to the flow-weighted average for both chloride and TDS, where the concentration is similar between the wells. The TDS and chloride concentration will be used to size the RO system, and thus the low variability in the estimates of these concentrations should allow for a design that is tailored to the source water quality. The estimates for iron and manganese, on the other hand, are less similar, where the concentration varies significantly between wells. Compared to the design of the RO system, however, variability in the source water iron and manganese concentrations is less significant, as an IM system will be able to treat a wide range of influent iron and manganese concentrations to a similar effluent water quality (the difference between the sensitivity of the RO and IM system is due to the inclusion of the by-pass in the RO system design, which allows for a tailored, but sensitive product water quality). These analyses suggest that a simple average of the water quality in all the wells is just about as useful as the more sophisticated and more accurate flow-weighted average. Thus a decision was made to use simple averages in the data analysis so that more years of sampling data could be included in the summary tables.

Table 2.4 – Comparison between flow-weighted average and simple average for TDS and chloride

Parameter (units)	April 2010[2]		April to May 2013	
	FW Avg[1]	Simple Avg	FW Avg	Simple Avg
Chloride (mg/L)	157	157	161	168
TDS (mg/L)	766	762	778	812

[1] FW Avg = flow-weighted average

Table 2.5 – Comparison between flow-weighted average and simple average for iron and manganese

Parameter (units)	April 2010[2]		April to May 2013	
	FW Avg[1]	Simple Avg	FW Avg	Simple Avg
Iron (µg/L)	29	55	121	215
Manganese (µg/L)	190	261	213	186

[1] FW Avg = flow-weighted average

2.8 COMPARISON TO OTHER TIME PERIODS

A summary of wellhead water quality from individual wellhead sampling conducted from 2008 to 2011 was reported in the Draft Environmental Impact Report (USMC, 2014). These data are compared against the samples collected during 2001 through 2010, and 2013, in Table 2.6. The average value for each parameter between the two datasets is within 10%, except for the following constituents: manganese (14% decrease in the 2008 to 2011 dataset), methylene blue active substances (MBAS, 33% decrease), nitrate (79% increase), and sulfate (11% increase)). Greater variation can be seen in the maximum and minimum values, with a wider rage in the 2001 through 2010, and 2013, data set. Unlike the larger 2001 to 2010, and 2013, dataset, the maximum chloride, color, and conductivity values in 2008 to 2011 water quality data summary do not exceed the sMCLs (Recommended for chloride and Upper for conductivity).

Table 2.6 – Individual wellhead sampling water quality comparison between 2008 to 2011 and 2001 to 2010, 2013[1]

Parameter	Unit	Average (range)	
		2008-2011	2001-2010, 2013
Bicarbonate alkalinity	mg/L as $CaCO_3$	224 (169 – 320)	210 (ND – 370)
Boron	mg/L	0.13 (ND – 0.24)	0.14 (ND – 0.26)
Calcium	mg/L	92 (71 – 100)	89 (61 – 120)
Chloride	mg/L	160 (130 – 190)	161 (125 – 430)
Color	color units	5 (ND – 15)	5 (ND – 107)
Fluoride	mg/L	0.4 (0.3 – 0.5)	0.4 (ND – 2.5)
Iron	mg/L	0.097 (ND – 1.0)	0.10 (ND – 2.2)
Magnesium	mg/L	37 (24 – 45)	35 (20 – 47)
Manganese	mg/L	0.25 (ND – 0.63)	0.29 (ND – 2.8)
Methylene blue active substances	mg/L	0.002 (ND – 0.07)	0.003 (ND – 0.06)
Nitrate	mg/L as N	0.59 (ND – 5.1)	0.33 (ND – 2.7)
pH	--	7.8 (7.5 – 8.0)	7.4 (5.4 – 8.2)
Conductivity	µS/cm	1,260 (1,100 – 1,400)	1,229 (ND – 1,660)
Sulfate	mg/L	207 (120 – 260)	186 (ND – 500)
Total dissolved solids	mg/L	790 (660 – 908)	743 (499 – 960)
Total hardness	mg/L	384 (280 – 430)	367 (236 – 472)
Turbidity	NTU	2 (0 – 9)	2 (ND – 25)

[1] 2008-2011 summary of water quality data was reported in the Draft Environmental Impact Report (USMC, 2014). Sampling was conducted from in the IM-24/P-113 well field (wells 2202, 2301 (currently monitoring well), 2393, 2602, 2603, 2673, 3924, 33924 (currently monitoring well), 23063, 23073, 26018, 2671 (destroyed), 26071, 26072, 330923, and 330925. The 2001-2010, 2013 water quality data excludes well 2202.

2.9 OCCURRENCE DISTRIBUTIONS

Probability plots for select water quality constituents (TDS, chloride, manganese and iron) are shown in Figure 2.3 through Figure 2.6. The simple-averages show less variability than individual wellhead samples (where variability in water quality between wells, in addition to variability in water quality over time, also contributes to variability in the probability plot). The chloride, iron, and manganese samples each have individual wellhead samples that deviate significantly from the bulk of the samples, but occur infrequently. The closer the slopes of the individual wellhead plots and the quarterly averaged wellhead plots are to each other the more similar the concentrations of the water quality constituents are between the wells, and the flatter the slope the more similar the concentrations are from one time to the next. These probability plots confirm the stability of TDS and chloride between the wells and the variability of iron and manganese. For both iron and manganese, much of the extreme data appear to be real whereas the two high values for chloride look as if they could easily be analytical error.

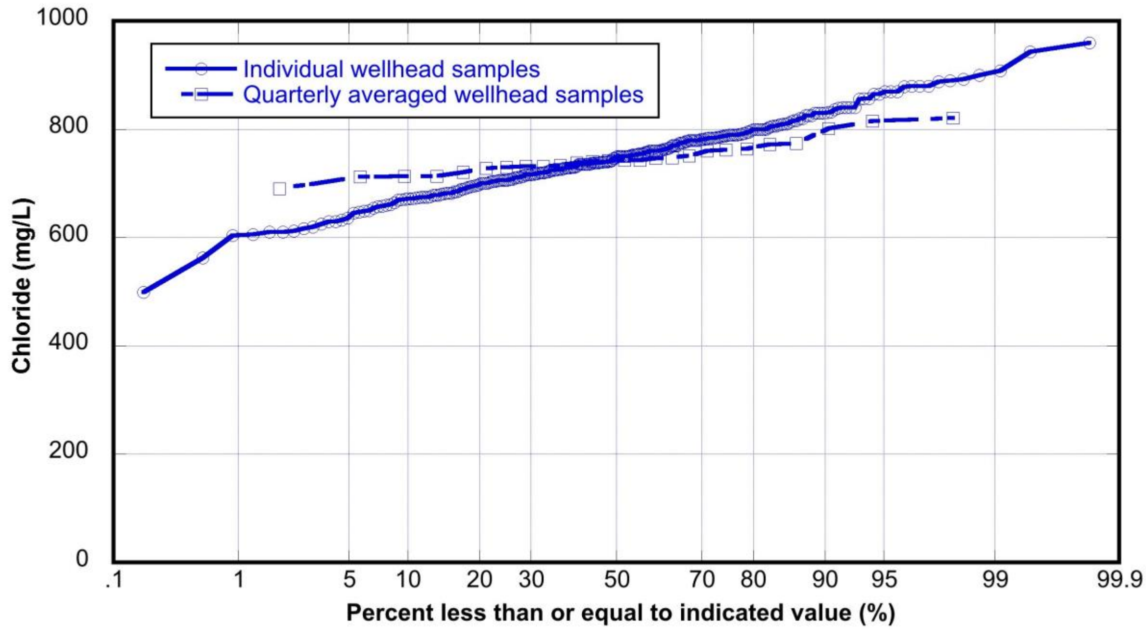

Figure 2.3 – Total dissolved solids (TDS) probability plot of 2001-2010, and 2013, wellhead sampling (quarterly averaged are simple averages)

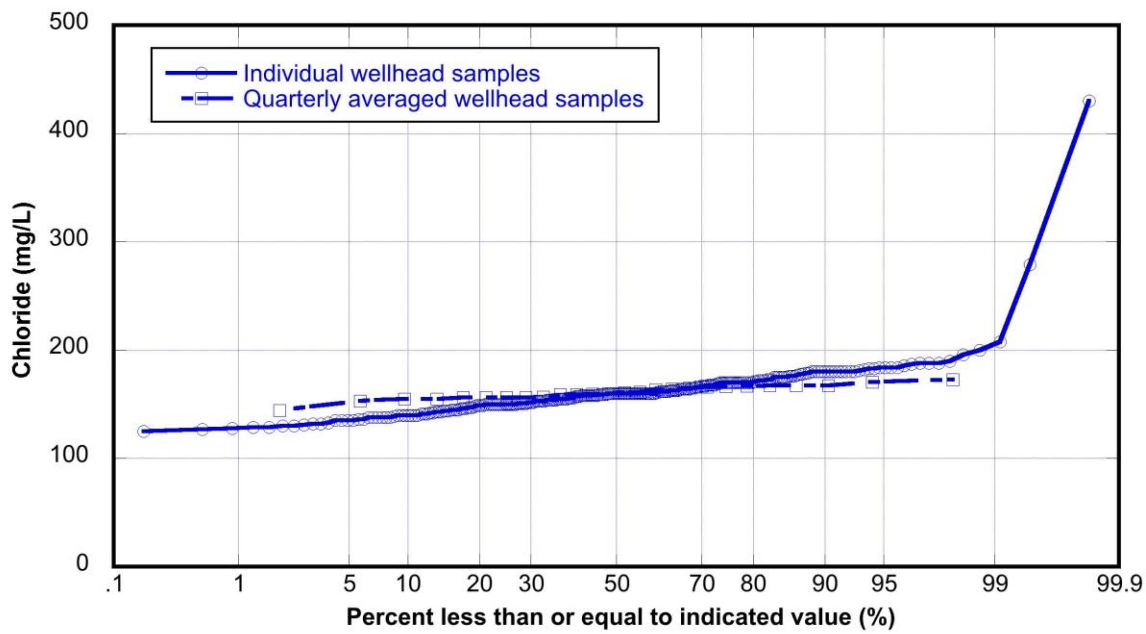

Figure 2.4 – Chloride probability plot of 2001-2010, and 2013, wellhead sampling (quarterly averaged are simple averages)

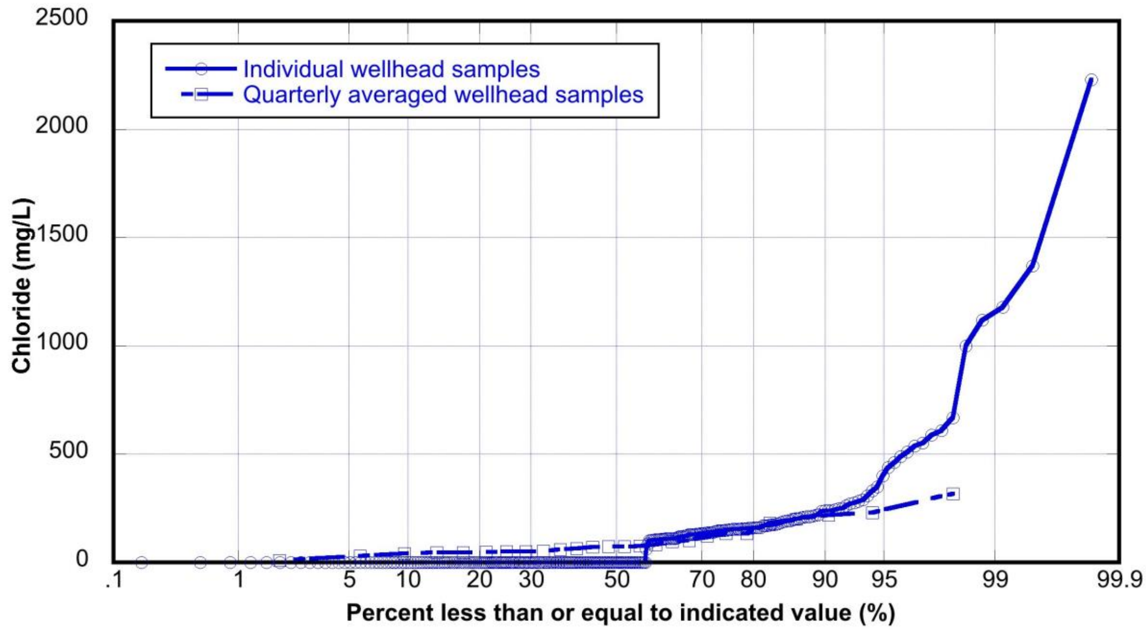

Figure 2.5 – Iron probability plot of 2001-2010, and 2013, wellhead sampling (quarterly averaged are simple averages)

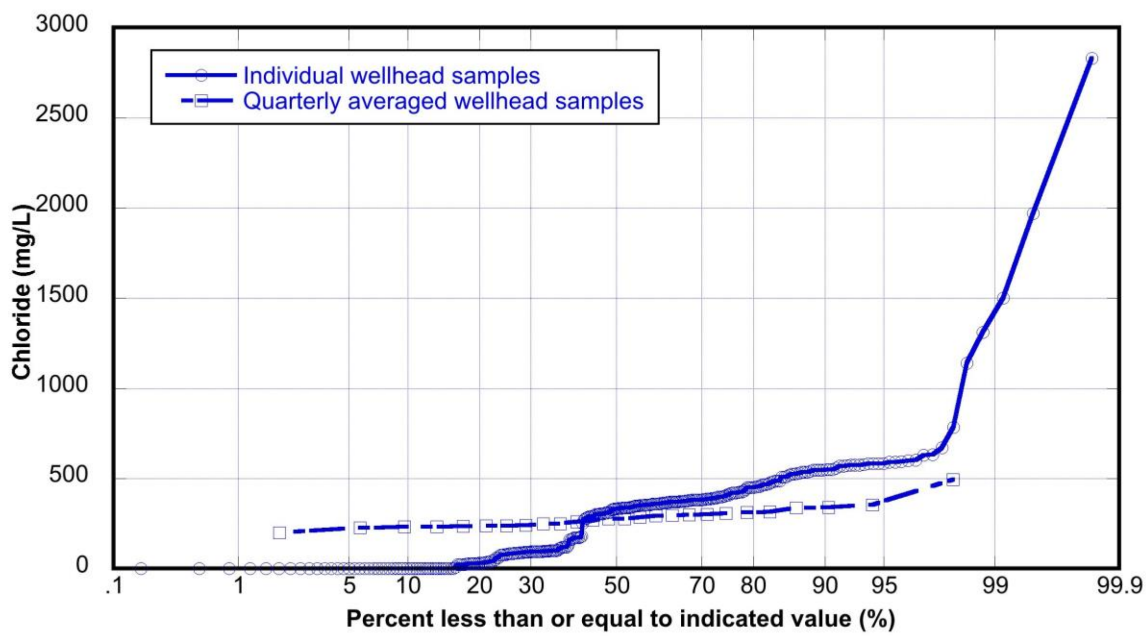

Figure 2.6 – Manganese probability plot of 2001-2010, and 2013, wellhead sampling (quarterly averaged are simple averages)

2.10 IMPACT OF SANTA MARGARITA RIVER FLOW

Water quality sampling in the Santa Margarita River reported in the Environmental Impact Report shows a TDS range of 790 to 977 during dry weather and a range of 143 to 820 during wet weather (USMC, 2014), so there is a possibility that the water withdrawn for SMRCUP would also be of better quality in wet years. If this is so, it could reduce the size of the RO system required to reduce TDS in those years, an important consideration because wet years determine the system capacity requirement. The impact of the SMR flow on TDS and chloride is examined in Figure 2.7. This plot also indicates the year type, with above normal (AN), very dry (VD), very wet (VW), and below normal (BN) years shown, per the definition of year type in the draft SMRCUP agreement (Stetson, 2009). Unfortunately, the chloride and TDS concentrations appear to be independent of the SMR flow, particularly chloride, indicating that wet weather flows with low TDS and chloride and dry weather flows with higher mineral content mix well in the infiltration basins and aquifers prior to withdrawal through pumping. Thus, it seems that the SMRCUP project will only indirectly benefit from the better quality water available in wet years.

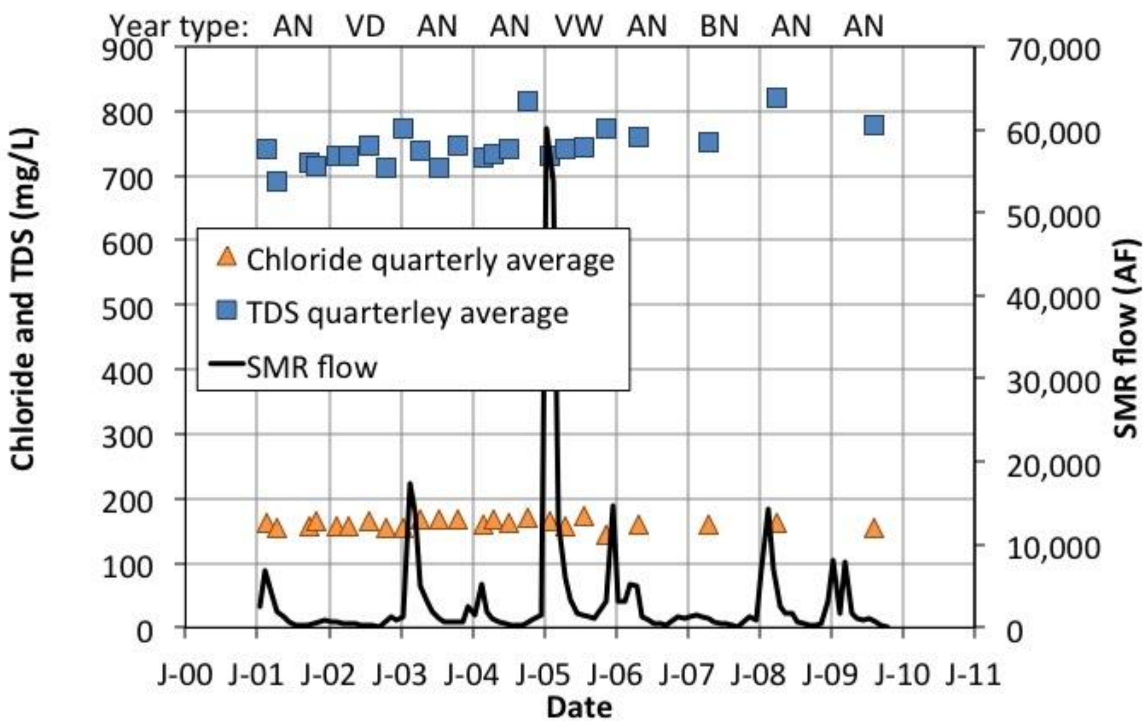

Figure 2.7 – Impact of SMR flow on wellhead TDS and chloride, 2001-2009 (quarterly averaged are simple averages)

The Environmental Impact Report offers several sources for the high concentrations of TDS found in the MCBCP aquifers (USMC, 2014), namely the following:

- Local geological formations,
- Wastewater discharges from the MCB Camp Pendleton (until waste streams were recycled through the Southern Region Tertiary Treatment Plant (SRTTP)), and
- High concentrations of TDS in the SMR (contributed by development and the geology of the watershed).

3 DESIGN WATER QUALITY

The design of the new SMRCUP treatment facilities requires assumed water quality values for specific constituents based on the raw water quality. The recommended design water quality is presented in this section. Specifically, a design water quality is recommended for constituents with regulatory limits, for constituents with health advisory limits for which water quality data is available, and for the design of IM and RO systems. The design water qualities may vary between the IM and the RO design, as their designs depend on differing considerations.

3.1 CONSTITUENTS WITH REGULATORY AND HEALTH-ADVISORY LIMITS

Given that all constituents with pMCLs were estimated to be present in the blended source water at concentrations less than half of their pMCLs, the recommended design assumption is that constituents with pMCLs will be present at concentrations less than their pMCLs in the source water.

Several constituents with sMCLs exceeded their sMCLs in the maximum estimated source water (color, iron), while other exceeded their sMCLs on averaged in the estimated source water (manganese, and both conductivity and TDS with respect to the Recommended sMCL), while others were close to their sMCL in the maximum blended estimate, to varying degrees (odor, chloride, sulfate and turbidity). These constituents may require IM and RO treatment and their recommended design values are presented in the subsequent section. The recommended design value for the remaining constituents with sMCLs (aluminum, copper, MBAS, silver, zinc) is that they will be present at concentrations less than their sMCL in the source water. Further, no constituent is expected to exceed its Upper sMCLs in the source water (neither chloride, conductivity, sulfate nor TDS).

It is our understanding that it is MCBCP’s practice to remove wells from service when they exhibit detectable concentration of TCP, only returning those wells to service if TCP concentrations return to undetectable levels. Assuming this practice, a design concentration of less than the NL is recommended for TCP. The other constituents with NLs for which sampling was conducted (vanadium and boron) were present at concentrations less than half of their NL in the estimated blend; thus, the recommended design values for these constituents is also that they will be present at concentrations less than their NL.

3.2 DESIGN WATER QUALITY FOR IM AND RO DESIGN

Recommended design water quality values for constituents relevant to the design of the IM and RO system are presented in Table 3.1 through Table 3.3, where water quality values related to RO design are divided into two categories: those relevant to determining the RO capacity (Table 3.2) and those relevant to determining RO pretreatment and recovery (Table 3.3). The recommended design water quality values were based on the estimated water quality and regulatory limits, which are included in the tables for reference (the design water quality values are based on the reference values shown in black font; the grey font indicates values that did not form the basis of the design water quality values). Rounding was applied to the estimated water quality and regulatory limits to arrive at the recommended design water quality values. Design considerations, deviations from the United States Bureau of Reclamation (USBR) feasibility design (USBR 2013), and recommendations for additional sampling are introduced below(the USBR developed a feasibility-level design in 2013 for the SMRCUP facilities, which included proposed design water quality values).

Design of the IM system is largely a function of the iron and manganese concentrations; however, other factors may influence the design. Natural organic matter (NOM), for whose concentration color and TOC may offer a surrogate, may complex with iron, decreasing its oxidation efficiency. The pH of the water may also affect the time required for oxidation. The oxidation reaction requires alkalinity, which must be present at a sufficiently high concentration. Aluminum affects the removal of manganese through the structure of precipitate that is formed. In addition to iron and manganese removal through the filters, turbidity will also be removed, contributing to headloss. As discussed previously, the concentration of iron that is removed in the filters will affect the settleability of the manganese particulates should washwater recovery be considered in the design. Design values for these parameters are included in Table 3.1, based on the minimum, average, maximum, and regulatory limit as appropriate.

As discussed previously, specific water quality goals, such as chloride, may govern the size of the RO facility. Assuming the water quality goals are based on averages, the appropriate design water quality values would also be averages. The recommended design water quality values for constituents of potential interest, based on the estimated average water quality, are shown in Table 3.2.

As discussed previously, the RO recovery is dictated by the solubility of specific constituents. The estimated blended maximum of these constituents is recommended for their design water quality values. The solubility of scaling minerals is also affected by the ionic strength of the RO feed water (which may be estimated by TDS or conductivity), with decreasing ionic strength leading to decreased solubility. Lastly, the pH also impacts solubility, with low pH conditions leading to an increase in the solubility of most scaling minerals (*e.g.*, calcium phosphate minerals), yet leading to a decrease in solubility of other minerals (*e.g.*, silica). Recommended design water quality values, based on the maximum estimated concentration of scaling constituents, the minimum ionic strength, and a range of pH conditions, are shown in Table 3.3. The iron and manganese concentrations reflect an assumed removal of 97% through the IM system. Similarly, the turbidity value reflects an assumed IM system effluent turbidity.

In addition to the IM and RO process, disinfection and product stabilization design will depend on the source water quality. Sufficient data is available for the design of these processes with the exception that disinfection by-product (DBP) testing should be conducted to evaluate if DBP formation in the new facilities and distribution system will occur to an acceptable degree.

Table 3.1 – Recommended design water quality for iron and manganese treatment system design[1]

Parameter	Units	Design Water Quality	Regulatory Limit	Water Quality from Table 2.1		
				Min	Avg	Max
Alkalinity as $CaCO_3$	mg/L	170	--	170	199	223
Aluminum	µg/L	ND	1000 pMCL 200 sMCL	ND	ND	ND
Color - Apparent	color units	20	15 sMCL	ND	5	18
Conductivity (EC)	µS/cm	1600	900 Rec. sMCL[2] 1600 Upper sMCL	1030	1230	1317
Iron	µg/L	10 min 400 max	300 sMCL	11	101	317
Manganese	µg/L	500	50 sMCL	199	283	494
pH	--	7.1	--	7.1	7.4	7.9
Total Dissolved Solids (TDS)	mg/L	900	500 Rec. sMCL 1000 Upper sMCL	690	748	821
Total Organic Carbon (TOC)	mg/L	3.5	--	1.4	2.0	6.4[3]
Turbidity	NTU	0.8	5 sMCL	0.06	0.76	2.6

[1] Regulatory limits and min, avg, and max water quality shown in black font used as basis for design water quality; those in grey font were not used as basis

[2] DDW Recommended Secondary Maximum Contaminant Level

[3] A max value of 3.4 mg/L is recommended for the basis of design, due to validity concerns surrounding the 6.4-mg/L value (see footnote in Table 2.1 for discussion)

Table 3.2 – Recommended design water quality for reverse osmosis system sizing[1]

Parameter	Units	Design Water Quality	Regulatory Limit	Water Quality from Table 2.1		
				Min	Avg	Max
Boron	µg/L	135	1000 NL	41	137	191
Calcium	mg/L	100	--	80	89	94
Chloride	mg/L	165	250 Rec. sMCL[2] 500 Upper sMCL	145	161	173
Conductivity (EC)	µS/cm	1230	900 Rec. sMCL 1600 Upper sMCL	1030	1230	1317
Magnesium	mg/L	40	--	31	37	68
Sodium	mg/L	115	--	95	115	132
Total Dissolved Solids (TDS)	mg/L	750	500 Rec. sMCL 1000 Upper sMCL	690	748	821

[1] Min, avg, and max water quality shown in black font used as basis for design water quality; those in grey font were not used as basis

[2] DDW Recommended Secondary Maximum Contaminant Level

Table 3.3 – Recommended design water quality for reverse osmosis system recovery and pretreatment design[1]

Parameter	Units	Design Water Quality	Regulatory Limit	Water Quality from Table 2.1		
				Min	Avg	Max
Ammonia	mg/L	ND[2]	--	--	--	--
Alkalinity as $CaCO_3$	mg/L	230	--	170	199	223
Aluminum	µg/L	ND	1000 pMCL 200 sMCL	ND	ND	ND
Barium	µg/L	140	1,000 pMCL	ND	59	140
Boron	µg/L	200	1000 NL	41	137	191
Calcium	mg/L	100	--	80	89	94
Chloride	mg/L	175	250 Rec. sMCL[6] 500 Upper sMCL	145	161	173
Conductivity (EC)	µS/cm	1030	900 Rec. sMCL 1600 Upper sMCL	1030	1230	1317
Fluoride	mg/L	0.7	2 pMCL	0.1	0.4	0.7
Iron	µg/L	12[3]	300 sMCL	11	101	317
Magnesium	mg/L	70	--	31	37	68
Manganese	µg/L	15[3]	50 sMCL	199	283	494
Nitrate as NO_3	mg/L	4.0	45 pMCL	0.4	1.6	4.0
pH	--	7.1 – 7.8[4]	--	7.1	7.4	7.9
Phosphate	mg/L	ND[2]	--	--	--	--
Potassium	mg/L	6.0	--	2.5	3.6	5.6
Silica	mg/L	30	--	24.0	27.2	30.0
Sodium	mg/L	135	--	95	115	132
Strontium	mg/L	0.70	--	0.55	0.58	0.70
Sulfate	mg/L	210	250 Rec. sMCL 500 Upper sMCL	63	186	208
Total Dissolved Solids (TDS)	mg/L	690	500 Rec. sMCL 1000 Upper sMCL	690	748	821
Total Organic Carbon (TOC)	mg/L	3.5	--	1.4	2.0	6.4[7]
Turbidity	NTU	0.5[5]	5 sMCL	0.06	0.76	2.6

[1] Min, avg, and max water quality shown in black font used as basis for design water quality; those in grey font were not used as basis

[2] Assumed to present at non-detectable concentrations in the groundwater

[3] Assuming 97% removal of IM design water quality concentrations

[4] Design value depends on controlling scalants and pretreatment strategy

[5] Assumed IM effluent turbidity

[6] DDW Recommended Secondary Maximum Contaminant Level

[7] A max value of 3.4 mg/L is recommended for the basis of design, due to validity concerns surrounding the 6.4-mg/L value (see footnote in Table 2.1 for discussion)

4 CONCLUSIONS

Sufficient water quality data were reviewed to develop preliminary design water quality assumptions for the design of the new SMRCUP facilities. The data suggests – depending on treatment goals – that IM and RO treatment may be required. Further, the manganese to iron ratio and the DIC concentration is high, indicating the potential need for ferric chloride addition to the washwater and orthophosphate addition to the product water, in addition to disinfection and product water stabilization.

Additional DBP-formation testing is recommended, as DPB formation may be high for a groundwater given the high TOC concentration.

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APPENDIX

The following tables are included in the appendix:

- Table A1 – Individual wellhead sampling expanded summary: 2001 to 2010, 2013, and
- Table A2 – Simple-averages of wellhead sampling expanded summary (quarterly averages are simple averages): 2001 to 2010, 2013.

These tables include data from the following wells: 2301 (currently monitoring well), 23063, 23073, 2393, 26018, 2602, 2603, 2671 (destroyed), 26071, 26072, 2673, 330923, 330925, and 33924 (currently monitoring well). They do not include data from well 2202 due to continued TCP detections. Further, the reported tritium counting error ranged from 117 to 216. Lastly, the tables also include the following acronyms:

- TT is treatment technique,
- ND is below the method reporting limit, and
- NA is not applicable.

Table A1 – Individual wellhead sampling expanded summary: 2001 to 2010, 2013

			All samples								
Parameter	**Units**	**Reg. Limit**	**Min**	**5th**	**10th**	**50th**	**Avg**	**90th**	**95th**	**Max**	**No.**
Microbiological parameters											
Coliform	P (1) / A (0)	--	ND	ND	ND	ND	0	ND	ND	1	194
E. Coli	P (1) / A (0)	TT	ND	ND	ND	ND	ND	ND	ND	ND	194
Heterotrophic Plate Count	CFU/100ml	--	ND	ND	ND	3	24	51	95	741	194
General water quality parameters without regulatory or advisory levels											
Aggressive Index	--	--	8	12	12	12	12	13	13	13	225
Alkalinity as $CaCO_3$	mg/L	--	ND	153	162	200	201	240	247	370	225
Bicarbonate Alkalinity	mg/L	--	ND	145	167	215	210	269	284	370	225
Calcium	mg/L	--	61	76	80	89	89	99	101	120	229
Carbonate Alkalinity	mg/L	--	ND	ND	ND	ND	0.0	ND	ND	2.8	246
Magnesium	mg/L	--	20	27	29	35	35	43	44	47	229
pH	--	--	5.40	7.00	7.04	7.30	7.39	7.80	7.90	8.20	255
Potassium	mg/L	--	ND	2.0	2.5	3.5	3.6	5.0	6.0	7.0	229
Sodium	mg/L	--	82	93	98	116	116	133	136	150	229
Total Hardness	mg/L	--	236	303	320	362	367	425	434	472	229
Total Organic Carbon (TOC)	mg/L	--	1.0	1.3	1.3	1.8	2.1	2.4	2.7	34.1	256
Primary Maximum Contaminant Levels (pMCL) or Action Levels (AL)											
Inorganic chemicals											
Aluminum	µg/L	1,000 pMCL 200 sMCL	ND	ND	ND	ND	ND	ND	ND	ND	255
Antimony	µg/L	6 pMCL	ND	ND	ND	ND	0.02	ND	ND	3.00	255
Arsenic	µg/L	10 pMCL	ND	ND	ND	ND	1	3	3	14	255
Asbestos	MFL	7 pMCL	ND	NA	NA	ND	ND	NA	NA	ND	84
Barium	µg/L	1,000 pMCL	ND	NA	ND	ND	56	126	NA	292	134
Beryllium	µg/L	4 pMCL	ND	ND	ND	ND	0.01	ND	ND	1.00	263
Cadmium	µg/L	5 pMCL	ND	ND	ND	ND	ND	ND	ND	ND	255
Chromium	µg/L	50 pMCL	ND	ND	ND	ND	0.010	ND	ND	1.450	255
Copper	µg/L	1,300 AL 1,000 sMCL	ND	ND	ND	ND	3	ND	ND	612	255
Cyanide	µg/L	150 pMCL	ND	ND	ND	ND	ND	ND	ND	ND	214
Fluoride	mg/L	2 pMCL	ND	0.2	0.3	0.4	0.4	0.5	0.5	2.5	229
Lead	µg/L	15 pMCL	ND	ND	ND	ND	0.1	ND	ND	9.1	255
Mercury	µg/L	2 pMCL	ND	ND	ND	ND	ND	ND	ND	ND	255
Nickel	µg/L	100 pMCL	ND	ND	ND	ND	0	ND	ND	109	255
Nitrate + Nitrite as N	µg/L	10,000 pMCL	ND	ND	ND	ND	306	1100	1395	2600	202
Nitrate as NO_3	mg/L	45 pMCL	ND	ND	ND	ND	1.5	5.1	6.9	12.0	238
Nitrite as N	µg/L	1,000 pMCL	ND	ND	ND	ND	4	ND	ND	630	258
Perchlorate	µg/L	6 pMCL	ND	ND	ND	ND	ND	ND	ND	ND	13
Selenium	µg/L	50 pMCL	ND	ND	ND	ND	0	ND	ND	41	255
Thallium	µg/L	2 pMCL	ND	ND	ND	ND	ND	ND	ND	ND	255
Radionuclides											
Gross Alpha	pCi/L	15 pMCL	ND	ND	ND	3	3	5	6	8	301
Gross Beta	pCi/L	50 pMCL	-1	ND	ND	2	2	4	5	14	157
Radium 226	pCi/L	5 pMCL	ND	ND	ND	0.12	0.15	0.32	0.37	0.83	107
Radium 228	pCi/L	(Ra226+Ra228)	ND	ND	ND	ND	0.3	1.2	1.8	3.1	98
Strontium 90	pCi/L	8 pMCL	-0.28	ND	ND	ND	0.06	0.13	0.29	4.95	157
Uranium	pCi/L	20 pMCL	ND	0.28	0.64	1.63	1.74	2.86	3.17	5.46	93
Volatile Organic Chemicals (VOCs)											
cis-1,2-Dichloroethylene	µg/L	6 pMCL	ND	ND	ND	ND	0.01	ND	ND	0.68	148
Dichloromethane	µg/L	5 pMCL	ND	ND	ND	ND	0.01	ND	ND	0.58	129
Trichloroethylene	µg/L	5 pMCL	ND	ND	ND	ND	0.06	ND	ND	2.60	134
Non-Volatile Synthetic Organic Chemicals (SOCs)											
Pentachlorophenol	µg/L	1 pMCL	ND	ND	ND	ND	0.02	ND	ND	0.67	37
Disinfection by-products (DPBs)											
Total THM	µg/L	80 pMCL	ND	ND	ND	ND	0.1	ND	ND	6.5	247
Secondary Maximum Contaminant Levels (sMCL)											
Chloride	mg/L	250 Rec. sMCL 500 Upper sMCL	125	135	140	160	161	180	184	430	229
Color - Apparent	color units	15 sMCL	ND	ND	ND	2	5	10	14	107	251
Conductivity (EC)	µS/cm	900 Rec. sMCL 1,600 Upper sMCL	ND	1070	1120	1230	1229	1350	1380	1660	225
Foaming Agents (MBAS)	mg/L	0.5 sMCL	ND	ND	ND	ND	0.001	ND	ND	0.063	93
Iron	µg/L	300 sMCL	ND	ND	ND	ND	97	214	315	2230	274
Manganese	µg/L	50 sMCL	ND	ND	ND	332	290	548	582	2830	262
Odor	TON	3 sMCL	ND	ND	ND	ND	0.2	1.0	1.0	3.0	227
Silver	µg/L	100 sMCL	ND	ND	ND	ND	ND	ND	ND	ND	255
Sulfate	mg/L	250 Rec. sMCL 500 Upper sMCL	ND	130	148	186	186	234	246	500	229
Total Dissolved Solids (TDS)	mg/L	500 Rec. sMCL 1,000 Upper sMCL	499	640	672	739	743	817	857	960	229
Turbidity	NTU	5 sMCL	ND	ND	ND	ND	0.8	1.5	2.5	25.3	244
Zinc	µg/L	5,000 sMCL	ND	ND	ND	ND	2	ND	ND	228	254
Notification Levels (NLs)											
1,2,3-TCP (1997-2008, 2013)	µg/L	0.005 NL	ND	ND	ND	ND	0.000	ND	ND	0.008	388
Boron	µg/L	1,000 NL	ND	ND	ND	164	137	211	224	264	162
Carbon Disulfide	µg/L	160 NL	ND	ND	ND	ND	0.002	ND	ND	0.077	45
Vanadium	µg/L	50 NL	ND	ND	ND	5	5	12	13	14	167

Table A2 – Quarterly averaged wellhead sampling expanded summary: 2001 to 2010, 2013

			Quarterly averaged									
Parameter	**Units**	**Reg. Limit**	**Min**	**5th**	**10th**	**50th**	**Avg**	**90th**	**95th**	**Max**	**Quarters**	**No.**
Microbiological parameters												
Coliform	P (1) / A (0)	--	0%	0%	0%	0%	1%	8%	9%	9%	20	194
E. Coli	P (1) / A (0)	TT	A	A	A	A	A	A	A	A	20	194
Heterotrophic Plate Count	CFU/100ml	--	1	1	2	11	24	78	83	84	20	194
General water quality parameters without regulatory or advisory levels												
Aggressive Index	--	--	11	12	12	12	12	13	13	13	26	225
Alkalinity as $CaCO_3$	mg/L	--	170	171	180	203	199	213	222	223	26	225
Bicarbonate Alkalinity	mg/L	--	42	88	183	209	210	251	255	256	26	225
Calcium	mg/L	--	80	82	85	90	89	93	94	94	26	229
Carbonate Alkalinity	mg/L	--	ND	ND	ND	ND	0.0	ND	0.6	0.9	26	246
Magnesium	mg/L	--	31	31	32	36	35	37	38	38	26	229
pH	--	--	7.07	7.07	7.10	7.33	7.39	7.81	7.86	7.87	26	255
Potassium	mg/L	--	2.5	2.6	2.9	3.3	3.6	5.3	5.5	5.6	26	229
Sodium	mg/L	--	95	98	104	116	115	124	130	132	26	229
Total Hardness	mg/L	--	328	331	344	372	369	386	389	390	26	229
Total Organic Carbon (TOC)	mg/L	--	1.4	1.4	1.5	1.8	2.0	2.7	5.4	6.4	26	256
Primary Maximum Contaminant Levels (pMCL) or Action Levels (AL)												
Inorganic chemicals												
Aluminum	µg/L	1,000 pMCL 200 sMCL	ND	ND	ND	ND	ND	ND	ND	ND	26	255
Antimony	µg/L	6 pMCL	ND	ND	ND	ND	0.02	0.05	0.26	0.30	26	255
Arsenic	µg/L	10 pMCL	0	0	0	1	1	2	2	3	26	255
Asbestos	MFL	7 pMCL	ND	NA	NA	ND	ND	NA	NA	ND	1	84
Barium	µg/L	1,000 pMCL	ND	NA	18	49	59	104	NA	140	17	134
Beryllium	µg/L	4 pMCL	ND	ND	ND	ND	0.01	ND	0.16	0.25	26	263
Cadmium	µg/L	5 pMCL	ND	ND	ND	ND	ND	ND	ND	ND	23	225
Chromium	µg/L	50 pMCL	ND	ND	ND	ND	0.010	0.023	0.145	0.181	26	255
Copper	µg/L	1,300 AL 1,000 sMCL	ND	ND	ND	ND	4.0	8.8	58.1	82.3	26	255
Cyanide	µg/L	150 pMCL	ND	ND	ND	ND	ND	ND	ND	ND	22	214
Fluoride	mg/L	2 pMCL	0.1	0.2	0.3	0.4	0.4	0.5	0.6	0.7	26	229
Lead	µg/L	15 pMCL	ND	ND	ND	ND	0.1	0.2	1.0	1.1	26	255
Mercury	µg/L	2 pMCL	ND	ND	ND	ND	ND	ND	ND	ND	26	255
Nickel	µg/L	100 pMCL	ND	ND	ND	ND	1	1	8	12	26	255
Nitrate + Nitrite as N	µg/L	10,000 pMCL	89	NA	195	388	380	680	NA	820	21	202
Nitrate as NO_3	mg/L	45 pMCL	0.4	0.5	0.8	1.7	1.7	3.2	3.8	4.0	25	238
Nitrite as N	µg/L	1,000 pMCL	ND	ND	ND	ND	3	6	48	63	26	258
Perchlorate	µg/L	6 pMCL	ND	ND	ND	ND	ND	ND	ND	ND	1	13
Selenium	µg/L	50 pMCL	ND	ND	ND	ND	0	1	4	4	26	255
Thallium	µg/L	2 pMCL	ND	ND	ND	ND	ND	ND	ND	ND	26	255
Radionuclides												
Gross Alpha	pCi/L	15 pMCL	ND	0	1	3	3	4	4	5	26	301
Gross Beta	pCi/L	50 pMCL	ND	NA	1	2	2	3	NA	3	16	157
Radium 226	pCi/L	5 pMCL	ND	NA	0.00	0.15	0.18	0.36	NA	0.48	17	107
Radium 228	pCi/L	(Ra226+Ra228)	ND	NA	ND	0.6	0.9	2.4	NA	3.1	15	98
Strontium 90	pCi/L	8 pMCL	-0.03	NA	-0.01	ND	0.07	0.37	NA	0.62	15	157
Uranium	pCi/L	20 pMCL	1.08	1.10	1.22	1.78	2.00	3.31	3.96	4.04	23	93
Volatile Organic Chemicals (VOCs)												
cis-1,2-Dichloroethylene	µg/L	6 pMCL	ND	ND	ND	ND	0.00	0.00	0.05	0.05	20	148
Dichloromethane	µg/L	5 pMCL	ND	ND	ND	ND	0.01	0.06	0.08	0.08	19	129
Trichloroethylene	µg/L	5 pMCL	ND	ND	ND	ND	0.08	0.35	0.87	0.87	19	134
Non-Volatile Synthetic Organic Chemicals (SOCs)												
Pentachlorophenol	µg/L	1 pMCL	ND	NA	NA	ND	0.01	NA	NA	0.07	8	37
Disinfection by-products (DPBs)												
Total THM	µg/L	80 pMCL	ND	ND	ND	ND	0.1	0.4	0.7	0.8	24	247
Secondary Maximum Contaminant Levels (sMCL)												
Chloride	mg/L	250 Rec. sMCL 500 Upper sMCL	145	148	154	161	161	168	172	173	26	229
Color - Apparent	color units	15 sMCL	ND	ND	1	4	5	15	17	18	26	251
Conductivity (EC)	µS/cm	900 Rec. sMCL 1,600 Upper sMCL	1030	1079	1192	1234	1230	1278	1305	1317	26	225
Foaming Agents (MBAS)	mg/L	0.5 sMCL	ND	NA	NA	0.002	0.003	NA	NA	0.007	8	93
Iron	µg/L	300 sMCL	11	18	38	74	101	222	286	317	26	274
Manganese	µg/L	50 sMCL	199	209	230	276	283	343	445	494	26	262
Odor	TON	3 sMCL	ND	ND	ND	ND	0.3	1.5	1.6	1.7	26	227
Silver	µg/L	100 sMCL	ND	ND	ND	ND	ND	ND	ND	ND	26	255
Sulfate	mg/L	250 Rec. sMCL 500 Upper sMCL	63	97	170	193	186	207	208	208	26	229
Total Dissolved Solids (TDS)	mg/L	500 Rec. sMCL 1,000 Upper sMCL	690	698	713	743	748	806	819	821	26	229
Turbidity	NTU	5 sMCL	0.06	0.10	0.18	0.45	0.76	2.1	2.4	2.6	26	244
Zinc	µg/L	5,000 sMCL	ND	ND	ND	ND	2	13	28	29	26	254
Notification Levels (NLs)												
1,2,3-TCP (1997-2008, 2013)	µg/L	0.005 NL	ND	ND	ND	ND	0.000	0.000	0.001	0.001	39	388
Boron	µg/L	1,000 NL	41	NA	42	161	137	183	NA	191	16	162
Carbon Disulfide	µg/L	160 NL	ND	NA	NA	ND	0.003	NA	NA	0.019	7	45
Vanadium	µg/L	50 NL	2	NA	2	4	5	9	NA	10	17	167

APPENDIX C

TECHNICAL MEMORANDUM NO. 2

TECHNICAL MEMORANDUM NO. 2 (TM 2)

Santa Margarita Conjunctive Use Project Facilities Predesign
for the Fallbrook Public Utility District

Draft Date: March 17, 2015
Final Date: August 28, 2015

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Job Number: 126.001

Subject: Water Quality Goals for the Fallbrook Public Utility District Santa Margarita River Conjunctive Use Project Facilities

EXECUTIVE SUMMARY

The purpose of this Technical Memorandum (TM) is to propose water quality goals for the Santa Margarita River Conjunctive Use Project (SMRCUP) and to provide a discussion of treatment processes that may be required to reach those goals. A subsequent TM (TM 3) will evaluate the feasibility of achieving the recommended water quality goals and recommend treatment processes, design capacity, and a project phasing.

The recommended goals are summarized in Table ES.1. These goals were developed based on consideration of the uses of the water (agricultural, potable consumption); the context of providing two major water sources in one distribution system (the SMRCUP water and imported water); the impact on recycled water quality; and past experience with waters from the same source (the south Marine Corps Base Camp Pendleton system). The reasoning behind the goals and detail of the goals is discussed in the body of the TM. The goals, which have the most impact on treatment, are those for iron, manganese and chloride.

Table ES.1 – Summary of recommended water quality goals for the SMRCUP[1]

Parameters	Units	Goals (descriptive)	Goals (quantitative)	Addresses
Iron	µg/L	Match existing supply	< 100	Aesthetics
Manganese	µg/L	Match existing supply	< 20	Aesthetics
Chloride	mg/L	Match existing supply	< 100 3-month avg (max) ≤ 87 long-term ≤ 87 Apr-Sept, when possible	Avocados & agriculture
TDS	mg/L	Meet accepted standard & match existing supply	≤ 483	Aesthetics
EC	µS/cm	Meet accepted standard & match existing supply	≤ 819	Aesthetics
SDSTHMs	µg/L	Conservative target	< 80% of pMCL	Regulation
SDSHAAs	µg/L	Conservative target	< 80% of pMCL	Regulation
LSI	--	Match existing supply	0.37 (0.1-1.0)	Corrosion
CCPP	mg/L as $CaCO_3$	Match existing supply	5.2 (1.0-10)	Corrosion
Calcium hardness	mg/L as $CaCO_3$	Match existing supply	≤ 133	Scale formation

[1] Water quality goals are averages unless otherwise indicated

A preliminary list of the required treatment technologies to meet these goals is as follows:

- Iron and manganese treatment with a backwash recovery system,
- Partial reverse osmosis (RO) treatment,
- Primary disinfection (*e.g.*, with free chlorine),
- Secondary disinfection with chloramines,
- Product water pH adjustment (*e.g.*, caustic addition), and
- Facilities for adding orthophosphate for copper corrosion control.

With the above treatment technologies, it is expected that the SMRCUP can provide a safe, reliable, and agriculturally productive water supply that meets all regulatory limits, recommended consumer acceptance levels, and essentially maintains or bests the quality of the imported water quality with respect to agricultural uses.

1 INTRODUCTION

Water quality goals for the Fallbrook Public Utility District (FPUD) Santa Margarita River Conjunctive Use Project (SMRCUP) facilities and treatment that may be required to reach those goals are discussed in this Technical Memorandum (TM). TM 1 preceded this TM with a characterization of the raw water quality. TM 3, which will follow this TM, will provide a recommendation for treatment technologies, as well as recommendations for design flow, project phasing, and evaluation of the feasibility of meeting the goals proposed in this TM.

1.1 BACKGROUND

The new facilities will receive groundwater from wells located on Marine Corps Base Camp Pendleton (MCBCP). The volume of water delivered by MCBCP will depend on the Santa Margarita River (SMR) flow, with higher SMR flows corresponding to larger deliveries (expected deliveries range from 0 to 7.8 MGD, depending on the proceeding year type and the month, and are fixed at a given flow rate over the month). The new facilities will treat this water with treatment processes that have not yet been finalized. The selection of treatment processes will result from the evaluation of the source water quality characterization (TM 1), the development of treatment goals (TM 2), and the evaluation of treatment alternatives (TM 3). After treatment at the new facilities, the product water will be conveyed to consumers via a tap into the existing distribution system or via Red Mountain reservoir. IEC will recommend the final conveyance system, although preliminary analysis by IEC shows that the conveyance system will likely tap into the distribution system.

The characterization of the raw water quality (TM 1) showed that the raw SMRCUP water is high in iron, manganese, total dissolved solids (TDS), chloride, color, and conductivity with respect to their Secondary Maximum Contaminant Levels (sMCLs) that are recommended by the Division of Drinking Water (DDW). The concentrations of these constituents can be reduced through iron and manganese (IM) and reverse osmosis (RO) treatment.

1.2 WATER QUALITY CONSIDERATIONS

The following is a list of the major constraints on the required treatment, product water quality, and delivered water quality:

- Regulatory constraints on drinking water (Primary Maximum Contaminant Levels, Secondary Maximum Contaminant Levels, Ground Water Rule requirements, Lead and Copper Rule requirements, Total Coliform Rule requirements, Maximum Residual Disinfection Levels),
- Unregulated constraints (Notification Levels, Archived Advisory Levels),

- Aesthetic constraints (*e.g.*, iron, manganese, total dissolved solids compared to imported water quality and compared to consumer acceptance levels),
- Agricultural constraints from both potable and recycled water users (chloride, sodium, boron, sodium adsorption ratio, electrical conductivity),
- Corrosivity constraints (calcium carbonate saturation in the distribution system),
- Regulatory constraints on recycled water (Waste Discharge Requirements),
- Performance compatibility with imported water (chloramines versus chlorine in the distribution system), and
- Regulatory constraints on ocean discharge (National Point Discharge Elimination System)[1].

The locations where the above water quality constraints apply vary by constraint. The major locations are listed below:

- During treatment (Ground Water Rule requirements),
- Treatment product water (Maximum Contaminant Levels, Secondary Maximum Contaminant Levels, Notification Levels, Archived Advisory Levels),
- Distribution system (Total Coliform Rule requirements, corrosivity constraints, performance compatibility with imported water),
- Consumer's tap (Lead and Copper Rule requirements, aesthetic constraints, Maximum Residual Disinfection Levels),
- Agricultural connection, where potable water is used (agricultural constraints), and
- Agricultural connection, where recycled water is used (Waste Discharge Requirements, agricultural constraints).

While water quality constraints that apply during treatment, or at the end of treatment, must be addressed by the SMRCUP treatment facilities, downstream water quality constrains may be affected by the SMRCUP conveyance design. For example, if the SMRCUP product water is piped to Red Mountain Reservoir, then blending with imported water could occur before use (*e.g.*, consumption, agricultural use). Alternatively, if the SMRCUP product water is tied directly into the distribution system, then some users will receive no blending with the imported water when FPUD is receiving deliveries from MCBCP.

As mentioned above, preliminary distribution modeling by IEC suggests that the distribution can take the full flow of the SMRCUP with a tie-in point close to the new facilities (IEC, monthly progress meeting, February 25, 2015). Given the cost savings of this option, the SMRCUP product will likely not be piped directly to the Red Mountain reservoir, where blending could occur. Without the effect of blending, all water quality goals must be met by treatment provided at the new SMRCUP facilities.

[1] The National Point Discharge Elimination System (NPDES) permit will be reviewed in a subsequent task for this project and reported elsewhere.

The following sections provide a discussion of water quality goals and a preliminary discussion of treatment that may be required to reach those goals.

2 REGULATED CONTAMINANTS

The SMRCUP facilities will be affected by the following regulatory limits on water quality constituents and treatment:

- DDW Primary Maximum Contaminant Levels (pMCLs), which include limits on:
  - Inorganic chemicals,
  - Organic chemicals (synthetic organic and volatile organic chemicals),
  - Disinfection by-products (DBPs),
  - Radionuclides, and
  - Microbiological constituents (or stipulations for treatment techniques).
- DDW Secondary Maximum Contaminant Levels (sMCLs),
- Ground Water Rule requirements,
- Lead and Copper Rule requirements,
- Total Coliform Rule requirements, and
- Disinfectants and Disinfection By-products Rule requirements (DDW 2014).

The Surface Water Treatment Rules do not apply, as the water source is a groundwater not under the direct influence of surface water. The applicable regulatory limits are discussed below.

2.1 CONSTITUENTS WITH PRIMARY MAXIMUM CONTAMINANT LEVELS

Primary MCLs are legally enforceable limits corresponding to concentrations that may have an adverse effect on the health of people. Primary MCLs are in place for microbiological constituents (*E. Coli*), inorganic chemicals (*e.g.*, perchlorate), organic chemicals, such as volatile organic chemicals (VOCs) and synthetic organic chemicals (SOCs), disinfection by-productions (DBPs), such as haloacetic acids (HAAs), and radionuclides (*e.g.*, uranium). The recommended water quality goal for constituents with pMCLs is to meet their pMCLs (*i.e.*, do not exceed their pMCLs). A summary of the constituents with pMCLs is shown in Table 2.1.

A review of available source water quality in TM 1 (Trussell Technologies 2015) suggests that all constituents with pMCLs will be present at concentrations below their pMCLs (*i.e.*, all pMCL goals will be met at the influent of the treatment plant); thus, the only constituents with pMCLs that require careful attention are those that are impacted by treatment processes (*e.g.*, DBPs).

Table 2.1 – Constituents with pMCLs

Parameter (units)	pMCL	Parameter (units)	pMCL
Microbiological constituents		Volatile organic chemicals continued…	
E. Coli	TT	Toluene (mg/L)	0.15
Inorganic chemicals		1,2,4-Trichlorobenzene (mg/L)	0.005
Aluminum (mg/L)	1	1,1,1-Trichloroethane (mg/L)	0.200
Antimony (µg/L)	6	1,1,2-Trichloroethane (mg/L)	0.005
Arsenic (µg/L)	10	Trichloroethylene (mg/L)	0.005
Asbestos (MFL)[1]	7	Trichlorofluoromethane (mg/L)	0.15
Barium (mg/L)	1	1,1,2-Trichloro-1,2,2-Trifluoroethane (mg/L)	1.2
Beryllium (µg/L)	4	Vinyl Chloride (mg/L)	0.0005
Cadmium (µg/L)	5	Xylenes (mg/L)[3]	1.75
Chromium (µg/L)	50	Synthetic organic chemicals	
Cyanide (mg/L)	0.15	Alachlor (mg/L)	0.002
Fluoride (mg/L)	2	Atrazine (mg/L)	0.001
Hexavalent chromium (µg/L)	10	Bentazon (mg/L)	0.018
Mercury (µg/L)	2	Benzo(a)pyrene (mg/L)	0.0002
Nickel (mg/L)	0.1	Carbofuran (mg/L)	0.018
Nitrate (mg/L as NO_3)	45	Chlordane (mg/L)	0.0001
Nitrate+Nitrite (mg/L as N	10	2,4-D (mg/L)	0.07
Nitrite (mg/L as N	1	Dalapon (mg/L)	0.2
Perchlorate (µg/L)	6	Dibromochloropropane (mg/L)	0.0002
Selenium (µg/L)	50	Di(2-ethylhexyl)adipate (mg/L)	0.4
Thallium (µg/L)	2	Di(2-ethylhexyl)phthalate (mg/L)	0.004
Radionuclides		Dinoseb (mg/L)	0.007
Radium-226 & -228 (pCi/L)	5	Diquat (mg/L)	0.02
Gross Alpha particle activity (pCi/L)[2]	15	Endothall (mg/L)	0.1
Uranium (pCi/L)	20	Endrin (mg/L)	0.002
Beta/photon emitters (pCi/L)	50	Ethylene Dibromide (mg/L)	0.00005
Strontium-90 (pCi/L)	8	Glyphosate (mg/L)	0.7
Tritium (pCi/L)	20,000	Heptachlor (mg/L)	0.00001
Organic chemicals		Heptachlor Epoxide (mg/L)	0.00001
Volatile organic chemicals		Hexachlorobenzene (mg/L)	0.001
Benzene (mg/L)	0.001	Hexachlorocyclopentadiene (mg/L)	0.05
Carbon Tetrachloride (mg/L)	0.0005	Lindane (mg/L)	0.0002
1,2-Dichlorobenzene (mg/L)	0.6	Methoxychlor (mg/L)	0.03
1,4-Dichlorobenzene (mg/L)	0.005	Molinate (mg/L)	0.02
1,1-Dichloroethane (mg/L)	0.005	Oxamyl (mg/L)	0.05
1,2-Dichloroethane (mg/L)	0.0005	Pentachlorophenol (mg/L)	0.001
1,1-Dichloroethylene (mg/L)	0.006	Picloram (mg/L)	0.5
cis-1,2-Dichloroethylene (mg/L)	0.006	Polychlorinated Biphenyls (mg/L)	0.0005
trans-1,2-Dichloroethylene (mg/L)	0.01	Simazine (mg/L)	0.004
Dichloromethane (mg/L)	0.005	Thiobencarb (mg/L)	0.07
1,2-Dichloropropane (mg/L)	0.005	Toxaphene (mg/L)	0.003
1,3-Dichloropropene (mg/L)	0.0005	2,3,7,8-TCDD (Dioxin) (mg/L)	$3x10^{-8}$
Ethylbenzene (mg/L)	0.3	2,4,5-TP (Silvex) (mg/L)	0.05
Methyl-*tert*-butyl ether (mg/L)	0.013	Disinfection By-Products	
Monochlorobenzene (mg/L)	0.07	Total trihalomethanes (TTHM) (mg/L)	0.08
Styrene (mg/L)	0.1	Haloacetic acids (five) (HAA5) (mg/L)	0.06
1,1,2,2-Tetrachloroethane (mg/L)	0.001	Bromate (mg/L)	0.01
Tetrachloroethylene (mg/L)	0.005	Chlorite (mg/L)	1

[1] Million fibers per liter; MCL is for fibers exceeding 10 µm in length

[2] Excluding radon and uranium

[3] MCL is for either a single isomer or the sum of the isomers.

TT is treatment technique

2.2 CONSTITUENTS WITH SECONDARY MAXIMUM CONTAMINANT LEVELS

Unlike pMCLs, Secondary MCLs (also known as Consumer Acceptance Levels) are not health based; rather, they are based on aesthetics. DDW provides fixed Consumer Acceptance Levels for some constituents and a range of levels for other constituents when fixed levels have not been established. The range of Consumer Acceptance Levels span from Recommended Levels to Upper Levels, where the Recommended Levels should yield a higher degree of consumer acceptance and the Upper levels are acceptable if it is neither reasonable nor feasible to provide more suitable water.

Iron and manganese deserve special attention, as they are easily detected by the pallet of some consumers at concentrations below their sMCLs. Iron is detectable at concentrations down to 100 µg/L, and manganese is detectable at concentrations down to 20 µg/L. Given that these constituents are well removed through iron and manganese treatment systems, a goal of removing these constituents to below their respective detection limits is recommended (<100 µg/L and less than 20 µg/L, respectively; a summary of these goals is shown in Table 2.2).

Table 2.2 – Recommended water quality goals for iron and manganese

Parameters (units)	Recommended goal
Iron (µg/L)	<100
Manganese (µg/L	<20

For the SMRCUP, the water quality goal with respect to other constituents with sMCLs is to meet their fixed Consumer Acceptance Levels (*i.e.*, their sMCLs) and to meet their Recommended sMCLs when reasonable and feasible. When it is not reasonable and feasible to meet the Recommended sMCLs, the goal should be to their Upper sMCLs. The feasibility of providing treatment to meet the Recommended sMCLs will be evaluated in TM 3. A summary of constituents with sMCLs is shown in Table 2.3 and Table 2.4.

Table 2.3 – Constituents with fixed Consumer Acceptance Levels (sMCLs)

Parameters (units)	sMCL
Aluminum (mg/L)	0.2
Color (color units)	15
Copper (mg/L)	1
Foaming Agents (MBAS) (mg/L)	0.5
Iron (mg/L)	0.3
Manganese (mg/L)	0.05
Methyl-*tert*-butyl ether (MTBE) (mg/L)	0.005
Odor --- Threshold (odor units)	3
Silver (mg/L)	0.1
Thiobencarb (mg/L)	0.001
Turbidity (NTU)	5
Zinc (mg/L)	5.0

Table 2.4 – Constituents with Consumer Acceptance Level Ranges (sMCLs)

Parameters (units)	Recommended sMCL	Upper sMCL
Total Dissolved Solids (mg/L)	500	1,000
Specific Conductance (mg/L)	900	1,600
Chloride (mg/L)	250	500
Sulfate (mg/L)	250	500

Review of the estimated source water quality (Trussell Technologies 2015) shows that treatment would be required to meet the fixed sMCL for color, iron, and manganese, and the Recommended sMCL for total dissolved solids (TDS) and conductivity. IM treatment could reduce the concentrations of iron and manganese to below their sMCLs, and it may also reduce color to below the sMCL, as iron and manganese can contribute to color. RO treatment could reduce the chloride, TDS, and color concentrations to below their fixed and Recommended sMCLs. All other sMCL goals do not require treatment (*i.e.*, the goals are met in the design influent water quality).

Although there are currently no health-based regulatory limits on manganese and methyl-*tert*-butyl ether (MTBE), both constituents are on the draft Contaminant Candidate List 4 (CCL 4), which the Environmental Protection Agency (EPA) uses to identify priority contaminants for regulatory decision making and information collection. Health Reference Levels (HRLs) were created for these contaminants during the draft CCL 4 process; the HRL for manganese (non-carcinogenic) is 300 µg/L and the non-carcinogenic and the carcinogenic HRLs for MTBE are 2,100 µg/L and 19.4 µg/L, respectively. MTBE was not detected in the raw water (*i.e.*, the concentration of MTBE was at least less than 3 µg/L, the regulatory Detection Limit for the Purposes of Reporting). The average manganese concentration in the raw water, on the other hand, is very close to the HRL (283 µg/L), with the maximum concentration exceeding the HRL

(494 µg/L); however, IM treatment can reduce this concentration significantly (*e.g.*, to an average of 8 µg/L – well below the HRL, assuming a typical removal of 97%).

2.3 GROUND WATER RULE

The groundwater that provides the raw water for the SMRCUP is not, and will not be, under direct influence of surface waters (per the draft agreement between Marine Corps Base Camp Pendleton and FPUD and per modeling work done by Stetson Engineers Inc. (personal communication with Steve Reich at Stetson Engineers, December 2014)); thus, the Ground Water Rule applies to this system (and the Surface Water Treatment Rules do not apply to this system). The Ground Water Rule requires sanitary surveys of groundwater systems and either triggered source water monitoring (E. Coli, enterococci, or coliphage) or 4-log removal/inactivation of viruses (*i.e.*, 99.99% removal or inactivation of viruses), where 4-log inactivation/removal must be continuously demonstrated (*e.g.*, via a continuously measured chlorine residual, if employing chlorine disinfection). The Marine Corps Base Camp Pendleton (MCBCP), it is assumed, will maintain the sanitary survey requirements but not perform triggered source water monitoring; thus, the recommended water quality goal for the SMRCUP with respect to the Ground Water Rule is to meet the treatment requirements of providing 4-logs of virus inactivation/removal and continuous demonstration.

Triggered source water monitoring may prove an effective strategy for meeting the Ground Water Rule. Only 1% of wellhead samples from 2001 to 2010, and 2013, yielded a positive total coliform result, with zero positive *E. Coli* results. Blending of the wells might have diluted the total coliform to the below the detection limit. The triggered source water monitoring approach, however, would require coordination with MCBCP to collect samples from the wells if a positive result is obtained in regular total coliform testing in the FPUD distribution system. Providing 4-logs virus inactivation or removal (*e.g.*, chlorine disinfection through a clearwell) avoids this triggered source water quality sampling.

2.4 LEAD AND COPPER RULE

The Lead and Copper Rule stipulates lead and copper concentrations (also known as action levels), which require prescribed corrosion control techniques if they are be exceeded at consumer taps, that are monitored throughout the distribution system, more than 10% of the time (*i.e.*, the action levels apply to the 90th percentile level of measurements). Corrosion control techniques include alkalinity, pH, and/or calcium adjustment, and/or the addition of phosphate or silica-based corrosion inhibitors. The recommended water quality goal with respect to the lead and copper rule is to not exceed the lead and copper Action Levels (ALs) in the 90th percentile of measurements at consumer's taps, per monitoring requirements of the Lead and Copper Rule. The ALs are summarized in Table 2.5.

The concentrations of copper and lead in the estimated source water (Trussell Technologies 2015) are more than an order of magnitude less than the ALs; however, the source water has a high concentration of Dissolved Inorganic Carbon (52 mg/L, based on average water quality), which can significantly increase the concentration of copper in the taps of consumers through copper corrosion. Dissolved Inorganic Carbon (DIC) forms complexes with copper, increasing its solubility. This phenomenon of increased copper solubility due to high DIC concentrations has been observed in both the North and the South MCBCP water systems, leading to copper concentrations near the AL (South system) and exceeding the AL (North System) at consumer's taps (Trussell Technologies, 2006; the new SMRCUP facilities will receive its water from the same source as the South MCBCP system). Both MCBCP systems have successfully utilized orthophosphate addition to reduce the solubility of copper, and, correspondingly, the capability to add orthophosphate may be included in the design of the new facilities.

The Metropolitan Water District (MWD) does not employ the use of orthophosphates as a corrosion inhibitor in the Lake Skinner Water Treatment Plant Effluent, the source of the FPUD imported water. Correspondingly, blending of the imported water and the SMRCUP water in the distribution system will cause a reduction in the orthophosphate concentration where these two source mix. The ability of orthophosphates to inhibit copper corrosion with this decreased concentration will be discussed in more detail in TM 3; however, preliminary analysis suggests that mixing with the imported water decreases copper solubility to such an extent that phosphate is not needed when the imported water dominates the mix (the imported water has a high pH and a low DIC concentration, which leads for the formation of few copper complexes, compared to the SMRCUP water). Thus, it appears that the lower concentrations of phosphate, that occur when the SMRCUP water mixes with the imported water, are acceptable, because the need for phosphate also decreases as the water mixes. Lastly, to the extent that RO is used for treatment, it will reduce the DIC concentration, thereby decreasing the copper corrosivity of the SMRCUP product water and decreasing the need for orthophosphate addition.

Table 2.5 – Lead and Copper Action Levels

Parameter (units)	Action level (based on 90th percentile levels)
Copper (mg/L)	1.3
Lead (mg/L)	0.015

2.5 REVISED TOTAL COLIFORM RULE

The Revised Total Coliform Rule (RTCR) requires regular monitoring of the distribution system for total coliform bacteria and *E. coli*, with assessments and corrective actions (together known as a treatment technique) required to determine sanitary defects (*e.g.*, failure to maintain the disinfectant residual throughout the distribution system) when there is an indication of coliform or fecal contamination. The RTCR also details the criteria for violating the *E. coli* pMCL, which occurs with any combination of a positive total coliform sample with a positive *E. coli* sample during routine and repeat sampling events (or missing *E. coli* samples, or repeated positive total coliforms when *E. coli* sampling is not conducted). The recommendation made previously to not exceed the pMCL of constituents with MCLs applies to *E. coli.*

Regular testing for *E. Coli* was conducted in many of the wells that will provide water to the new facilities, from 2001 to 2010, and 2013 (Trussell Technologies 2015). These samples contained no positive results for *E. Coli*, suggesting that that the total coliform rule requirements might be met in the absence of disinfection treatment.

2.6 STAGE 1 AND 2 DISINFECTANTS AND DISINFECTION BY-PRODUCTS RULE

Stage 1 and 2 Disinfectants and Disinfection By-Product Rules (D/DBPR) established pMCLs for several DBPs (total trihalomethanes[2], five haloacetic acids[3], bromate, and chlorite), established maximum residual disinfect levels (MRDLs) for several oxidants (chlorine, chloramines, and chlorine dioxide), and required reductions in Total Organic Carbon (TOC) through "enhanced coagulation" to reduce DBP precursors in conventional filtration plants. The DBPs must be monitored in distribution systems, through monitoring plans that focus on locations where high DBP concentrations occur, using local averages for compliance. The recommended water quality goal with respect to the D/DBPR is to exceed the MRDLs and DBP pMCLs.

Data on the DBP formation potential of the source water was not available for review, and DBP formation potential testing is recommended given the high concentration of TOC in the source water (Trussell Technologies 2015). The source water may have an unusually high concentration of DBP precursors for a groundwater, given its high color concentration. DBP formation typically correlates to absorbance in the ultraviolet (UV) spectrum (*e.g.*, 254 nm), and although color is a measure of florescence and absorbance in the visible spectrum (*i.e.*, not in the UV spectrum), color and UV_{254nm} absorbance typically correlate.

If RO is used in the new treatment system, it is expected to significantly reduce the concentration of DBP precursors in the portion of the stream that is treated by RO. The principle DBP precursors are large organic molecules, which are well removed through RO. Another significant precursor is the bromide ion, which is also very effectively removed through RO.

The use of free chlorine for primary disinfection (disinfection to achieve CT credit, at the treatment plant, to meet pathogen removal requirements) reduces the required

[2] Total trihalomethanes (THMs) is comprised of chloroform, bromodichloromethane, dibromochloromethane, and bromoform.
[3] The five haloacetic acids (HAAs) are monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, bromoacetic acid, and dibromoacetic acid.

clearwell size compared to chloramines, as free chlorine is a more effective oxidant for virus inactivation. However, free chlorine decays rapidly in the distribution system (due to its high reactivity) and can form significant concentrations of trihalomethanes (THMs) and haloacetic acids (HAAs). To avoid the significant formation of THMs and HAAs in the distribution system, chloramines may be used for secondary disinfection (disinfection used to maintain a residual in the distribution system).

Although chloramines have lower THM and HAA yields, they can form nitrosamines, such as *N*-nitrosodimethylamine (NDMA). Nitrosamines are not currently regulated; however, DDW considers NDMA a good candidate for future regulation (it has a current Notification Level of 10 ng/L). Despite the risk for nitrosamine formation, chloramines are the current industry standard for secondary disinfection where THM and HAA formation is a concern, or where chloramines are already used in the distribution system (such as is the case with the imported water in the FPUD distribution system).

Table 2.6 – Maximum Residual Disinfectant Levels

Parameter (units)	MRDL
Chlorine (mg/L as Cl_2)	4.0
Chloramines (mg/L as Cl_2)	4.0
Chlorine dioxide (mg/L)	0.8

3 UNREGULATED CONTAMINANTS

Several lists or classifications of unregulated contaminants that may pose health risks are available, including the following:

- Constituents with Notification Levels (NLs),
- Constituents with Achieved Advisory Levels (AALs),
- Contaminant Candidate Lists 1 to 3,
- Priority Pollutants, and
- Various lists of Containments of Emerging Concern (CECs).

Health-based advisory levels have not been developed by DDW for many unregulated contaminants; however, the NL and AAL lists do contain health-based advisory levels, developed by the DDW (DDW 2010a, DDW 2010b). These constituents may become regulated if they are determined to pose sufficient risk to human health. If a constituent with a NL or AAL is detected above its limits, the local government must be notified (consumer notice and additional sampling is also recommended). If they are detected above their Response Level (10 to 100 times the NL or AAL), then discontinuation of the source is recommended. The recommended water quality goal with respect to constituents with an NL or AAL is to meet the NL or AAL.

Source water data is only available for three constituents with NLs and AALs, namely, 1,2,3-trichloropropane (1,2,3-TCP), boron, and vanadium (Trussell Technologies 2015). Data on the concentration of these constituents and MCBCP well field usage, suggests that MCBCP discontinues the use of wells with significant concentrations of 1,2,3-TCP until the concentrations in those wells drop below the method reporting limit[4]. Assuming that this practice is continued, the concentration of 1,2,3-TCP is expected to be below the method reporting limit in the blended source water (the method reporting limit is equal to the notification level). Boron and vanadium are not expected to be present in the source water above their NLs. Thus, treatment for these constituents should not be required at the new SMRCUP facilities.

4 AESTHETICS

4.1 CONSUMER ACCEPTANCE LEVELS

Aesthetic considerations regarding drinking water include odor, color (and clarity), taste, the staining potential of the water, and the scaling potential of the water. Guidelines for consumer acceptance levels are available in the form of sMCLs, Recommended sMCLs, and Upper sMCLs from DDW, although several other constituents may impact the aesthetics of water (*e.g.*, hardness and pH). Additionally, changes in water quality, rather than fixed levels, can also be important from an aesthetic viewpoint, even when the concentration goes from "worse" (*e.g.*, higher concentration) to "better" (*e.g.*, lower concentration). Goals for constituents with sMCLs were presented previously; goals for other constituents (*e.g.*, hardness) and goals related to changes in water quality are discussed below.

Constituents other than those with sMCLs that may also contribute to the aesthetics of water include pH and hardness. With respect to pH, consumers typically find a wide range of pH values acceptable: pH 5 to pH 11. The raw water is within this range with an average of 7.4 and a range of 7.1 to 7.9. Thus, treatment for pH specifically should not be required. Hardness can be a concern due to the potential for scale and soap scum formation; however, the popularity of detergents, which contain surfactants that are not typically affected hardness, has led to a decrease in the relevance of the soap consumption and soap scum formation from hard waters.

Whereas both magnesium hardness and calcium hardness form precipitates with soap (soap scum), calcium hardness is typically the predominate contributor to scale formation. Calcium readily comes out of solution with carbonate, or to a lesser degree with sulfate, whereas high concentrations of silica are required to form an insoluble magnesium product. Further, the solubility of calcium carbonate decreases with increasing temperature (unlike most minerals in drinking water) and decreases with increasing velocity, which leads to an elevated potential for scale formation products

[4] Sanitation and Radiation Laboratories (SRL) method (0.005 µg/L)

such as tea pots, faucets, valves, coffee makers, and hot water heaters. In an effort to categorize waters by potential for scale or soap scum formation, waters can be classified by their hardness (sum of calcium and magnesium concentration), according to the following schedule: waters with a hardness is in the range of 100 to 180 mg/L as $CaCO_3$ are hard waters, while hardness values greater than 180 mg/L as $CaCO_3$ are very hard waters.

Although calcium hardness is an indication of scale forming potential, it only accounts for one variable in the forces that lead to the precipitation of calcium carbonate, which is the principle mineral formed in typical scales (the carbonate concentration, pH, and ionic strength also affect precipitation). An indicator that typically has a better relationship to calcium scale is the Calcium Carbonate Precipitation Potential (CCPP) index, which accounts for the carbonate concentration, pH, and ionic strength of the water, in addition to calcium concentration. Typically, a CCPP of 4 to 10 mg/L as $CaCO_3$ is targeted to achieve negligible corrosion in conveyance piping and minimal scale formation. To minimize scale formation, a CCPP of 10 mg/L as $CaCO_3$ or less is recommended.

The Langelier Saturation Index (LSI) also relates to calcium carbonate scale. It is proportional to the energy required to precipitate calcium carbonate (*i.e.*, LSI is proportional to the Gibb's free energy for the precipitation reaction) and represents the driving force for the precipitation/dissolution reaction. In addition, a positive LSI indicates that a water is supersaturated with respect to calcium carbonate, whereas a negative LSI indicates that the water is undersaturated (the water is at equilibrium when the LSI is zero). Maintaining a low LSI, such as that found in the imported water, should minimize scale formation, and thus, targeting the imported LSI is recommended. Similarly, targeting the imported water calcium hardness concentration, on average, will minimize scale formation, relative to the imported water.

The calcium hardness of the raw SMRCUP water is 225 mg/L as $CaCO_3$, based on the median water quality, which puts the raw water in the very hard category. However, the CCPP is 4.9 mg/L as $CaCO_3$, which is within the acceptable range with respect scale formation. The low CCPP, despite the high calcium concentration (and high alkalinity), is due to the low pH of the water. RO treatment effectively reduces the concentration of divalent cations, such as magnesium and calcium; thus, if RO treatment is employed, the scaling potential of the water, and the total hardness, would be reduced (conversely, alkaline chemicals, such as lime or caustic, can increase the LSI and the CCPP; application of these chemical is common practice downstream of RO to decrease the corrosivity of the water). Lastly, the temporal nature of the SMRCUP supply may allow for the dissolution of scale formation when delivers through the SMRCUP are low (assuming that the imported water source continues to be softer). The recommended pH and hardness goals are summarized in Table 4.1 (hardness, CCPP, and pH values of the raw water are included in Table 4.2, for reference).

Table 4.1 – Recommended aesthetic goals, in addition to sMCLs

Parameter (units)	Goal
pH	5 to 11
CCPP (mg/L as $CaCO_3$)	≤ 10
LSI[1]	0.04 to 0.94
Calcium hardness (mg/L as $CaCO_3$)	≤ 133

[1] Based on historical imported water quality: October 2004 to September 2014

4.2 COMPARISON TO IMPORTED WATER

As mentioned previously, product water from the new facilities may be supplied to Fallbrook directly through the distribution system (as opposed to adding the product water to Red Mountain Reservoir). Depending on the exact configuration of this distribution tie-in, some consumers may receive alternating water supplies (imported water and SMRCUP water) when system demands and SMRCUP supply fluctuates. If these fluctuations are significant (*e.g.*, 100% imported water on one day and 100% SMRCUP water on the next day), and if the water quality difference between these two waters is significant, then consumers may be able to detect the change in water quality.

The primary source of water for the FPUD is imported water through the San Diego County Water Authority (SDCWA), which provides water from the Metropolitan Water District (MWD), through the Robert A. Skinner Water Treatment Plant (Skinner WTP). MWD typically supplies this plant with large fractions of water from the San Joaquin Delta, near Sacramento, through the State Water Project and the Colorado River through the Colorado Aqueduct. The water quality of Skinner WTP effluent from October 2004 to September 2014 compared to the estimated raw water quality for the new SMRCUP facilities for constituents related to aesthetic concerns is shown in Table 4.2 (a complete summary of available water quality data from the Skinner WTP effluent is shown in the appendix).

The summary in Table 4.2 shows that the estimated SMRCUP source water has higher average concentrations of several constituents that are related to aesthetics (calcium hardness, sulfate, chloride, TDS, conductivity, color, turbidity, iron and manganese), a lower TOC, and a lower pH, compared to the imported water. The water with the higher maximum value varies per constituent, as does the difference between the maximum and minimum values compared to the averages.

If feasible, IM and RO treatment, to reduce the iron, manganese, and salt concentrations, is recommended to reduce the difference in water quality between the SMRUCP water and the imported water.

Table 4.2 – Summary of Skinner WTP effluent aesthetic water quality parameters

Parameter	Units	Skinner Treatment Plant Effluent[1]	MCBCP wellhead sampling[2]
Calcium	mg/L	55 (21 - 74)	90 (80 - 94)
Calcium hardness as $CaCO_3$	mg/L	138 (53 - 185)	225 (200 - 235)
Calcium Carbonate Precipitation Potential as $CaCO_3$	mg/L	5.2[3]	4.9[3]
Chloride	mg/L	88 (58 - 100)	161 (145 - 173)
Color	CU	1.0 (1.0 - 3.0)	4 (ND - 18)
Iron	µg/L	Not detected[4]	74 (11 - 317)
LSI	--	0.35 (0.04 – 0.94)	0.08[3]
Magnesium	mg/L	22 (11 - 29)	36 (31 - 68)
Magnesium hardness as $CaCO_3$		91 (45 - 119)	148 (128 - 280)
Manganese	µg/L	Not detected[4]	276 (199 - 494)
pH	--	8.10 (7.8 - 8.4)	7.33 (7.07 - 7.87)
Sodium	mg/L	82 (49 - 102)	116 (95 - 132)
Specific conductance	µS/cm	852 (468 - 1050)	1234 (1030 - 1317)
Sulfate	mg/L	176 (49 - 254)	193 (63 - 208)
Temperature	°C	21 (11 - 30)	Not available
Total alkalinity as $CaCO_3$	mg/L	104 (75 - 128)	203 (170 - 223)
Total dissolved solids	mg/L	506 (261 - 643)	743 (690 - 821)
Total hardness as $CaCO_3$	mg/L	229 (104 - 301)	372 (328 - 390)
Total organic carbon	mg/L	2.6 (2.1 - 3.1)	1.8 (1.4 - 6.4)[5]
Turbidity	NTU	0.05 (0.04 - 0.16)	0.45 (0.06 - 2.6)

[1] Monthly averages compiled from Table Ds, October 2004 to September 2014; median (range)
[2] Blended source water estimate, 2001 to 2010, and 2013; median (range)
[3] Calculated for median water quality, assuming a temperature of 20°C for the MCBCP well water
[4] Reported in 2009 to 2013 Easter Municipal Water District Water Quality Report
[5] 6.4 mg/L may include non-representative data; the next highest value is 3.4 mg/L (TM 1)

One challenge in matching the imported water quality is the variable nature of the imported water quality supply. For example, the impact of the percent of State Water Project that makes up the Skinner WTP effluent on the TDS of the Skinner WTP effluent is shown in Figure 4.1 and Figure 4.2. These plots show that that the make up of the imported water portfolio can have a significant impact on the imported TDS. Uncertainty with the future imported water portfolio presents a challenge with matching the imported water quality. Contrary to the imported water, the SMRCUP supply may offer a more stable water quality source for FPUD.

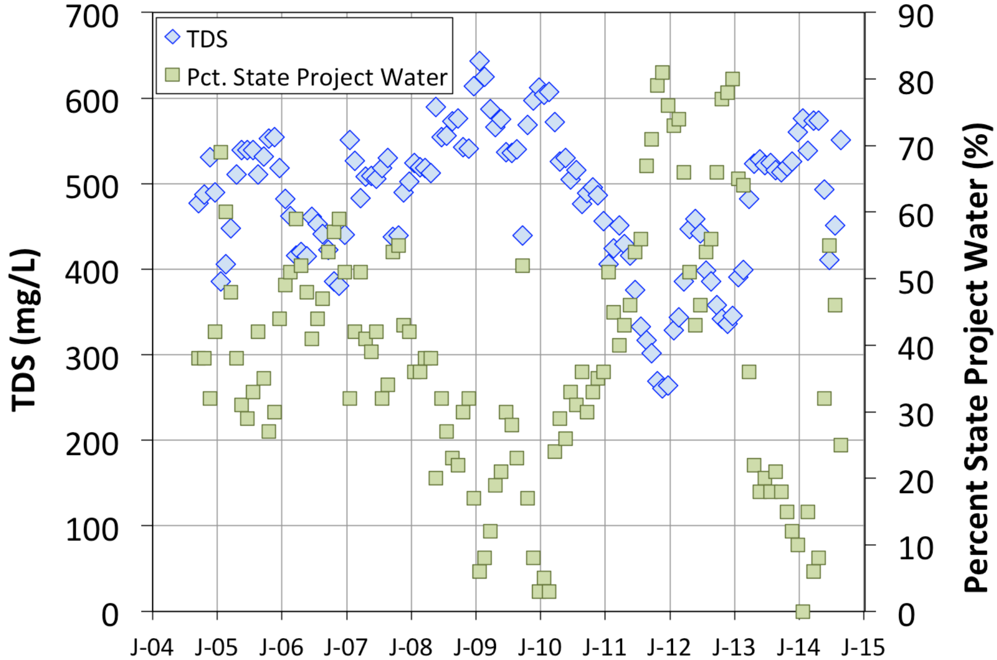

Figure 4.1 – Trend of TDS in Skinner WTP effluent with percent State Project Water

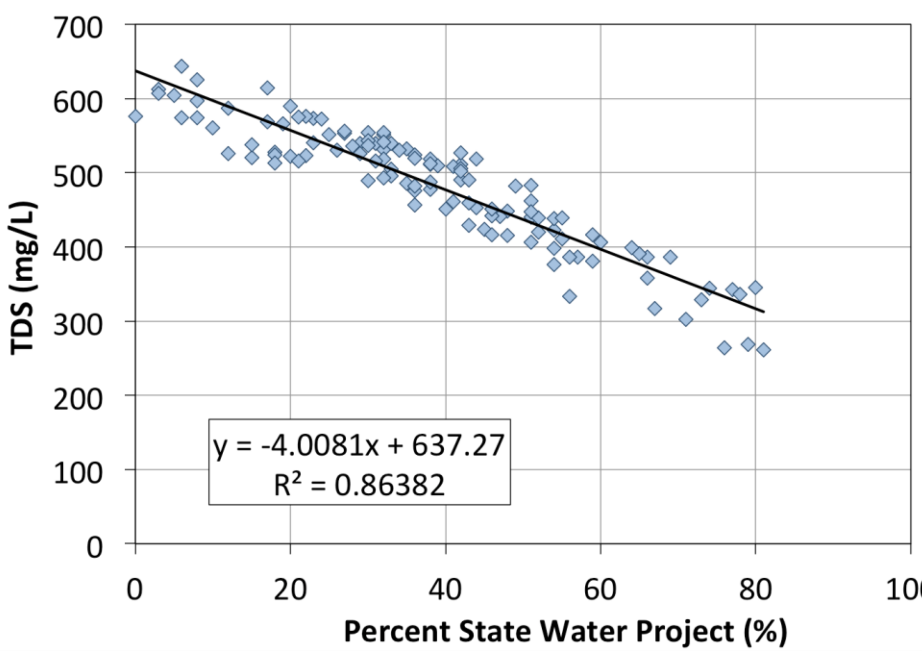

Figure 4.2 – Relationship between percent State Water Project and TDS in Skinner WTP effluent

5 AGRICULTURE

5.1 IMPACTS OF WATER QUALITY ON AGRICULTURE

The quality of irrigation water can impact agriculture through several avenues, including the following:

- Water availability,
- Infiltration rates, and
- Specific ion toxicity (*e.g.*, chloride).

These impacts are introduced below and general guideline values are discussed in the following section, Section 5.2.

Plants and soil lose water through evapotranspiration and irrigation water and/or rainwater (applied water) must be provided to meet this demand. The applied water percolates through the soil surface and into the root zone at which point it is known as soil water. Plants draw from the soil water, making the use of favorable pressure (and osmotic) gradients, extracting more solvent (water) than solutes (salts). Over time, the salt concentration in the soil water increases as water is preferentially drawn up through the root system, leaving the salts behind. The concentrated solution of salts can decrease water availability, by decreasing the pressure gradients (by decreasing the osmotic pressure gradient), which can lead to drought symptoms.

When the applied water supply is equal to the evapotranspiration demand, salt enters the system through the applied water and only exits the system through plant uptake. Assuming partial salt exclusion during water uptake, salt will accumulate in the soil for any applied water that contains salt. In practice all irrigation waters and rainwaters contain salt, and an excess of salt accumulation is prevented by providing more applied water than is required by the evapotranspiration demand (known as salt leaching, where the leaching fraction quantifies the level of salt leaching[5]). The excess water percolates below the root zone by the force of gravity, depositing salts out of reach of the roots (*i.e.*, wasting salts from the system).

The salt concentration of the soil water is equal to the applied water at the soil surface. As the applied water moves downward through the root zone, the concentration of salts increases as water is draw up through the roots. Within the root zone, the concentration of salts is greatest at the bottom, where leaching has concentrated salts downward and where water uptake continues to concentrate salts. Given this salt concentration gradient in the soil water, water uptake in the root zone varies with depth, with a greater water draw near the surface (where the lower salt concentration

[5] The leaching fraction is equal to one minus the quantity of the evapotranspiration demand over the applied water supply

near the surface yields a more favorable pressure gradient for osmosis). Typically, the assumed water uptake pattern is 40% uptake in the upper quarter of the root system, 30% uptake in the second to top quarter, 20% in the second to bottom quarter, and 10% in the bottom quarter. With this assumption, a relationship between the salt concentration in the applied water and the average soil water can be developed for different leaching fractions (see Table 5.1).

Leaching fractions are selected based on the quality of irrigation waters and sensitivity of crops in an effort to avoid the negative effects of salinity on water availability and to avoid accumulation of specific salts that can be toxic to crops (*e.g.*, chloride).

Table 5.1 – Salt concentration in irrigation water compared to soil water[1]

Leaching Fraction (%)	Salt Concentration Factor
5%	6.5
10%	4.1
15%	3.2
20%	2.7
25%	2.3
30%	2.1
40%	1.7
50%	1.5
60%	1.4
70%	1.2
80%	1.1

[1] Assuming 40-30-20-10 root water uptake, following the procedure in Ayers and Westcot 1985

The quality of the supply water can also affect soil infiltration if the water has a disproportionately high concentration of sodium ions compared to the divalent ions magnesium and calcium. In this case, the sodium ions substitute for the magnesium and calcium ions in the soil, decreasing soil particle attraction through the relatively weak charge of sodium and increasing soil particle separation through its relatively high degree of hydration. The net effect is that the soil particles become more dispersed, which can lead to the clogging of soil pores, swelling, and the reduction of infiltration rates. The relationship between the sodium ion and the magnesium and calcium ions is typically characterized by the Sodium Adsorption Ratio (SAR), which is calculated by the following equation:

$$SAR = \frac{[Na^{+}]}{\sqrt{\frac{1}{2}([Ca^{2+}] + [Mg^{2+}])}}$$

Where concentrations are in terms of equivalents (*e.g.*, milliequivalents per liter).

In addition to SAR, infiltration is also typically affected by the total salinity of the supply water (*i.e.*, the total concentration of salts in the supply water). An increased salt concentration tends to lead to the flocculation of soil particles and the formation of soil aggregates, which allow for infiltration, drainage and root penetration. Thus, both SAR and salinity impact infiltration, with decreasing SAR and increasing salinity leading to increased infiltration. The relationship between SAR and salinity, typically characterized by electrical conductivity (EC), is shown in Figure 5.1 with the position of raw water quality from MCBCP and the imported water indicated in the figure. In this respect both water qualities are excellent.

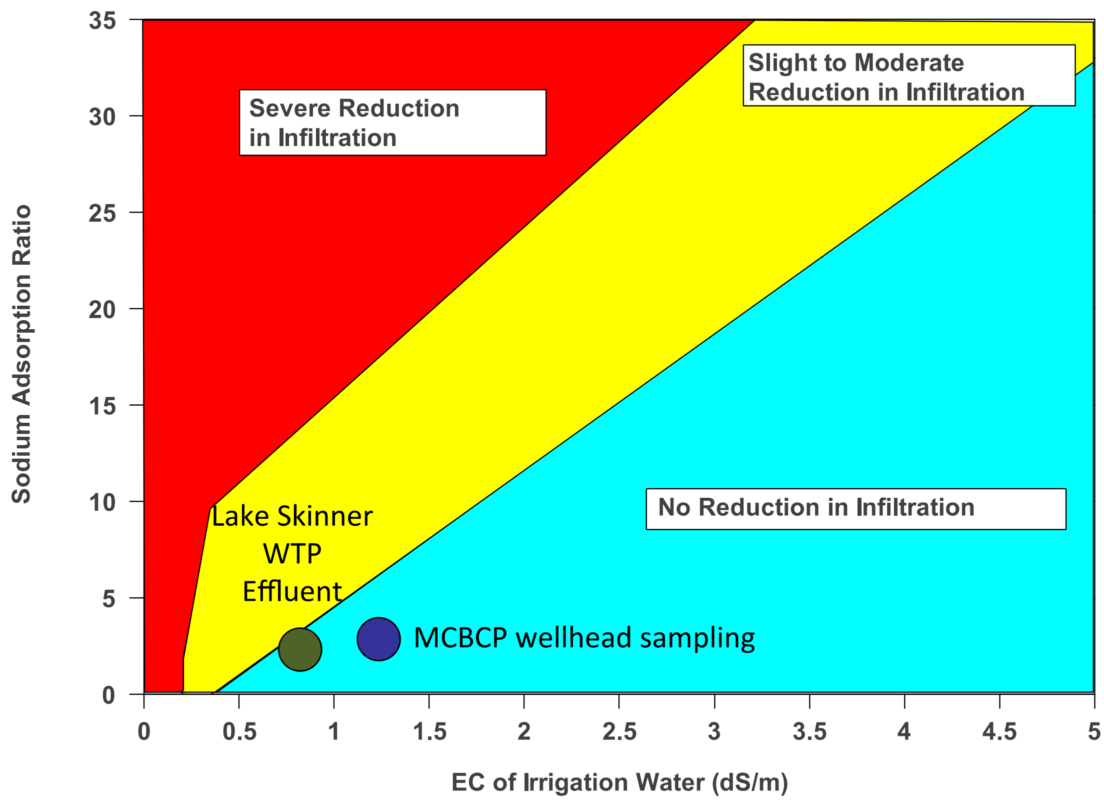

Figure 5.1 – Estimated impact on infiltration of untreated MCBCP groundwater (Tanji, et al., 2007, adapted from Ayers 1985). SAR calculated from average water quality.

Lastly, specific ions in the supply water can cause toxicity in some woody plants if they are accumulated in sufficient concentrations. The ions whose concentrations are of concern in typical supply waters are boron, chloride, and sodium. Typically, these ions enter through the root system, although ions may also enter through foliage when sprinklers are used. Sensitivity to specific ion toxicity varies by plant, cultivar, and rootstock, where some root systems are better able to exclude ions, some plants and cultivars are more able to compartmentalize salts to minimize toxic effects, and where the concentration of ions that results in impaired plant activity varies by plant. Avocado trees, for example, accumulate chloride in their leaves, which can cause tip burn. An example of tip burn in avocado leaves is shown in Figure 5.2.

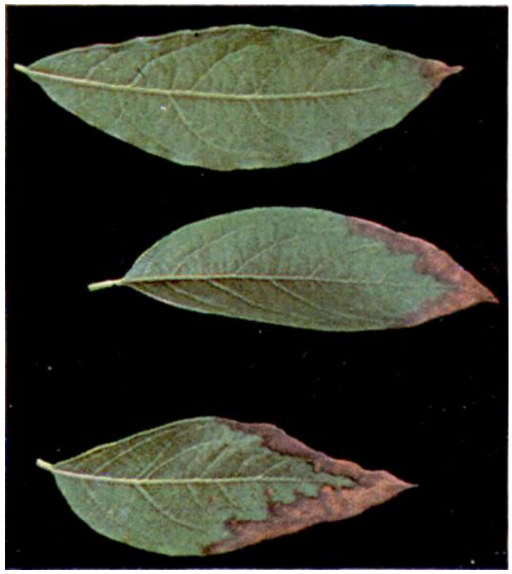

Figure 5.2 – Example of tip burn in avocado leaves: 1.6 to 2.2% chloride of dry leaf weight (Berstein 1965)

5.2 WATER QUALITY GUIDELINES

General water quality guidelines, based on the water quality impacts presented above, can be found in a standard agricultural reference developed for the State Water Resources Control Board (SWRCB). These guidelines were developed around the long-term influent of water quality on crop production, and they represent a water quality that can be used without restriction or without special management practices. In the absence of site-specific information, these guidelines (Table 5.2 and Table 5.3) can offer direction for developing agricultural goals.

Table 5.2 includes guidelines regarding some miscellaneous effects of water quality on agriculture (concerning nitrate, bicarbonate, and pH). Although nitrate is an essential nutrient for plant growth, excessive nitrate can lead to over stimulation, delayed maturity and/or poor crop quality. Bicarbonate is included as an indicator that scale may form if calcium is present in sufficient concentrations and if the pH of the water is appropriate for calcium carbonate formation. The scale reduces marketability when deposited on fruits or cut flowers. Sprinkler application with high rates of evaporation, or intermittent wetting, are most prone to scale formation. The pH is included, because a pH outside of the normal range may change the soil pH overtime or damage irrigation equipment.

The recommended goal for the SMRCUP product water with respect to these general agricultural considerations is to meet the general guidelines, except for when the imported water quality, which is already being successfully used for agricultural purposes in the area, does not the meet the guidelines. In the latter case, the recommendation is to meet or best the imported water quality.

Table 5.2 – Agricultural industry guidelines for interpreting irrigation water quality[1]

Potential irrigation problems	Units	Degree of restriction on use[3]			Raw SMRCUP Median Water Quality (Range)	Lake Skinner WTP Eff Median Water Quality (Range)
		None	Slight to moderate	Severe		
Salinity (affects crop water availability)						
EC_w[2]	µS/cm	<700	700-3000	>3000	1234 (1030-1317)	819 (468-1050)
TDS	mg/L	<450	450-2000	>2000	743 (690-821)	483 (261-643)
SAR and salinity (affects infiltration rate of water into soil)						
See Figure 5.1, where the "no reduction in infiltration" region represents a degree of restriction on use of "none."					SAR 2.6[4] EC see above	SAR 2.3[4] EC see above
Specific ion toxicity (affects sensitive crops)						
Sodium *(sprinkler irrigation only)*	mg/L	<69	>69		116 (95-132)	80 (49-102)
Chloride[2]	mg/L	<142	142-355	>355	161 (145-173)	87 (58-100)
Boron[2]	mg/L	<0.7	0.7-3.0	3	0.16 (0.04-0.19)	0.14 (0.10-0.16)
Miscellaneous effects (affects susceptible crops)						
Nitrate	mg/L-N	<5	5-30	>30	1.7 (0.4-4.0)	1.2 (0.3-3.3)
Bicarbonate *(overhead sprinklers only)*	mg/L	<92	92-519	>519	255 (51-312)	124 (92-156)
pH	--	Normal range 6.5-8.4			7.3 (7.1-7.9)	8.1 (7.8-8.4)

[1] Adapted from Ayers 1977 and Ayers 1985. Assumes semi-arid to arid climate and low rainfall; sandy-loam to clay-loam soils with good internal drainage; no uncontrollable shallow water table present within 2 meters of the surface; a leaching fraction of 15-20% LF; infrequent irrigations; and a 40-30-20-10% root water uptake pattern.

[2] See Table 5.3 for a list of particularly sensitive crops

[3] Full production capability of all crops, without the use of special practices, is assumed when the guidelines indicate no restrictions on use. A "restriction on use" indicates that there may be a limitation in choice of crop, or special management may be needed to maintain full production capability. A "restriction on use" does not indicate that the water is unsuitable for use.

[4] Calculated for average water quality

Compared to the general guidelines, the SMRCUP water does not require treatment for pH, boron, and nitrate. Unrestricted use with respect to EC, TDS, sodium and chloride on the other hand, could require treatment. Note that the sodium guideline only applies to sprinkler systems with foliar-irrigation water contact.

However, the imported water also exceeds these general guidelines with respect to EC, TDS, and sodium. To match the greater of the imported water quality and the general guidelines, EC, TDS, sodium and chloride would require treatment. The imported chloride concentration (87 mg/L average, 100 mg/L maximum) was lower than the general guideline for sensitive crops (118 mg/L). The recommended chloride limit is further discussed in the next two sections, Sections 5.3 and 5.4.

Table 5.3 – Guidelines specific to particularly sensitive crops[1]

Potential irrigation problems (units)	Sensitive species (hazard)	
Salinity (irrigation water EC, or less, for 100% yield potential)		
EC_w (µS/cm)[2]	Turnip (600) Carrot (700) Strawberry (700)	Beans (700) Radish (800) Onion (800)
Specific ion toxicity (maximum permissible concentrations without leaf injury)		
Chloride (mg/L)	Avocado, Mexican (118) Shasta strawberry (118) Indian summer raspberry (118)	
Specific ion toxicity (tolerance of agricultural crops)		
Boron (mg/L)	Lemon (0.5) Blackberry (0.5)	

[1] Adapted from Ayers 1985. See assumptions in footnotes to Table 5.2.
[2] 90% yield potential of sensitive crops: strawberry (900), bean (100), carrot (1,100), onion (1,200), radish (1,300), turnip (1,300), blackberry (1,300), and boysenberry (1,300).

The bicarbonate concentration in the SMRCUP water is also higher than the general guideline; however, the CCPP, as discussed above, is low (4.9 mg/L as $CaCO_3$), due to the low pH, and minimal scale formation is expected. A summary of general agricultural goals is shown in Table 5.4.

Table 5.4 – General agricultural water quality goals

Parameter (units)	Goal
Electrical conductivity, EC (µS/cm)	≤ 819 (imported water quality)
Total dissolved solids, TDS (mg/L)	≤ 483 (imported water quality)
SAR and salinity	No reduction in infiltration (Figure 5.1)
Sodium	< 80 (imported water quality)
Chloride (mg/L)	TBD[1]
Boron (mg/L)	< 0.50 (general guideline)
Nitrate (mg/L)	< 5 (general guideline)
CCPP (mg/L as $CaCO_3$)	< 10 (general guideline)
pH	6.5 – 8.4 (general guideline)

[1] The recommended chloride limit is discussed in Sections 5.3 and 5.4.

Further discussion is required regarding chloride. Regarding EC, TDS, and chloride removal, initial modeling shows that the limiting constituent via RO treatment depends on the exact chloride goal[6]. If the chloride goal is less than 105 mg/L, then it appears that chloride removal will control the RO design. If the chloride goal is greater than 105 mg/L, then it appears that TDS will control the RO design.

One of the most sensitive agricultural crops to chloride concentrations is the avocado, which is grown throughout Fallbrook for commercial and private purposes. Due to the effect of the chloride goal on the final RO design, and the sensitivity of the avocado, specific goals for chloride concentrations in avocado irrigation water were further investigated (see the following two sections).

5.3 CHLORIDE ION TOXICITY IN AVOCADOS: INTRODUCTION

Avocado in California, including Fallbrook, is typically grown on Mexican rootstock, the rootstock with the highest uptake of chloride (*i.e.*, the lowest exclusion of chloride from the soil water, during water uptake). The Mexican rootstock is chosen for its frost resistance, which makes it viable in Northern San Diego County; however, this variety also shows signs of tip burn and other symptoms of chloride toxicity at lower soil water chloride concentrations than other avocado rootstock.

Chloride primarily enters the soil through the application of irrigation water, which contains chloride ions. Irrigation water is typically applied to avocado groves through mini sprinklers, which have a low evaporation loss (*e.g.*, less than 1%). After application, avocado trees uptake chloride through the root system when the plant draws water from the soil. After uptake, the chloride and water are transported to the leaves. At the leaf, water escapes through stomata when carbon dioxide is converted to carbohydrate to support plant growth during the process of photosynthesis, leaving the chloride behind. As transpiration continues, chloride accumulates. Leaf drop, which occurs roughly every two years, allows for the wasting of the chloride from the tree. Tip burn occurs when the chloride accumulation exceeds the threshold tolerance of the leaf prior to leaf drop. Based on Figure 5.2, that threshold would appear to be between 1.5 and 2% by weight.

Tip burn reduces the leaf area that is able to photosynthesize, which reduces the energy available to the plant. The reduction in energy can affect various functions of the plant, including fruit set (growth of fruit after fertilization) and flowering, which can affect yield. High concentrations of chloride may also lead to premature leaf drop, which can affect yield due to the diversion of fruit set and flowering energy to the production of new leaves.

Given that chloride is transported to the leaves during transpiration, chloride accumulation in the leaves will be more sensitive to the chloride concentration in the soil water during periods of higher transpiration. Additionally, chlorides can also

[6] Assuming 98.1% rejection of chloride and TDS and 97.3% rejection of EC, using average influent values.

accumulate in the soil water during transpiration if accumulation is not limited through appropriate leaching fractions, further increasing the concentration of chloride that is drawn into the tree and accumulated in the leaves. A trend of estimated avocado transpiration in nearby Escondido is shown in Figure 5.3. This trend shows that evaporation, and thus the importance of the chloride concentration in the irrigation water, is highest during the months of April through September. Tip burn is typically most apparent in the fall, after this period of high evapotranspiration, and before leaf drop and winter rains.

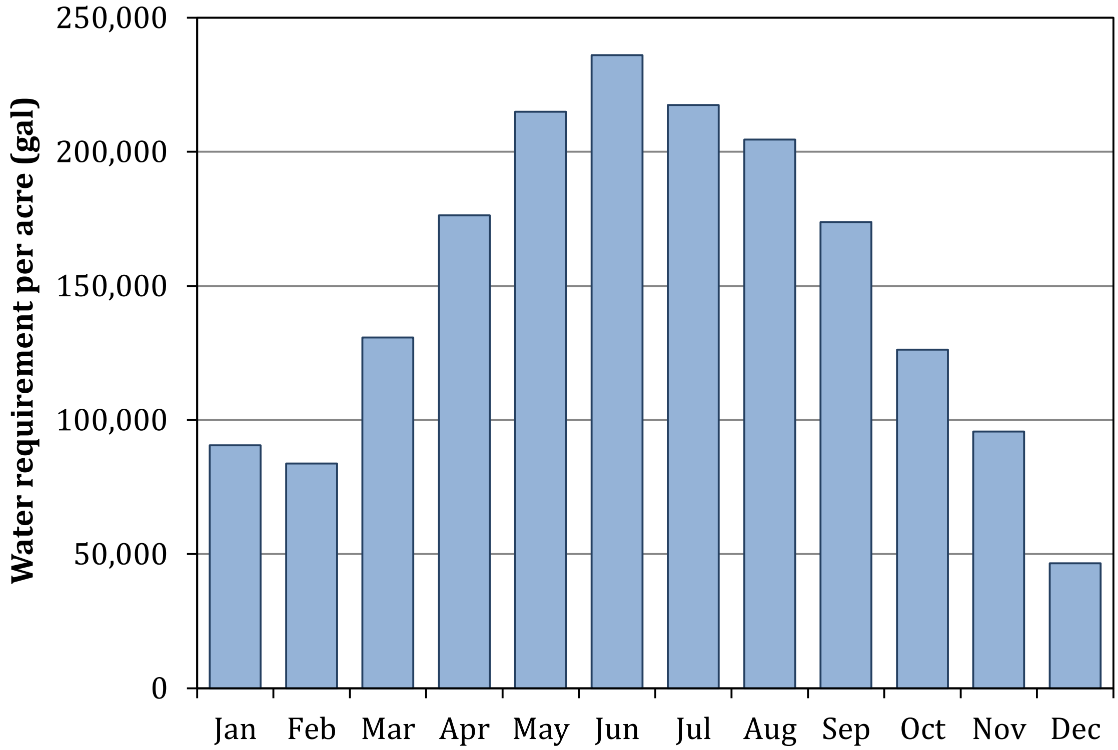

Figure 5.3 – Estimated water requirement of avocados in Escondido (developed in 2014 using California Irrigation Management Information System; Leaching Factor 10%, distribution uniformity 80% (Personal communication: data from Gary S. Bender at the University of California Cooperative Extension San Diego County)

Evapotranspiration is primarily affected by temperature, humidity, and wind speed. Specific climatic events, such as the dry Santa Anna winds, can have a significant impact on evapotranspiration. In addition to evapotranspiration, chloride ion uptake may also be influenced by cultural practices, such as the irrigation saturation period.

The nature of chloride accumulation in soil and avocado leaves affords some flexibility in maintaining a suitable chloride concentration in the irrigation water. At a constant transportation rate, chloride accumulation will be same for any water that has the same average chloride concentration (assuming the chloride rejection of the rootstock is independent of the soil water chloride concentration). For example, an avocado receiving water with 87 mg/L should accumulate the same amount of chloride over two weeks as an avocado receiving water with 80 mg/L during the first week and 94 mg/L during the second week (assuming equal leaching fractions). The flexibility holds so long as the averaging period is less than the time period required to cause stress in the avocado tree at the accumulated concentrations.

5.4 CHLORIDE LIMIT IN AVOCADOS: LITERATURE REVIEW

Several studies have examined the effect of chloride on avocado trees, and a number of these studies were reviewed to better define an appropriate chloride goal (a summary of chloride limits in these studies is shown in Table 5.5). The review included the following:

- Guidelines from the United States Department of Agriculture (USDA), Food and Agriculture Organization of the United Nations (FAO), and from the University of California Committee of Consultants (developed for the State Water Resources Control Board (SWRCB)),
- Recommendations from the recent development of the Upper Santa Clara River (USCR) chloride Total Maximum Daily Load (TMDL),
- Results from the five-year pilot study in Escondido, comparing recycled water and imported water,
- Rules of thumbs reported by Mission Resources Irrigation District (MRID) and the University of California Cooperative Extension, San Diego County, and
- Results from sand culture studies and other agricultural reports.

These efforts include work by notable agricultural experts, such as Leon Berstein, Eugene V. Maas, Robert Ayers, Dennis Westcot, and Gary Bender, and local experts, such as Bill Darlington at Plant and Soil Laboratory and Lance Anderson at Mission Resources Irrigation District.

Table 5.5 – Maximum permissible chloride concentration in irrigation water with respect to avocado tip-burn (*Persea americana*), Mexican rootstock

Literature Reference	Irrigation water chloride (mg/L)
Based on research in Weslaco, TX	
Agricultural Research Service, USDA (Berstein 1965)	118[1]
CRC Handbook of Plant Science in Agriculture (Maas 1987)	118[1]
Irrigation with Reclaimed Municipal Wastewater (SWRCB 1984)	110[1]
Water Quality for Agriculture: FAO 29 (Ayers and Westcot 1985)	118[1]
Upper Santa Clara River TMDL process	
RWQCB, Los Angeles Region Staff Report (RWQCB LA 2002)	100
CH2MHill Literature Review Evaluation (CH2MHill 2005)	100 - 120[2]
Technical Advisory Panel: Critical Review (Moore 2005)	100 - 117
Rule of thumb	
Mission Resources Irrigation District (Anderson 2015[9])	100
University of California Cooperative Extension (Bender 2015)	100[4]
City of Escondido Avocado Pilot Study (Montgomery Watson 1997)	< 56 – 115[3]
Other studies	
Fallbrook, San Diego Farm Advisor (Gustafson 1962, Branson 1972)	79 – 100[5]
University of California at Riverside (Bingham 1966)	59 – 118[6]
Kennedy-Leigh Centre for Horticultural Research, Israel (Bar 1997)	< 71[7]
Institute of Horticulture, Israel: 9-year study (Ben-Ya'acov 1992)	approx. 100[8]

[1] Assuming chloride in the extract equal to 1.5 times the chloride in the irrigation water ($Cl_e = 1.5Cl_w$), which is based on 15-20% leaching fraction, a 40-30-20-10% by quarters of soil depth water usage pattern, and chloride in the soil water to chloride in the extract ratio of 2 to 1

[2] Found no evidence that hazard is below 100 mg/L

[3] Six to 10% tip-burn observed with potable water ranging from 56 to 115 mg/L chloride; LF is not clear

[4] "When chloride exceed 100 ppm in the water there should be an alerted concern for ensuring adequate leaching of the root zone to prevent accumulation of these ions; pure Colorado River water has an average of 113 ppm chloride; this is acceptable with conscientious irrigation and regular leaching."

[5] No tip-burn at 79 mg/L and slight tip-burn at 100 mg/L; "tip-burn on leaves was prevalent in late summer if the chloride concentration of the irrigation water was higher than roughly 100 ppm . . . subsequent research also indicated that tip burn is likely to occur if chloride in the irrigation water is higher than about 100 ppm;" Leaching Fraction (LF) not reported

[6] No to very slight leaf injury at 59 mg/L and moderate leaf injury at 118 mg/L; LF not reported

[7] Leaf scorching score of 1.0 to 1.5 at 71 mg/L chloride; LF not reported

[8] 10% lower yield in Mexican compared to the chloride tolerant West Indian rootstock with 100 mg/L; however, the LF was not reported

[9] Personal communication Lance Anderson: Mission Resources Conservation District, January 29, 2015

The bulk of results fall in the range of 100 to 120 mg/L of chloride in the irrigation water, with all guidelines and recommendations within the range of 100 to 120 mg/L. The USCR TMDL literature review, for example, suggest that there is no scientific evidence that leaf injury occurs at concentrations less than 100 mg/L, and that the exact limit is between 100 and 120 mg/L. However, there is some uncertainty with these results:

most studies are based on vegetative growth of young trees rather than on yield, somewhat rough assumptions were required for the construction of some of the guidelines, and Eugene Maas, for one, suggests that few, if any, rigorous studies on chloride tolerance are available (Maas personal communication February 13, 2015; Maas 1987). Thus, these results are best viewed as guidelines in absence of additional information.

In addition to reviewing literature on the chloride hazard, a review was made of an appropriate chloride goal averaging period. The USCR TMDL process included a study to recommend an averaging period for their chloride guideline of 100 to 120 mg/L (Newfields 2007). This study found that duration of exposure is more important than the exposure occurring during a critical growth period (*e.g.*, fruit set, flowering, bud initiation, shoot growth, young grafts). They list two relevant factors that impact the averaging period: (1) the minimum period of exposure required for injury, and (2) the ability of soil and water to buffer, or equilibrate, variable chloride concentrations. They found that injury typically occurs after four to eight weeks of exposure; however, all available studies used significantly higher chloride concentrations (170 to 360 mg/L). They estimate that injury would occur after 2 to 3 months when an irrigation water with a chloride concentration of 100 mg/L is used, with 3 months as their final recommendation.

It should be noted that results from studies conducted in nearby Escondido did show injury from chloride concentrations in irrigation water below the range of 100 to 120 mg/L. Unfortunately these studies did not typically report the leaching fraction, which is necessary for normalizing irrigation water concentrations between studies and for developing guidelines from studies. The five-year pilot study at Escondido showed some tip burn, even in avocados irrigated with potable water, which had a chloride concentration ranging from 56 to 115 mg/L (see Figure 5.4)

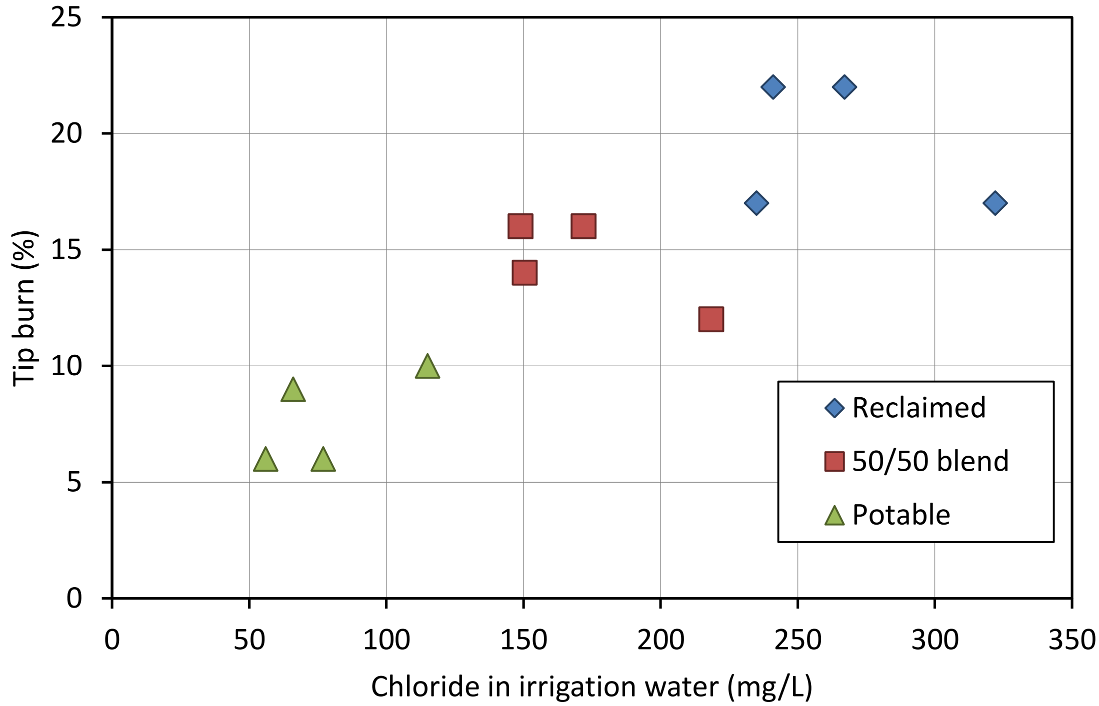

Figure 5.4 – Tip burn observed with potable water during Five-year Escondido Study

The best available information from the literature review suggests that a chloride concentration of 100 mg/L will likely avoid avocado injury when typical agricultural practices are employed (15 to 20% leaching fraction) and that injury will likely occur in the range of 100 to 120 mg/L. On the other hand given that there is evidence that some tip burn may occur at levels below these guidelines, and given that Fallbrook's agricultural community is accustomed to the chloride levels in imported water, an alternative, more conservative, goal would be to use the imported water as a precedent and to match the historical water quality of the Lake Skinner WTP, which had a 10-year average of 87 mg/L and maximum 3-month average of 99.3 mg/L.

Given the uncertainty in the literature review guidelines, the conservative goal of matching the historical Lake Skinner WTP Effluent chloride concentration is recommended for agricultural application to avocados, when feasible, with emphasis on the months of April through September. In other words, the recommended goal is to not exceed a 3-month average of 100 mg/L and to meet a long-term average of 87 mg/L, with operational focus on achieving concentrations equal to or less than 87 mg/L April through September, when possible.

Although operational focus should be placed on April through September, design of a treatment system should be based around the maximum 3-month average. Design of an RO system, for example, to meet the maximum 3-month average, assuming the *maximum* influent chloride concentration (173 mg/L, not the *average* chloride concentration of 161 mg/L), should yield a RO capacity capable of replicating the chloride concentration in the historical imported water. Preliminary modeling suggests that a sidestream RO system sized to 3.4 MGD would meet the maximum 3-month average goal, given the maximum raw water quality.

Further, it appears that an RO system this size would be able to produce a chloride concentration of 87 mg/L or less April through September on average with Above Normal Year flows (see Request for Qualifications for deliveries associated with year types). With Very Wet Year flows, the product water would exceed 87 mg/L February, May and June, on average; however, the imported water exceeds 87 mg/L, on average, more than 50% of the time (88 mg/L is the imported water median value, which is exceeded 50% of the time). In short, an RO design based on the proposed water quality goals is expected to be able to produce a water with a 3-month average chloride concentration less 100 mg/L during the design flow and maximum chloride concentration, a long-term average of 87 mg/L, and a concentration equal to or less than 87 mg/L April through September most of the time.

As mentioned previously, providing RO treatment to match the imported water quality would improve the quality of the SMRUCP product water with respect to other agriculturally relevant parameters (TDS, EC, chloride, boron, sodium, CCPP), but it would have a slight negative impact on the product water with respect to infiltration. RO treatment would indeed reduce the SAR (from an average of approximately 2.6 to an average of approximately 2.0); however, it would also reduce the salinity of the water (from an average of approximately 1,234 to an average of approximately 671 µS/cm). The net result is estimated to yield a water that still lies in the "no reduction in infiltration" zone of Figure 5.1 on average, but now very near to the "slight to moderate reduction in infiltration" zone. Most utilities operate in the "slight to moderate reduction in infiltration" zone; however, to mitigate a potential impact on infiltration, lime (CaO) may be more suitable than sodium hydroxide for product water pH adjustment (pH adjustment is discussed in Section 6). Likewise, calcium thiosulfate might be more suitable than sodium bisulfate for chlorine quenching upstream of RO.

6 CORROSIVITY

The major goals with respect to corrosivity of the SMRCUP product water are the following:

- Minimize corrosion of household plumbing (*e.g.*, copper corrosion),
- Minimize corrosion of the distribution system piping, and
- Mitigate negative effects due to mixing of the SMRCUP water with imported water in the distribution system (*e.g.*, "red water" events).

The primary concern regarding corrosion of household plumbing is copper corrosion, which was discussed in Section 2.4. In short, before their new RO system was installed, MCBCP experienced copper corrosion due to high concentrations of DIC and this was remedied with the addition of orthophosphate addition. Most likely this problem will be addressed through partial RO treatment in the SMCUP project as well. An additional strategy may be required for the distribution system, which is comprised of cement mortar lined steel (CMS) pipes (mostly pre-fabricated, but some had mortar sprayed in place).

Standard practice for minimizing corrosion of CMS pipelines is to maintain calcium carbonate saturation. This can be accomplished by maintaining a CCPP in the range of approximately 3 to 5 mg/L as $CaCO_3$, which corresponds to a slightly positive Langelier Saturation Index (LSI) and minimizes the leaching of calcium from the cement mortar lining, which protects the steel. A CCPP of 3 to 5 mg/L as $CaCO_3$ also closely matches the imported water, which had a median CCPP of 5.2 mg/L as $CaCO_3$ over the last 10 years (October 2004 to September 2013). If the SRMCUP product water CCPP is between 3 and 5 mg/L as $CaCO_3$, then the CCPP when the two waters mix will also be approximately within the recommended range (assuming the imported water CCPP also stays within the recommend range). A CCPP in the range of 3 to 5 mg/L as $CaCO_3$ corresponds to a LSI that closely matches that of the imported water and which signifies a suitable level of energy for minimizing corrosion. Thus, a CCPP goal of 3 to 5 mg/L as $CaCO_3$ and an LSI goal of 0.1 to 1 is recommended for stabilization of the product water.

The raw water has a CCPP of 4.9 mg/L as $CaCO_3$, within the goal of 3 to 5 mg/L as $CaCO_3$; however, RO treatment will significantly reduce the CCPP of the RO permeate, which will lower the CCPP of the blended water (*e.g.*, to negative 39 mg/L as $CaCO_3$), when the RO permeate is recombined with the RO bypass (the portion of the IM effluent that does not receive RO treatment).

The CCPP of the blended water can be increased to the target CCPP by increasing the carbonate concentration, the calcium concentration, the temperature, and/or the TDS, where the carbonate concentration can be increased by increasing the pH or the DIC concentration. Meeting the CCPP target through increasing the pH is typically the most cost effective option. Example strategies include the following:

- Decarbonation through air stripping (although stripping reduces the dissolve inorganic concentration, this negative impact is negligible compared to the positive impact of increasing the pH),
- Lime addition (*e.g.*, hydrated lime, hydrated lime slurry, quicklime), and
- Sodium hydroxide addition.

As mentioned previously, lime addition, instead of sodium hydroxide, may be more appropriate, as it will push the product water further into the zone of “no reduction in infiltration” in Figure 5.1. Recently, a liquid lime product (actually a hydrated lime slurry) has come on the market that makes lime addition much more practical than it once was.

Lastly, some water systems experience iron mobilization when new water supplies are introduced into the distribution system (also known as “red water” events). These events occur when iron scales or tubercles are scoured from the pipe surface, due to the weakening of the scale shell, when dissolved iron, released from corrosion processes due to a weakened scale shell, is oxidized, or when a stable corrosion scale becomes destabilized due to changes in water quality. All of these mechanisms are effectively arrested with cement mortar lining. Given that FPUD has no unlined steel or iron pipe, red water events from the introduction of the SMRCUP should not occur. Protecting the cement mortar lining, as discussed above, should avoid red water events.

7 IMPACT ON RECYCLED WATER

The discussion of the impact of the SMRCUP water on the recycled water quality is divides into two sections: (1) meeting regulatory requirements specified in the Waste Discharge Requirements (WDR), and (2) meeting water quality objectives for agricultural use of recycled water.

7.1 WASTE DISCHARGE REQUIREMENTS

The new SMRCUP water source will impact the water quality of the recycled water, as the recycled water is predominately comprised of drinking water, with the addition of salts, proteins, and other dissolved by-products of its use and treatment (*e.g.*, the TDS of the recycled water will increase if the drinking water supply TDS increases). However, the quality of the recycled water is regulated through Regional Water Quality Control Board (RWQCB) San Diego Region WDRs; thus, the impact of the new SMRCUP water on the recycled water quality must fit within the bounds of the WDRs. The WDRs and the estimated impact of the SMRCUP on the WDRs are discussed below.

FPUD supplies non-potable recycled water to customers in two hydrographic units - the Santa Margarita Hydrographic Unit (SMHU) and the San Luis Rey HU (SLRHU) - with only one customer under the SMHU requirements. The WDRs for discharge to these areas were developed to meet the San Diego Basin Plan water quality objectives for ground water in their areas. The relevant WDRs are shown in Table 7.1.

The recommended goal of the SMRCUP product water with respect to the quality of recycled water and WDRs is to produce a water that does not cause the recycled water to exceed the SMHU and SLRHU WDRs, when feasible. It may be infeasible to meet the more stringent SMHU WDRs; however, these apply to only one recycled water customer.

Table 7.1 – RWQCB San Diego Region Waste Discharge Requirements[1, 2, 3]

Parameter (units)	Santa Margarita Hydrographic Unit		San Luis Rey Hydrographic Unit	
	30-day	Daily Max	30-day	Daily Max
pH	6 – 9 at all times		6 – 9 at all times	
TDS (mg/L)	750	900	--	Supply + 450 Upper 1500
Chloride (mg/L)	300	350	--	Supply + 150 Upper 500
Percent sodium (%)	60	65	60	
Sulfate (mg/L)	300	350	--	Supply + 150 Upper 500
Iron (mg/L)	0.3	0.4	0.85	1.0
Manganese (mg/L)	0.05	0.06	0.15	0.20
MBAS (mg/L)	0.5	0.6	0.5	0.6
Boron (mg/L)	0.5	0.6	0.5	0.6
Fluoride (mg/L)	1.0	1.2	1.0	1.2

[1] Order No. 91-39, including Addendum No. 3
[2] 30-day is a running average over 30 days; daily max applies to individual composite or grab samples
[3] Discharge to the Good Earth Nursery and HMS Co. must meet the SLRHU requirements

The parameters in Table 7.1 that are most likely to be influenced by drinking water quality are TDS, chloride, sulfate, boron and fluoride. A summary of these parameters for Skinner Water, raw SMRCUP water and FPUD recycled water are shown in Table 7.2. Table 7.2 also reports the recycled water increment, which is the difference between the recycled water quality and the imported water quality. The increment for certain constituents is regulated in the SLRHU WDRs. The increment also allows for one to estimate the recycled water quality with the SMRCUP product as the supply water. All else being held equal, changing the supply water does not change the recycled water increment; thus, the SMRCUP product water concentrations plus the recycled water increments yield an estimate of the recycled when the SMRCUP is used exclusively as the supply water (*i.e.*, when the SMRCUP delivery flow is greater than the Fallbrook system demand). The scenario where the SMRCUP is the exclusive source water offers an extreme case, which can be compared against WDRs.

Table 7.2 – Select summary of average recycled, imported, and raw SMRCUP water quality (range of water quality reported in parenthesis)

Parameter	Units	Skinner WTP Effluent[1]	FPUD Recycled Water[2]	FPUD Recycled Water Increment[3]	Raw SMRCUP Water Quality[4]
TDS	mg/L	483 (261 - 643)	775 (490 - 980)	292	748 (690 - 821)
Chloride	mg/L	87 (58 - 100)	164 (82 - 200)	77	161 (145 - 173)
Sulfate	mg/L	165 (49 - 254)	190[5]	25	186 (63 - 208)
Boron	mg/L	0.14 (0.10 – 0.16)	0.32[5]	0.18	0.14 (0.04 – 0.19)
Fluoride	mg/L	0.6 (0.2 - 0.9)	0.84[5]	0.24	0.4 (0.1 - 0.7)

[1] Monthly averages from October 2004 to September 2014
[2] Monthly averages from January 2005 to December 2014
[3] Calculated from average differences between Skinner WTP and FPUD
[4] Estimated from wellhead sampling over 2001 to 2010, and 2013; see TM 1 (TT, 2015)
[5] Current average in Discharge Permit Comparison spreadsheet obtained March 12, 2015

The estimated recycled water quality under the sole influence of the untreated SMRCUP water satisfies all WDRs except for SMHU TDS WDR. Treatment would be required to meet this WDR. However, RO treatment to match the historical imported chloride concentration is expected to lower the SMRCUP TDS to below that of the historical imported water; thus, RO treatment can improve the recycled water quality, with respect to TDS, which is close to the SMHU WDR. RO treatment would also reduce the sulfate, boron, fluoride, and potentially chloride concentration (RO treatment will increase the percent sodium, but by a small amount that still keeps it below the level in the imported water: approximately from 40% to 41%, compared to the imported percent sodium of 43% calculated from average values).

The recycled water iron, manganese, and MBAS concentrations are largely determined by treatment at the wastewater treatment, as iron and manganese are dependent on redox conditions and MBAS are dependent on biological degradation. The dependence on wastewater treatment makes a mass balance analysis of these constituents inappropriate (such as determining recycled water increments). Regardless, the MBAS concentration is already very low in the raw SMRCUP water, and IM and RO treatment will reduce the iron and manganese concentrations to levels similar to the imported water.

Lastly, given the proximity of the recycled water manganese concentration to the SMHU WDR limit, the iron and manganese backwash sludge for the SMRCUP facilities should not be disposed to the FPUD sewer, which would increase the recycled water manganese concentration. Rather, the design should include a backwash recovery system with provisions for final disposal of the manganese solids to a landfill.

A summary of the effects of the SMRCUP water on compliance with recycle water WDRs is as follows: Compliance with recycled water WDRs is expected if treatment is provided to remove iron and manganese and partial treatment with RO is provide to match average chloride levels in the current imported supply.

7.2 AGRICULTURAL USE OF RECYCLED WATER

FPUD supplies recycled water to customers who use it for agricultural purposes, and these customers require a certain quality of recycled water for their applications. FPUD contacted a recycled water customer and Bill Darlington at the Soil and Plant Laboratory to discuss water quality goals for recycled water. These sources suggested the following goals for recycled water: keep the EC below 1,500 µS/cm, sodium and chloride below 150 mg/L, boron below 0.5 mg/L, fluoride below 0.8 mg/L, and iron and manganese below 1 mg/L. When recycled water increments are known, goals for the SRMCUP product water quality can be constructed from these recycled water quality goals.

An alternative set of goals would be for the SMRCUP product water to provide the same or better water quality as the imported water, which would lead to the same recycled water quality, holding all else equal. This goal of matching or besting, on an annual average basis, the imported water quality with respect to EC, sodium, chloride, boron, fluoride, iron and manganese is recommended, when feasible. The untreated SMRCUP water has higher levels of all of these constituents, compared to the imported water; however, with IM treatment and RO treatment to achieve an average of 87 mg/L chloride, the levels of these constituents in the SMRCUP product water are expected to be essentially equal to those in the imported water, or lower[7].

In addition to the above parameters, the effect on infiltration can be important for recycled water applications. The current recycled water is in the region of “no reduction in infiltration” in Figure 5.1 (see water quality parameters in Table 7.3). Untreated SMRCUP plus recycled water increments would actually reduce the SAR and increase the EC, thereby moving the position of the recycled water even more securely into the “no reduction” region. RO treatment to achieve an average of 87 mg/L chloride also keeps the recycled water in the “no reduction” region, about equidistant from the “slight to moderate reduction in infiltration” line as the current recycled water, but with a lower SAR and EC. Thus, the SMRCUP water is not expected to negatively impact the ability of the recycled water to infiltrate.

[7] The exact iron and manganese concentration of the imported water is unknown, since it was not detected in samples that have been reported. IM treatment of the SMRCUP water is expected to produce similarly low iron and manganese concentrations.

Table 7.3 – Recycled water quality, in addition to TDS and chloride[1]

Parameter (units)	Average (range)
Calcium (mg/L)	67 (41 - 86)
Magnesium (mg/L)	27 (19 - 35)
Sodium (mg/L)	134 (100 - 170)
Conductivity (µS/cm)	1327 (936 - 2457)
SAR	3.5 (2.9 - 4.1)

[1] Monthly averages from January 2005 to December 2014

A summary of effects on recycled water for agriculture is as follows: No adverse effects on the use of recycled water for irrigation are expected, if treatment is provided to remove iron and manganese and partial treatment with RO is provide to match average chloride levels in the current imported supply.

8 PERFORMANCE COMPATIBILITY

The SMRCUP product water and the imported water will mix in the distribution system when both waters are serving Fallbrook, just as the water from Red Mountain mixes with the imported water when water is drawn from Red Mountain. Given that the imported water contains chloramines as a secondary disinfectant, chlorine and ammonia are dosed at Red Mountain to also provide chloramines (5:1 ratio of Cl_2:N). Alternatively, the use of free chlorine would have to be carefully regulated to avoid breakpoint the imported water ammonia and the potential for subsequent loss of chlorine residual. These limits would have to be a function of the ammonia residual in the imported water, which in turn is a function of the ammonia dose at Skinner WTP and nitrification in the distribution system.

Chloramination, like what is conducted at Red Mountain, is recommended to maintain compatibility with the imported water secondary disinfectant. Chloramination avoids the hassles of mixing free chlorine and chloramines in the distribution system, forms fewer THMs and HAAs in the distribution system, and has a more stable residual.

9 CONCLUSIONS

A summary of the recommended water quality goals for the SMRCUP is shown in Table 9.1.

Table 9.1 – Summary of water quality goals for SMRCUP

Parameters	Units	Raw SMRCUP[4]	Lake Skinner[4] WTP	Goals (average)	Addresses
Iron	µg/L	101 (11-317)	Not detected[6]	< 100	Aesthetics
Manganese	µg/L	283 (199-494)	Not detected[6]	< 20	Aesthetics
Chloride[1]	mg/L	161 (145-173)	87 (58-100)	< 100 3-month avg (max) ≤ 87 (long-term) ≤ 87 (April-Sept.)	Avocados & agriculture
TDS	mg/L	748 (690-821)	483 (261-643)	≤ 483	Aesthetics
EC	µS/cm	1230 (1030-1317)	819 (468-1050)	≤ 819	Aesthetics
SDSTHMs[2]	µg/L	To be determined	Not reported	< 80% of pMCL	Regulation
SDSHAAs[2]	µg/L	To be determined	Not reported	< 80% of pMCL	Regulation
LSI[3]	--	0.08[5]	0.35 (0.04-0.94)	0.37 (0.1-1.0 range)	Corrosion
CCPP[3]	mg/L as $CaCO_3$	4.9[5]	5.2[5]	5.2 (1.0-10 range)	Corrosion
Calcium hardness	mg/L as $CaCO_3$	223 (200-235)	133 (53-185)	≤ 133	Scale formation

[1] The recommended operational chloride goal for April, May, June, July, August, and September is to have a monthly average concentration that is equal to or less than 87 mg/L, when possible (the recommended design constraint is to not exceed a 3-month average chloride concentration of 100 mg/L, assuming the *maximum* influent chloride concentration); preliminary modeling suggests that RO treatment to meet the long-term chloride goal will also meet the long-term agricultural goals for TDS, EC, boron, and SAR
[2] Simulated Distribution System (SDS) THMs and HAAs
[3] Median values shown, instead of averages
[4] Average and range shown, unless otherwise indicated
[5] Calculated from average water quality, assuming a temperature of 20°C for the Raw SMRCUP
[6] Reported in 2009 to 2013 Easter Municipal Water District Water Quality Report

Preliminary distribution system modeling results suggest that the SMRCUP product water will be tied directly into the distribution system, and thus, blending cannot be relied upon to provide treatment for all users. Therefore, the water quality goals must be met with treatment provided at the new SMRCUP facilities, if treatment is required.

A comparison of the recommended water quality goals and the raw SMRCUP water suggests that treatment, such as IM and RO treatment, is indeed required. IM treatment would reduce the iron and manganese concentrations in the SMRCUP water to concentrations similar to the imported water, which are below the sMCLs. Matching or besting the imported water manganese concentration is required to maintain compliance with the SMHU WDR. The exact imported water manganese concentration is unknown, and thus additional sampling is recommended.

IM treatment would also require a backwash recovery system to avoid disposing particulate manganese, which was removed from the SMRCUP water, to the FPUD sewer system. Disposing manganese to the sewer system would increase the recycled water manganese concentration, likely leading to an exceedance of the SMHU WDR.

RO treatment, downstream of IM treatment, could reduce the concentration of chloride in the SMRCUP water to meet the agricultural water quality goal of matching the historical imported water chloride concentration (the RO would be sized to meet the goal of less than 100 mg/L, based on the maximum influent chloride concentration of 173 mg/L and the three maximum consecutive deliveries: April, May, and June of a Very Wet Year). RO treatment to match the historical chloride concentration is expected to also reduce TDS and EC to levels below their DDW Recommended sMCLs and the color to levels below its sMCL. The TDS and EC should also be reduced to levels that meet the general agricultural goals. Additionally, RO sized for chloride is expected to also reduce the salt content of the water to a level that is close to the imported water, which should minimize taste complaints associated with changes in water quality. Lastly, the ability of RO to match the imported water salt concentration will maintain the concentrations of TDS, chloride, sodium, and sulfate at concentrations below their WDRs in the recycled water.

IM and RO treatment would provide other ancillary benefits: turbidity would be reduced through IM treatment; color may also be reduced through IM treatment; and RO would also reduce the concentrations of most other constituents of interest including odor, DIC, pathogens (including *E. Coli*), total coliform, DPBs, DBP precursors, SAR, and boron.

The reduction in EC by RO would also cause the product water to move closer to the "slight to moderate reduction in infiltration" in Figure 5.1; however, the product water is expected to remain in the "no reduction in infiltration" zone. RO would also slightly increase the corrosivity of the water, and thus, product water stabilization would be required. Stabilization may be provided with lime addition, instead of caustic addition, to move the product water deeper into the "no reduction in infiltration" zone.

In addition to IM, backwash recovery, RO, and stabilization, disinfection is required (unless triggered monitoring is employed) and facilities should be included for the addition of orthophosphate. Primary disinfection with free chlorine may be employed to reduce the clearwell size. Secondary disinfection with chloramines would reduce THM and HAA formation in the distribution system. Orthophosphate addition capabilities would allow for the control of copper corrosion, which is due to the high concentrations of DIC in the SMRCUP water.

With the above treatment technologies, the SMRCUP product water is expected to meet all regulatory and non-regulatory goals recommended in this TM, with the exception that the impact on the recycled water quality has not yet been fully evaluated. In addition to the imported manganese sampling at low levels, additional recycled water quality data for iron and MBAS, which FPUD likely already records, is also required to estimate the impact of the treated SMRCUP water on the recycled water quality.

A final recommendation for treatment technologies, the design flows, and phasing will be presented in TM 3.

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APPENDIX

The appendix contains the following:

- Table A.1 – Statistics on historical Skinner WTP Effluent water quality
- Table A.2 - Preliminary model results for the concentration of select salts in the product water of the SMRUCP facilities when treating an average influent chloride to 87 mg/L chloride with RO
- Table A.3 - Preliminary model results for the concentration of select salts in the product water of the SMRUCP facilities when treating a maximum influent chloride to 100 mg/L chloride with RO

Table A.1 – Skinner WTP Effluent water quality form Table D monthly averages (October 2014 to September 2014)

Constituents	Units	Min	5th pct.	10th pct.	Avg	Median	90th pct.	95th pct.	Max	No.
Silica	mg/L	5.6	7.3	7.6	9.1	8.9	10.6	11.4	12.5	120
Calcium	mg/L	21	32	38	53	55	67	70	74	120
Magnesium	mg/L	11	14	16	21	22	26	27	29	120
Sodium	mg/L	49	58	63	80	82	92	94	102	120
Potassium	mg/L	2.5	3.2	3.4	4.0	4.1	4.6	4.8	5.0	119
Carbonate	mg/L	0.00	0.00	0.00	0.07	0.00	0.00	1.00	2.00	120
Bicarbonate	mg/L	92	100	105	125	126	143	144	156	120
Sulfate	mg/L	49	83	102	165	176	213	224	254	120
Chloride	mg/L	58	68	73	87	88	97	98	100	120
Nitrate	mg/L	0.3	0.6	0.7	1.2	1.2	1.7	2.0	3.3	120
Fluoride	mg/L	0.2	0.2	0.2	0.6	0.8	0.9	0.9	0.9	120
Boron	mg/L	0.10	0.12	0.12	0.14	0.14	0.16	0.16	0.16	19
Total dissolved solids	mg/L	261	333	374	483	506	574	597	643	120
Total hardness as $CaCO_3$	mg/L	104	140	166	220	229	273	280	301	120
Total alkalinity as $CaCO_3$	mg/L	75	82	86	102	104	117	118	128	120
Free carbon dioxide	mg/L	0.8	0.8	0.9	1.7	1.6	2.7	3.0	3.3	120
H^+ Concentration	pH	7.8	7.9	7.9	8.1	8.1	8.4	8.4	8.4	120
Specific conductance	µS/cm	468	587	648	819	852	950	998	1050	120
Color	CU	1.0	1.0	1.0	1.4	1.0	2.0	2.0	3.0	39
Filter effluent turbidity	NTU	0.04	0.04	0.05	0.06	0.05	0.07	0.07	0.16	78
Turbidity	NTU	0.04	0.04	0.05	0.06	0.05	0.07	0.07	0.08	120
Temperature	°C	11	14	15	21	21	28	29	30	120
Bromide	mg/L	0.06	0.07	0.08	0.12	0.12	0.15	0.17	0.20	78
Total organic carbon	mg/L	2.1	2.2	2.3	2.6	2.6	2.8	2.9	3.1	15
Langelier index	n/a	0.04	0.17	0.21	0.39	0.35	0.60	0.72	0.94	120
Pct. State Water Project	%	0	8	15	39	38	66	74	81	120

Notes from Table Ds:

1. Bromide sample is collected at the WTP influent
2. TOC is collected at filter effluent
3. Langelier saturation indicies are cacluated using USGS PHREEQC computer program at source temperature

Table A.2 – Preliminary modeling results of estimated product water for select salts, when treating the average influent chloride to 87 mg/L of chloride with RO[1]

Parameter (units)	Groundwater[2]	Product water
Chloride (mg/L)	161	87
TDS (mg/L)	743	401
Conductivity (µS/cm)	1234	671
Calcium (mg/L)	90	48
Magnesium (mg/L)	36	19
Sodium (mg/L)	116	63
SAR	2.6	2.0

[1] Assuming 100% IM recovery, 85% RO recovery, 98.1% chloride and TDS rejection, 97.3% EC rejection, 99.3% calcium and magnesium rejection, 96.7% sodium rejection
[2] Based on wellhead sampling from 2001 to 2010, and 2013 (TT, 2013); median values shown

Table A.3 – Preliminary modeling results of estimated product water for select salts, when treating the maximum influent chloride to 100 mg/L of chloride with RO[1]

Parameter (units)	Groundwater[2]	Product water
Chloride (mg/L)	173	100
TDS (mg/L)	743	429
Conductivity (µS/cm)	1234	718
Calcium (mg/L)	90	52
Magnesium (mg/L)	36	21
Sodium (mg/L)	116	68
SAR	2.6	2.0

[1] Assuming 100% IM recovery, 85% RO recovery, 98.1% chloride and TDS rejection, 97.3% EC rejection, 99.3% calcium and magnesium rejection, 96.7% sodium rejection
[2] Based on wellhead sampling from 2001 to 2010, and 2013 (TT, 2013); median values shown, except for chloride (max)

APPENDIX D

TECHNICAL MEMORANDUM NO. 3

TECHNICAL MEMORANDUM NO. 3 (TM 3)

Santa Margarita Conjunctive Use Project Facilities Predesign
for the Fallbrook Public Utility District

Draft Date: August 14, 2015
Final Date: August 28, 2015

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Job Number: 126.001

Subject: Predesign treatment alternatives narrative

EXECUTIVE SUMMARY

The treatment processes and conveyance facilities that are described in the Preliminary Design Report (PDR) have been developed throughout the Santa Margarita River Conjunctive Use Project (SMRCUP) predesign and preliminary design process. The preliminary design is based around a design capacity of 7.8 MGD, which represents the largest minimum delivery that is guaranteed to the Fallbrook Public Utility District (FPUD) by the Marine Corps Base Camp Pendleton (MCBCP). This design capacity allows for full utilization of the SMRCUP water supply, providing less dependence on imported water and the largest reduction in imported water expenditures. Preliminary analysis, summarized in this Technical Memo (TM), suggests that the net present value of avoided imported water costs with this size facility may be close to $150M.

During the predesign process it was determined that a product water conveyance pipeline to Red Mountain Reservoir was not required; rather, the product water can be conveyed through the existing distribution, with limited modifications (see TM 4). Prior to this determination, several treatment and conveyance alternatives were considered, with pipeline-based conveyance alternatives (more expensive conveyance alternatives) requiring smaller treatment facilities with less than ideal product water quality. The determination that pipeline-based conveyance systems were not required allowed for a suitably sized treatment facility, which could provide an excellent product water quality.

Several alternatives were considered during predesign to reduce the size of the required treatment facilities. One alternative utilized blending with imported water in Red Mountain Reservoir. This alternative was discarded when it was determined that a pipeline to Red Mountain was not required. Another alternative was to only serve non-agricultural users because agricultural uses require lower levels of chloride. However, agricultural users (*e.g.*, avocado groves) are dispersed throughout the FPUD distribution system and separating non-agricultural users from agricultural users is infeasible. The selected alternative was to provide treatment facilities that will meet all water quality goals for both agricultural and non-agricultural uses, without relying on blending. This alternative allows for the greatest flexibility in use of the product water, and fully utilizes the new water supply.

1 INTRODUCTION

The purpose of this Technical Memo (TM) is to provide supplemental background on the development of the treatment approach for the Santa Margarita River Conjunctive Use Project (SMRCUP). The approach includes treatment facilities, which are capable of meeting strict water quality goals, and which are capable of treating the full flow of groundwater from the Marine Corps Base Camp Pendleton (7.8 MGD). A preliminary design for these facilities is being developed (see Draft Preliminary Design Report), and several TMs summarize specific predesign considerations (raw water quality in TM 1, water quality goals in TM 2, and distribution system hydraulic modeling in TM 4). Select predesign considerations, that have not been documented elsewhere, are summarized in this TM.

The SMRCUP will provide the Fallbrook Public Utility District (FPUD) with groundwater from the Marine Corps Base Camp Pendleton (MCBCP). At the new FPUD facilities, all of this water will undergo iron and manganese (IM) treatment, while a side-stream will undergo reverse osmosis (RO) treatment, to develop a blended water quality that can be used for both potable consumption and agricultural use. Following treatment, product water will be conveyed to consumers through the existing distribution system, after modest modifications, which will include new water storage and a new pump station at the FPUD Gheen facility.

The SMRCUP facilities preliminary design is an optimization of an earlier feasibility design by the United State Bureau of Reclamation (USBR). The USBR feasibility design also included IM with sidestream RO treatment, but employed a separate conveyance pipeline to Red Mountain Reservoir. A study, done as part of this effort, which included modeling of the FPUD distribution system, found the construction of this conveyance could be avoided, provided modest modifications to the distribution were made to support the project (see TM 4). This TM summarizes predesign considerations related to facility capacity, configuration, and alternatives.

2 AVOIDED COST OF IMPORTED WATER

The SMRCUP provides a new source of potable water, which allows FPUD to reduce imported water orders. Reducing the use of imported water provides a cost savings, which can be compared to the estimated SMRCUP costs. The avoided costs of imported water from the SMRCUP are estimated at a net present value of approximately $150M, based on the distribution of expected number of year types, base entitlement flows, and other assumptions detailed in this section. The details behind this estimate are discussed in this section (see the Preliminary Design Report for estimate of SMRCUP costs), as well as other considerations concerning the capacity of the treatment facilities.

The reduction in imported water demand is determined by the expected production from the SMRCUP facilities, which can vary on a monthly basis, with minimum feed flows guaranteed by MCBCP. The tentatively agreed-upon minimum flows are a function of Santa Margarita River (SMR) flow in the previous year, with the SMR flow categorized into year types and flow deliveries discretized by month (see Table 2.1 for draft of delivery schedule). These flows represent the minimum deliveries; actual deliveries may be greater, depending on several factors, including actual MBCBP demand.

Table 2.1: Minimum flow deliveries from MCBCP to FPUD, categorized by year type, which is based on SMR flow in the previous year (units of MGD)

Month	Extremely Dry	Very Dry	Below Normal	Above Normal	Very Wet
May	0	0	0.6	6.3	7.8
June	0	0	0.7	6.5	7.1
July	0	0	0.6	5.3	5.8
August	0	0	1.6	4.2	4.7
September	0	0	1.6	3.3	3.8
October	0	0	1.6	2.4	3.7
November	0	0	1.6	2.5	4.3
December	0	1.2	1.6	3.8	5.3
January	0	1.2	1.6	4.7	5.8
February	0	1.3	1.7	5.3	6.9
March	0	1.2	1.6	5.2	6.2
April	0	1.3	1.1	5.4	6.5

Source: RFQ 2014

Stetson Engineers estimated the frequency of year types (*e.g.*, frequency of very wet years) over the next 50 years based on historical SMR flow data, assuming that the distribution of year types over the next 50 years will be the same as the distribution of year types over the last 50 years (see Table 2.2).).

Table 2.2: Expected distribution of year types over the next 50 years

Year type	Extremely Dry	Very Dry	Below Normal	Above Normal	Very Wet
Number of expected years	9	15	14	5	7

Source: RFQ 2014

The estimated project flow per year type, and estimated distribution of year types, can be combined with the cost of imported water to yield an estimated annual average avoided cost of imported water for the project. Figure 2.1 shows such an estimate, as a function of facility capacity. As shown in the figure, the facility size impacts the avoided cost. For example, a smaller facility produces less water, and thus the decrease in imported water use would be less compared to a larger facility. The curve tapers off toward the high facilities capacities because the frequency of minimum guaranteed large flows is low (*e.g.*, the maximum flow of 7.8 MGD is only guaranteed for one month in the Very Wet year type). If delivery volumes exceed the minimum deliveries (*i.e.*, if the plant becomes more base-loaded), then the shape of the curve will change and the frequency of large flows could increase.

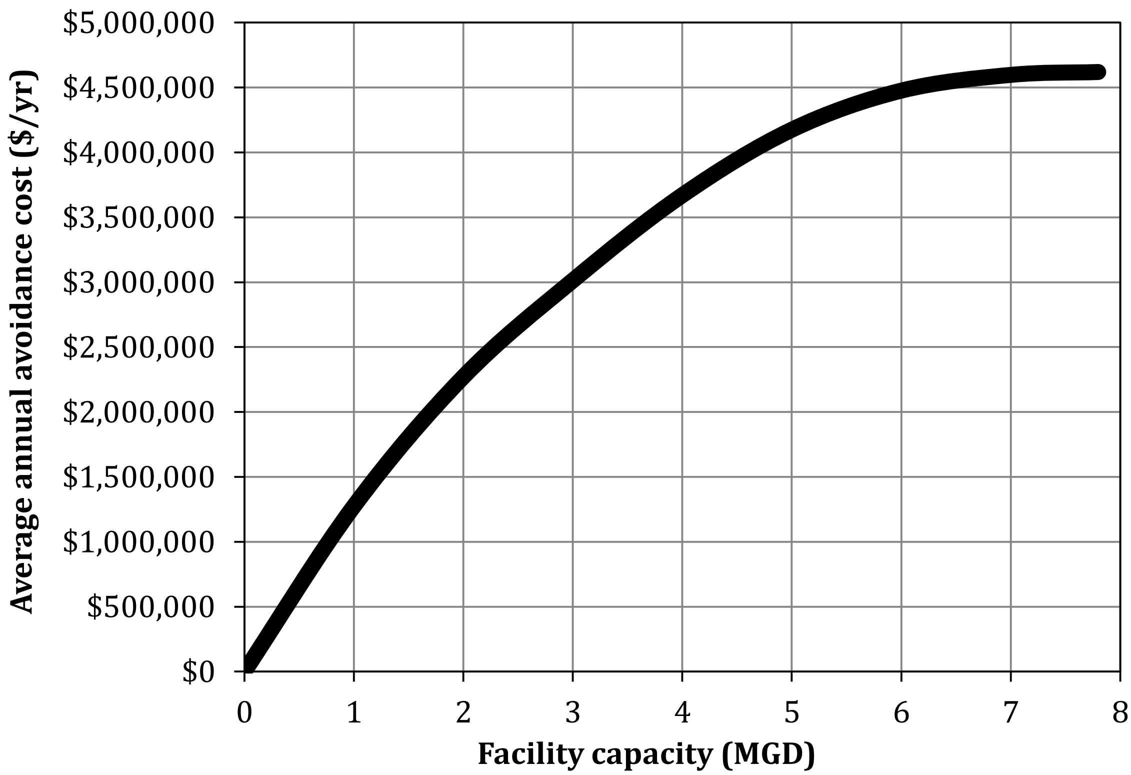


Figure 2.1: Average annual avoided cost of imported water per facility capacity, developed from baseline delivery flows (assuming 94% overall recovery and an imported water cost of $1,564 per acre-foot).

The average annual avoidance cost can be used to estimate the net present worth of constructing a treatment facility, based on minimum guaranteed flows. For example, using this method, a facility with a capacity of 7.8 MGD equates to a net present value avoided cost of $150M, based on the average expected production[1]. This net savings can be compared to the SMRCUP costs (see Preliminary Design Report for estimate of constructed costs).

Facilities smaller than 7.8 MGD were considered; however, given the potential for flow increases beyond the minimum guaranteed deliveries (*i.e.*, given the potential for the project to become more base loaded), the preliminary design was based around a facility with a capacity of 7.8 MGD of feed water from MCBCP.

3 CONFIGURATION ALTERNATIVES

The SMRCUP facilities consist of two major components: (1) treatment facilities and (2) product water conveyance facilities. With limited financial resources available, there is a balance, or trade-off, between the costs of these two components, such that an increase one cost requires a reduction in the cost of the other (*e.g.*, larger conveyance costs would lead to less resources being available for treatment facilities). The predesign efforts eventually led to the determination that a pipeline to Red Mountain Reservoir was not needed and that the distribution system with modest modifications could be used instead, which allowed for more stringent water quality goals (*i.e.*, more treatment). This section summarizes alternative considerations prior to this determination.

Conveyance alternatives included the following, in order of decreasing cost:

- New pipeline to Red Mountain Reservoir, with Gheen-site storage and pump station (most expensive),
- New pipeline to Gheen, with Gheen-site storage and pump station, and
- Only Gheen-site storage and pump station (least expensive option, utilizing existing distribution system instead of new pipelines).

These conveyance alternatives impacted treated options, which in turn impact possible product water qualities. Conceptual-level treatment alternatives, in response to possible conveyance alternatives, included the following in order of increasing cost:

- Only iron and manganese (IM) treatment (less expensive, but poorest product water quality),

[1] Overall recovery of 94%, a discount rate of 5% per year, a lifespan of 30 years, an imported water cost of $1,564, and a compounding increase in imported water costs of 6% per year, based on the average expected production developed from the expected distribution of year types and associated minimum guaranteed flows. Discount rate includes the rate of inflation.

- IM treatment with small reverse osmosis (RO) system, and
- IM treatment with larger RO system (most expensive, but best product water quality).

Following the determination that the least expensive conveyance option was viable, the treatment option with the best water quality was selected as the basis for further predesign and preliminary design work. With the treatment approach selected, corresponding water quality goals were finalized, which were used to guide the preliminary design (further discussion regarding water quality goals and the impact of treatment can be found in TM 2).

4 TREATMENT ALTERNATIVES

Treatment requirements were developed by comparing the estimated raw water quality (TM 1) to the treatment goals (TM 2), with some treatment requirements being a function of time and geographic location (*e.g.*, chloride treatment requirements are more sensitive in the summer compared to the non-summer months, and chloride treatment is not required for drinking water consumption but is required for agricultural usage). Various treatment strategies were considered for meeting these treatment requirements, including the following:

1. Blending with imported water in Red Mountain Reservoir,
2. Serving non-agricultural users only, and
3. Full treatment, such that blending is not required and such that both agricultural users and non-agricultural users can be served.

Blending
Blending, as an alternative to treatment for meeting water quality goals, was an option when the water was going to be conveyed to Red Mountain Reservoir, where it could be blended prior to entering the distribution system. However, it was demonstrated during the predesign effort that a conveyance pipeline was not needed and that sufficient capacity existed within the distribution system, with small modifications, to receive the groundwater flow, saving the expense of constructing a pipeline to Red Mountain Reservoir. With the treated groundwater going directly into the distribution system, blending the groundwater at Red Mountain Reservoir is not an option for meeting water quality goals.

Serving non-agricultural areas only
Some of the treatment requirements are dictated by agricultural-related water quality goals. If agricultural and non-agricultural users could be segregated, then it might be possible to reduce treatment requirements. However, agricultural users (*e.g.*, avocado groves) are dispersed throughout the FPUD service area in all pressure zones, and thus, segregation is infeasible.

Full treatment

Full treatment, such that all water quality goals at met at the treatment plant, is recommended. This approach affords the greatest flexibility in terms of use of the water and allows for full utilization of the SMRCUP water supply. Given the constraints on the other two alternatives (*i.e.*, blending and segregation infeasibility), and the benefits of this alternative, the full treatment approach was selected for the basis of the preliminary design. Details of the treatment facilities are described in the Preliminary Design Report (PDR).

5 REFERENCES:

PDR. Infrastructure Engineering (IEC), Separations Processes (SPI), and Trussell Technologies. Draft Preliminary Design Report. June 26, 2015.

RFQ 2014. Request for Proposals To Provide Consulting Services to the Fallbrook Public Utilities District For Professional Engineering Design Services for the District's Santa Margarita Conjunctive Use Project Facilities. August 5, 2014

TM 1. Trussell Technologies, Infrastructure Engineering (IEC), and Separations Processes (SPI). Draft Technical Memorandum No. 1: Raw Water Quality Characterization for the Fallbrook Public Utility District's Santa Margarita River Conjunctive Use Project Facilities. February 12, 2015.

TM 2. Trussell Technologies, Infrastructure Engineering (IEC), and Separations Processes (SPI). Draft Technical Memorandum No. 2: Water Quality Goals for the Fallbrook Public Utility District Santa Margarita River Conjunctive Use Project Facilities. March 19, 2015.

TM 4. Infrastructure Engineering (IEC), Trussell Technologies, and Separations Processes (SPI). Draft Technical Memorandum No. 2: Water Quality Goals for the Fallbrook Public Utility District Santa Margarita River Conjunctive Use Project Facilities. March 19, 2015.

USBR. United States Bureau of Reclamation. Feasibility Design Report – Santa Margarita River Conjunctive Use Project. September 2013.

APPENDIX E

TECHNICAL MEMORANDUM NO. 4

TECHNICAL MEMORANDUM NO. 4 (TM 4)

Santa Margarita Conjunctive Use Project Facilities Predesign
For the Fallbrook Public Utility District

Draft Date: April 27, 2015
Final Date: August 28, 2015

Authors: Scott Humphrey, P.E.

Reviewers: Rick Kennedy, P.E.

Job Number: 112.FPUD.0002.01

Subject: Water Distribution System Hydraulic Modeling

EXECUTIVE SUMMARY

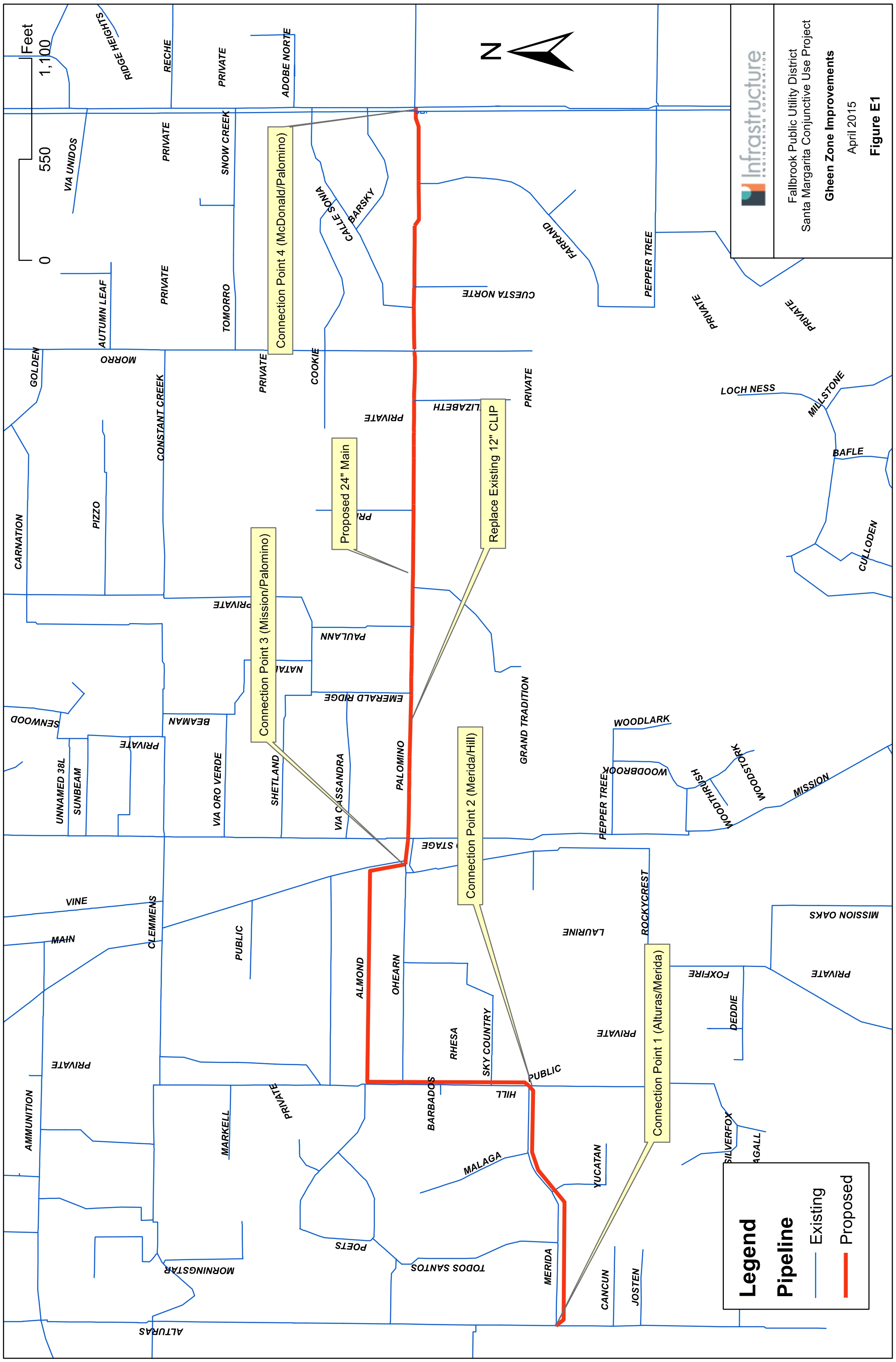
In support of the Santa Margarita Conjunctive Use Project (SMCUP), an InfoWater water distribution system hydraulic model for the Fallbrook Public Utility District (District) has been developed and used to determine necessary system improvements. The model considers well water supplied from the Camp Pendleton Marine Corps Base (CPEN), flowing through a proposed groundwater treatment facility (SMCUP plant) and pumped into the distribution system. Water quantities supplied are based upon monthly deliveries entitled to the District depending on rainfall of the previous year.

The water model was analyzed for May demand conditions, which represent the maximum potential delivery from CPEN of 7.8 million gallons per day (MGD) to the District. The model was used to determine if the distribution system could accept the maximum water production of the plant into the Gheen pressure zone, and determine any pipeline improvements that may be necessary. The model was also used to determine potential improvements at the District's Gheen Reservoir site including: 1.) additional storage, 2.) a pump station to pump from the Gheen zone into the Red Mountain zone in the event that plant production exceeds the Gheen zone demands, and 3.) pipeline improvements to the adjacent Red Mountain zone.

The model was used to determine the maximum amount of flow that the San Diego County Water Authority, through the District's system, could supply to CPEN in a local extended drought situation.

Based on input from the District and our evaluation the recommended improvements and findings include the following:

- Gheen zone pipeline improvements are shown in Figure E1 which include replacement and addition of nearly 8500 feet of 24-inch diameter pipeline from the SMCUP plant site to McDonald Road.
- Red Mountain zone improvements near the Gheen reservoir site are shown in Figure E2 which includes about 2000 feet of new 24-inch pipeline from the Gheen Reservoir site north to the Kauffman PRV, and upsizing of about 800 feet of the 12-inch main from the Gheen Reservoir site south to Gumtree PRV with a 24-inch main.
- Figure 2 also shows a new pump station at the Gheen reservoir site to produce a total dynamic head (TDH) of 170 feet at a flow rate of 4 MGD, and a TDH of 202 feet at a flow rate of 8 MGD, requiring 200 and 400 horsepower respectively.
- A new 6 million gallon (MG) reservoir of additional storage at the Gheen reservoir site.
- A product water SMCUP pump station to produce a TDH of 375 feet at a flow rate of 7.8 MGD requiring 2,500 horsepower.
- Return flows to CPEN, while limiting customer pressure reduction to 20 psi, was determined to be 7.3 MGD.


Feet
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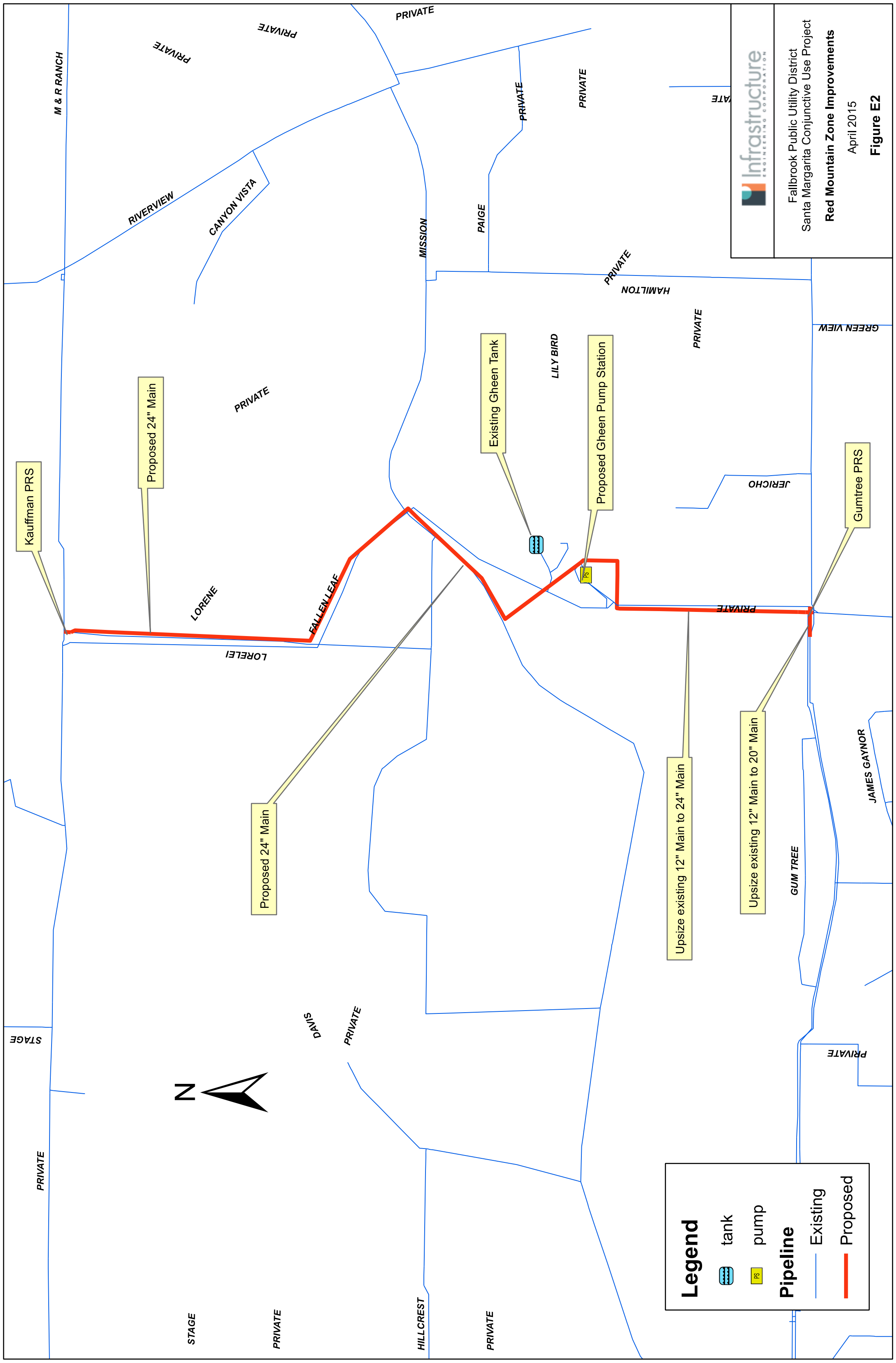
Infrastructure
ENGINEERING CORPORATION
Fallbrook Public Utility District
Santa Margarita Conjunctive Use Project
Gheen Zone Improvements
April 2015
Figure E1
Connection Point 4 (McDonald/Palomino)
Proposed 24" Main
Replace Existing 12" CLIP
Connection Point 3 (Mission/Palomino)
Connection Point 2 (Merida/Hill)
Connection Point 1 (Alturas/Merida)
Legend
Pipeline
Existing
Proposed


Infrastructure
ENGINEERING CORPORATION
Fallbrook Public Utility District
Santa Margarita Conjunctive Use Project
Red Mountain Zone Improvements
April 2015
Figure E2
Kauffman PRS
Proposed 24" Main
Existing Gheen Tank
Proposed Gheen Pump Station
Gumtree PRS
Proposed 24" Main
Upsize existing 12" Main to 24" Main
Upsize existing 12" Main to 20" Main
Legend
tank
pump
Pipeline
Existing
Proposed
N
M & R RANCH
RIVERVIEW
CANYON VISTA
MISSION
PAIGE
HAMILTON
LILY BIRD
GREEN VIEW
JERICHO
LORENE
FALLEN LEAF
LORELEI
JAMES GAYNOR
GUM TREE
STAGE
DAVIS
HILLCREST
PRIVATE

1. BACKGOUND AND PURPOSE

In support of the Santa Margarita Conjunctive Use Project (SMCUP), an InfoWater water distribution system hydraulic model for the Fallbrook Public Utility District (District) has been developed and used to determine necessary system improvements. The model considers well water supplied from the Camp Pendleton Marine Corps Base (CPEN), flowing through a proposed groundwater treatment facility (SMCUP plant) and pumped into the distribution system. Water quantities supplied are based upon monthly deliveries entitled to the District depending on rainfall of the previous year.

The water model was analyzed for May demand conditions, which represent the maximum potential delivery from CPEN of 7.8 million gallons per day (MGD) to the District. The model was used to determine if the distribution system could accept the maximum water production of the plant into the Gheen pressure zone, and determine any pipeline improvements that may be necessary. The model was also used to determine potential improvements at the District's Gheen Reservoir site including: 1.) additional storage, 2.) a pump station to pump from the Gheen zone into the Red Mountain zone in the event that plant production exceeds the Gheen zone demands, and 3.) pipeline improvements to the adjacent Red Mountain zone.

The model was used to determine the maximum amount of flow that the San Diego County Water Authority, through the District's system, could supply to CPEN in a local extended drought situation.

This technical memorandum addresses the topics as indicated by the following headings:

- Backgound and Purpose
- Hydraulic Model Development
- Water Demands
- Hydraulic Analysis
    - Gheen Zone Improvements
    - Gheen Pump Station
    - Red Mountain Zone Improvements
    - Evaluation of Storage at Gheen Tank Site
    - Supply to CPEN
    - System Head Curves
- Conclusions and Recommendations

2. HYDRAULIC MODEL DEVELOPMENT

We used the District's most current GIS database to develop a hydraulic model using InfoWater software for each pressure zone within the District with the exception of the De Luz service area.

We worked with District Staff to reconcile anomalies in the GIS data as part of the hydraulic modeling process, verifying input data, and validating that the model accurately represents field conditions.

3. WATER DEMANDS

We received water consumption data from the District for the period of June 1999 to May 2013. The most recent 5 years of data were used for the demand analysis (i.e. May 2008 to May 2013). The water use data were averaged by month per pressure zone to determine the monthly average for each zone. The Gheen reservoir tank can serve the following pressure zones via gravity either directly or through pressure reducing stations:

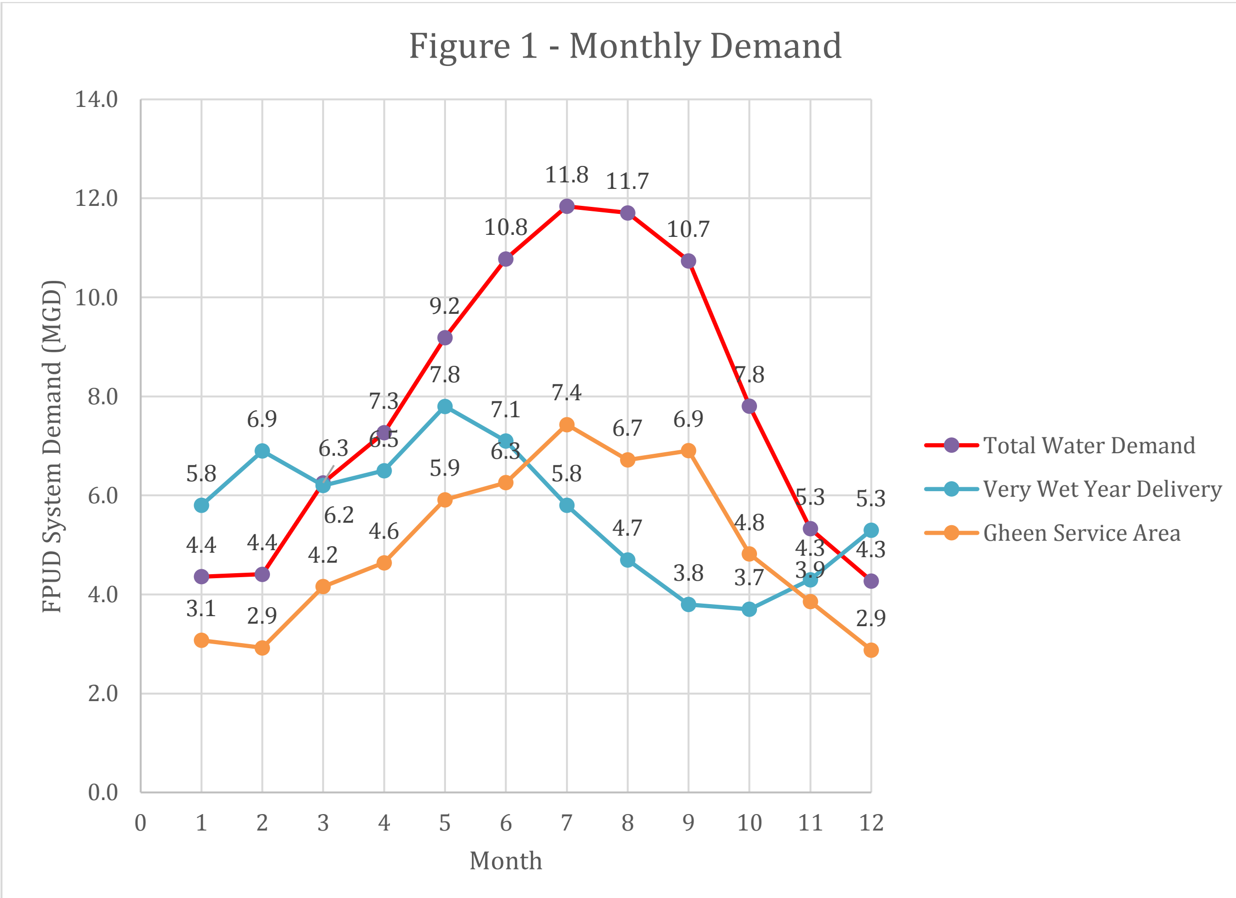
- Gheen
- Rattlesnake
- Modified Town

CPEN water deliveries by month are presented in Table 1 for extremely dry (ED), very dry (VD), below normal (BN), above normal (AN), and very wet (VW) water year types.

Table 1 - Daily Base Entitlement Deliveries (MGD)

Month	ED	VD	BN	AN	VW
May	0	0	0.6	6.3	7.8
June	0	0	0.7	6.5	7.1
July	0	0	0.6	5.3	5.8
August	0	0	1.6	4.2	4.7
September	0	0	1.6	3.3	3.8
October	0	0	1.6	2.4	3.7
November	0	0	1.6	2.5	4.3
December	0	1.2	1.6	3.8	5.3
January	0	1.2	1.6	4.7	5.8
February	0	1.3	1.7	5.3	6.9
March	0	1.2	1.6	5.2	6.2
April	0	1.3	1.1	5.4	6.5

Figure 1 shows a graph of deliveries for a very wet year compared to the overall District demand, as well as demands for the Gheen service area (Gheen, Rattlesnake, and Modified Town zones).

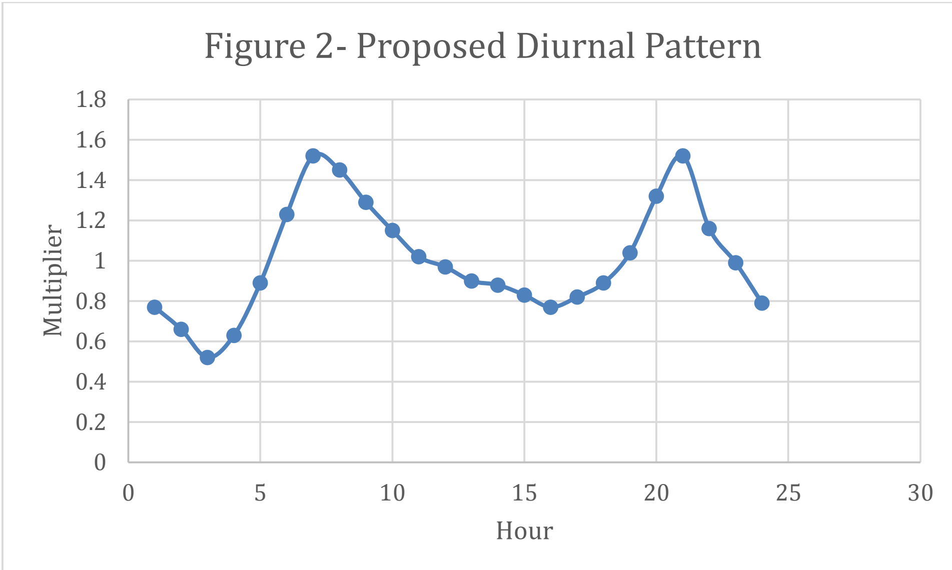


With the addition of a pump station at the Gheen tank site, the Gheen zone will be capable of moving water into the Red Mountain Pressure zone, allowing supply above what is used by the Gheen service area to be pumped into the Red Mountain zone and related Red Mountain Reservoir.

From Figure 2, it can be seen that during the maximum delivery month of May (7.8 MGD), approximately 1.9 MGD will need to be pumped into the Red Mountain zone to balance supply versus demand. The largest differential between demand in the Gheen service area and supply from the SMCUP plant occurs in February when 4.0 MGD will need to be pumped into the Red Mountain zone to balance supply and demand.

In an effort to analyze supply and demand over a 24 hour period and also to analyze lower nighttime demand periods, we have developed a diurnal pattern for the District, based upon the American Water Works Association (AWWA) Manual of Practice 32 (M32), Computer Modeling of Water Distribution Systems, as well as our experience with other water municipalities.

The proposed diurnal pattern for use in the modeling effort is shown in Figure 2.



The proposed diurnal pattern has a minimum factor of 0.52 (for night time demand) and a maximum factor of 1.52 (for peak demand). In February with a maximum 6.9 mgd plant production, less the 0.52 minimum factor times the average 2.9 mgd Gheen zone demand, results in 5.4 MGD being pumped from the Gheen service area to the Red Mountain zone.

4. HYDRAULIC ANALYSIS

Using the hydraulic model developed as part of this project, we analyzed the necessary improvements the District's system to accept the wet year maximum delivery of 7.8 MGD. This is indicated shown in the delivery schedule shown in Table 1.

4.1 GHEEN ZONE IMPROVEMENTS

The District has an existing 12" concrete lined in-place (CLIP) water main in Palomino Road that has a reduced diameter and thus capacity. The water main is now older and is reaching the end of its useful life and the District has requested that pipeline be replaced as part of this project. The upsizing of this 12" line between Mission Road and McDonald Road is recommended.

The Gheen zone improvements are recommended based on the ability of the District's system to accept 7.8 MGD during May demand conditions, utilizing a pump station at the Gheen tank site to move water from the Gheen zone into the Red Mountain zone as may be necessary. Recommended system facilities are shown in Figure 3. Using the standard system velocities during maximum pumping conditions, a 24” main will be required from the proposed SMCUP plant to the proposed connection point at the intersection of McDonald Road and Palomino Road. We are proposing four points of connection to the existing distribution system:

1. A connection to the existing 8” main at the intersection of Alturas Road and Merida Drive.
2. A connection to the existing 12” main at the intersection of Merida Drive and South Hill Avenue.
3. A connection to the existing 12” main at the intersection of South Mission Road and Ohearn Road (the beginning of the 12” CLIP main).
4. A connection to the existing 20” main at the intersection of McDonald Road and Palomino Road.

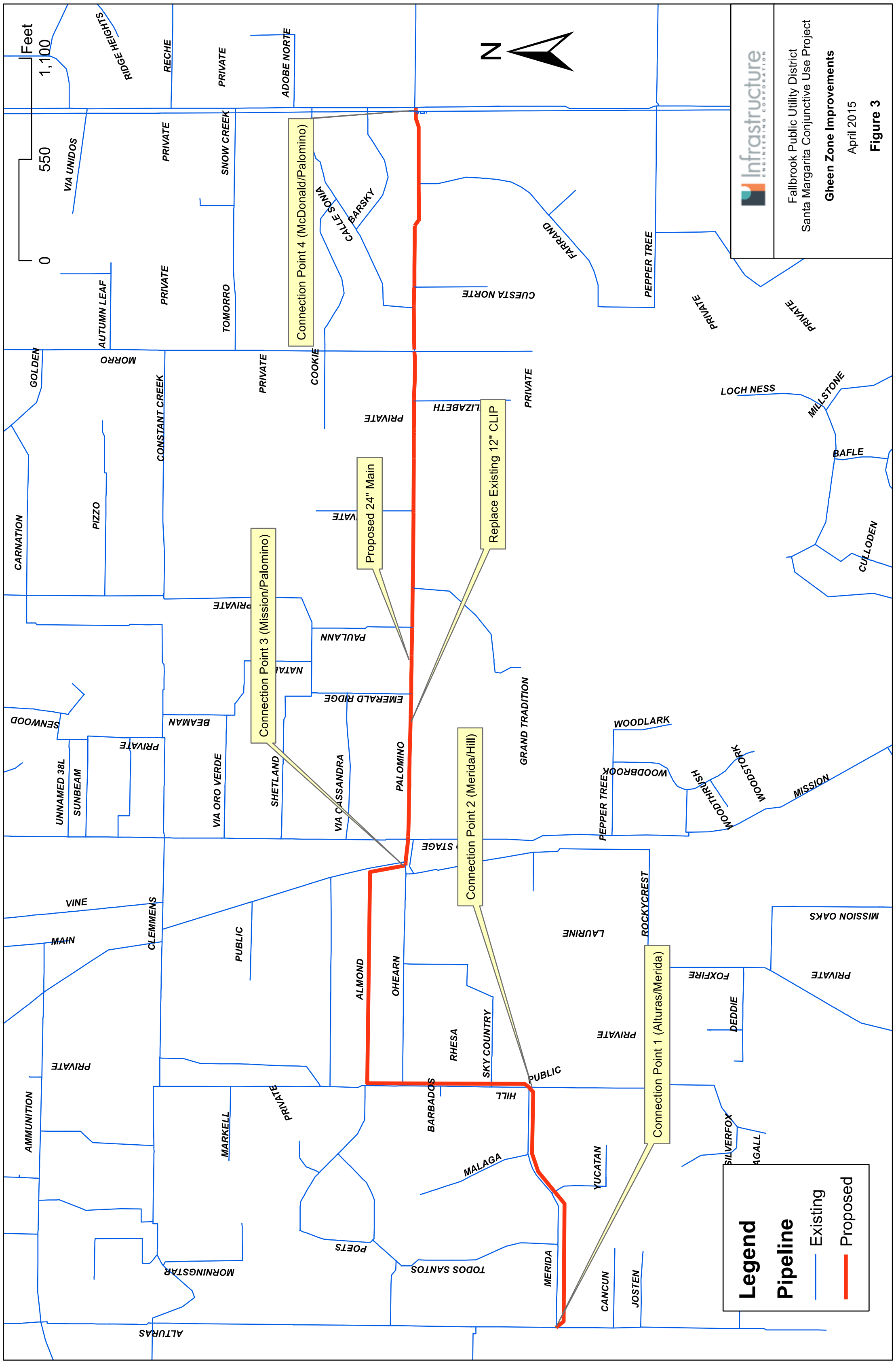
4.2 GHEEN PUMP STATION

As noted under Section 3 a new pump station will be required at the Gheen tank site to move excess water, as much as 5.4 MGD, not utilized by the Gheen service area into the Red Mountain zone. We analyzed two alternative flow scenarios to determine the system improvements necessary to accommodate a proposed pump station. We considered a 4 MGD pumping condition and included a maximum possible 8 MGD scenario. See Section 4.6 for pumping system curves.

4.3 RED MOUNTAIN ZONE IMPROVEMENTS

There is an existing 12” main in the Red Mountain zone that heads southerly from the Gheen tank site to the Gumtree PRS that will need to be upsized to accommodate the additional flows from the proposed Gheen Pump Station. The 12” main is shown in Figure 4. This main will need to be upsized to a 16” main to accommodate 4 MGD and would need to be upsized to a 24” main to accommodate an 8 MGD pump station. Since there would not be a significant cost difference pipeline material costs, we are recommending a 24” main be constructed. In close proximity to these Red Mountain zone improvements, and thus included in this section, is a short length of existing 12” main that presents a restriction running east west in Gumtree Lane, in the Gheen zone, that connects a 20” main to a 16” main. We are recommending this main be upsized to a 20” main, see Figure 5 (District Valve Book Map F093).

In addition, the District asked us to analyze the addition of a pipeline in the Red Mountain zone from the Gheen pump station northerly to the Kauffman PRS to improve overall system flexibility and reliability. We are recommending that a 24” main be added between these connection points.


Fallbrook Public Utility District
Santa Margarita Conjunctive Use Project
Gheen Zone Improvements
April 2015
Figure 3
Infrastructure
Legend
Pipeline
Existing
Proposed
Feet
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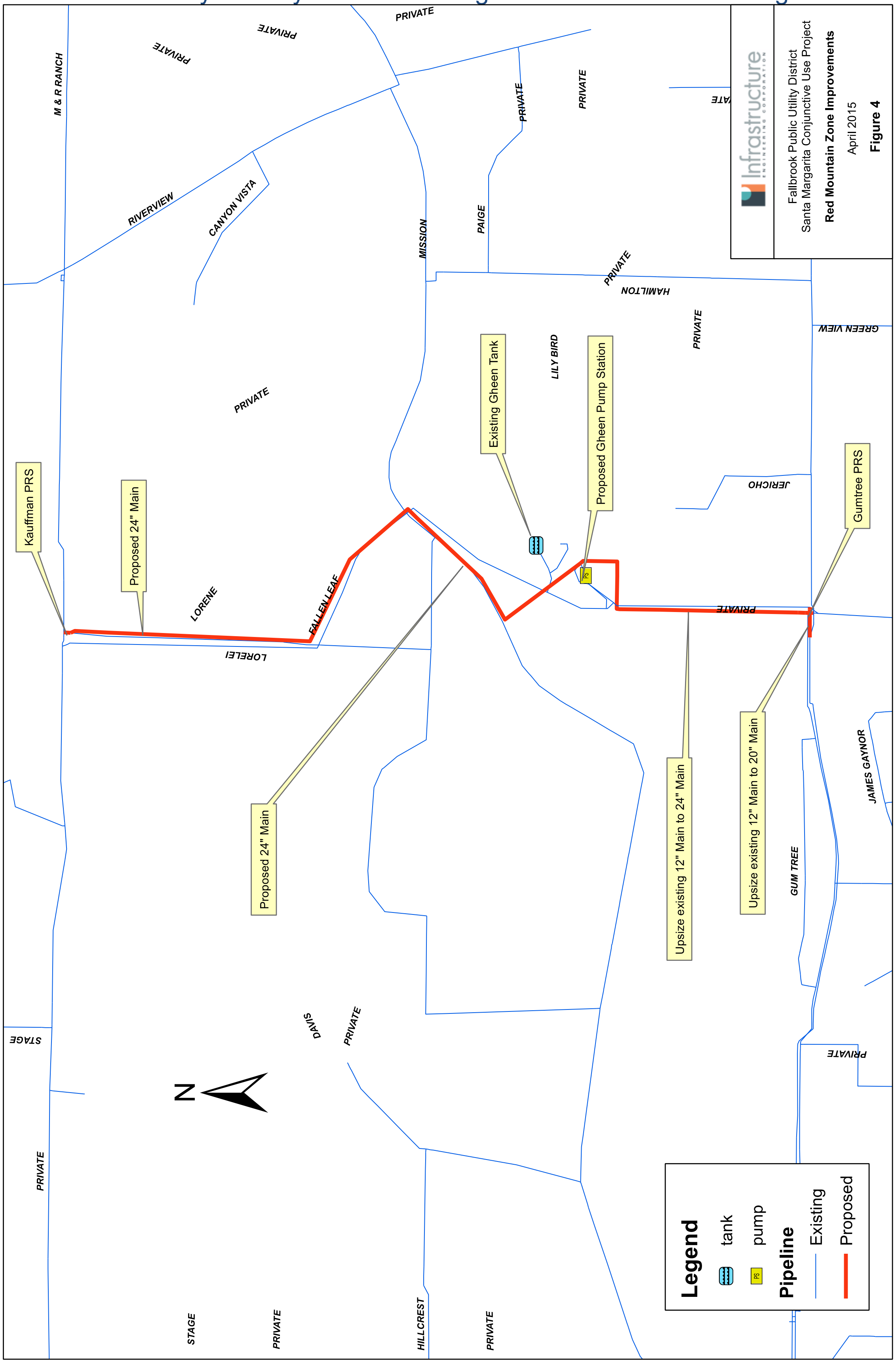
Connection Point 4 (McDonald/Palomino)
Proposed 24" Main
Replace Existing 12" CLIP
Connection Point 3 (Mission/Palomino)
Connection Point 2 (Merida/Hill)
Connection Point 1 (Alturas/Merida)


Infrastructure
Fallbrook Public Utility District
Santa Margarita Conjunctive Use Project
Red Mountain Zone Improvements
April 2015
Figure 4
Kauffman PRS
Proposed 24" Main
Proposed 24" Main
Existing Gheen Tank
Proposed Gheen Pump Station
Upsize existing 12" Main to 24" Main
Upsize existing 12" Main to 20" Main
Gumtree PRS
Legend
tank
pump
Pipeline
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Proposed
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RIVERVIEW
CANYON VISTA
MISSION
PAIGE
PRIVATE
HAMILTON
GREEN VIEW
LILY BIRD
JERICHO
LORENE
FALLEN LEAF
LORELEI
JAMES GAYNOR
GUM TREE
STAGE
DAVIS
HILLCREST

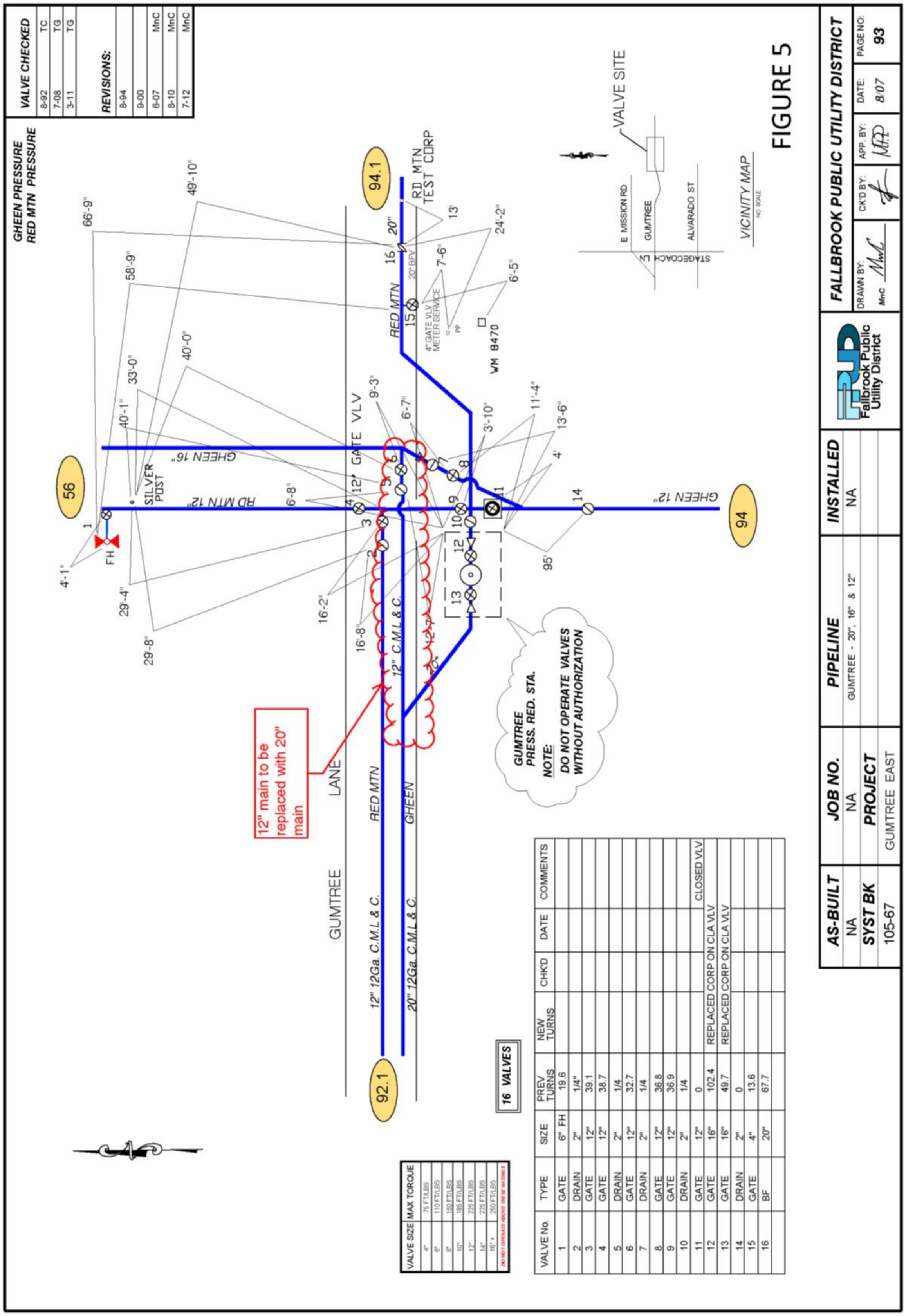


FIGURE 5
FALLBROOK PUBLIC UTILITY DISTRICT
Fallbrook Public Utility District
GHEEN PRESSURE
RED MTN PRESSURE
VALVE CHECKED
REVISIONS:
12" main to be replaced with 20" main
GUMTREE LANE
RED MTN
GHEEN
12" 12Ga. C.M.L.& C.
20" 12Ga. C.M.L.& C.
GHEEN 16"
RD MTN 12"
GHEEN 12"
RD MTN TEST CORP
SILVER POST
WM 8470
GUMTREE PRESS. RED. STA.
NOTE: DO NOT OPERATE VALVES WITHOUT AUTHORIZATION
VALVE SITE
VICINITY MAP
E MISSION RD
GUMTREE
ALVARADO ST
STAGECOACH LN
16 VALVES
VALVE No. | TYPE | SIZE | PREV TURNS | NEW TURNS | CHK'D | DATE | COMMENTS
1 | GATE | 6" FH | 19.6
2 | DRAIN | 2" | 1/4"
3 | GATE | 12" | 39.1
4 | GATE | 12" | 38.7
5 | DRAIN | 2" | 1/4
6 | GATE | 12" | 32.7
7 | DRAIN | 2" | 1/4
8 | GATE | 12" | 36.8
9 | GATE | 12" | 36.9
10 | DRAIN | 2" | 1/4
11 | GATE | 12" | 0 | CLOSED VLV
12 | GATE | 16" | 102.4 | REPLACED CORP ON CLA VLV
13 | GATE | 16" | 49.7 | REPLACED CORP ON CLA VLV
14 | DRAIN | 2" | 0
15 | GATE | 4" | 13.6
16 | BF | 20" | 67.7
AS-BUILT NA
JOB NO. NA
PIPELINE GUMTREE - 20", 16" & 12"
INSTALLED NA
SYST BK 105-67
PROJECT GUMTREE EAST
DATE: 8/07
PAGE NO: 93

4.4 EVALUATION OF STORAGE AT GHEEN TANK SITE

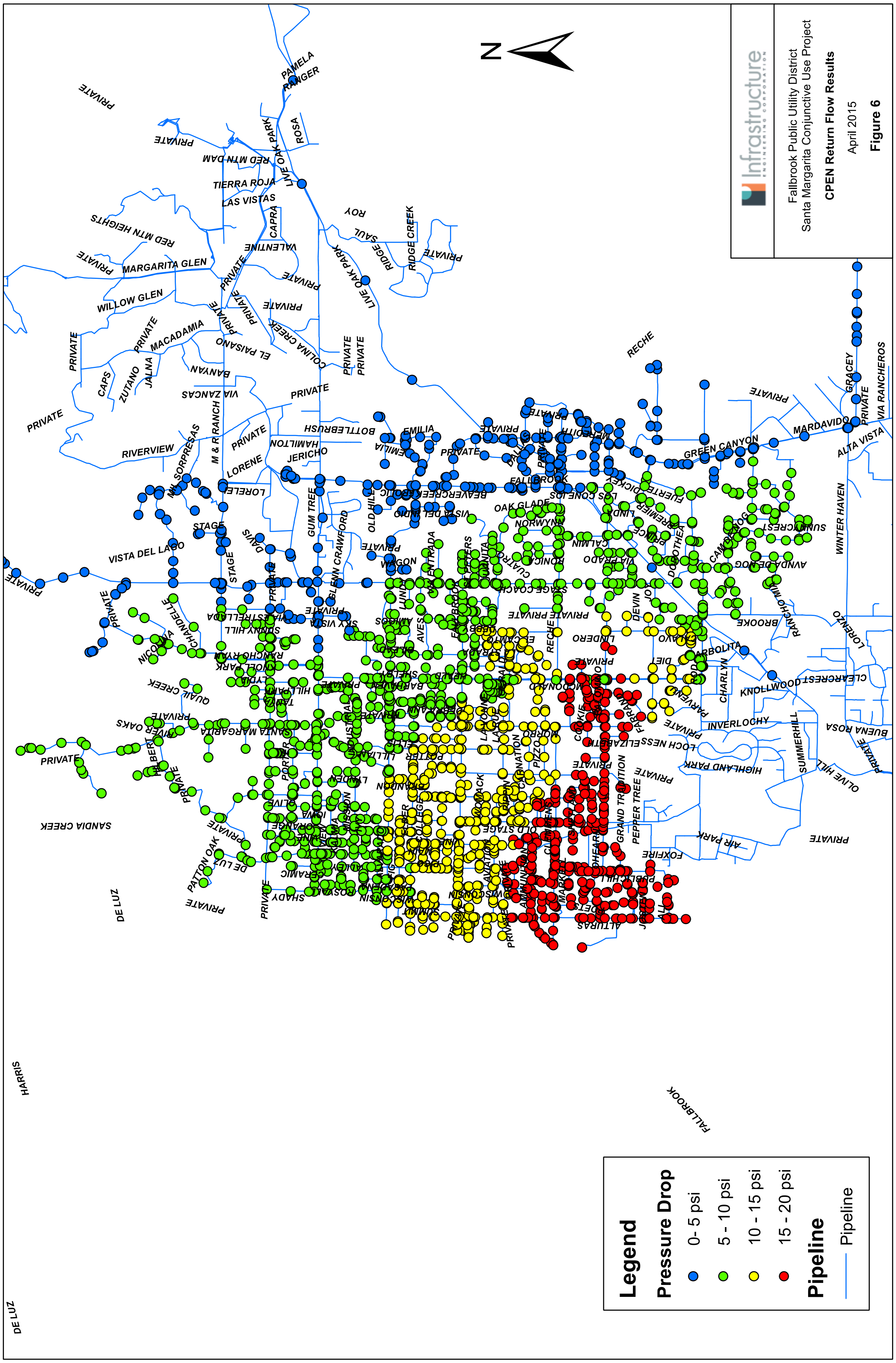
The District asked us to analyze the need for additional storage at the Gheen tank site.

Assuming May demands, which is when the maximum supply from CPEN could potentially occur, necessitating the most need for storage volume, the total demand for the Gheen, Rattlesnake, and Modified Town zones is 6.36 MGD. Under these conditions when the plant would be under maximum production, the Red Mountain UV facility would not be in operation and water would not be ordered from the San Diego County Water Authority (SDCWA). If the plant were to experience a power failure or otherwise be forced off-line it would be reasonable to allow 24 hours for the plant to come back on line, bring the UV facility on-line or complete a water order and receive water from SDCWA. Considering a typical peaking factor of 1.74 the maximum day of storage volume is 11.1 MGD. The existing Gheen tank is 6 MG. We would normally recommend duplicating the current capacity with an additional 6 MG of storage at the Gheen site to meet the peak maximum storage volume, but given the limited physical area available and that a 4 MG tank fits well on the site, a new 4 MG reservoir is recommended.

4.5 SUPPLY TO CPEN

We analyzed the amount of water that could be supplied to CPEN from the San Diego County Water Authority through the District to CPEN in an emergency or during extended drought conditions.

The pressure in the District's system at the proposed point of connection to CPEN (intersection of Alturas Road and Merida Drive) is approximately 135 psi. The model was used to analyze the potential supply to CPEN while maintaining less than a 20 psi pressure drop at all junction nodes within the Gheen zone. Results indicate that the District can provide approximately 7.3 MGD to CPEN under these conditions. See the pressure map shown in Figure 6.


Infrastructure
Fallbrook Public Utility District
Santa Margarita Conjunctive Use Project
CPEN Return Flow Results
April 2015
Figure 6
Legend
Pressure Drop
0- 5 psi
5 - 10 psi
10 - 15 psi
15 - 20 psi
Pipeline
Pipeline

4.6 SYSTEM HEAD CURVES

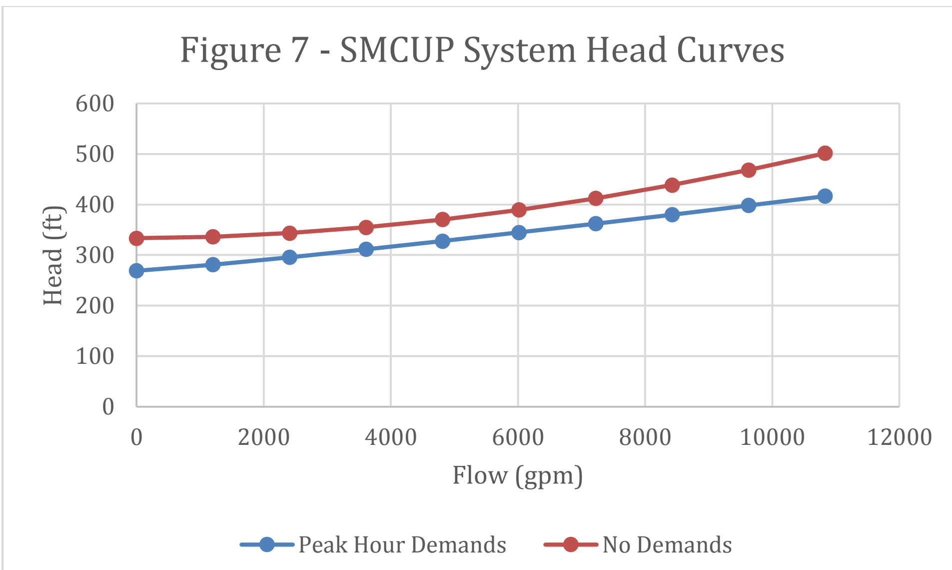
To assist with pump selection during preliminary design the model was used to develop system head curves for the proposed SMCUP plant product water pump station and at the proposed Gheen pump station over a range of varying demand conditions.

Plant Product Water Pump Station System Curves

System head curves were developed for the following conditions associated with plant product water pump station:

1. No demands with the Gheen tank at mid height with a water surface elevation (WSE) of 1014 feet (Gheen tank maximum WSE is 1029.2 feet) and an assumed plant clearwell WSE of 680 feet.
2. July peak hour demands (a peak hour factor of 3.0 was used) at minimum water surface elevation of 1014 feet.

System Head curves for the SMCUP plant are shown in Figure 7.



The product water pump SMCUP pump station may have to produce a total dynamic head (TDH) of 375 feet at a flow rate of 7.8 MGD equating to 2,500 horsepower. Actual horsepower and end static head conditions may be modified during the pump selection and design process.

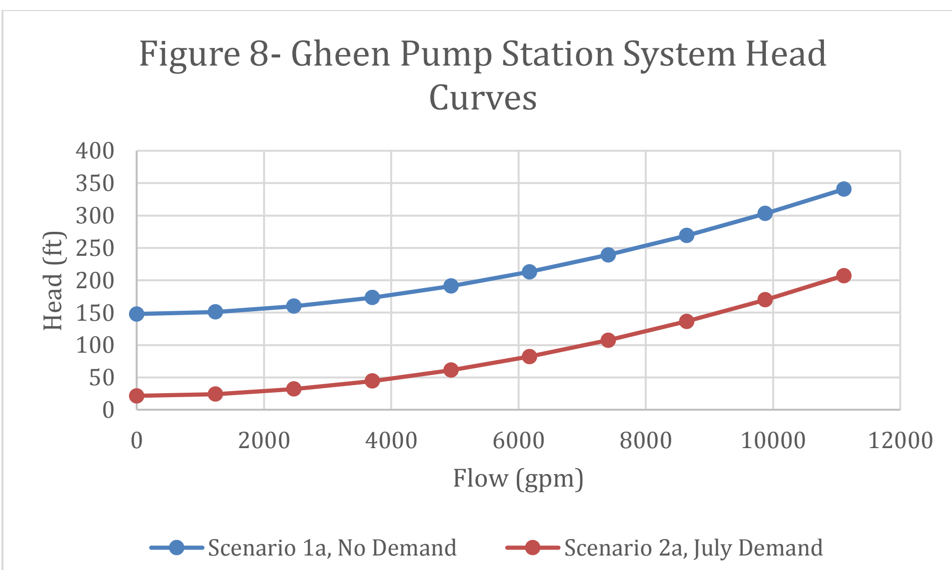
Gheen Pump Station System Curves
For the Gheen pump station, the following conditions were analyzed:

1. Low WSE in the Gheen tank of 1000 feet, and high WSE of 1150 feet, in the Red Mountain reservoir with the following pipeline configurations:
   a. Southerly pipeline from the Gheen pump station to the Kauffman PRS.
   b. Northerly pipeline from the Gheen pump station to the Gumtree PRS
   c. Both northerly and southerly pipelines.
2. High WSE in the Gheen tank at 129.2 feet, and low WSE in the Red Mountain reservoir at 1050 feet, under the following pipeline configurations:
   a. Southerly pipeline from the Gheen pump station to the Kauffman PRS alone.
   b. Northerly pipeline from the Gheen pump station to the Gumtree PRS alone
   c. Both northerly and southerly pipelines together.

The above scenarios were analyzed during July demands and during a no demand scenario to create the limiting conditions of system. The head curves (high head and low head) occurred during the following scenarios:

1. High head = Scenario 1a, no demands.
2. Low head = Scenario 2a, July demands

The high head and low head system curves are shown in Figure 8.



A new pump station at the Gheen reservoir site may need to produce TDH of 170 feet at a flow rate of 4 MGD or a TDH of 202 feet at a flow rate of 8 MGD equating to 200 and 400 horsepower respectively. Actual horsepower and end static head conditions may be modified during the pump selection and design process.

5. CONCLUSIONS AND RECOMMENDATONS

Based upon the distribution system analysis we are recommending the following improvements:

- Gheen zone pipeline improvements are shown in Figure 3 which include replacement and addition of nearly 8500 feet of 24-inch diameter pipeline from the SMCUP plant site to McDonald Road.
- Red Mountain zone improvements near the Gheen reservoir site are shown in Figure 4 which include about 2000 feet of new 24-inch pipeline from the Gheen Reservoir site north to the Kauffman PRV, and upsizing of about 800 feet of the 12-inch main from the Gheen Reservoir site south to Gumtree PRV with a 24-inch main.
- A new pump station at the Gheen reservoir site to produce a TDH of 170 feet at a flow rate of 4 MGD or a TDH of 202 feet at a flow rate of 8 MGD requiring about 200 and 400 horsepower respectively.
- A new 6 MG reservoir of additional storage at the Gheen reservoir site.
- A 2,500 horsepower product water SMCUP pump station to produce a TDH of 375 feet at a flow rate of 7.8 MGD.
- The return flow to CPEN, while limiting customer pressure reduction to 20 psi, is 7.3 MGD

APPENDIX F

GEOTECHNICAL INVESTIGATION REPORT

Ninyo & Moore
Geotechnical and Environmental Sciences Consultants

GEOTECHNICAL EVALUATION
SANTA MARGARITA
CONJUNCTIVE USE PROJECT
FALLBROOK, CALIFORNIA

PREPARED FOR:
Infrastructure Engineering Corporation
301 Mission Avenue, Suite 202
Oceanside, California 92054

PREPARED BY:
Ninyo & Moore
Geotechnical and Environmental Sciences Consultants
5710 Ruffin Road
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July 22, 2015
Project No. 107931001

Ninyo & Moore
Geotechnical and Environmental Sciences Consultants

July 22, 2015
Project No. 107931001

Mr. Rick Kennedy
Infrastructure Engineering Corporation
301 Mission Avenue, Suite 202
Oceanside, California 92054

Subject: Geotechnical Evaluation
Santa Margarita Conjunctive Use Project
Fallbrook, California

Dear Mr. Kennedy:

In accordance with your authorization, we have performed a geotechnical evaluation for the proposed Santa Margarita Conjunctive Use Project in Fallbrook, California. This report presents our geotechnical findings, conclusions, and recommendations regarding the proposed project. Our report was prepared in accordance with our proposal dated March 23, 2015. We appreciate the opportunity to be of service on this project.

Sincerely,
NINYO & MOORE

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Distribution: (1) Addressee (via e-mail)

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1. INTRODUCTION

In accordance with your request and our proposal dated March 23, 2015, we have performed a geotechnical evaluation for the proposed Santa Margarita Conjunctive Use Project in Fallbrook, California (Figure 1). This report presents our conclusions regarding the geotechnical conditions at the subject site and our recommendations for the design of this project.

2. SCOPE OF SERVICES

The scope of our geotechnical services included the following:

- Reviewing readily available published and in-house geotechnical literature pertaining to the site and the general site area, including geologic and fault maps.
- Conducting a geotechnical reconnaissance to observe the existing site conditions and to mark-out boring locations for utility clearance by Underground Service Alert (USA).
- Obtaining excavation and traffic control permits from the County of San Diego Department of Public Works.
- Performing a subsurface exploration program consisting of excavating, logging, and sampling of sixteen exploratory borings in the project area. Bulk and relatively undisturbed drive samples of soil were collected at selected intervals from the borings and transported to our in-house geotechnical laboratory for testing.
- Performing geotechnical laboratory testing on selected soil samples to evaluate geotechnical design parameters.
- Performing geotechnical analysis of the data obtained from our site reconnaissance, subsurface exploration, and laboratory testing.
- Preparing this report presenting our findings, conclusions, and recommendations pertaining to the design and construction of the proposed project.

3. SITE AND PROJECT DESCRIPTION

The Santa Margarita Conjunctive Use Project includes construction of a new groundwater desalter (water treatment plant), a new 4 million gallon water reservoir, a pump station, and roughly 9,300 feet of associated pipelines in Fallbrook, California. The site of the proposed desalter (water treatment plant) is located south of the existing wastewater treatment plant at

1425 Alturas Road in Fallbrook, California (Figures 1 and 2). The groundwater desalter site is bounded by Marine Corp Base Camp Pendleton to the south and west, Alturas Road to the east, and residential developments to the north. The site previously supported several sewage treatment drying ponds, and utility storage yards. Remaining improvements include paved roads, fencing, and one structure. Topography at the site is variable and consists of a relatively level area in the southern portion, an approximately 50-foot high knoll in the northern portion, and a gently sloping area in the western portion. Elevations range from approximately 660 feet above mean sea level (MSL) on the southern portion of the site to approximately 710 feet MSL at the northern portion of the site. Drainage is to the south towards Marine Corp Base Camp Pendleton. Vegetation generally consists of grass, weeds, and bushes.

The site of the proposed new pump station and water reservoir is located at the existing Gheen Reservoir facility, located to the south of East Mission Road. This site is presently developed with two existing above-ground reservoirs, with a paved driveway and other associated improvements. Current access to the site is afforded by East Mission Road, which bounds the site to the north. The site is also bounded to the west and south by residential properties and to the east by citrus groves. The ground surface elevation ranges from roughly 975 feet MSL in the northern portion of the site to approximately 1,030 feet MSL in the northeast portion of the site. Vegetation at the site generally consists of scattered trees, brush and weeds.

Three pipelines are planned as part of the project. Approximately 8,500 lineal feet of pipeline will extend east from the groundwater desalter facility within portions of Alturas road, Merida Drive, South Hill Avenue, Almond Street, South Mission Road, and Palomino Road, where it terminates near the intersection of Palomino Road and McDonald Road (Figure 3). A second pipeline will be approximately 800 feet in length and will be constructed within a private road that extends north from Gumtree Lane to the Gheen Reservoir site. A third pipeline will be roughly 2,000 feet in length and will extend north from Gheen Reservoir through Fallen Leaf Lane and Lorelei Lane to M&R Ranch Road.

It is our understanding that some buried tanks may be constructed at the desalter facility and that the other structures at the desalter facility will be constructed at or near existing grades and structures will be supported by conventional spread footings. Proposed depths of the tanks are not known at this time; however, we have assumed that the tanks will be installed to depths on the order of 15 feet. We also understand that the reservoir, pump station and ancillary structures will primarily be constructed at similar to those that currently exist and that the structures at the Gheen reservoir facility will also be supported by conventional spread footings. The proposed pipelines are assumed to be constructed at an invert depth of approximately 10 feet.

4. FIELD EXPLORATION AND LABORATORY TESTING

Our subsurface exploration was conducted on May 13, 14, 18 and 19, 2015 and consisted of drilling, logging, and sampling 16 exploratory borings. Five borings (B-1 through B-5) were drilled in the vicinity of the new groundwater desalter facility. Ten borings (B-6 through B-13, and B-15 through B-16) were drilled at various locations along the proposed pipelines along Merida Drive, South Hill Avenue, Almond Street, Palomino Road, and Gum Tree Lane. One boring (B-14) was drilled at the proposed Gheen Reservoir site, while one boring (B-15) was drilled near the northern terminus of the pipeline that will extend north from the Gheen Reservoir site to M&R Ranch Road. The borings were drilled to depths of up to approximately 20 feet below existing grades with a truck mounted, hollow stem auger drill rig. Soil samples were obtained at intervals from the borings. The samples were then transported to our in-house geotechnical laboratory for testing. The approximate locations of the exploratory borings are shown on Figures 2 through 4. Logs of the borings are included in Appendix A.

Laboratory testing of representative soil samples included in-situ dry density and moisture content, gradation, Atterberg limits, direct shear, expansion index, soil corrosivity, and R-value. The results of the in-situ dry density and moisture content tests are presented on the boring logs in Appendix A. The results of the other laboratory tests are presented in Appendix B.

5. GEOLOGY AND SUBSURFACE CONDITIONS

Our findings regarding regional and site geology and groundwater conditions at the project site are provided in the following sections.

5.1. Regional Geologic Setting

The project area is situated in the coastal foothill section of the Peninsular Ranges Geomorphic Province. This geomorphic province encompasses an area that extends approximately 900 miles from the Transverse Ranges and the Los Angeles Basin south to the southern tip of Baja California (Norris and Webb, 1990; Harden, 2004). The province varies in width from approximately 30 to 100 miles. In general, the province consists of rugged mountains underlain by Jurassic metavolcanic and metasedimentary rocks, and Cretaceous igneous rocks of the southern California batholith. The portion of the province in San Diego County that includes the project area is underlain by Cretaceous granitic rock (Figure 5).

The Peninsular Ranges Province is traversed by a group of sub-parallel faults and fault zones trending roughly northwest. Several of these faults, which are shown on Figure 6, are considered active faults. The Elsinore, San Jacinto, and San Andreas faults are active fault systems located northeast of the project area and the Rose Canyon, Coronado Bank, San Diego Trough, and San Clemente faults are active faults located west of the project area. The Elsinore Fault Zone, the nearest active fault system, has been mapped approximately 8 miles east of the project site. Major tectonic activity associated with these faults within this regional tectonic framework consists primarily of right-lateral, strike-slip movement. Further discussion of faulting relative to the site is provided in the Faulting and Seismicity and Seismic Hazards section of this report.

5.2. Site Geology

Geologic units encountered during our subsurface evaluation include fill, alluvium, and granitic rock. Generalized descriptions of the earth units encountered are provided in the subsequent sections. Additional descriptions of the subsurface units are provided on the boring logs in Appendix A.

5.2.1. Fill

Fill was encountered in each of our drilled borings, beneath existing pavements and from the ground surface to depths of up to 10 feet. As encountered, the fill consists of various shades of brown and gray, moist, loose to medium dense, silty sand with scattered cobbles, along with brownish gray, moist, stiff, sandy clay. Geotechnical literature documenting the placement/compaction of the fill was not available.

5.2.2. Alluvium

Alluvium was encountered in boring B-1, B-9, B-13, B-15, and B-16 from beneath the fill to approximate depths of up to 11 feet. As encountered, the alluvium generally consists of reddish brown to brown, moist, medium dense to dense, silty sand.

5.2.3. Granitic Rock

Granitic rock was encountered in each of our exploratory borings and extended from beneath the fill and/or alluvium to the depths explored of up to 20.5 feet. As encountered, the granitic rock generally consists of various shades of brown to gray, moist, weathered, granitic rock. Granitic rock boulders and outcrops were also observed across the site.

5.3. Groundwater

Groundwater was not encountered during our subsurface exploration. However, laboratory moisture content testing of a sample obtained at an approximate depth of 15 feet from our boring B-16 (drilled near an intermittent stream channel crossing at Palomino Road) indicates an elevated degree of saturation. Consequently, groundwater/saturated conditions could be encountered in the vicinity of the channel, particularly following periods of precipitation. However, it should be noted that in areas of granitic bedrock, groundwater can be expected to occur within joints or fractures and may not occur at a specific elevation. Fluctuations in the groundwater level and perched conditions typically occur due to variations in precipitation, ground surface topography, subsurface stratification, irrigation, and other factors.

6. GEOLOGIC HAZARDS

In general, hazards associated with seismic activity include strong ground motion, ground surface rupture, and liquefaction. These considerations and other geologic hazards such as landsliding are discussed in the following sections.

6.1. Faulting and Seismicity

The project area is considered to be seismically active. Based on our review of the referenced geologic maps as well as on our geologic field mapping, the subject site is not underlain by known active or potentially active faults (i.e., faults that exhibit evidence of ground displacement in the last 11,000 years and 2,000,000 years, respectively). However, the site is located in a seismically active area, as is the majority of southern California, and the potential for strong ground motion is considered significant during the design life of the proposed structure. The nearest known active fault is the maximum moment magnitude 7.1 Elsinore Fault (Temecula segment), located approximately 8 miles northeast of the site (Figure 6).

Table 1 lists selected principal known active faults that may affect the subject site, the maximum moment magnitude (M_{max}) and the fault types as published for the California Geological Survey (CGS) by Cao et al. (2003). The approximate fault to site distance was calculated by the United States Geological Survey (2008) National Seismic Hazard Maps database.

Table 1 – Principal Active Faults

Fault	Distance miles [1]	Moment Magnitude/ Fault Type [1,2]
Elsinore (Temecula Segment)	8	6.8/A
Elsinore (Julian Segment)	13	7.1/A
Elsinore (Glen Ivy Segment)	17	6.8/A
Newport-Inglewood (Offshore)	20	7.1/B
Rose Canyon	22	7.2/B
San Jacinto (Anza Segment)	30	7.2/A
San Joaquin Hills	30	6.6/B
San Jacinto (San Jacinto Valley Segment)	31	6.9/A
Chino (Alt 2)	36	6.7/B
Coronado Bank	37	7.6/B
Elsinore (Whittier Segment)	37	6.8/A

Table 1 – Principal Active Faults

Fault	Distance miles [1]	Moment Magnitude/ Fault Type [1,2]
Chino (Alt 1)	39	6.7/B
Earthquake Valley	39	6.5/B
San Jacinto (Coyote Creek Segment)	39	6.8A
Palos Verdes	41	7.3/B
San Jacinto (San Bernardino Segment)	43	6.7/A
Newport-Inglewood (Alt 1)	44	7.1/B
San Andreas (Banning/Garnett Hill Segment)	45	7.2/A
Puente Hills (Coyote Hills Segment)	51	7.1/B
San Andreas (North San Bernardino Segment)	52	6.7/A
Pinto Mountain	54	7.2/B
Cucamonga	56	6.9/B
San Jose	56	6.4/B
Elsinore (Coyote Mountain Segment)	58	6.8/A
Sierra Madre	59	6.7/B
Puente Hills (Santa Fe Springs Segment)	59	7.1/B
San Jacinto (Borrego Segment)	60	6.6/A
Burnt Mountain	61	6.5/B
Cleghorn	61	6.5B

Notes:
[1] USGS (2012)
[2] Cao, et al. (2003)

In general, hazards associated with seismic activity include ground surface rupture, strong ground motion, ground surface rupture, liquefaction, and seismically induced settlement. These hazards are discussed in the following sections.

6.1.1. Ground Rupture

There are no known active faults crossing the subject site, and the potential for ground rupture due to faulting is considered low. The potential for surface ground cracking related to shaking from distant events is also considered low.

6.1.2. Ground Motion

The 2013 California Building Code (CBC) specifies that the Risk-Targeted, Maximum Considered Earthquake (MCE_R) ground motion response accelerations be used to evaluate seismic loads for design of buildings and other structures. The MCE_R ground motion response accelerations are based on the spectral response accelerations for

5 percent damping in the direction of maximum horizontal response and incorporate a target risk for structural collapse equivalent to 1 percent in 50 years with deterministic limits for near-source effects. The horizontal peak ground acceleration (PGA) that corresponds to the MCE_R for the site was calculated as 0.47g using the United States Geo-Geological Survey (USGS, 2013) seismic design tool (web-based). Spectral response acceleration parameters, consistent with the 2013 CBC, are also provided in Section 8.2. for the evaluation of seismic loads on buildings and other structures.

The 2013 CBC specifies that the potential for liquefaction and soil strength loss be evaluated, where applicable, for the Maximum Considered Earthquake Geometric Mean (MCE_G) peak ground acceleration with adjustment for site class effects in accordance with the American Society of Civil Engineers (ASCE) 7-10 Standard. The MCE_G peak ground acceleration is based on the geometric mean peak ground acceleration with a 2 percent probability of exceedance in 50 years. The MCE_G peak ground acceleration with adjustment for site class effects (PGA_M) was calculated as 0.43g using the USGS (USGS, 2013) seismic design tool that yielded a mapped MCE_G peak ground acceleration of 0.43g for the site and a site coefficient (F_{PGA}) of 1.000 for Site Class C.

6.1.3. Liquefaction

Liquefaction is the phenomenon in which loosely deposited granular soils with silt and clay contents of less than approximately 35 percent and non-plastic silts located below the water table undergo rapid loss of shear strength when subjected to strong earthquake-induced ground shaking. Ground shaking of sufficient duration results in the loss of grain-to-grain contact due to a rapid rise in pore water pressure, and causes the soil to behave as a fluid for a short period of time. Based on the dense nature of the underlying bedrock materials, along with the observed lack of shallow ground water, liquefaction is not anticipated to be a design consideration.

6.2. Landsliding

No landslides or indications of deep-seated landslides were noted underlying the project site during our field exploration or our review of available geologic literature and topographic maps.

7. CONCLUSIONS

Based on our geotechnical evaluation, it is our opinion that construction of the proposed project is feasible from a geotechnical standpoint, provided the following conclusions and recommendations are incorporated into the design and construction of the project. The following includes geotechnical considerations and conclusions for the project:

- The project area is underlain by fill, alluvium, and granitic rock with varying degrees of weathering. Fill and alluvium are not considered suitable for structural support of the proposed improvements in their current condition. Where structures will be founded near grade, these soils should be removed and replaced with compacted fill as recommended herein. The underlying granitic rock is considered suitable for structural support.

- Groundwater was not encountered during our subsurface exploration. However, laboratory testing of a sample obtained from boring B-16 (drilled near the crossing of Palomino Road at an intermittent stream channel) at a depth of approximately 15 feet indicated an elevated in-situ moisture content. It should be noted that in areas of granitic bedrock, seepage can be expected to occur within joints or fractures and may not occur at a specific elevation. Fluctuations in the groundwater level and perched water conditions may occur due to variations in ground surface topography, subsurface geologic conditions and structure, rainfall, irrigation, and other factors.

- Based on the results of our exploratory borings, and our experience with similar soils, it is our opinion that the fill and alluvial materials can be excavated using heavy duty earthmoving equipment in good working condition. However, it is anticipated that most of the proposed improvements will encounter granitic rock.

- Difficult ripping, rock breaking, and/or blasting should be anticipated for excavations in the granitic bedrock. Excavations will encounter corestones and hard to very hard rock, which will make such excavations difficult. Granitic rock boulders and outcrops were observed across the site.

- Disposal, crushing, or special handling of the resulting oversize material should be anticipated. Provisions should be made for breaking or disposal of boulders on the order of several feet in dimension.

- We anticipate trench bottoms to generally be stable. However, areas where loose, wet alluvium is present may necessitate removal and replacement with crushed rock as recommended herein.
- Based on the laboratory test results, ACI 318, and Caltrans (2012) criteria, the on site soils are not considered corrosive.

8. RECOMMENDATIONS

Based on our understanding of the project, the following recommendations are provided for the design and construction of the proposed project.

8.1. Earthwork

In general, earthwork should be performed in accordance with the recommendations presented in this report. Ninyo & Moore should be contacted for questions regarding the recommendations or guidelines presented herein.

8.1.1. Pre-Construction Conference

We recommend that a pre-construction conference be held. The owner and/or their representative, the governing agencies' representatives, the civil engineer, the architect, Ninyo & Moore, and the contractor should be in attendance to discuss the work plan and project schedule and earthwork requirements.

8.1.2. Site Preparation

Prior to performing excavations or other earthwork, the site should be cleared of trash, debris, vegetation, and loose or otherwise unsuitable soils. Existing utilities should be relocated and protected from damage by construction activities. Obstructions that extend below the finished grade, if encountered, should be removed and the resulting holes filled with compacted fill. Materials generated from the demolition and clearing operations should be removed from the project site and disposed of at a legal dump site.

8.1.3. Remedial Grading

We recommend that to provide support for the structures, unsuitable material i.e., existing fill, alluvium and loose/disturbed decomposed granite be removed to expose competent decomposed granite or granitic rock within structural areas. For the purpose of this report, structural areas are defined as the areas underlying the structures and extending a horizontal distance of 5 feet beyond the footprints of the structures. Table 2 summarizes the depth of fill/alluvium encountered within the exploratory borings drilled within the groundwater desalter facility, as well as that drilled at the Gheen Reservoir site.

Table 2 – Encountered Thickness of Fill/Alluvium Near Proposed Structures

Structure	Nearest Boring	Encountered Thickness of Fill/Alluvium
Equalizer Tank	B-1	3 feet
Reverse Osmosis Building	B-2	3 feet
Chemical Building	B-3	10 feet
Iron & Magnesium System	B-4	2 feet
Reverse Osmosis Feed	B-5	8 feet
Clear Well		
Wash Wastewater		
Gheen Reservoir	B-14	1 foot

The depth and extent of the removal should be observed in the field by Ninyo & Moore. Based on our field observations, deeper removals may be recommended.

8.1.4. Treatment of Cut/Fill Transitions Beneath Structures

We understand that grading plans have not yet been developed; however, some structures could be underlain by a cut/fill transition. In order to mitigate the potential for differential settlement, we recommend that where a cut/fill transition line extends beneath a proposed structure location, the cut portion of the pad should be undercut. The undercut should be performed to a depth of 2 feet below proposed foundations or to a depth one-third or more of the deepest fill depth (including remedial grading depths) beneath the structure, whichever is greater. The resulting undercut should be filled with compacted fill. The undercut should be extended outward a distance of 5 feet beyond the lateral limits of the structure, where practical.

As an alternative to the recommended undercut, the potential for differential settlement across the cut-fill transition can also be mitigated by the deepening of structure foundations through the fill and into the underlying bedrock.

8.1.5. Excavation Characteristics

Based on our site reconnaissance and subsurface exploration, the on-site fill, alluvium, and upper portions of granitic rock are expected to be rippable with heavy-duty earth-moving equipment. Heavy ripping, rock breaking, and blasting are anticipated at depth and in the vicinity of corestone outcrops. Resistant rock masses or corestones should be anticipated at variable depths. Rippability of a rock mass will also be dependent on the excavation equipment used, the geometry of the excavation, and the skill and experience of the equipment operator.

8.1.6. Fill Material

The soils encountered at the project site should be generally suitable for reuse as fill or backfill provided they are free of organic material, clay, and rocks or debris greater than 4 inches in diameter. Utility trench backfill material should not contain rocks or lumps over 3 inches in largest dimension and not more than 30 percent larger than 3/4-inch. Cobbles or rock chunks, if generated during excavation, may be broken into acceptably sized pieces or disposed of off site.

Potential fill soil imported to the site should consist of granular material with a low potential for expansion (EI 50 or less) as evaluated by the ASTM International (ASTM) D 4829 and a low corrosivity potential. Ninyo & Moore should evaluate materials before importation.

8.1.7. Compacted Fill

Prior to placement of compacted fill the contractor should request an evaluation of the exposed ground surface by Ninyo & Moore. Unless otherwise recommended, the exposed ground surface should then be scarified to a depth of approximately 8 inches and watered or dried, as needed, to achieve moisture contents generally above the laboratory optimum moisture content. The scarified materials should then be compacted to a relative compaction of 90 percent as evaluated in accordance with ASTM D 1557. The evaluation of compaction by the geotechnical consultant should not be considered to preclude any requirements for observation or approval by governing agencies. It is the contractor's responsibility to notify the geotechnical consultant and the appropriate governing agency when project areas are ready for observation, and to provide reasonable time for that review.

Fill materials should be moisture conditioned to generally above the laboratory optimum moisture content prior to placement. The optimum moisture content will vary with material type and other factors. Moisture conditioning of fill soils should be generally consistent within the soil mass.

Prior to placement of additional compacted fill material following a delay in the grading operations, the exposed surface of previously compacted fill should be prepared to receive fill. Preparation may include scarification, moisture conditioning, and recompaction.

Compacted fill should be placed in horizontal lifts of approximately 8 inches in loose thickness. Prior to compaction, each lift should be watered or dried as needed to achieve a moisture content generally above the laboratory optimum, mixed, and then compacted by mechanical methods, using sheepsfoot rollers, multiple-wheel pneumatic-tired rollers or other appropriate compacting rollers, to a relative compaction of 90 percent as evaluated by ASTM D 1557, or to the degree of compaction required by the Fallbrook Public Utilities District (whichever is more stringent). Successive lifts should be treated in a like manner until the desired finished grades are achieved.

For proposed pavement areas, the subgrade should be scarified to a depth of 12 inches, moisture conditioned to near optimum moisture content, and compacted to 95 percent relative compaction as evaluated by ASTM D1557.

8.1.8. Temporary Excavations

We recommend that trenches and excavations be designed and constructed in accordance with Occupational Safety and Health Administration (OSHA) regulations. These regulations provide trench sloping and shoring design parameters for trenches up to 20 feet deep based on the soil types encountered. Trenches over 20 feet deep should be designed by the contractor's engineer based on site-specific geotechnical analyses. For planning purposes, we recommend that the following OSHA soil classifications be used:

Fill, Alluvium	*Type C*
Granitic Rock	*Type B*

Temporary excavations should be constructed in accordance with OSHA recommendations. For trench or other excavations, OSHA requirements regarding personnel safety should be met by using appropriate shoring (including trench boxes) or by laying back the slopes no steeper than 1-1/2:1 (horizontal to vertical) in fill, topsoil, alluvium, and decomposed granitic rock materials and 1:1 in granitic rock. Zones of seepage or perched water may be encountered at shallower depths. Temporary excavations that encounter seepage may need shoring or may be mitigated by placing sandbags or gravel along the base of the seepage zone. Excavations encountering seepage should be evaluated on a case-by-case basis. Dewatering is not anticipated to be needed in the performance of the overexcavation for the proposed pads. On-site safety of personnel is the responsibility of the contractor.

8.1.9. Shoring

Shoring systems may be constructed through fill, alluvium, and granitic rock materials. The shoring system should be designed using the lateral earth pressures shown on Figures 7 and 8 for cantilevered and braced shoring, respectively. The recommended design pressures are based on the assumptions that the shoring system is constructed without raising the ground surface elevation behind the shoring, that there are no surcharge loads (such as soil stockpiles and construction materials). The contractor should include the effect of any surcharge loads on the lateral pressures against the shoring.

The contractor should retain a qualified and experienced engineer to design the shoring system, to evaluate the adequacy of these parameters, and to provide modifications for the design. When designing the shoring system, the presence of granitic rock and corestones should be considered when selecting the type of shoring and installation, as these materials may be difficult to drive or drill piling. Shoring plans should be reviewed by the geotechnical engineer. We recommend that the contractor take appropriate measures to protect workers. OSHA requirements pertaining to worker safety should be observed.

8.1.10. Excavation Bottom Stability

In general, we anticipate that the bottom of the excavations will be stable and should provide suitable support to the proposed improvements. However, excavations in loose alluvium or that are close to or below the ground water surface or that encounter seepage (such as in the vicinity of the intermittent channel that crosses Palomino Road) may be unstable. In general, unstable bottom conditions may be mitigated by overexcavating the bottom approximately 1 foot and replacing with crushed rock. Recommendations for stabilizing excavation bottoms should be based on evaluation in the field by Ninyo & Moore at the time of construction.

8.1.11. Slopes

Unless otherwise recommended by Ninyo & Moore and approved by the regulating agencies, fill and cut slopes should not be steeper than 2:1 (horizontal to vertical).

Compaction of the face of fill slopes should be performed by backrolling at intervals of 4 feet or less in vertical slope height or as dictated by the capability of the available equipment, whichever is less. Fill slopes should be backrolled utilizing a sheepsfoot-type roller. Care should be taken in maintaining the desired moisture conditions and/or reestablishing them, as needed, prior to backrolling. The placement, moisture conditioning, and compaction of fill slope materials should be done in accordance with the recommendations presented in the Compacted Fill section of this report.

Site runoff should not be permitted to flow over the tops of slopes. Positive drainage should be established away from the slopes. This may be accomplished by incorporating brow ditches placed at the top of the slopes to divert surface runoff away from the slope face where drainage devices are not otherwise available.

The on-site soils are susceptible to erosion. Therefore, the project plans and specifications should contain design features and construction requirements to mitigate erosion of on-site soils during and after construction. Imported fill materials should be evaluated for suitability by Ninyo & Moore prior to their use in constructing fill slopes.

8.2. Seismic Design Considerations

Design of the proposed improvements should be performed in accordance with the requirements of governing jurisdictions and applicable building codes. Table 3 presents the seismic design parameters for the site in accordance with the CBC (2013) guidelines and adjusted MCE_R spectral response acceleration parameters (USGS, 2013).

Table 3 – 2013 California Building Code Seismic Design Criteria

Site Coefficients and Spectral Response Acceleration Parameters	Values
Site Class	C
Site Coefficient, F_a	1.000
Site Coefficient, F_v	1.347
Mapped Short Period Spectral Acceleration at 0.2-second Period, S_S	1.167g
Mapped One-Second Period Spectral Acceleration at 1.0-second Period, S_1	0.453g
Short Period Spectral Acceleration at 0.2-second Period Adjusted For Site Class, S_{MS}	1.167g
One-Second Period Spectral Acceleration at 1.0-second Period Adjusted For Site Class, S_{M1}	0.610g
Design Short Period Spectral Acceleration at 0.2-second Period, S_{DS}	0.778g
Design One-Second Period Spectral Acceleration at 1.0-second Period, S_{D1}	0.407g

8.3. Foundations

The proposed structures may be supported on foundations bearing on either compacted fill or granitic rock materials. Foundations should be designed in accordance with structural considerations and the following recommendations. In addition, requirements of the appropriate governing jurisdictions and applicable building codes should be considered in the design of the structures.

8.3.1. Shallow Footings

We anticipate that the proposed structures may be supported on conventional spread footings. Spread footings bearing on compacted fill soils prepared in accordance with this report may be designed using a net allowable bearing capacity of 2,500 pounds per square foot (psf), while those bearing on granitic rock may be designed for a net allowable bearing capacity of 3,500 psf. These allowable values are based on a factor of safety of roughly three. Conventional spread footings should be embedded 18 inches below finish grade. Continuous footings should be 15 inches or more in width and isolated footings should be 24 inches or more in width. The allowable bearing capacity can be increased by 300 psf for each additional foot of embedment or width up to a value of 3,500 psf within compacted fill and to a value of 4,500 psf within granitic rock. The allowable bearing capacity can also be increased by one-third for loads of short duration, including wind and seismic forces. The spread footings should be reinforced in accordance with the recommendations of the structural engineer.

Footings bearing on granitic rock or compacted fill may be designed using a coefficient of friction of 0.35, where the total frictional resistance equals the coefficient of friction times the dead load. The footings may be designed using a passive resistance of 350 psf per foot of depth up to a value of 3,500 psf. The allowable lateral resistance can be taken as the sum of the frictional resistance and passive resistance, provided the passive resistance does not exceed one-half of the total allowable resistance. The passive resistance may be increased by one-third when considering loads of short duration, such as wind or seismic forces.

Trenches should not be excavated adjacent to spread footings. If trenches are to be excavated near a footing, the bottom of the trench should be located above a 2:1 (horizontal to vertical) plane projected downward from the bottom of the footing. Utility lines that cross beneath footings should be encased in lean concrete below the footing.

8.3.2. Settlement

Due to shallow bedrock and the understanding that remedial grading will remove potentially compressible material, total settlement of foundations designed and constructed as recommended herein may be estimated to be on the order of 1/2-inch. Differential settlement on the order of 1/2-inch over a horizontal span of 50 feet should be expected.

8.4. Slabs-on-Grade

We recommend that conventional, slab-on-grade floors, underlain by 2 feet or more of compacted fill materials of generally very low to low expansion potential, be 5 inches in thickness and be reinforced with No. 4 reinforcing bars spaced 18 inches on center each way. The reinforcing bars should be placed near the middle of the slab. As a means to help reduce shrinkage cracks, we recommend that the slabs be provided with expansion joints at intervals of approximately 12 feet each way. The slab reinforcement and expansion joint spacing should be designed by the project structural engineer.

If moisture sensitive floor coverings are to be used, we recommend that slabs be underlain by a vapor retarder and capillary break system consisting of a 10-mil polyethylene (or equivalent) membrane placed over 4 inches of medium to coarse, clean sand or pea gravel and overlain by an additional 2 inches of sand to help protect the membrane from puncture during placement and to aid in concrete curing. The exposed subgrade should be moistened just prior to the placement of concrete.

8.5. Underground Structures

Restrained underground structures may be designed for lateral pressures represented by the pressure diagram on Figure 9, while unrestrained underground structures may be designed for the lateral pressures presented by the pressure diagram on Figure 10. For preliminary design purposes, we recommend that the groundwater level be assumed at a depth of 15 feet for evaluation of lateral pressures and calculating the factor of safety against uplift. It is recommended that the exterior of underground walls and horizontal and vertical construction joints be waterproofed, as indicated by the project civil engineer and/or architect. For pipe wall penetrations into the lift station, vaults, and other structures, standard "water-tight" penetration design should be utilized. To reduce the potential for relative pipe to wall differential settlement, which could cause pipe shearing, we recommend that a pipe joint be located close to the exterior of the wall. The type of joint should be such that minor relative movement can be accommodated without distress.

8.6. Underground Utilities

For the construction of new underground utility pipelines, we anticipate that they will be supported on granitic or alluvial materials. The depths of the pipelines are not known but are generally anticipated to be less than 10 feet deep.

8.6.1. Pipe Bedding

For new piping, we recommend that bedding material be placed around pipe zones to 1 foot or more above the top of the pipe in accordance with the recent edition of the Standard Specifications for Public Works Construction ("Greenbook"). The bedding material should be classified as sand, be free of organic material, and have a sand equivalent of 30 or more. If gravel is used for bedding material in trenches constructed below future improvements, the gravel should be wrapped in overlapped filter fabric to mitigate fines migration into the voids.

Special care should be taken not to allow voids beneath and around the pipe. Compaction of the bedding material and backfill should proceed up both sides of the pipe. Trench backfill, including bedding material, should be compacted in accordance with the recommendations presented in this report.

8.6.2. Trench Zone Backfill

For the purpose of this report, the trench zone is considered to extend from 1 foot above the top of the pipe to the top of the trench. The backfill material should not generally contain rocks or lumps greater than approximately 3 inches, and particles not more than approximately 30 percent larger than 3/4 inch. Soils classified as silts or clays should not be used for trench backfill.

As required by Section 02223 of the Fallbrook Public Utility District's Technical Specifications, backfill should be moisture conditioned to near the optimum moisture content, placed, and compacted to a relative compaction of 95 percent as evaluated by ASTM D 1557. Wet soils should be allowed to dry to moisture contents near the optimum prior to their placement as backfill. Backfill lift thickness will be dependent upon the type of compaction equipment utilized. Backfill should generally be placed in lifts not exceeding 8 inches in loose thickness. Care should be taken to not damage utilities during the backfill process. Pavement subgrade should be compacted to 95 percent relative compaction as evaluated by ASTM D 1557.

8.6.3. Modulus of Soil Reaction (*E'*)

The modulus of soil reaction (*E'*) is used to characterize the stiffness of soil backfill placed at the sides of buried flexible pipes for the purpose of evaluating deflection caused by the weight of the backfill over the pipe (Hartley and Duncan, 1987). A soil reaction modulus of 1,600 pounds per square inch (psi) may be used for excavation depths less than 5 feet and 2,200 psi may be used for excavation depths of more than 5 feet, backfilled with granular soil compacted to 90 percent based on ASTM D 1557.

8.7. Lateral Pressures for Thrust Blocks

Thrust restraint for buried pipelines may be achieved by transferring the thrust force to the soil outside the pipe through a thrust block. Thrust blocks may be designed using the lateral passive earth pressures presented on Figure 11. Thrust blocks should be backfilled with granular backfill material, and compacted in accordance with recommendations presented in this report.

8.8. Preliminary Pavement Design

For design of asphalt concrete pavements which may be constructed at the reservoir site, we assumed Traffic Indices (TI) of 5 and 6 for site pavements. If traffic loads are different from those assumed, the pavement design should be re-evaluated. Actual pavement recommendations should be based on R-value tests performed on bulk samples of the soils exposed at the finished subgrade elevations once grading operations have been performed.

The results of our R-value testing on a representative soil sample obtained from our exploratory borings indicated an R-value of 43. For preliminary design we used an R-value of 35 due to the variations of the on-site soils. We recommend that R-value testing be performed on the actual material exposed at subgrade at the completion of grading. The preliminary recommended pavement sections are as follows:

Table 4 – Recommended Preliminary Flexible Pavement Sections

Traffic Index	R-Value	Asphalt Concrete (inches)	Class 2 Aggregate Base (inches)
5	35	3	5.5
6	35	3	8.5

We recommend that the upper 12 inches of the subgrade and aggregate base materials be compacted to a relative compaction of 95 percent relative density as evaluated by the current version of ASTM D 1557. If traffic loads are different from those assumed, the pavement design should be re-evaluated.

Where rigid pavement sections are proposed, we recommend a 6-inch thickness of Portland cement concrete underlain by 4 inches of compacted aggregate base. We recommend that the Portland cement concrete have a 600 pounds per square inch (psi) flexural strength and that it be reinforced with No. 3 bars that are placed 18 inches on center (both ways). The rigid pavement and aggregate base should be placed on compacted subgrade that is prepared in accordance with the recommendations presented above.

8.9. Corrosivity

Laboratory testing was performed on a representative sample of near-surface soil to evaluate soil pH, electrical resistivity, water-soluble chloride content, and water-soluble sulfate content. The soil pH and electrical resistivity tests were performed in general accordance with California Test (CT) 643. Chloride content tests were performed in general accordance with CT 422. Sulfate testing was performed in general accordance with CT 417. The laboratory test results are presented in Appendix B.

The pH of the tested samples ranged from 6.5 to 7.1. The electrical resistivity of the tested samples ranged from approximately 1,700 to 15,000 ohm-centimeters. The chloride content of the tested samples ranged from approximately 40 to 400 parts per million (ppm). The sulfate content of the tested samples ranged from approximately 0.001 to 0.008 percent by weight (i.e., 10 ppm to 80 ppm). Based on the laboratory test results, ACI 318, and Caltrans (2012) corrosion criteria, the project site would not be classified as corrosive, which is defined as having earth materials with an electrical resistivity of less than 1,000 ohm-centimeters, more than 500 ppm chlorides, more than 0.20 percent sulfates (i.e., 2,000 ppm), or a pH of 5.5 or less.

8.10. Concrete Placement

Concrete in contact with soil or water that contains high concentrations of soluble sulfates can be subject to chemical deterioration. Laboratory testing indicated a sulfate content ranging from approximately 0.001 to 0.008 percent for the tested samples, which is considered to represent a negligible potential for sulfate attack (ACI, 318). Type II cement may be used, however, due to the potential for variability of soils, consideration should be given to using Type II/V cement for concrete structures in contact with soil and a water-to-cement ratio of no more than 0.45.

8.11. Drainage

Roof, pad, and slope drainage should be designed such that runoff water is conveyed away from slopes and structures to suitable discharge areas by nonerodible devices (e.g., gutters, downspouts, concrete swales, etc.). Positive drainage adjacent to structures should be established and maintained. Positive drainage may be accomplished by providing drainage away from the foundations of the structure at a gradient of 2 percent or steeper for a distance of 5 feet or more outside the building perimeter, and further maintained by a graded swale leading to an appropriate outlet, in accordance with the recommendations of the project civil engineer and/or landscape architect.

Surface drainage on the site should be provided so that water is not permitted to pond. A gradient of 2 percent or steeper should be maintained over the pad area and drainage patterns should be established to convey and remove water from the site to appropriate outlets.

Care should be taken by the contractor during final grading to preserve any berms, drainage terraces, interceptor swales or other drainage devices of a permanent nature on or adjacent to the property. Drainage patterns established at the time of final grading should be maintained for the life of the project. The property owner and the maintenance personnel should be made aware that altering drainage patterns might be detrimental to slope stability and foundation performance.

9. CONSTRUCTION OBSERVATION

The recommendations provided in this report are based on our understanding of the proposed project and on our evaluation of the data collected based on subsurface conditions disclosed by widely spaced exploratory borings. It is imperative that the interpolated subsurface conditions be checked by our representative during construction. Observation and testing of compacted fill and backfill should be performed by our representative during construction. In addition, we should review the project plans and specifications prior to construction. It should be noted that, upon review of these documents, some recommendations presented in this report might be revised or modified.

During construction we recommend that our duties include, but not be limited to:

- Observing removals and excavation bottoms.
- Observing the placement and compaction of fill, including trench backfill.
- Evaluating on-site and imported materials prior to their use as fill.
- Performing laboratory and field tests to evaluate fill compaction.
- Observing and testing foundation excavations for bearing materials, compaction and cleaning prior to placement of reinforcing steel or concrete.

The recommendations provided in this report assume that Ninyo & Moore will be retained as the geotechnical consultant during the construction phase of this project. If another geotechnical consultant is selected, we request that the selected consultant indicate to the owner and to our firm in writing that our recommendations are understood and that they are in full agreement with our recommendations.

10. LIMITATIONS

The field evaluation, laboratory testing, and geotechnical analyses presented in this geotechnical report have been conducted in general accordance with current practice and the standard of care exercised by geotechnical consultants performing similar tasks in the project area. No warranty, expressed or implied, is made regarding the conclusions, recommendations, and opinions presented in this report. There is no evaluation detailed enough to reveal every subsurface condition. Variations may exist and conditions not observed or described in this report may be encountered during construction. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface evaluation will be performed upon request. Please also note that our evaluation was limited to assessment of the geotechnical aspects of the project, and did not include evaluation of structural issues, environmental concerns, or the presence of hazardous materials.

This document is intended to be used only in its entirety. No portion of the document, by itself, is designed to completely represent any aspect of the project described herein. Ninyo & Moore should be contacted if the reader requires additional information or has questions regarding the content, interpretations presented, or completeness of this document.

This report is intended for design purposes only. It does not provide sufficient data to prepare an accurate bid by contractors. It is suggested that the bidders and their geotechnical consultant perform an independent evaluation of the subsurface conditions in the project areas. The independent evaluations may include, but not be limited to, review of other geotechnical reports prepared for the adjacent areas, site reconnaissance, and additional exploration and laboratory testing.

Our conclusions, recommendations, and opinions are based on an analysis of the observed site conditions. If geotechnical conditions different from those described in this report are encountered, our office should be notified and additional recommendations, if warranted, will be provided upon request. It should be understood that the conditions of a site could change with time as a result of natural processes or the activities of man at the subject site or nearby sites. In addition, changes to the applicable laws, regulations, codes, and standards of practice may occur due to government action or the broadening of knowledge. The findings of this report may, therefore, be invalidated over time, in part or in whole, by changes over which Ninyo & Moore has no control.

This report is intended exclusively for use by the client. Any use or reuse of the findings, conclusions, and/or recommendations of this report by parties other than the client is undertaken at said parties' sole risk.

11. REFERENCES

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United States Geological Survey, 1968b, Morro Hill Quadrangle, California, San Diego County, 7.5-Minute Series (Topographic): Scale 1:24,000.

United States Geological Survey, 1968c, Temecula Quadrangle, California, San Diego County, 7.5-Minute Series (Topographic): Scale 1:24,000.

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United States Geological Survey, 2015c, Temecula Quadrangle, California, San Diego County, 7.5-Minute Series (Topographic): Scale 1:24,000.

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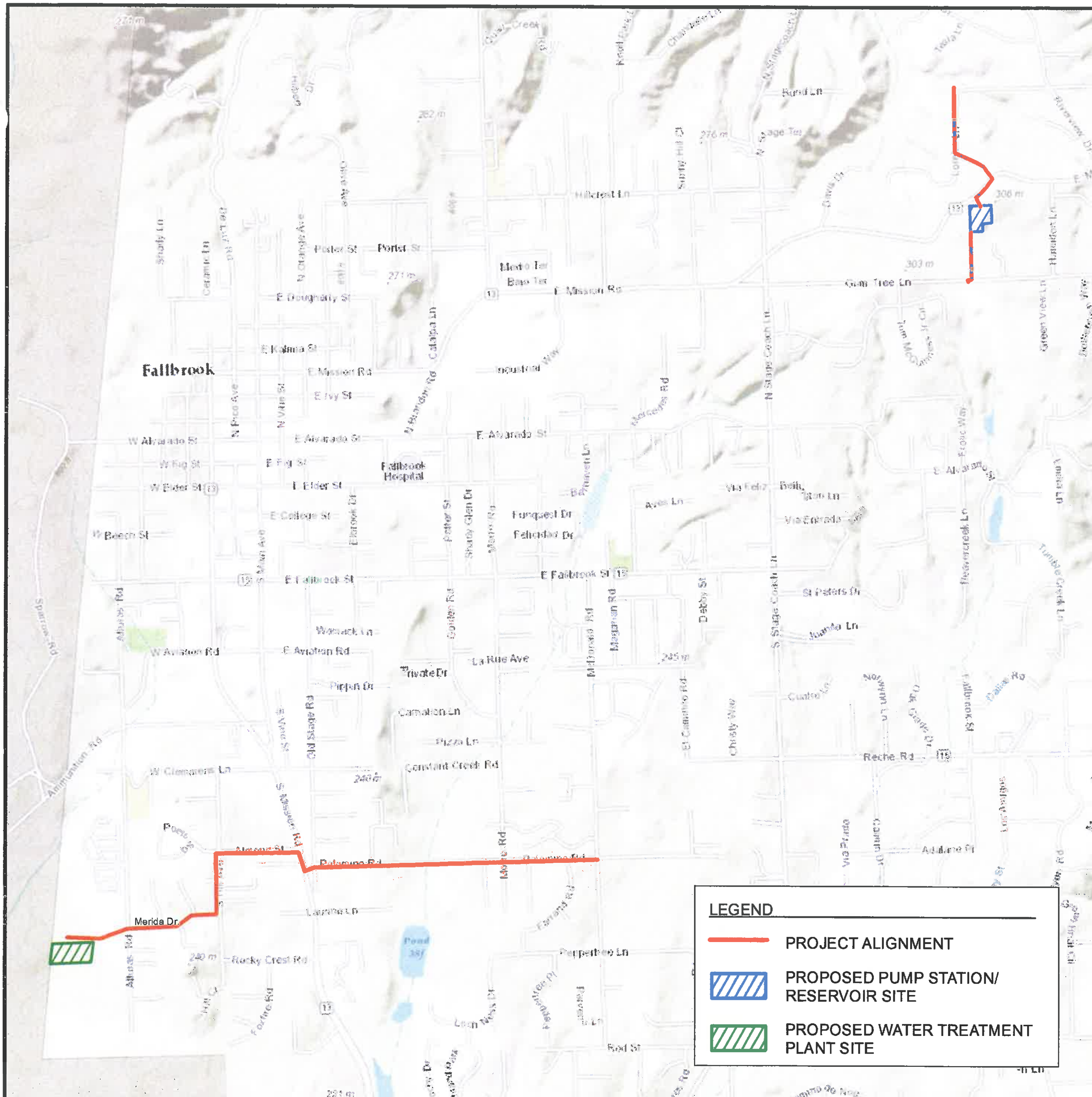
AERIAL PHOTOGRAPHS

Source	Date	Flight	Numbers	Scale
USDA	3-31-1953	AXN-4M	51 and 52	1:24,000
USDA	4-11-1953	AXN-8M	35 and 36	1:24,000



SOURCE: 2008 THOMAS GUIDE FOR SAN DIEGO COUNTY, STREET GUIDE AND DIRECTORY; MAP © RAND MCNALLY, R.L.07-S-129

MAP INDEX

N

SCALE IN FEET

0 2,000 4,000

NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE

Ninyo & Moore	SITE LOCATION	FIGURE
PROJECT NO. 107931001	SANTA MARGARITA CONJUNCTIVE USE PROJECT FALLBROOK, CALIFORNIA	1
DATE 7/15		

1_107931001_SL AOB

SOURCE: 2012 SAN DIEGO IMAGERY ACQUISITION PARTNERSHIP (FLIGHT DATES: MAY 20 - JUNE 6, 2012)

LEGEND

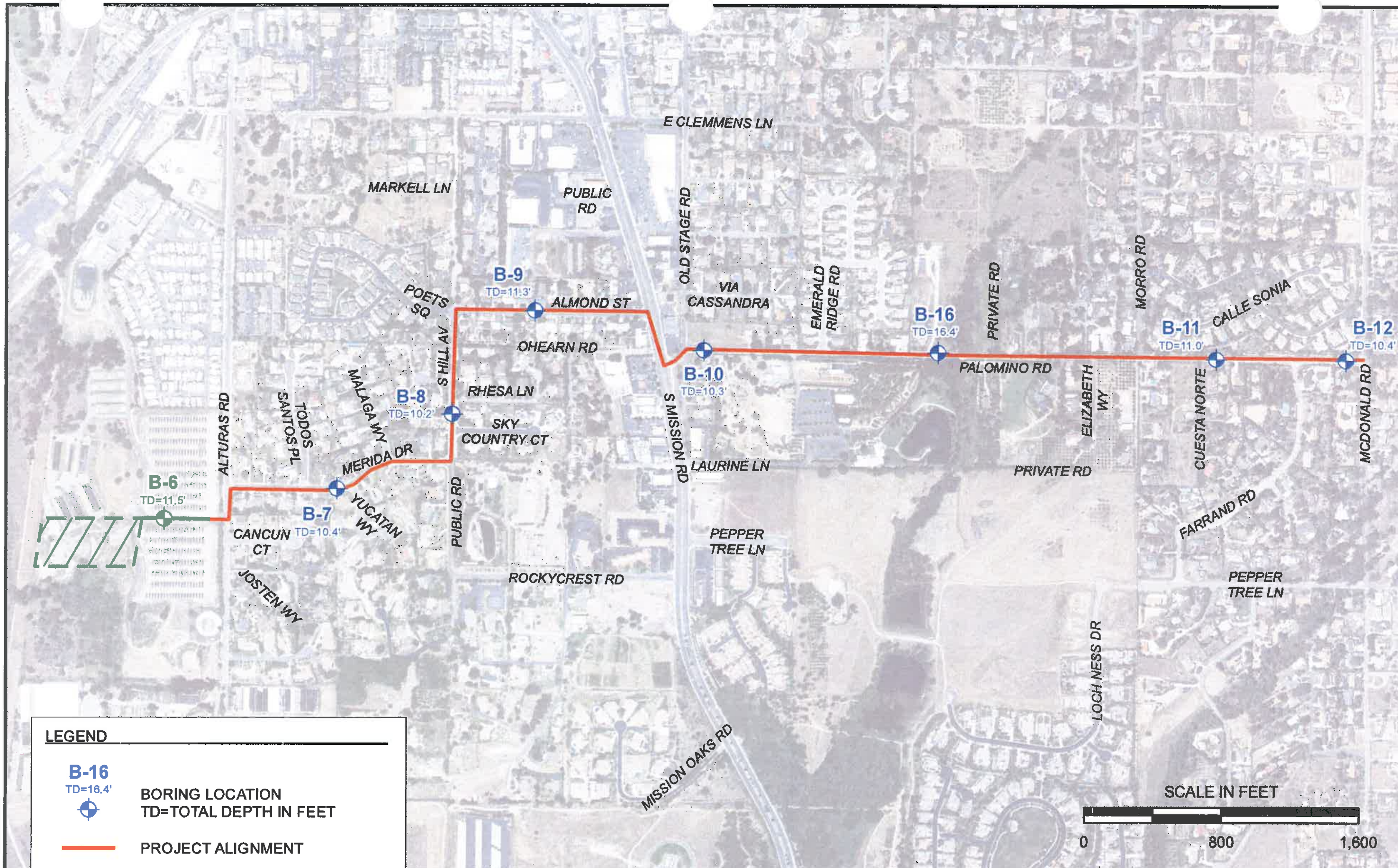
B-5 TD=14.0' BORING LOCATION
TD=TOTAL DEPTH IN FEET

NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE

N

Ninyo & Moore		BORING LOCATIONS	FIGURE
PROJECT NO.	DATE	SANTA MARGARITA CONJUNCTIVE USE PROJECT FALLBROOK, CALIFORNIA	2
107931001	7/15		

2_107931001_PBL.mxd AOB



LEGEND

B-16
TD=16.4'

BORING LOCATION
TD=TOTAL DEPTH IN FEET

PROJECT ALIGNMENT

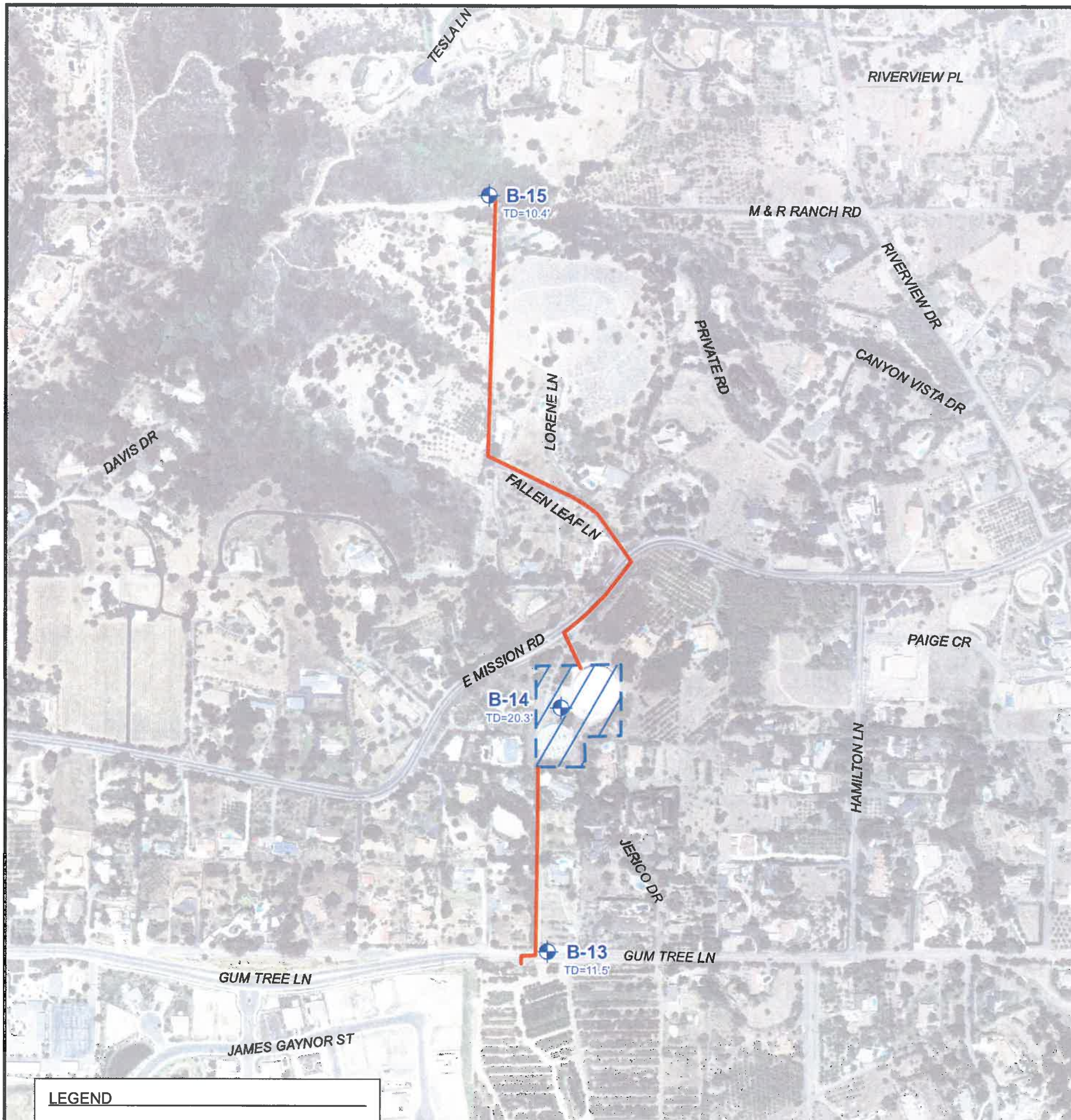
PROPOSED WATER TREATMENT PLANT SITE

SOURCE: 2012 SAN DIEGO IMAGERY ACQUISITION PARTNERSHIP (FLIGHT DATES: MAY 20 - JUNE 6, 2012)

NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE

Ninyo & Moore		BORING LOCATIONS	FIGURE
PROJECT NO.	DATE	SANTA MARGARITA CONJUNCTIVE USE PROJECT FALLBROOK, CALIFORNIA	3
107931001	7/15		

3_107931001_BL.mxd AOB



LEGEND

B-15
TD=10.4'
BORING LOCATION
TD=TOTAL DEPTH IN FEET

PROJECT ALIGNMENT

PROPOSED PUMP STATION/
RESERVOIR SITE

SOURCE: 2012 SAN DIEGO IMAGERY ACQUISITION PARTNERSHIP (FLIGHT DATES: MAY 20 - JUNE 6, 2012)

N

SCALE IN FEET

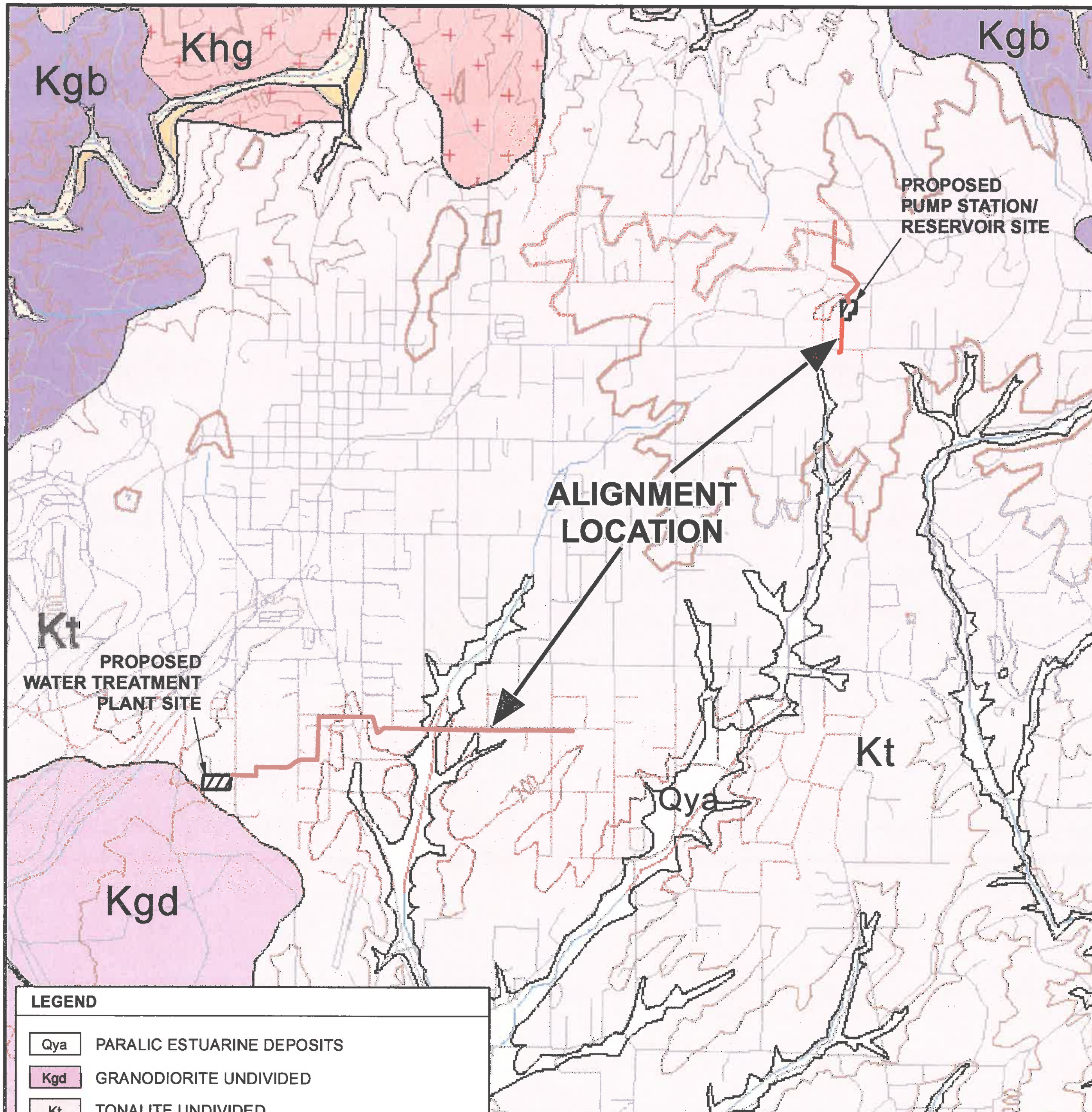
0 500 1,000

NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE.

Ninyo & Moore

		BORING LOCATIONS	FIGURE
PROJECT NO.	DATE	SANTA MARGARITA CONJUNCTIVE USE PROJECT FALLBROOK, CALIFORNIA	4
107931001	7/15		

4_107931001_L 6/23/2015 JDL



LEGEND

Qya	PARALIC ESTUARINE DEPOSITS
Kgd	GRANODIORITE UNDIVIDED
Kt	TONALITE UNDIVIDED
Kgb	GABBRO UNDIVIDED
Khd	HETEROGENEOUS GRANITIC ROCKS

65 U D — FAULT - SOLID WHERE ACCURATELY LOCATED, DASHED WHERE APPROXIMATE, DOTTED WHERE CONCEALED. ARROW AND NUMBER INDICATE DIRECTION AND ANGLE OF DIP OF FAULT PLANE

SOURCE: KENNEDY, M.P., AND TAN, S.S., 2005, GEOLOGIC MAP OF THE OCEANSIDE 30' X 60' QUADRANGLE, CALIFORNIA

N

SCALE IN FEET

0 3,000 6,000

5_107931001_G_93.mxd AOB

NOTES: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE

Ninyo & Moore		GEOLOGY	FIGURE
PROJECT NO.	DATE	SANTA MARGARITA CONJUNCTIVE USE PROJECT FALLBROOK, CALIFORNIA	5
107931001	7/15		

LEGEND

CALIFORNIA FAULT ACTIVITY

- HISTORICALLY ACTIVE
- HOLOCENE ACTIVE
- LATE QUATERNARY (POTENTIALLY ACTIVE)
- QUATERNARY (POTENTIALLY ACTIVE)
- STATE/COUNTY BOUNDARY

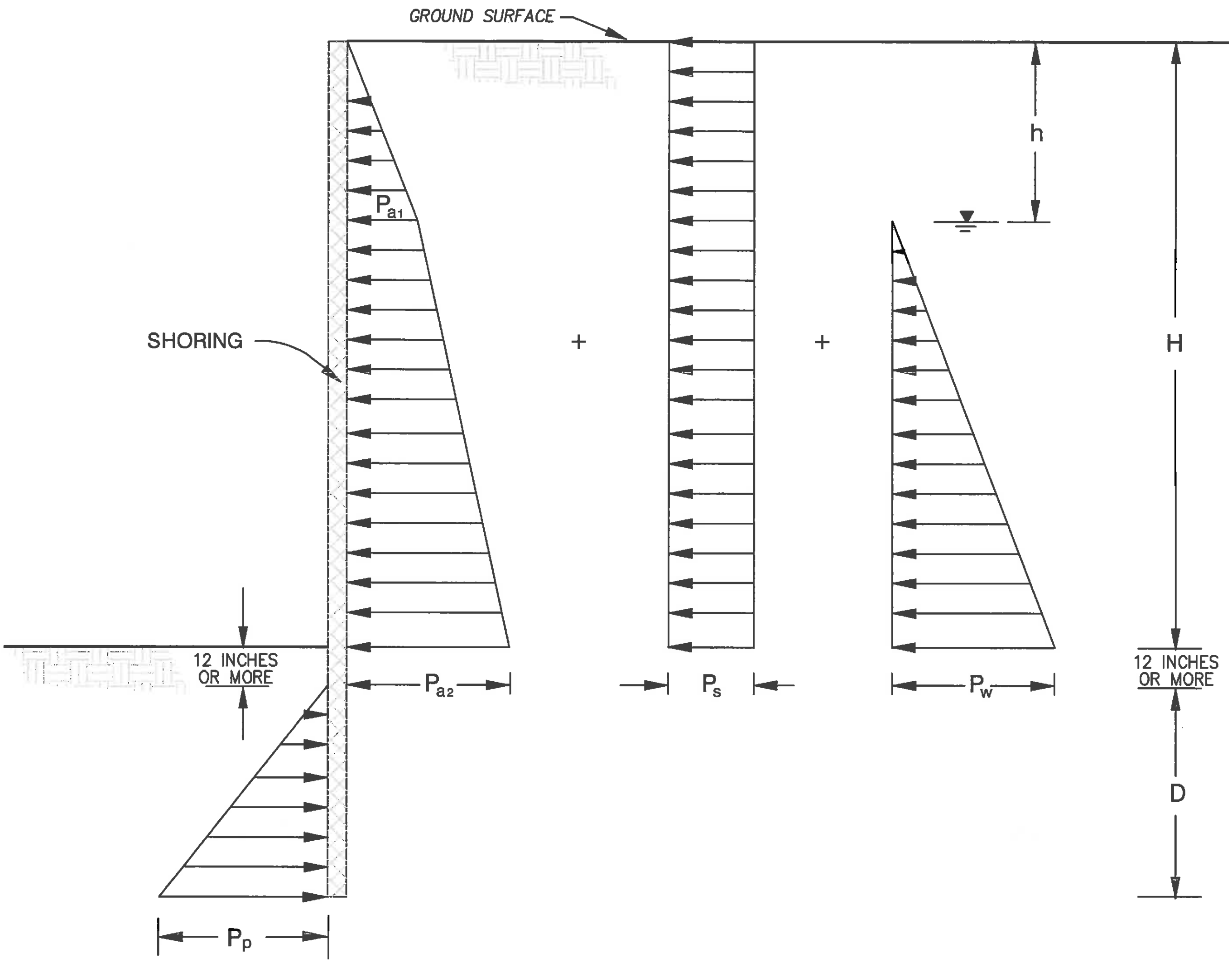
SOURCE: JENNINGS, C.W., AND BRYANT, W.A., 2010, FAULT ACTIVITY MAP OF CALIFORNIA, CALIFORNIA GEOLOGICAL SURVEY.

SCALE IN MILES

0 30 60

NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE.

Ninyo & Moore		FAULT LOCATIONS	FIGURE
PROJECT NO.	DATE	SANTA MARGARITA CONJUNCTIVE USE PROJECT FALLBROOK, CALIFORNIA	6
107931001	7/15		



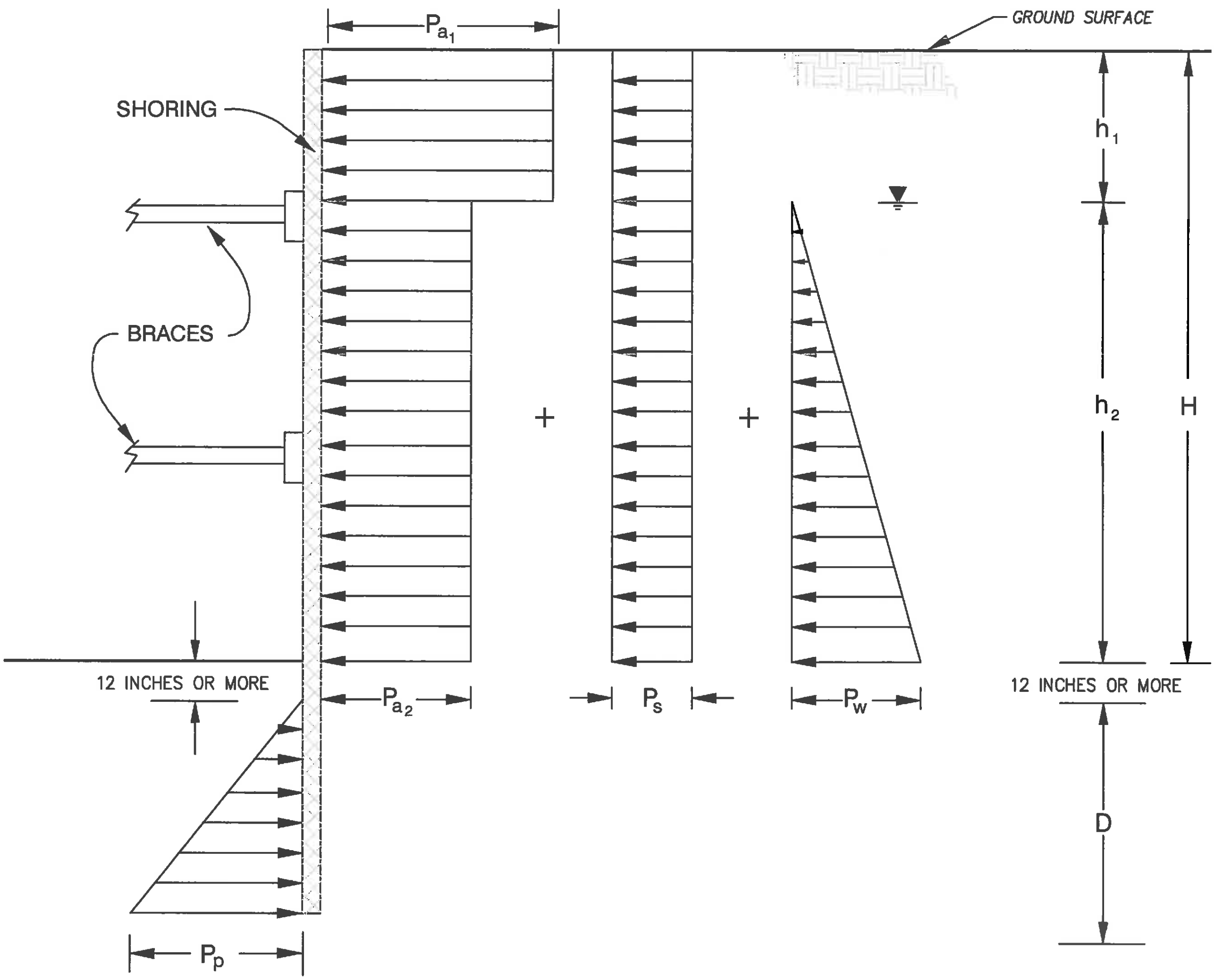
NOTES:

1. ACTIVE LATERAL EARTH PRESSURE, P_a
   P_{a1} = 40 H psf; $P_{a2} = P_{a1}$ + 20 (H - h) psf
2. CONSTRUCTION TRAFFIC INDUCED SURCHARGE PRESSURE, P_s
   P_s = 120 psf
3. HYDROSTATIC PRESSURE, P_w
   P_w=62.4 (H - h) psf
4. PASSIVE LATERAL EARTH PRESSURE, P_p
   P_p = 350 D psf
5. SURCHARGES FROM EXCAVATED SOIL OR CONSTRUCTION MATERIALS ARE NOT INCLUDED
6. H, h AND D ARE IN FEET
7. GROUNDWATER TABLE

NOT TO SCALE

7 107931001 d-csbg.dwg

Ninyo & Moore		LATERAL EARTH PRESSURES FOR TEMPORARY CANTILEVERED SHORING BELOW GROUNDWATER	FIGURE
PROJECT NO.	DATE	SANTA MARGARITA CONJUNCTIVE USE PROJECT FALLBROOK, CALIFORNIA	7
107931001	7/15		



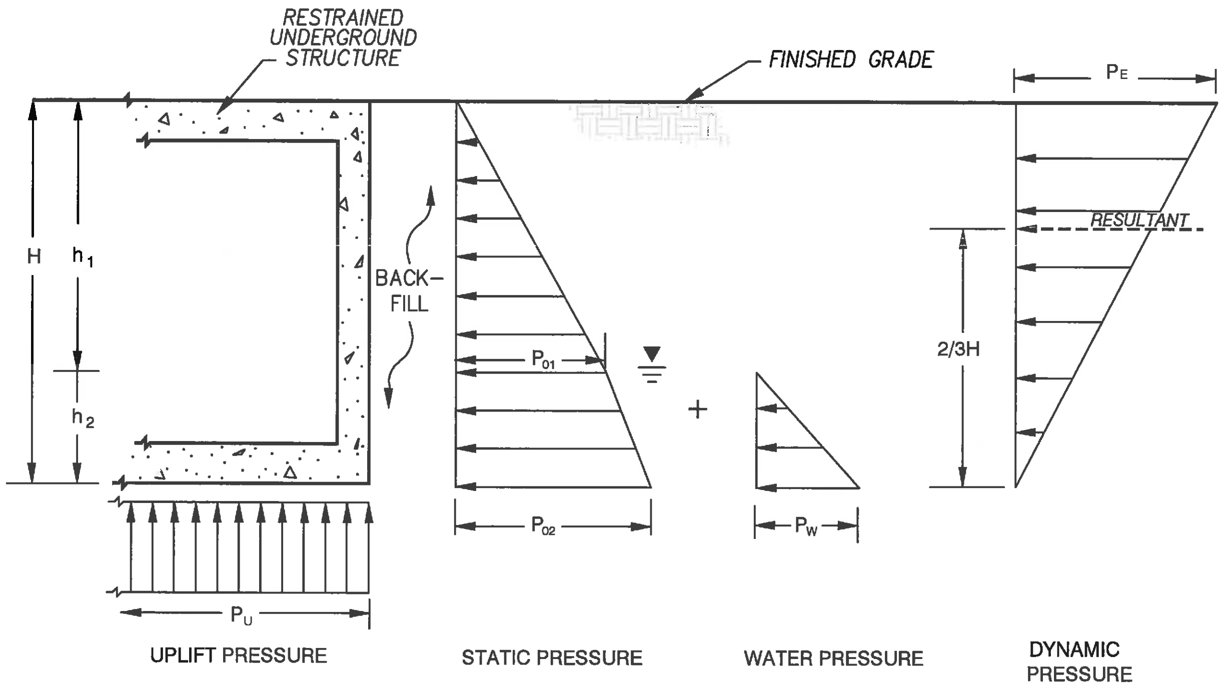
NOTES:

1. APPARENT LATERAL EARTH PRESSURES, P_{a_1} AND P_{a_2}
   P_{a_1} = 26 H psf
   P_{a_2} = 13 H psf
2. CONSTRUCTION TRAFFIC INDUCED SURCHARGE PRESSURE, P_s
   P_s = 120 psf
3. WATER PRESSURE, P_w
   P_w= 62.4 h_2 psf
4. PASSIVE PRESSURE, P_p
   P_p = 350 D psf
5. SURCHARGES FROM EXCAVATED SOIL OR CONSTRUCTION MATERIALS ARE NOT INCLUDED
6. H, h_1, h_2 AND D ARE IN FEET
7. GROUNDWATER TABLE

NOT TO SCALE

8 10. _1 d-bebg.dwg

Ninyo & Moore		LATERAL EARTH PRESSURES FOR BRACED EXCAVATION BELOW GROUNDWATER	FIGURE
PROJECT NO.	DATE	SANTA MARGARITA CONJUNCTIVE USE PROJECT FALLBROOK, CALIFORNIA	8
107931001	7/15		



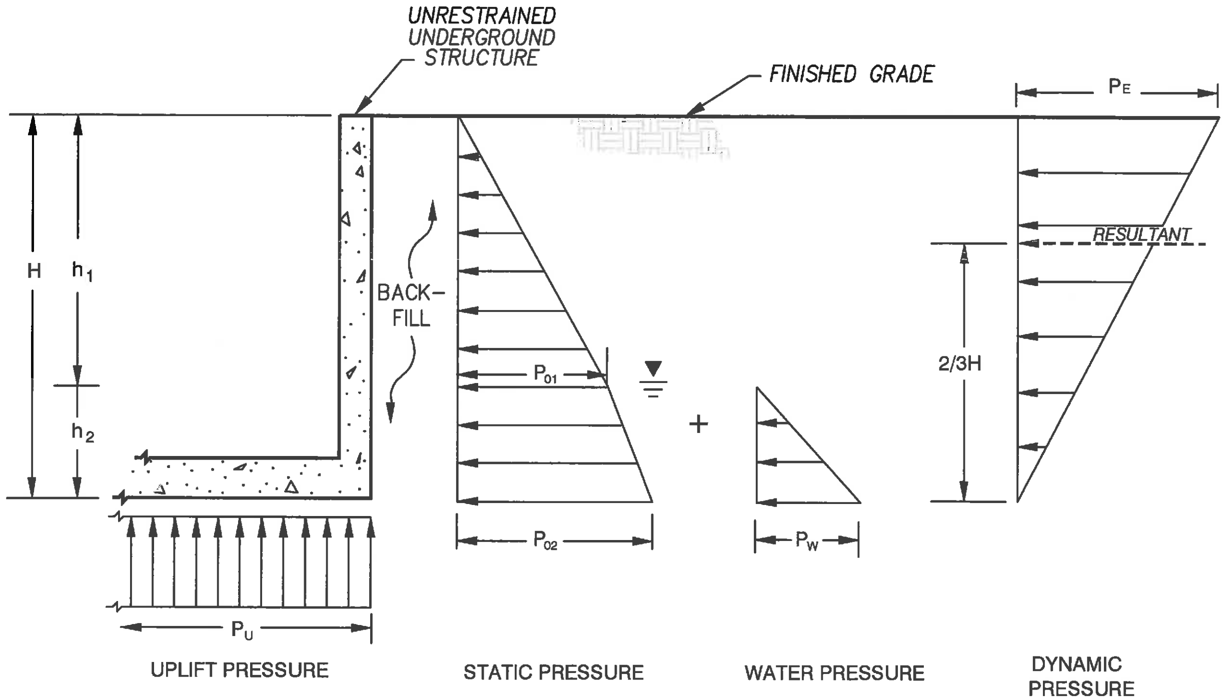
NOTES:

1. APPARENT LATERAL EARTH PRESSURES, P_{01} AND P_{02}
   $P_{01} = 60\ h_1$ psf
   $P_{02} = 60\ h_1 + 29\ h_2$ psf
2. WATER PRESSURE, P_w
   $P_w = 62.4\ h_2$ psf
3. DYNAMIC LATERAL EARTH PRESSURE IS BASED ON A PEAK GROUND ACCELERATION OF 0.43 g
   $P_E = 18\ H$ psf
4. UPLIFT PRESSURE, P_u
   $P_u = 62.4\ h_2$ psf
5. SURCHARGE PRESSURES CAUSED BY VEHICLES OR NEARBY STRUCTURES ARE NOT INCLUDED
6. H, h_1 AND h_2 ARE IN FEET
7. ▼ GROUNDWATER TABLE

NOT TO SCALE

9 107931001 d-rus.dwg

Ninyo & Moore		LATERAL EARTH PRESSURES FOR RESTRAINED UNDERGROUND STRUCTURES	FIGURE
PROJECT NO.	DATE	SANTA MARGARITA CONJUNCTIVE USE PROJECT FALLBROOK, CALIFORNIA	9
107931001	7/15		



NOTES:

1. APPARENT LATERAL EARTH PRESSURES, P_{01} AND P_{02}
   $P_{01} = 40\ h_1$ psf
   $P_{02} = 40\ h_1 + 19\ h_2$ psf

2. WATER PRESSURE, P_w
   $P_w = 62.4\ h_2$ psf

3. DYNAMIC LATERAL EARTH PRESSURE IS BASED ON A PEAK GROUND ACCELERATION OF 0.43 g
   $P_E = 18\ H$ psf

4. UPLIFT PRESSURE, P_u
   $P_u = 62.4\ h_2$ psf

5. SURCHARGE PRESSURES CAUSED BY VEHICLES OR NEARBY STRUCTURES ARE NOT INCLUDED

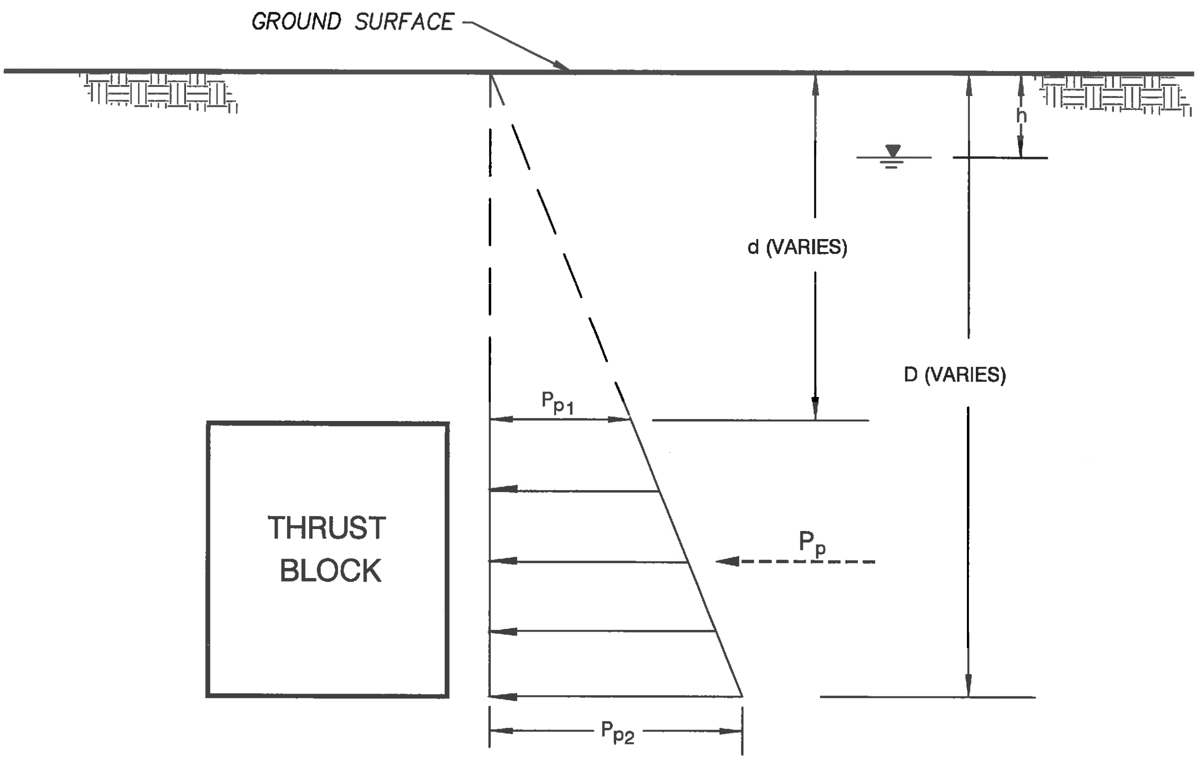
6. H, h_1 AND h_2 ARE IN FEET

7. ▼ GROUNDWATER TABLE

NOT TO SCALE

10 107931001 d-urus.dwg

Ninyo & Moore	LATERAL EARTH PRESSURES FOR UNRESTRAINED UNDERGROUND STRUCTURES	FIGURE
PROJECT NO. 107931001 / DATE 7/15	SANTA MARGARITA CONJUNCTIVE USE PROJECT FALLBROOK, CALIFORNIA	10



NOTES:

1. GROUNDWATER BELOW BLOCK
   $P_p = 175\ (D^2 - d^2)$ lb/ft
2. GROUNDWATER ABOVE BLOCK
   $P_p = 175\ (D - d)[\ 124.8h + 67.6\ (D + d)]$ lb/ft
3. ASSUMES BACKFILL IS GRANULAR MATERIAL
4. ASSUMES THRUST BLOCK IS ADJACENT TO COMPETENT MATERIAL
5. D, d AND h ARE IN FEET
6. GROUNDWATER TABLE

11 107931001 d-tb.dwg

NOT TO SCALE

Ninyo & Moore

THRUST BLOCK LATERAL EARTH PRESSURE DIAGRAM

PROJECT NO.	DATE		FIGURE
107931001	7/15	SANTA MARGARITA CONJUNCTIVE USE PROJECT FALLBROOK, CALIFORNIA	11

APPENDIX A

BORING LOGS

Field Procedure for the Collection of Disturbed Samples

Disturbed soil samples were obtained in the field using the following methods.

Bulk Samples

Bulk samples of representative earth materials were obtained from the cuttings of the exploratory borings. The samples were bagged and transported to the laboratory for testing.

The Standard Penetration Test (SPT) Sampler

Disturbed drive samples of earth materials were obtained by means of a Standard Penetration Test sampler. The sampler is composed of a split barrel with an external diameter of 2 inches and an unlined internal diameter of 1-3/8 inches. The sampler was driven into the ground 12 to 18 inches with a 140-pound hammer falling freely from a height of 30 inches in general accordance with ASTM D 1586. The blow counts were recorded for every 6 inches of penetration; the blow counts reported on the logs are those for the last 12 inches of penetration. Soil samples were observed and removed from the sampler, bagged, sealed and transported to the laboratory for testing.

Field Procedure for the Collection of Relatively Undisturbed Samples

Relatively undisturbed soil samples were obtained in the field using a modified split-barrel drive sampler. The sampler, with an external diameter of 3.0 inches, was lined with 1-inch long, thin brass rings with inside diameters of approximately 2.4 inches. The sample barrel was driven into the ground with the weight of a 140-pound hammer, in general accordance with ASTM D 3550. The driving weight was permitted to fall freely. The approximate length of the fall, the weight of the hammer, and the number of blows per foot of driving are presented on the boring logs as an index to the relative resistance of the materials sampled. The samples were removed from the sample barrel in the brass rings, sealed, and transported to the laboratory for testing.

TH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	BORING LOG EXPLANATION SHEET
0								Bulk sample.
								Modified split-barrel drive sampler.
								2-inch inner diameter split-barrel drive sampler.
								No recovery with modified split-barrel drive sampler, or 2-inch inner diameter split-barrel drive sampler.
								Sample retained by others.
5								Standard Penetration Test (SPT).
								No recovery with a SPT.
			XX/XX					Shelby tube sample. Distance pushed in inches/length of sample recovered in inches.
								No recovery with Shelby tube sampler.
								Continuous Push Sample.
								Seepage.
								Groundwater encountered during drilling.
								Groundwater measured after drilling.
							SM	MAJOR MATERIAL TYPE (SOIL): Solid line denotes unit change.
							CL	Dashed line denotes material change.
15								Attitudes: Strike/Dip b: Bedding c: Contact j: Joint f: Fracture F: Fault cs: Clay Seam s: Shear bss: Basal Slide Surface sf: Shear Fracture sz: Shear Zone sbs: Shear Bedding Surface
20								The total depth line is a solid line that is drawn at the bottom of the boring.

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BORING LOG		
Explanation of Boring Log Symbols		
PROJECT NO.	DATE	FIGURE

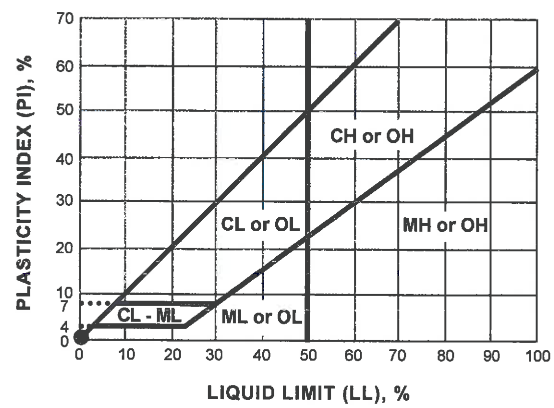
SOIL CLASSIFICATION CHART PER ASTM D 2488

PRIMARY DIVISIONS			SECONDARY DIVISIONS: GROUP SYMBOL	SECONDARY DIVISIONS: GROUP NAME
COARSE-GRAINED SOILS more than 50% retained on No. 200 sieve	**GRAVEL** more than 50% of coarse fraction retained on No. 4 sieve	CLEAN GRAVEL less than 5% fines	GW	well-graded GRAVEL
			GP	poorly graded GRAVEL
		GRAVEL with DUAL CLASSIFICATIONS 5% to 12% fines	GW-GM	well-graded GRAVEL with silt
			GP-GM	poorly graded GRAVEL with silt
			GW-GC	well-graded GRAVEL with clay
			GP-GC	poorly graded GRAVEL with clay
		GRAVEL with FINES more than 12% fines	GM	silty GRAVEL
			GC	clayey GRAVEL
			GC-GM	silty, clayey GRAVEL
	SAND 50% or more of coarse fraction passes No. 4 sieve	CLEAN SAND less than 5% fines	SW	well-graded SAND
			SP	poorly graded SAND
		SAND with DUAL CLASSIFICATIONS 5% to 12% fines	SW-SM	well-graded SAND with silt
			SP-SM	poorly graded SAND with silt
			SW-SC	well-graded SAND with clay
			SP-SC	poorly graded SAND with clay
		SAND with FINES more than 12% fines	SM	silty SAND
			SC	clayey SAND
			SC-SM	silty, clayey SAND
FINE-GRAINED SOILS 50% or more passes No. 200 sieve	**SILT and CLAY** liquid limit less than 50%	INORGANIC	CL	lean CLAY
			ML	SILT
			CL-ML	silty CLAY
		ORGANIC	OL (PI > 4)	organic CLAY
			OL (PI < 4)	organic SILT
	SILT and CLAY liquid limit 50% or more	INORGANIC	CH	fat CLAY
			MH	elastic SILT
		ORGANIC	OH (plots on or above "A"-line)	organic CLAY
			OH (plots below "A"-line)	organic SILT
	Highly Organic Soils		PT	Peat

GRAIN SIZE

DESCRIPTION		SIEVE SIZE	GRAIN SIZE	APPROXIMATE SIZE
Boulders		> 12"	> 12"	Larger than basketball-sized
Cobbles		3 - 12"	3 - 12"	Fist-sized to basketball-sized
Gravel	Coarse	3/4 - 3"	3/4 - 3"	Thumb-sized to fist-sized
	Fine	#4 - 3/4"	0.19 - 0.75"	Pea-sized to thumb-sized
Sand	Coarse	#10 - #4	0.079 - 0.19"	Rock-salt-sized to pea-sized
	Medium	#40 - #10	0.017 - 0.079"	Sugar-sized to rock-salt-sized
	Fine	#200 - #40	0.0029 - 0.017"	Flour-sized to sugar-sized
Fines		Passing #200	< 0.0029"	Flour-sized and smaller

PLASTICITY CHART



APPARENT DENSITY - COARSE-GRAINED SOIL

APPARENT DENSITY	SPOOLING CABLE OR CATHEAD: SPT (blows/foot)	SPOOLING CABLE OR CATHEAD: MODIFIED SPLIT BARREL (blows/foot)	AUTOMATIC TRIP HAMMER: SPT (blows/foot)	AUTOMATIC TRIP HAMMER: MODIFIED SPLIT BARREL (blows/foot)
Very Loose	≤ 4	≤ 8	≤ 3	≤ 5
Loose	5 - 10	9 - 21	4 - 7	6 - 14
Medium Dense	11 - 30	22 - 63	8 - 20	15 - 42
Dense	31 - 50	64 - 105	21 - 33	43 - 70
Very Dense	> 50	> 105	> 33	> 70

CONSISTENCY - FINE-GRAINED SOIL

CONSISTENCY	SPOOLING CABLE OR CATHEAD: SPT (blows/foot)	SPOOLING CABLE OR CATHEAD: MODIFIED SPLIT BARREL (blows/foot)	AUTOMATIC TRIP HAMMER: SPT (blows/foot)	AUTOMATIC TRIP HAMMER: MODIFIED SPLIT BARREL (blows/foot)
Very Soft	< 2	< 3	< 1	< 2
Soft	2 - 4	3 - 5	1 - 3	2 - 3
Firm	5 - 8	6 - 10	4 - 5	4 - 6
Stiff	9 - 15	11 - 20	6 - 10	7 - 13
Very Stiff	16 - 30	21 - 39	11 - 20	14 - 26
Hard	> 30	> 39	> 20	> 26

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USCS METHOD OF SOIL CLASSIFICATION

Explanation of USCS Method of Soil Classification

PROJECT NO.	DATE	FIGURE

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							SM	FILL: Reddish brown, moist, medium dense, silty SAND.
							SM	ALLUVIUM: Reddish brown, moist, medium dense, silty SAND.
								GRANITIC ROCK: Light brown, moist, weathered GRANITIC ROCK.
			50/3"					
10			50/4"					Difficulty in drilling.
			50/2"					
20			50/2"					
								Total Depth = 20.5 feet. (Refusal) Groundwater not encountered during drilling. Backfilled shortly after drilling on 5/14/15.
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40								

DATE DRILLED 5/14/15 BORING NO. B-1

GROUND ELEVATION 710' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING 8" Diameter Hollow Stem Auger (CME-75) (Baja)

DRIVE WEIGHT 140 lbs. (Auto-Trip) DROP 30"

SAMPLED BY BTM LOGGED BY BTM REVIEWED BY GTF

Note: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.

The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.

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BORING LOG

SANTA MARGARITA CONJUNCTIVE USE PROJECT
FALLBROOK, CALIFORNIA

PROJECT NO.	DATE	FIGURE
107931001	7/15	A-1

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							SM	ASPHALT CONCRETE: Approximately 2.5 inches.
								FILL: Brown, moist, medium dense, silty SAND; scattered cobbles.
								GRANITIC ROCK: Reddish brown, moist, weathered GRANITIC ROCK.
			50/5"					Hard drilling.
10			50/3"					
								Light brown to light gray.
			50/5"					
20								Total Depth = 19 feet. (Refusal) Groundwater not encountered during drilling. Backfilled shortly after drilling on 5/18/15. Note: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
30								

DATE DRILLED 5/18/15 BORING NO. B-2

GROUND ELEVATION 665' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING 8" Diameter Hollow Stem Auger (CME-75) (Baja)

DRIVE WEIGHT 140 lbs. (Auto-Trip) DROP 30"

SAMPLED BY BTM LOGGED BY BTM REVIEWED BY GTF

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BORING LOG

SANTA MARGARITA CONJUNCTIVE USE PROJECT
FALLBROOK, CALIFORNIA

PROJECT NO.	DATE	FIGURE
107931001	7/15	A-2

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							SM	FILL: Brown, moist, loose, silty SAND.
			11					Reddish brown.
10			91/11"					GRANITIC ROCK: Brown to reddish brown, moist, weathered GRANITIC ROCK.
			50/2"					
								Total Depth = 15.5 feet. (Refusal) Groundwater not encountered during drilling. Backfilled shortly after drilling on 5/18/15. Note: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
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DATE DRILLED 5/18/15 BORING NO. B-3

GROUND ELEVATION 665' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING 8" Diameter Hollow Stem Auger (CME-75) (Baja)

DRIVE WEIGHT 140 lbs. (Auto-Trip) DROP 30"

SAMPLED BY BTM LOGGED BY BTM REVIEWED BY GTF

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BORING LOG

SANTA MARGARITA CONJUNCTIVE USE PROJECT
FALLBROOK, CALIFORNIA

PROJECT NO.	DATE	FIGURE
107931001	7/15	A-3

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							SM	FILL: Brown, moist, loose, silty SAND.
								GRANITIC ROCK: Brown to reddish brown, moist, weathered GRANITIC ROCK.
			50/5"					
10			50/6"					
			50/2"					
								Total Depth = 15.5 feet. (Refusal) Groundwater not encountered during drilling. Backfilled shortly after drilling on 5/18/15. Note: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
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DATE DRILLED 5/18/15 BORING NO. B-4

GROUND ELEVATION 660' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING 8" Diameter Hollow Stem Auger (CME-75) (Baja)

DRIVE WEIGHT 140 lbs. (Auto-Trip) DROP 30"

SAMPLED BY BTM LOGGED BY BTM REVIEWED BY GTF

Ninyo & Moore

BORING LOG

SANTA MARGARITA CONJUNCTIVE USE PROJECT
FALLBROOK, CALIFORNIA

PROJECT NO.	DATE	FIGURE
107931001	7/15	A-4

DATE DRILLED 5/18/15 BORING NO. B-5

GROUND ELEVATION 660' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING 8" Diameter Hollow Stem Auger (CME-75) (Baja)

DRIVE WEIGHT 140 lbs. (Auto-Trip) DROP 30"

SAMPLED BY BTM LOGGED BY BTM REVIEWED BY GTF

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							CL	ASPHALT CONCRETE: Approximately 1.5 inches thick.
								FILL: Brownish gray, moist, stiff, sandy CLAY.
			32					Hard.
								GRANITIC ROCK: Brown to reddish brown, moist, weathered GRANITIC ROCK.
10			50/5"					
								Total Depth = 14 feet. (Refusal) Groundwater not encountered during drilling. Backfilled shortly after drilling on 5/18/15.
20								
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Note: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.

The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.

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BORING LOG

SANTA MARGARITA CONJUNCTIVE USE PROJECT
FALLBROOK, CALIFORNIA

PROJECT NO.	DATE	FIGURE
107931001	7/15	A-5

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							SM	FILL: Brown, moist, medium dense, silty SAND.
								GRANITIC ROCK: Brown to reddish brown, moist, weathered GRANITIC ROCK.
		■	57					
10		■	49					
								Total Depth = 11.5 feet. Groundwater not encountered during drilling. Backfilled shortly after drilling on 5/18/15. Note: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
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DATE DRILLED 5/18/15 BORING NO. B-6

GROUND ELEVATION 700' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING 8" Diameter Hollow Stem Auger (CME-75) (Baja)

DRIVE WEIGHT 140 lbs. (Auto-Trip) DROP 30"

SAMPLED BY BTM LOGGED BY BTM REVIEWED BY GTF

Ninyo & Moore

BORING LOG

SANTA MARGARITA CONJUNCTIVE USE PROJECT
FALLBROOK, CALIFORNIA

PROJECT NO.	DATE	FIGURE
107931001	7/15	A-6

DATE DRILLED	5/13/15	BORING NO.	B-7
GROUND ELEVATION	750' ± (MSL)	SHEET	1 OF 1
METHOD OF DRILLING	8" Diameter Hollow Stem Auger (CME-75) (Baja)		
DRIVE WEIGHT	140 lbs. (Auto-Trip)	DROP	30"
SAMPLED BY	BTM	LOGGED BY	BTM
REVIEWED BY	GTF		

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							SM	ASPHALT CONCRETE: Approximately 3 inches thick.
								FILL: Brown, moist, medium dense, silty SAND; scattered construction debris (concrete; clay pipe).
								GRANITIC ROCK: Reddish brown, moist, weathered GRANITIC ROCK.
			18					
10			50/5"					Brown.
								Total Depth = 10.4 feet. Groundwater not encountered during drilling. Backfilled shortly after drilling on 5/13/15.
20								
30								

Total Depth = 10.4 feet.
Groundwater not encountered during drilling.
Backfilled shortly after drilling on 5/13/15.

Note: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.

The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.

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BORING LOG

SANTA MARGARITA CONJUNCTIVE USE PROJECT
FALLBROOK, CALIFORNIA

PROJECT NO.	DATE	FIGURE
107931001	7/15	A-7

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							GM	ASPHALT CONCRETE: Approximately 3 inches thick.
								AGGREGATE BASE: Gray, moist, dense, silty GRAVEL with sand; approximately 7 inches thick.
							SM	FILL: Brown to reddish brown, medium dense, silty SAND.
			14					GRANITIC ROCK: Brown, moist, weathered GRANITIC ROCK.
10			50/2"					Total Depth = 10.2 feet. Groundwater not encountered during drilling. Backfilled shortly after drilling on 5/13/15. Note: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
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DATE DRILLED 5/13/15 BORING NO. B-8

GROUND ELEVATION 710' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING 8" Diameter Hollow Stem Auger (CME-75) (Baja)

DRIVE WEIGHT 140 lbs. (Auto-Trip) DROP 30"

SAMPLED BY BTM LOGGED BY BTM REVIEWED BY GTF

Ninyo & Moore

BORING LOG

SANTA MARGARITA CONJUNCTIVE USE PROJECT
FALLBROOK, CALIFORNIA

PROJECT NO.	DATE	FIGURE
107931001	7/15	A-8

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							SM	ASPHALT CONCRETE: Approximately 4 inches thick.
							SM	FILL: Brown, moist, medium dense, silty SAND.
			32					ALLUVIUM: Brown, moist, medium dense, silty SAND.
								GRANITIC ROCK: Brown, moist, weathered GRANITIC ROCK.
10			82/9"					
								Total Depth = 11.3 feet. Groundwater not encountered during drilling. Backfilled shortly after drilling on 5/13/15. Note: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
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30								

DATE DRILLED 5/13/15 BORING NO. B-9

GROUND ELEVATION 680' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING 8" Diameter Hollow Stem Auger (CME-75) (Baja)

DRIVE WEIGHT 140 lbs. (Auto-Trip) DROP 30"

SAMPLED BY BTM LOGGED BY BTM REVIEWED BY GTF

Ninyo & Moore

BORING LOG

SANTA MARGARITA CONJUNCTIVE USE PROJECT
FALLBROOK, CALIFORNIA

PROJECT NO.	DATE	FIGURE
107931001	7/15	A-9

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.

DATE DRILLED 5/13/15 BORING NO. B-10

GROUND ELEVATION 645' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING 8" Diameter Hollow Stem Auger (CME-75) (Baja)

DRIVE WEIGHT 140 lbs. (Auto-Trip) DROP 30"

SAMPLED BY BTM LOGGED BY BTM REVIEWED BY GTF

DESCRIPTION/INTERPRETATION

Depth	Blows/Foot	U.S.C.S.	Description/Interpretation
0			ASPHALT CONCRETE: Approximately 2.5 inches thick.
		GM	AGGREGATE BASE: Gray, moist, dense, silty GRAVEL with sand; approximately 7 inches thick.
		SM	FILL: Brown, moist, medium dense, silty SAND.
	50/6"		GRANITIC ROCK: Brown, moist, weathered GRANITIC ROCK.
10	50/3"		

Total Depth = 10.3 feet.
Groundwater not encountered during drilling.
Backfilled shortly after drilling on 5/13/15.

Note: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.

The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.

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Ninyo & Moore

BORING LOG

SANTA MARGARITA CONJUNCTIVE USE PROJECT
FALLBROOK, CALIFORNIA

PROJECT NO.	DATE	FIGURE
107931001	7/15	A-10

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED 5/13/15 BORING NO. B-11 GROUND ELEVATION 700' ± (MSL) SHEET 1 OF 1 METHOD OF DRILLING 8" Diameter Hollow Stem Auger (CME-75) (Baja) DRIVE WEIGHT 140 lbs. (Auto-Trip) DROP 30" SAMPLED BY BTM LOGGED BY BTM REVIEWED BY GTF DESCRIPTION/INTERPRETATION
0								ASPHALT CONCRETE: Approximately 3 inches thick.
							GM	AGGREGATE BASE: Brown, moist, dense, silty GRAVEL with sand; approximately 4 inches thick.
							SM	FILL: Brown, moist, medium dense, silty SAND.
			63					GRANITIC ROCK: Light brown to reddish brown, moist, weathered GRANITIC ROCK.
10			50/6"					
								Total Depth = 11 feet. Groundwater not encountered during drilling. Backfilled shortly after drilling on 5/13/15. Note: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
20								
30								
40								

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BORING LOG

SANTA MARGARITA CONJUNCTIVE USE PROJECT
FALLBROOK, CALIFORNIA

PROJECT NO.	DATE	FIGURE
107931001	7/15	A-11

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							GM	ASPHALT CONCRETE: Approximately 2 inches thick.
							SM	AGGREGATE BASE: Brown, moist, dense, silty GRAVEL with sand; approximately 4 inches thick.
								FILL: Brown, moist, medium dense, silty SAND.
			50/4"					GRANITIC ROCK: Brown, moist, weathered GRANITIC ROCK.
10			50/5"					Total Depth = 10.4 feet. Groundwater not encountered during drilling. Backfilled shortly after drilling on 5/13/15.
								Note: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.
								The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
20								
30								
40								

DATE DRILLED 5/13/15 BORING NO. B-12

GROUND ELEVATION 720' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING 8" Diameter Hollow Stem Auger (CME-75) (Baja)

DRIVE WEIGHT 140 lbs. (Auto-Trip) DROP 30"

SAMPLED BY BTM LOGGED BY BTM REVIEWED BY GTF

Ninyo & Moore

BORING LOG

SANTA MARGARITA CONJUNCTIVE USE PROJECT
FALLBROOK, CALIFORNIA

PROJECT NO.	DATE	FIGURE
107931001	7/15	A-12

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							SM	FILL: Brown, moist, medium dense, silty SAND.
							SM	ALLUVIUM: Brown, moist, medium dense, silty SAND. Dark brown.
		■	19					
10		■	53					
								GRANITIC ROCK: Light brown to light gray, moist, weathered GRANITIC ROCK. Total Depth = 11.5 feet. Groundwater not encountered during drilling. Backfilled shortly after drilling on 5/14/15. Note: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
20								
30								
40								

DATE DRILLED 5/14/15 BORING NO. B-13

GROUND ELEVATION 935' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING 8" Diameter Hollow Stem Auger (CME-75) (Baja)

DRIVE WEIGHT 140 lbs. (Auto-Trip) DROP 30"

SAMPLED BY BTM LOGGED BY BTM REVIEWED BY GTF

Ninyo & Moore

BORING LOG

SANTA MARGARITA CONJUNCTIVE USE PROJECT
FALLBROOK, CALIFORNIA

PROJECT NO.	DATE	FIGURE
107931001	7/15	A-13

DATE DRILLED	5/14/15
BORING NO.	B-14
GROUND ELEVATION	1,010' ± (MSL)
SHEET	1 OF 1
METHOD OF DRILLING	8" Diameter Hollow Stem Auger (CME-75) (Baja)
DRIVE WEIGHT	140 lbs. (Auto-Trip)
DROP	30"
SAMPLED BY	BTM
LOGGED BY	BTM
REVIEWED BY	GTF

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							SM	FILL: Light brown, moist, medium dense, silty SAND.
	X							GRANITIC ROCK: Light brown, moist, weathered GRANITIC ROCK.
		X	50/5"					Light brown to gray.
10		X	50/3"					
		X	50/5"					Hard drilling.
20		X	50/3"					Total Depth = 20.3 feet. Groundwater not encountered during drilling. Backfilled shortly after drilling on 5/14/15.
30								
40								

Note: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.

The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.

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BORING LOG

SANTA MARGARITA CONJUNCTIVE USE PROJECT
FALLBROOK, CALIFORNIA

PROJECT NO.	DATE	FIGURE
107931001	7/15	A-14

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							SM	FILL: Brown, moist, loose to medium dense, silty SAND.
							SM	ALLUVIUM: Brown, moist, dense, silty SAND.
			43					
								GRANITIC ROCK: Brown, moist, weathered GRANITC ROCK.
10			50/5"					Total Depth = 10.4 feet. Groundwater not encountered during drilling. Backfilled shortly after drilling on 5/14/15. Note: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
20								
30								

DATE DRILLED 5/14/15 BORING NO. B-15

GROUND ELEVATION 810' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING 8" Diameter Hollow Stem Auger (CME-75) (Baja)

DRIVE WEIGHT 140 lbs. (Auto-Trip) DROP 30"

SAMPLED BY BTM LOGGED BY BTM REVIEWED BY GTF

Ninyo & Moore

BORING LOG

SANTA MARGARITA CONJUNCTIVE USE PROJECT
FALLBROOK, CALIFORNIA

PROJECT NO.	DATE	FIGURE
107931001	7/15	A-15

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.
0							SM
							SM
			18				
10			39				
			83/11"				
20							
30							
40							

DATE DRILLED 5/19/15 BORING NO. B-16

GROUND ELEVATION 650' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING 8" Diameter Hollow Stem Auger (CME-75) (Baja)

DRIVE WEIGHT 140 lbs. (Auto-Trip) DROP 30"

SAMPLED BY BTM LOGGED BY BTM REVIEWED BY GTF

DESCRIPTION/INTERPRETATION

FILL:
Brown, moist, medium dense, silty SAND.

ALLUVIUM:
Brown, moist, medium dense, silty SAND.

GRANITIC ROCK:
Light brown, moist, weathered GRANITIC ROCK.

Total Depth = 16.4 feet.
Groundwater not encountered during drilling.
Backfilled shortly after drilling on 5/19/15.

Note: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.

The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.

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BORING LOG

SANTA MARGARITA CONJUNCTIVE USE PROJECT
FALLBROOK, CALIFORNIA

PROJECT NO.	DATE	FIGURE
107931001	7/15	A-16

APPENDIX B

LABORATORY TESTING

Classification
Soils were visually and texturally classified in accordance with the Unified Soil Classification System (USCS) in general accordance with ASTM D 2488. Soil classifications are indicated on the logs of the exploratory borings in Appendix A.

In-Place Moisture and Density Tests
The moisture content and dry density of relatively undisturbed samples obtained from the exploratory borings were evaluated in general accordance with ASTM D 2937. The test results are presented on the logs of the exploratory borings in Appendix A.

Gradation Analysis
Gradation analysis tests were performed on selected representative soil samples in general accordance with ASTM D 422. The grain-size distribution curves are shown on Figures B-1 through B-4. The test results were utilized in evaluating the soil classifications in accordance with the USCS.

Atterberg Limits
Tests were performed on a selected fine-grained soil sample to evaluate the liquid limit, plastic limit, and plasticity index in general accordance with ASTM D 4318. These test results were utilized to evaluate the soil classification in accordance with the Unified Soil Classification System (USCS). The test results and classifications are shown on Figure B-5.

Direct Shear Tests
Four direct shear tests were performed on samples in general accordance with ASTM D 3080 to evaluate the shear strength characteristics of the selected materials. The samples were inundated during shearing to represent adverse field conditions. The test results are shown on Figures B-6 through B-9.

Expansion Index Tests
The expansion index of selected materials was evaluated in general accordance with ASTM D 4829. Specimens were molded under a specified compactive energy at approximately 50 percent saturation (plus or minus 1 percent). The prepared 1-inch thick by 4-inch diameter specimens were loaded with a surcharge of 144 pounds per square foot and were inundated with tap water. Readings of volumetric swell were made for a period of 24 hours. The results of these tests are presented on Figure B-10.

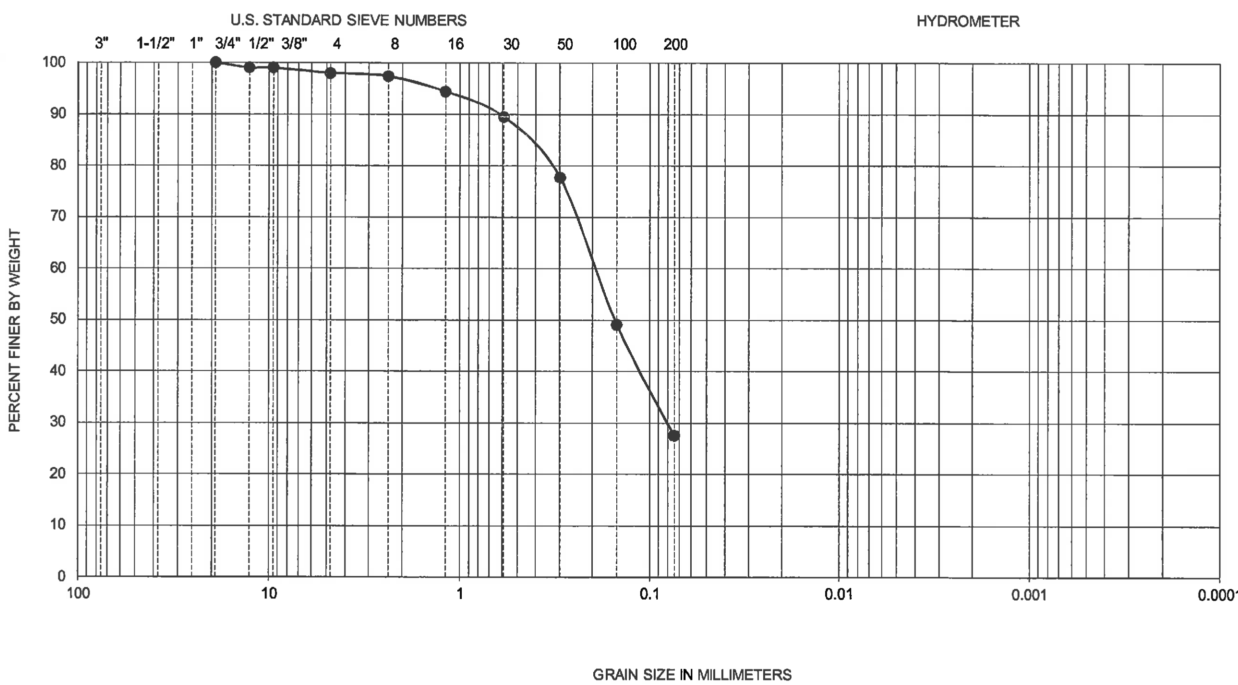
Soil Corrosivity Tests

Soil pH, and electrical resistivity tests were performed on a representative sample in general accordance with CT 643. The chloride content of the selected sample was evaluated in general accordance with CT 422. The sulfate content of the selected sample was evaluated in general accordance with CT 417. The test results are presented on Figure B-11.

R-Value

The resistance value, or R-Value, of a representative sample of near-surface soil was evaluated in general accordance with CT 301. Samples were prepared and evaluated for exudation pressure and expansion pressure. The equilibrium R-value is reported as the lesser or more conservative of the two calculated results. The test results are shown on Figure B-12.

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay



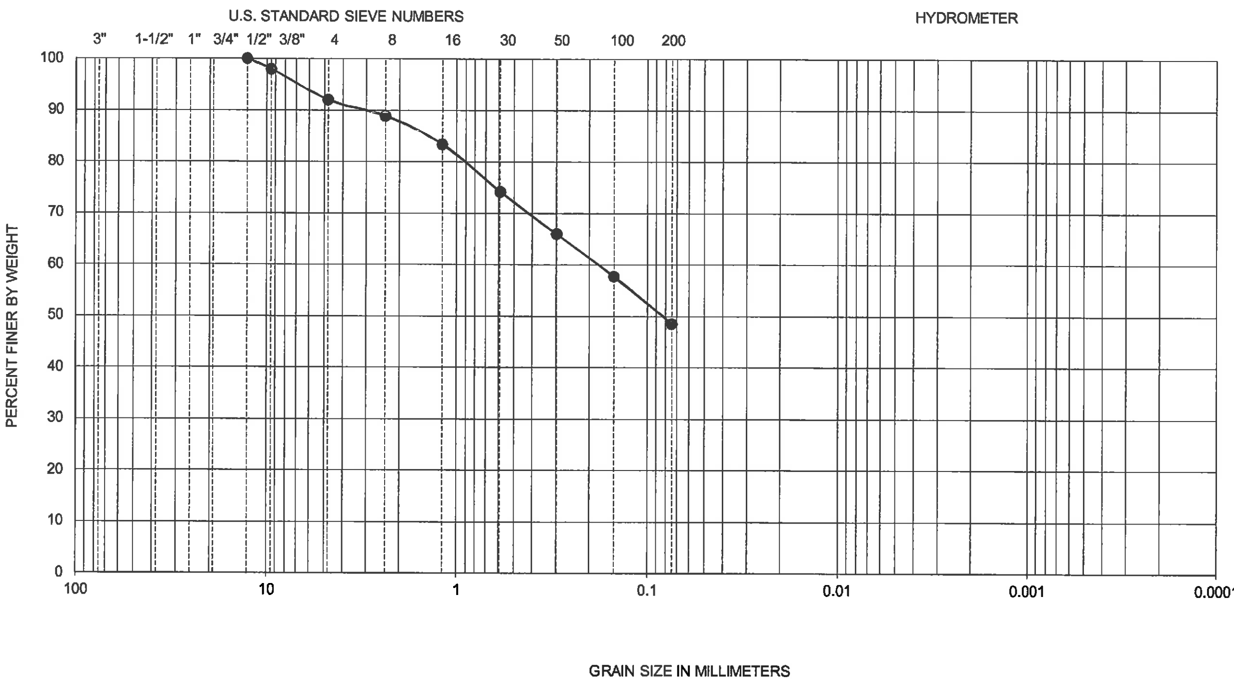
Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	U.S.C.S
●	B-3	1.0-5.0	--	--	--	--	--	--	--	--	28	SM

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore		GRADATION TEST RESULTS	FIGURE
PROJECT NO.	DATE	SANTA MARGARITA CONJUNCTIVE USE PROJECT FALLBROOK, CALIFORNIA	B-1
107931001	7/15		

107931001 SIEVE B-3 @ 1.0-5.0.xls

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

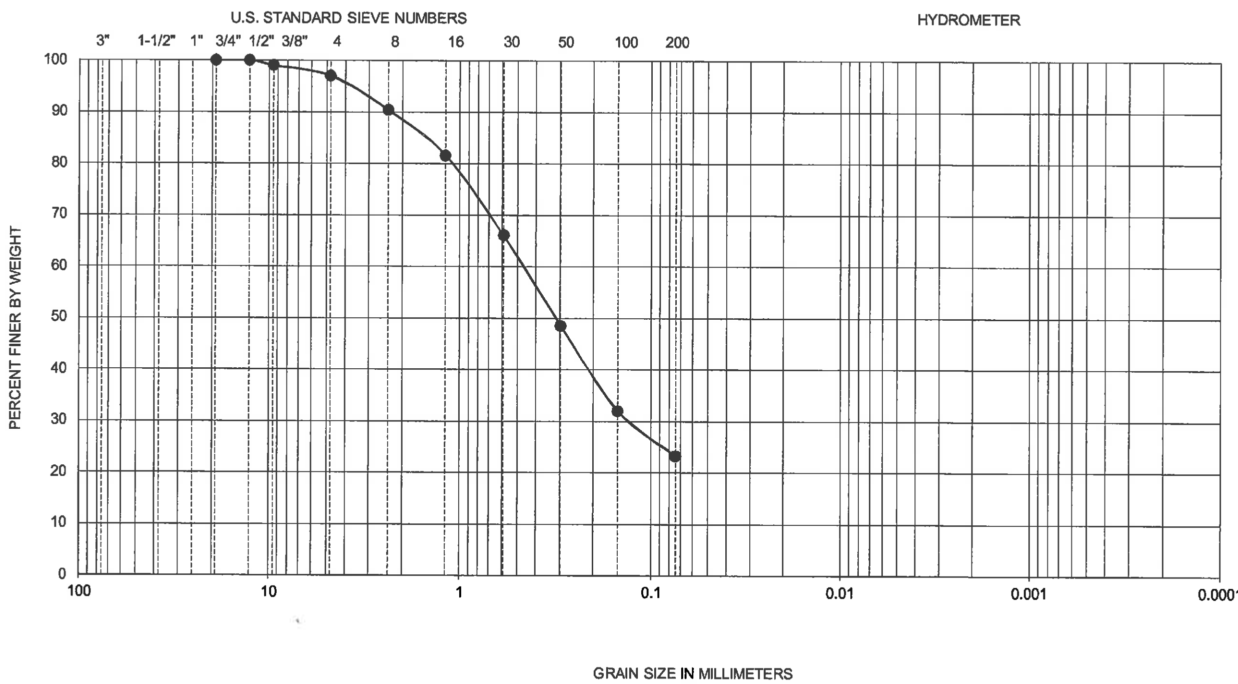


Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	U.S.C.S
●	B-5	0.5-5.0	39	21	18	--	--	--	--	--	49	SC

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. / DATE	SANTA MARGARITA CONJUNCTIVE USE PROJECT FALLBROOK, CALIFORNIA	B-2
107931001 / 7/15		

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

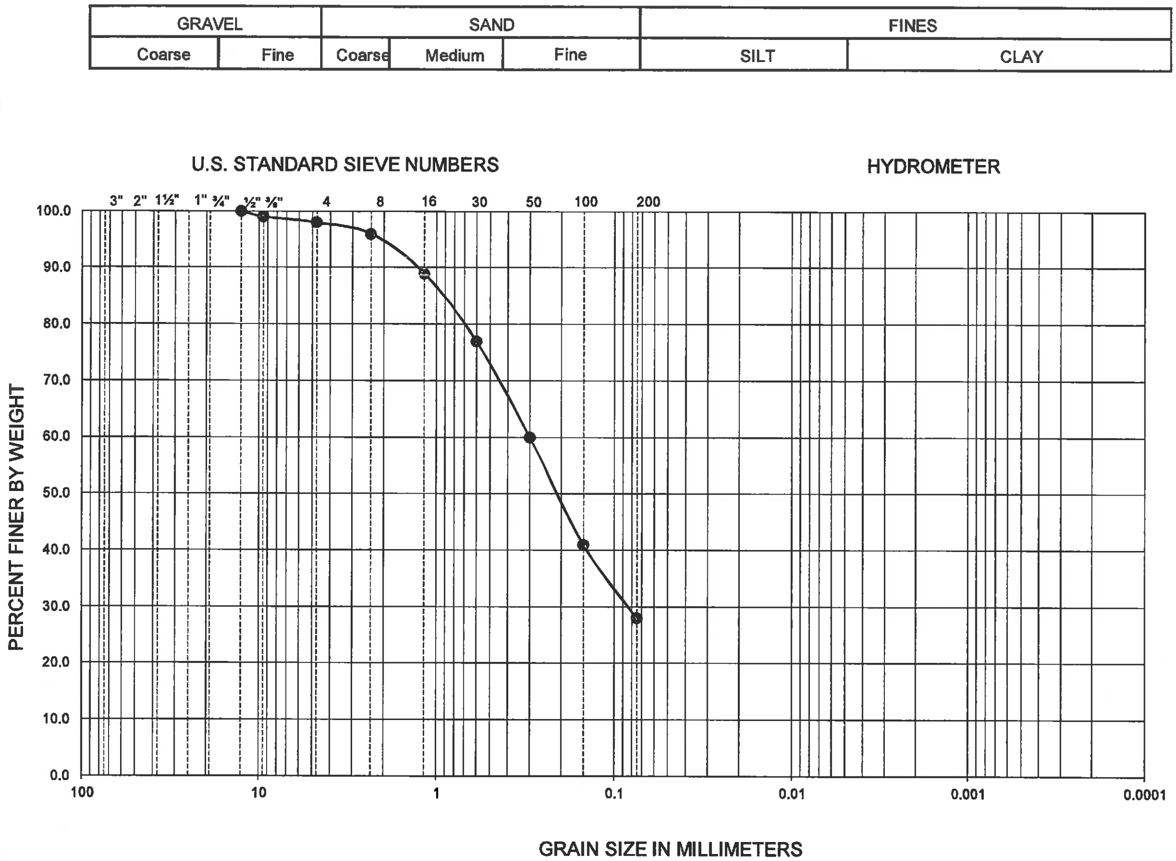


Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	U.S.C.S
●	B-8	1.0-5.0	--	--	--	--	--	--	--	--	23	SM

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore		GRADATION TEST RESULTS	FIGURE
PROJECT NO.	DATE	SANTA MARGARITA CONJUNCTIVE USE PROJECT FALLBROOK, CALIFORNIA	B-3
107931001	7/15		

107931001 SIEVE B-8 @ 1.0-5.0.xls



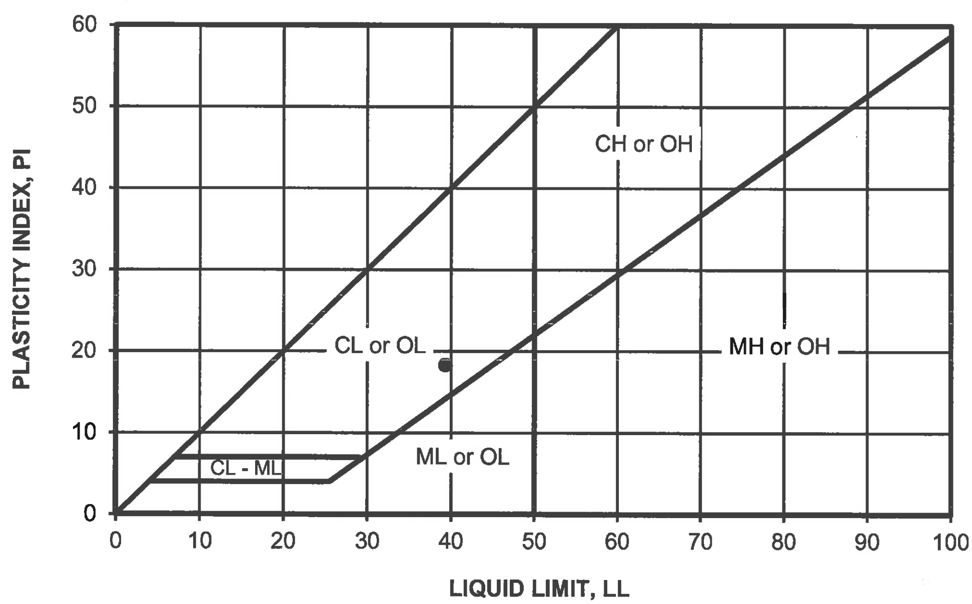
Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-16	1.0-5.0	–	–	–	–	–	–	–	–	28	SM

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. 107931001 / DATE 7/15	SANTA MARGARITA CONJUNCTIVE USE PROJECT FALLBROOK, CALIFORNIA	B-4

SYMBOL	LOCATION	DEPTH (FT)	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	USCS CLASSIFICATION (Fraction Finer Than No. 40 Sieve)	USCS (Entire Sample)
●	B-5	0.5-5.0	39	21	18	CL	SC

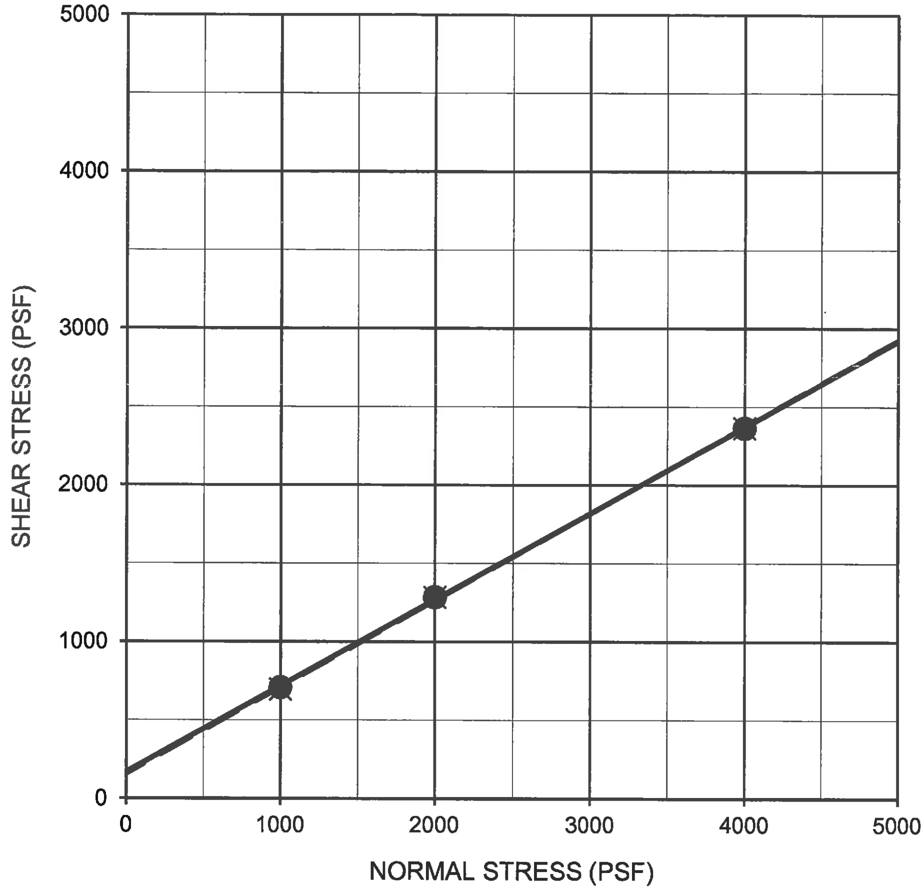
NP - INDICATES NON-PLASTIC



PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 4318

Ninyo & Moore	ATTERBERG LIMITS TEST RESULTS	FIGURE
PROJECT NO. 107931001 / DATE 7/15	SANTA MARGARITA CONJUNCTIVE USE PROJECT FALLBROOK, CALIFORNIA	B-5

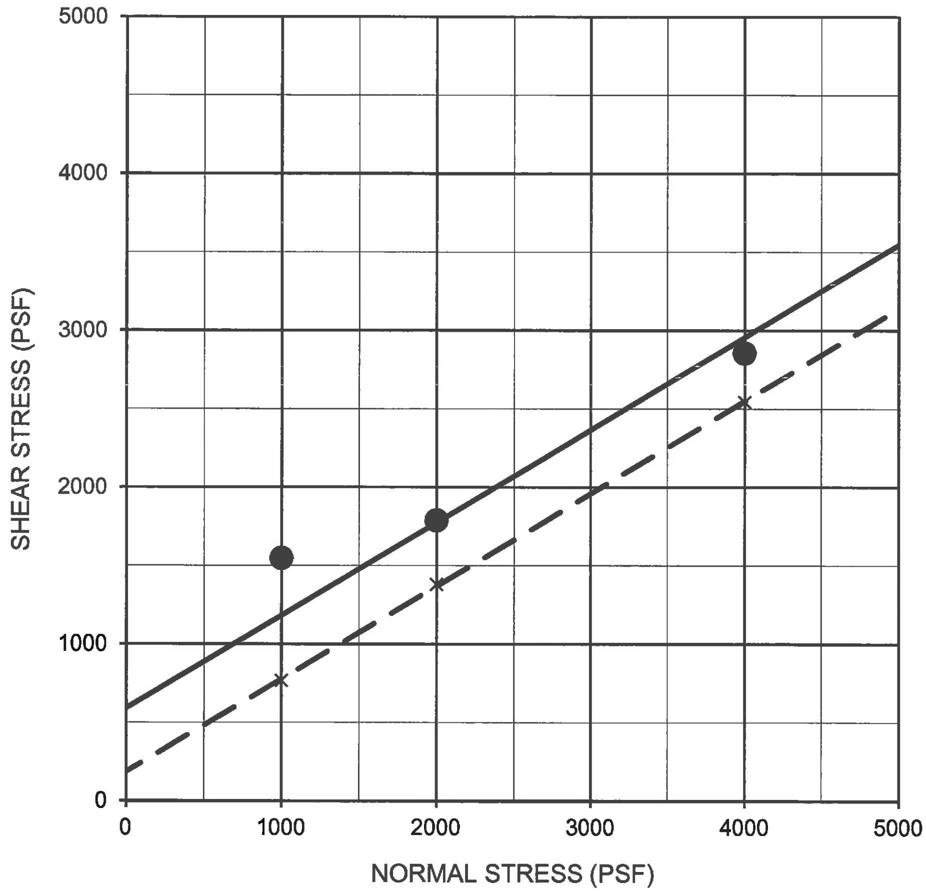
107931001 ATTERBERG Page 1.xls



Description	Symbol	Sample Location	Depth (ft)	Shear Strength	Cohesion, c (psf)	Friction Angle, ϕ (degrees)	Soil Type
Silty SAND	——●——	B-3	5.0-6.5	Peak	170	29	SM
Silty SAND	- - X - -	B-3	5.0-6.5	Ultimate	160	29	SM

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 3080

Ninyo & Moore	DIRECT SHEAR TEST RESULTS	FIGURE
PROJECT NO. 107931001 / DATE 7/15	SANTA MARGARITA CONJUNCTIVE USE PROJECT FALLBROOK, CALIFORNIA	B-6

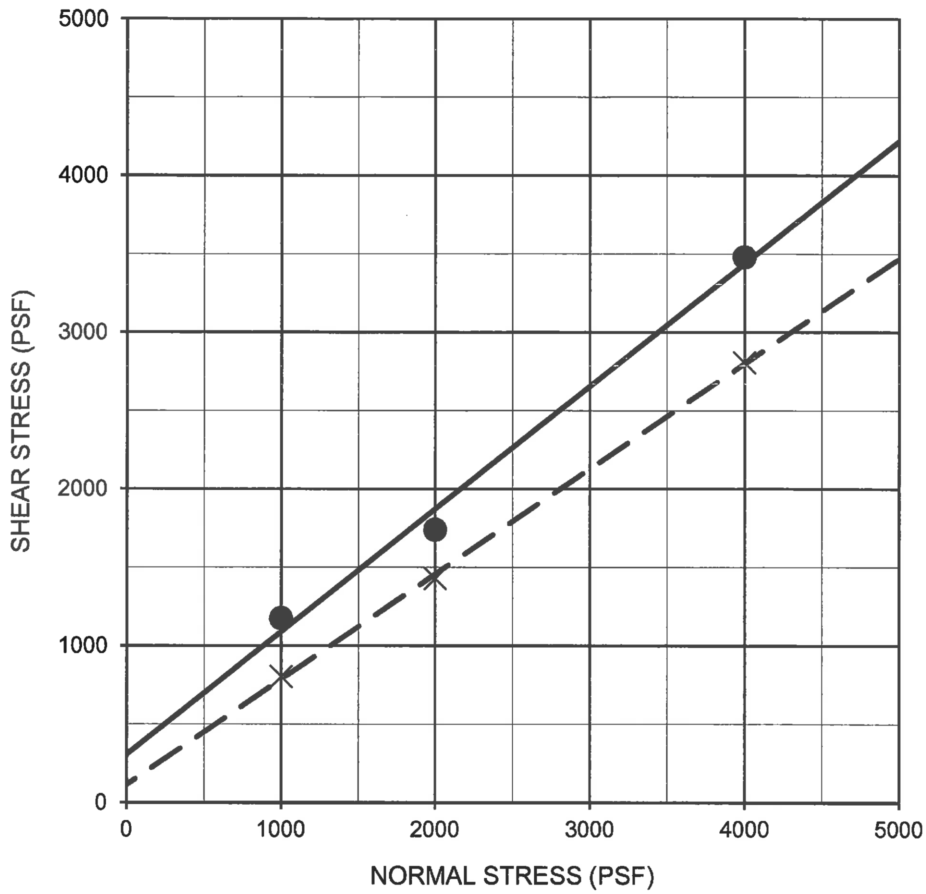


Description	Symbol	Sample Location	Depth (ft)	Shear Strength	Cohesion, c (psf)	Friction Angle, ϕ (degrees)	Soil Type
Weathered GRANITIC ROCK	——●——	B-6	5.0-6.5	Peak	590	31	Bedrock
Weathered GRANITIC ROCK	- - X - -	B-6	5.0-6.5	Ultimate	190	31	Bedrock

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 3080

Ninyo & Moore		DIRECT SHEAR TEST RESULTS	FIGURE
PROJECT NO.	DATE	SANTA MARGARITA CONJUNCTIVE USE PROJECT FALLBROOK, CALIFORNIA	B-7
107931001	7/15		

107931001 SHEAR B-6 @ 5.0-6.5.xls



Description	Symbol	Sample Location	Depth (ft)	Shear Strength	Cohesion, c (psf)	Friction Angle, ϕ (degrees)	Soil Type
Weathered GRANITIC ROCK	—●—	B-11	5.0-6.5	Peak	310	38	Bedrock
Weathered GRANITIC ROCK	- - x - -	B-11	5.0-6.5	Ultimate	110	34	Bedrock

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 3080

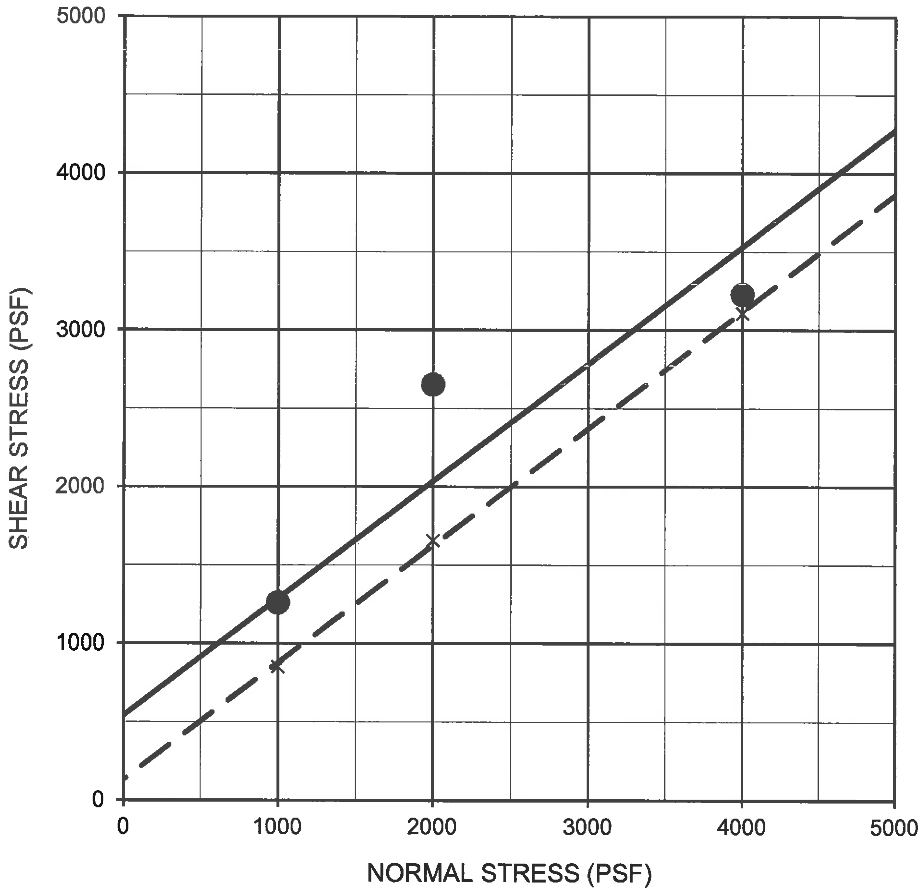
Ninyo & Moore

DIRECT SHEAR TEST RESULTS

PROJECT NO.	DATE
107931001	7/15

SANTA MARGARITA CONJUNCTIVE USE PROJECT
FALLBROOK, CALIFORNIA

FIGURE
B-8



Description	Symbol	Sample Location	Depth (ft)	Shear Strength	Cohesion, c (psf)	Friction Angle, ϕ (degrees)	Soil Type
Weathered GRANITIC ROCK	—●—	B-14	5.0-5.9	Peak	540	37	Bedrock
Weathered GRANITIC ROCK	- - X - -	B-14	5.0-5.9	Ultimate	130	37	Bedrock

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 3080

Ninyo & Moore		DIRECT SHEAR TEST RESULTS	FIGURE
PROJECT NO.	DATE	SANTA MARGARITA CONJUNCTIVE USE PROJECT FALLBROOK, CALIFORNIA	B-9
107931001	7/15		

SAMPLE LOCATION	SAMPLE DEPTH (FT)	INITIAL MOISTURE (%)	COMPACTED DRY DENSITY (PCF)	FINAL MOISTURE (%)	VOLUMETRIC SWELL (IN)	EXPANSION INDEX	POTENTIAL EXPANSION
B-3	1.0-5.0	8.5	115.9	12.0	0.001	1	Very Low
B-5	0.5-5.0	9.0	114.8	17.0	0.052	52	Medium

PERFORMED IN GENERAL ACCORDANCE WITH ☐ UBC STANDARD 18☑ ASTM D 4829

Ninyo & Moore

EXPANSION INDEX TEST RESULTS

PROJECT NO.	DATE
107931001	7/15

SANTA MARGARITA CONJUNCTIVE USE PROJECT
FALLBROOK, CALIFORNIA

FIGURE
B-10

SAMPLE LOCATION	SAMPLE DEPTH (FT)	pH [1]	RESISTIVITY [1] (Ohm-cm)	SULFATE CONTENT [2]		CHLORIDE CONTENT [3] (ppm)
				(ppm)	(%)	
B-3	1.0-5.0	6.5	1,700	80	0.008	400
B-12	1.5-5.0	7.1	7,500	10	0.001	25
B-14	1.0-5.0	6.6	15,000	10	0.001	40

[1] PERFORMED IN GENERAL ACCORDANCE WITH CALIFORNIA TEST METHOD 643
[2] PERFORMED IN GENERAL ACCORDANCE WITH CALIFORNIA TEST METHOD 417
[3] PERFORMED IN GENERAL ACCORDANCE WITH CALIFORNIA TEST METHOD 422

Ninyo & Moore

CORROSIVITY TEST RESULTS

FIGURE

PROJECT NO. 107931001

DATE 7/15

SANTA MARGARITA CONJUNCTIVE USE PROJECT
FALLBROOK, CALIFORNIA

B-11

SAMPLE LOCATION	SAMPLE DEPTH (FT)	SOIL TYPE	R-VALUE
B-8	1.0-5.0	Silty SAND (SM)	43

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 2844/CT 301

Ninyo & Moore		R-VALUE TEST RESULTS	FIGURE
PROJECT NO.	DATE	SANTA MARGARITA CONJUNCTIVE USE PROJECT FALLBROOK, CALIFORNIA	B-12
107931001	7/15		

APPENDIX G

PRELIMINARY HYDROLOGY CALCULATIONS

Worksheet B.2-1. Design Capture Volume

	Design Capture Volume	*Worksheet B.2-1.* *Model BMP Design Manual* *January 2015*		
1	85th percentile 24-hr storm depth from Figure B.1	d=	0.86	inches
2	Area tributary to BMP (s)	A=	3.63	acres
3	Area weighted runoff factor (estimate using section B.1 and B.2.1)	C=	0.37	unitless
4	Street trees volume reduction	TCV=	0	cubic-feet
5	Rain barrels volume reduction	RCV=	0	cubic-feet
6	Calculate DCV = (C x d x A x 43560 x (1/12)) - TCV - RCV	DCV=	4195	cubic-feet

				Adjusted C-factor
Tributary Area:				
Proposed - WTP:				
	Roadway	0.85	AC	0.72
	Buildings & Structures	0.39	AC	0.72
	RO/Chem	11000	SF	
	WWW	1500	SF	
	CW	1500	SF	
	RO Feed	700	SF	
	IM Vessels (7)	2275	SF	
	Future Decarbonator	100	SF	
	Gravel Area	0.80	AC	0.1
Proposed - Hill Area:		1.58	AC	
	Roadway	0.34	AC	0.72
	Ground	1.24	AC	0.1
	Total Area	3.63		0.37

Worksheet B.5-1: Simple Sizing Method for Biofiltration BMPs

Simple Sizing Method for Biofiltration BMPs		Worksheet B.5-1	
1	Remaining DCV after implementing retention BMPs	4195	cubic-feet
Partial Rentention			
2	Infiltration rate from Worksheet D.5-1 if partial infiltration is feasible	0	in/hr.
3	Allowable drawdown time for aggregate storage below the underdrain	*36*	hours
4	Depth of runoff that can be infiltrated [Line 2 x Line 3]	0	inches
5	Aggregate pore space	*0.4*	in/in
6	Required depth of gravel below the underdrain [Line 4 / Line 5]	0	inches
7	Assumed surface area of the biofiltration BMP	2168	sq-ft
8	Media retained pore space	*0.1*	in/in
9	Volume retained by BMP [[Line 4 + (Line 12 x Line 8)]/12] x Line 7	325.2	cubic-feet
10	DCV that requires biofiltration [Line 1 - Line 9]	3870	cubic-feet
BMP Parameters			
11	Surface Ponding [6 inch minimum, 12 inch maximum]	12	inches
12	Media Thickness [18 inches minimum]	18	inches
13	Aggregate Storage above underdrain invert (12 inches typical) - use 0 inches for sizing if the aggregate is not over the entire bottom surface area	*12*	inches
14	Media available pore space	*0.2*	in/in
15	Media filtration rate to be used for sizing	*5*	in/hr
Baseline Calculations			
16	Allowable Routing Time for sizing	*6*	hours
17	Depth filtered during storm [Line 15 x Line 16]	*30*	inches
18	Depth of Detention Storage [Line 11 + (Line 12 x Line 14) + (Line 13 x Line 5)]	20.4	inches
19	Total Depth Treated [Line 17 + Line 18]	50.4	inches
Option 1 - Biofilter 1.5 times the DCV			
20	Required biofiltered volume [1.5 x Line 10]	5,805	cubic-feet
21	Required Footpint [Line 20/Line 19] x 12	1,382	sq-ft
Option 2 - Store 0.75 of remaining DCV on pores and ponding			
22	Required Storage (surface + pores) Volume [0.75 x Line 10]	2,902	cubic-feet
23	Required Footprint [Line 22/Line 18] x 12	1,707	sq-ft
Footprint of the BMP			
24	Impervious area drainging to the BMP	68,965	sq-ft
25	Footprint of the BMP = Minimum (Line 21, Line 23, 3% of Line 24)	2,069	sq-ft

Note: Line 7 is used to estimate the amount of volume retained by the BMP. Update assumed surface area in Line 7 Until its equivalent to the required biofiltration footprint (either Line 21 or Line 23)

BASIN VOLUME - LONGER BASIN

Prizmoidal Basin		
Width:	varies	ft
Length:	varies	ft
Side Slope, z:	3.0	
Total Depth:	4.0	ft
Depth Increment:	0.50	ft

Bottom of Basin Elev = 650 ft
Top of Basin Elev = 654 ft

Min WQ Surface Area = 2069 sf
Min Volume (WQV) = 5805 cf

Area calculated using CADD & avg end area method

	Depth	Elevation	Area	Inc. Volume	Total Volume	Total Volume	Outflow
	(ft)	(ft)	(sf)	(cf)	(acre-ft)	(cf)	cfs
1	0.00	650.00	874	0	0.000	0	0.0
2	0.50	650.50	1,127	500	0.011	500	0.0
3	1.00	651.00	1,399	632	0.026	1,132	0.1
4	1.50	651.50	1,688	772	0.044	1,904	0.1
5	2.00	652.00	1,995	921	0.065	2,824	0.1
6	2.50	652.50	2,320	1,079	0.090	3,903	0.1
7	3.00	653.00	2,663	1,246	0.118	5,149	0.1
8	3.50	653.50	3,025	1,422	0.151	6,571	4.1
9	4.00	654.00	3,404	1,607	0.188	8,178	5.1
10		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	

Min depth for Water Quality Volume (5805 CF) = 3.2ft.

WEIGHTED RUNOFF COEFFICIENTS

PROJECT NAME: Santa Margarita Conjunctive Use Project
PROJECT NO: 112.FPUD.0002 DATE: 6/18/2015

Reference: San Diego County Hydrology Manual, June 2003, Section 3.1.2.

Weighted C = $C_{Imperrvious}$ * (% Impervious) + $C_{Pervious}$ * (1-% Impervious)

10yr Storm

	Pervious			Impervious							
Subarea	**Area (sf)**	**Area (ac)**	**C (pervious)**	**Area (sf)**	**Area (ac)**	**C (impervious)**	**% Impervious**	**Total Area (sf)**	**Total Area (ac)**	**Weighted C**	**C*A**
Existing Condition											
E1 - Initial Area Node 1 to Node 2	6,954	0.1596	0.50	0	0.0000	0.87	0.0%	6,954	0.1596	0.50	0.080
E1 - Node 2 to Node 3	15,446	0.3546	0.48	4,263	0.0979	0.87	21.6%	19,709	0.4525	0.56	0.255
E1 - Node 3 to Node 4	57,966	1.3307	0.48	32,029	0.7353	0.87	35.6%	89,995	2.0660	0.62	1.278
		0.0000			0.0000		0.0%	0	0.0000		
								116,658	2.6781	0.60	
E2 - Node 5 to Node 4	20,862	0.4789	0.39	20,520	0.4711	0.87	49.6%	41,382	0.9500	0.63	0.597
		0.0000			0.0000		0.0%	0	0.0000		
		0.0000			0.0000		0.0%	0	0.0000		
		0.0000			0.0000		0.0%	0	0.0000		
								41,382	0.9500	0.63	
Totals:	101,228	2.3239		56,812	1.3042			158,040	3.6281		

100yr Storm

	Pervious			Impervious							
Subarea	**Area (sf)**	**Area (ac)**	**C (pervious)**	**Area (sf)**	**Area (ac)**	**C (impervious)**	**% Impervious**	**Total Area (sf)**	**Total Area (ac)**	**Weighted C**	**C*A**
Existing Condition											
E1 - Initial Area Node 1 to Node 2	6,954	0.1596	0.63	0	0.0000	0.87	0.0%	6,954	0.1596	0.63	0.101
E1 - Node 2 to Node 3	15,446	0.3546	0.60	4,263	0.0979	0.87	21.6%	19,709	0.4525	0.66	0.298
E1 - Node 3 to Node 4	57,966	1.3307	0.60	32,029	0.7353	0.87	35.6%	89,995	2.0660	0.70	1.438
		0.0000			0.0000		0.0%	0	0.0000		
								116,658	2.6781	0.69	
E2 - Node 5 to Node 4	20,862	0.4789	0.49	20,520	0.4711	0.87	49.6%	41,382	0.9500	0.68	0.643
		0.0000			0.0000		0.0%	0	0.0000		
		0.0000			0.0000		0.0%	0	0.0000		
		0.0000			0.0000		0.0%	0	0.0000		
								41,382	0.9500	0.68	
Totals:	101,228	2.3239		56,812	1.3042			158,040	3.6281		

WEIGHTED RUNOFF COEFFICIENTS

PROJECT NAME: Santa Margarita Conjunctive Use Project
PROJECT NO: 112.FPUD.0002 DATE: 6/18/2015

Reference: San Diego County Hydrology Manual, June 2003, Section 3.1.2.

Weighted C = $C_{Imperrvious}$ * (% Impervious) + $C_{Pervious}$ * (1-% Impervious)

10yr Storm

	Pervious			Impervious							
Subarea	Area (sf)	Area (ac)	C (pervious)	Area (sf)	Area (ac)	C (impervious)	% Impervious	Total Area (sf)	Total Area (ac)	Weighted C	C*A
Proposed Condition											
P1 - Initial Area Node 1 to Node 2	4,574	0.1050	0.50	653	0.0150	0.87	12.5%	5,227	0.1200	0.55	0.066
P1 - Node 2 to Node 3	11,717	0.2690	0.48	10,440	0.2397	0.87	47.1%	22,157	0.5087	0.66	0.338
P1 - Node 3 to Node 4	0	0.0000	0.48	10,251	0.2353	0.87	100.0%	10,251	0.2353	0.87	0.205
P1 - Node 6 to Node 4	37,604	0.8633	0.48	2,875	0.0660	0.87	7.1%	40,479	0.9293	0.51	0.472
P1 - Node 4 to Node 5	19,160	0.4399	0.34	21,035	0.4829	0.87	52.3%	40,195	0.9228	0.62	0.570
								118,309	2.7160	0.61	
P2 - Node 7 to Node 5	15,339	0.3521	0.34	22,741	0.5221	0.87	59.7%	38,080	0.8742	0.66	0.574
		0.0000			0.0000		0.0%	0	0.0000		
		0.0000			0.0000		0.0%	0	0.0000		
		0.0000			0.0000		0.0%	0	0.0000		
								38,080	0.8742	0.66	
Totals:	88,394	2.0292		67,995	1.5610			156,389	3.5902		

100yr Storm

	Pervious			Impervious							
Subarea	Area (sf)	Area (ac)	C (pervious)	Area (sf)	Area (ac)	C (impervious)	% Impervious	Total Area (sf)	Total Area (ac)	Weighted C	C*A
Proposed Condition											
P1 - Initial Area Node 1 to Node 2	4,574	0.1050	0.63	653	0.0150	0.87	12.5%	5,227	0.1200	0.66	0.079
P1 - Node 2 to Node 3	11,717	0.2690	0.60	10,440	0.2397	0.87	47.1%	22,157	0.5087	0.73	0.370
P1 - Node 3 to Node 4	0	0.0000	0.60	10,251	0.2353	0.87	100.0%	10,251	0.2353	0.87	0.205
P1 - Node 6 to Node 4	37,604	0.8633	0.60	2,875	0.0660	0.87	7.1%	40,479	0.9293	0.62	0.575
P1 - Node 4 to Node 5	19,160	0.4399	0.43	21,035	0.4829	0.87	52.3%	40,195	0.9228	0.66	0.609
								118,309	2.7160	0.68	
P2 - Node 7 to Node 5	15,339	0.3521	0.43	22,741	0.5221	0.87	59.7%	38,080	0.8742	0.69	0.606
		0.0000			0.0000		0.0%	0	0.0000		
		0.0000			0.0000		0.0%	0	0.0000		
		0.0000			0.0000		0.0%	0	0.0000		
								38,080	0.8742	0.69	
Totals:	88,394	2.0292		67,995	1.5610			156,389	3.5902		

Runoff Coefficients for Undeveloped Areas

Reference: Caltrans Highway Design Manual, 2012, Topic 819.

Subarea: E-1 Node 1 to 2

Parameter	**C_p:**	
Relief:	0.13	
Soil Infiltration:	0.12	
Vegetal Cover:	0.16	
Surface Storage:	0.09	
Storm Frequency:	10	yrs.
C =	**0.50**	

Subarea: E-1 Node 2 to 3

Parameter	**C_p:**	
Relief:	0.15	
Soil Infiltration:	0.12	
Vegetal Cover:	0.12	
Surface Storage:	0.09	
Storm Frequency:	10	yrs.
C =	**0.48**	

Subarea: E-1 Node 3 to 4

Parameter	**C_p:**	
Relief:	0.15	
Soil Infiltration:	0.12	
Vegetal Cover:	0.12	
Surface Storage:	0.09	
Storm Frequency:	10	yrs.
C =	**0.48**	

Subarea: E-2 Node 5 to 4

Parameter	**C_p:**	
Relief:	0.10	
Soil Infiltration:	0.10	
Vegetal Cover:	0.12	
Surface Storage:	0.07	
Storm Frequency:	10	yrs.
C =	**0.39**	

Subarea: E-1 Node 1 to 2

Parameter	**C_p:**	
Relief:	0.13	
Soil Infiltration:	0.12	
Vegetal Cover:	0.16	
Surface Storage:	0.09	
Storm Frequency:	100	yrs.
C =	**0.63**	

Subarea: E-1 Node 2 to 3

Parameter	**C_p:**	
Relief:	0.15	
Soil Infiltration:	0.12	
Vegetal Cover:	0.12	
Surface Storage:	0.09	
Storm Frequency:	100	yrs.
C =	**0.60**	

Subarea: E-1 Node 3 to 4

Parameter	**C_p:**	
Relief:	0.15	
Soil Infiltration:	0.12	
Vegetal Cover:	0.12	
Surface Storage:	0.09	
Storm Frequency:	100	yrs.
C =	**0.6**	

Subarea: E-2 Node 5 to 4

Parameter	**C_p:**	
Relief:	0.10	
Soil Infiltration:	0.10	
Vegetal Cover:	0.12	
Surface Storage:	0.07	
Storm Frequency:	100	yrs.
C =	**0.4875**	

Subarea: P-1 Node 4 to 5

Parameter	**C_p:**	
Relief:	0.10	
Soil Infiltration:	0.10	
Vegetal Cover:	0.14	
Surface Storage:	0.07	
Storm Frequency:	10	yrs.
C =	**0.41**	

Subarea: P-2 Node 6 to 5

Parameter	**C_p:**	
Relief:	0.10	
Soil Infiltration:	0.10	
Vegetal Cover:	0.14	
Surface Storage:	0.07	
Storm Frequency:	10	yrs.
C =	**0.41**	

Runoff Coefficients for Undeveloped Areas

Reference: Caltrans Highway Design Manual, 2012, Topic 819.

Subarea: P-1 Node 1 to 2

Parameter	**C_p:**	
Relief:	0.13	
Soil Infiltration:	0.12	
Vegetal Cover:	0.16	
Surface Storage:	0.09	
Storm Frequency:	10	yrs.
C =	**0.50**	

Subarea: P-1 Node 2 to 3

Parameter	**C_p:**	
Relief:	0.15	
Soil Infiltration:	0.12	
Vegetal Cover:	0.12	
Surface Storage:	0.09	
Storm Frequency:	10	yrs.
C =	**0.48**	

Subarea: P-1 Node 3 to 4

Parameter	**C_p:**	
Relief:	0.15	
Soil Infiltration:	0.12	
Vegetal Cover:	0.12	
Surface Storage:	0.09	
Storm Frequency:	10	yrs.
C =	**0.48**	

Subarea: P-1 Node 4 to 5

Parameter	**C_p:**	
Relief:	0.10	
Soil Infiltration:	0.05	
Vegetal Cover:	0.14	
Surface Storage:	0.05	
Storm Frequency:	10	yrs.
C =	**0.34**	

Subarea: P-2 Node 6 to 5

Parameter	**C_p:**	
Relief:	0.10	
Soil Infiltration:	0.05	
Vegetal Cover:	0.14	
Surface Storage:	0.05	
Storm Frequency:	10	yrs.
C =	**0.34**	

Subarea: P-1 Node 1 to 2

Parameter	**C_p:**	
Relief:	0.13	
Soil Infiltration:	0.12	
Vegetal Cover:	0.16	
Surface Storage:	0.09	
Storm Frequency:	100	yrs.
C =	**0.63**	

Subarea: P-1 Node 2 to 3

Parameter	**C_p:**	
Relief:	0.15	
Soil Infiltration:	0.12	
Vegetal Cover:	0.12	
Surface Storage:	0.09	
Storm Frequency:	100	yrs.
C =	**0.6**	

Subarea: P-1 Node 3 to 4

Parameter	**C_p:**	
Relief:	0.15	
Soil Infiltration:	0.12	
Vegetal Cover:	0.12	
Surface Storage:	0.09	
Storm Frequency:	100	yrs.
C =	**0.60**	

Subarea: P-1 Node 4 to 5

Parameter	**C_p:**	
Relief:	0.10	
Soil Infiltration:	0.05	
Vegetal Cover:	0.14	
Surface Storage:	0.05	
Storm Frequency:	100	yrs.
C =	**0.43**	

Subarea: P-2 Node 6 to 5

Parameter	**C_p:**	
Relief:	0.10	
Soil Infiltration:	0.05	
Vegetal Cover:	0.14	
Surface Storage:	0.05	
Storm Frequency:	100	yrs.
C =	**0.43**	

Figure 819.2A

Runoff Coefficients for Undeveloped Areas

Watershed Types

	Extreme	High	Normal	Low
Relief	.28 -.35 Steep, rugged terrain with average slopes above 30%	.20 -.28 Hilly, with average slopes of 10 to 30%	.14 -.20 Rolling, with average slopes of 5 to 10%	.08 -.14 Relatively flat land, with average slopes of 0 to 5%
Soil Infiltration	.12 -.16 No effective soil cover, either rock or thin soil mantle of negligible infiltration capacity	.08 -.12 Slow to take up water, clay or shallow loam soils of low infiltration capacity, imperfectly or poorly drained	.06 -.08 Normal; well drained light or medium textured soils, sandy loams, silt and silt loams	.04 -.06 High; deep sand or other soil that takes up water readily, very light well drained soils
Vegetal Cover	.12 -.16 No effective plant cover, bare or very sparse cover	.08 -.12 Poor to fair; clean cultivation crops, or poor natural cover, less than 20% of drainage area over good cover	.06 -.08 Fair to good; about 50% of area in good grassland or woodland, not more than 50% of area in cultivated crops	.04 -.06 Good to excellent; about 90% of drainage area in good grassland, woodland or equivalent cover
Surface Storage	.10 -.12 Negligible surface depression few and shallow; drainageways steep and small, no marshes	.08 -.10 Low; well defined system of small drainageways; no ponds or marshes	.06 -.08 Normal; considerable surface depression storage; lakes and pond marshes	.04 -.06 High; surface storage, high; drainage system not sharply defined; large floodplain storage or large number of ponds or marshes
Given	An undeveloped watershed consisting of; 1) rolling terrain with average slopes of 5%, 2) clay type soils, 3) good grassland area, and 4) normal surface depressions.		Solution: Relief 0.14 Soil Infiltration 0.08 Vegetal Cover 0.04 Surface Storage 0.06 C = 0.32	
Find	The runoff coefficient, C, for the above watershed.			

PROJECT: FPUD SMCUP **DATE:** 6/18/2015

PURPOSE: Determine the weir length required for emergency overflow of the detention basin for the treatment plant tank overflow

GIVEN: Q(100) = 12.6 cfs
8 MGD

ASSUMPTIONS: Suppressed Weir

METHOD: "Civil Engineering Reference Manual for the PE Exam, Tenth Edition" by Michael R. Lindeburg

Flow (Q) = 3.33bh^(3/2) rectangular weir

where,
b = length of weir
h = height of weir = 0.5 ft

CALCULATIONS:

Solve for b,
b = 10.70 ft min weir length

Design b =	**11 ft**

PURPOSE: Determine the weir length required for emergency overflow of the detention basin for the 100 yr storm

GIVEN: Q(100) = 16.57 cfs

ASSUMPTIONS: Suppressed Weir

METHOD: "Civil Engineering Reference Manual for the PE Exam, Tenth Edition" by Michael R. Lindeburg

Flow (Q) = 3.33bh^(3/2) rectangular weir

where,
b = length of weir
h = height of weir = 0.5

CALCULATIONS:

Solve for b,
b = 14.07 ft min weir length

Design b =	**15 ft**

BASIN DRAW DOWN TIME CALCULATIONS

DATE: 6/18/2015

References:
1. Caltrans Stormwater Quality Handbooks, Construction Site Best Management Practices Manual, March 1, 2003.
2. California Stormwater BMP Handbook, New Development and Redevelopment, January 2003.

Note: Analysis applies to depth-prismatic basins, i.e., basin mid-depth corresponds to approximate average volume.

	100% Parameters	50% Parameters	
Water Quality Treatment Vol., WQV:	5,860	2,930	cf
Water Surface Elev.:	653.20	652.00	ft
Surface Area at Mid-Elev., $A_{mid:}$	1,688	1,399	sf

Single Row of Orifices at Basin Bottom		
Orifice Diameter:	1	in
Orifice Center Elev.:	650.00	ft
Number of Orifices, *N* :	2	
Orifice Coefficient, *C:*	0.66	
Area, Single Orifice:	0.01	sf
Total Orifice Area:	0.01	sf

	100% WQV	50% WQV	
h_{max} for Given WQV:	3.20	2.00	ft
WQV Draw Down Time, *T* :	29.0	19.0	hrs
	Drain time for 100% WQV is adequate.	Drain time for 50% WQV is adequate.	

E.12 BF-1 Biofiltration

Photo Credit: San Diego Low Impact Development Design Manual

MS4 Permit Category
Biofiltration

BMP Manual Category
Biofiltration

Applicable Performance Standard
Pollutant Control
Flow Control

Primary Benefits
Treatment
Volume Reduction (Incidental)
Peak Flow Attenuation (Optional)

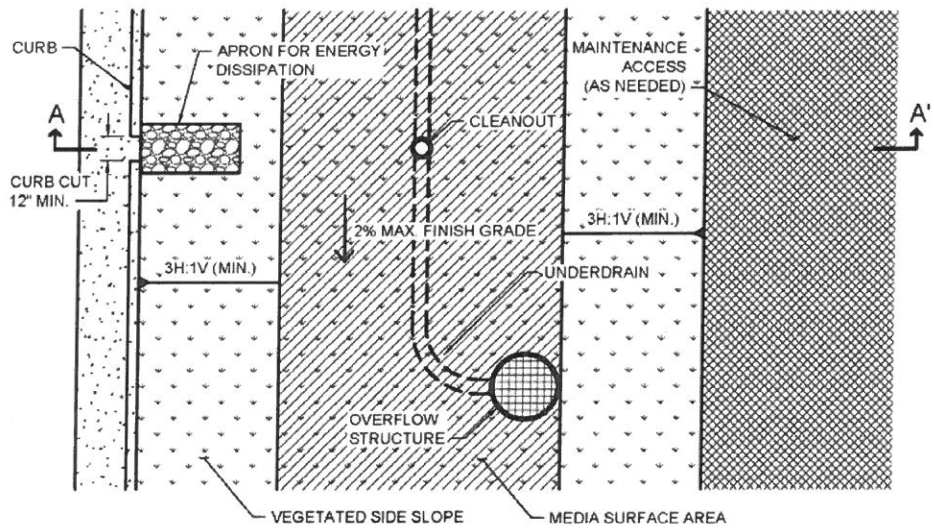
Description

Biofiltration (Bioretention with underdrain) facilities are vegetated surface water systems that filter water through vegetation, and soil or engineered media prior to discharge via underdrain or overflow to the downstream conveyance system. Bioretention with underdrain facilities are commonly incorporated into the site within parking lot landscaping, along roadsides, and in open spaces. Because these types of facilities have limited or no infiltration, they are typically designed to provide enough hydraulic head to move flows through the underdrain connection to the storm drain system. Treatment is achieved through filtration, sedimentation, sorption, biochemical processes and plant uptake.

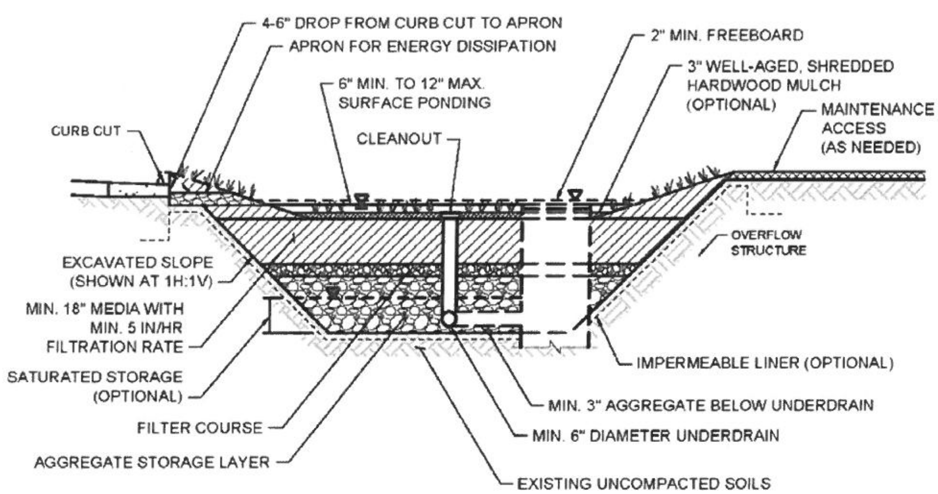
Typical bioretention with underdrain components include:

- Inflow distribution mechanisms (e.g, perimeter flow spreader or filter strips)
- Energy dissipation mechanism for concentrated inflows (e.g., splash blocks or riprap)
- Shallow surface ponding for captured flows
- Side slope and basin bottom vegetation selected based on expected climate and ponding depth
- Non-floating mulch layer (Optional)
- Media layer (planting mix or engineered media) capable of supporting vegetation growth
- Filter course layer consisting of aggregate to prevent the migration of fines into uncompacted native soils or the aggregate storage layer
- Aggregate storage layer with underdrain(s)

- Impermeable liner or uncompacted native soils at the bottom of the facility
- Overflow structure



PLAN
NOT TO SCALE



SECTION A-A'
NOT TO SCALE

Design Adaptations for Project Goals

Biofiltration Treatment BMP for storm water pollutant control. The system is lined or unlined to provide incidental infiltration, and an underdrain is provided at the bottom to carry away filtered runoff. This configuration is considered to provide biofiltration treatment via flow through the media layer. Storage provided above the underdrain within surface ponding, media, and aggregate storage is considered included in the biofiltration treatment volume. Saturated storage within the aggregate storage layer can be added to this design by raising the underdrain above the bottom of the aggregate storage layer or via an internal weir structure designed to maintain a specific water level elevation.

Integrated storm water flow control and pollutant control configuration. The system can be designed to provide flow rate and duration control by primarily providing increased surface ponding and/or having a deeper aggregate storage layer above the underdrain. This will allow for significant detention storage, which can be controlled via inclusion of an outlet structure at the downstream end of the underdrain.

Design Criteria and Considerations

Bioretention with underdrain must meet the following design criteria:

	Siting and Design	*Intent/Rationale*
☐	Placement observes geotechnical recommendations regarding potential hazards (e.g., slope stability, landslides, liquefaction zones) and setbacks (e.g., slopes, foundations, utilities).	Must not negatively impact existing site geotechnical concerns.
☐	An impermeable liner or other hydraulic restriction layer is included if site constraints indicate that infiltration or lateral flows should not be allowed.	Lining prevents storm water from impacting groundwater and/or sensitive environmental or geotechnical features. Incidental infiltration, when allowable, can aid in pollutant removal and groundwater recharge.
☐	Contributing tributary area shall be ≤ 5 acres (≤ 1 acre preferred)	Higher ratios increase the potential for clogging
☐	Finish grade of the facility is ≤ 2%.	Flatter surfaces reduce erosion and channelization within the facility.
	Surface Ponding	
☐	Surface ponding is limited to a 24-hour drawdown time.	Surface ponding limited to 24 hour for plant health
☐	Surface ponding depth is ≥ 6 and ≤ 12 inches.	Surface ponding capacity lowers subsurface storage requirements. Deep surface ponding raises safety concerns.

☐	A minimum of 2 inches of freeboard is provided	Freeboard provides room for head over overflow structures and minimizes risk of uncontrolled surface discharge.
☐	Side slopes are stabilized with vegetation and are = 3H:1V or shallower	Gentler side slopes are safer, less prone to erosion, able to establish vegetation more quickly and easier to maintain.
Vegetation		
☐	Plantings are suitable for the climate and expected ponding depth. A plant list to aid in selection can be found in Appendix E.15	Plants suited to the climate and ponding depth are more likely to survive.
☐	An irrigation system with a connection to water supply should be provided as needed.	Seasonal irrigation might be needed to keep plants healthy.
Mulch (Optional)		
☐	A minimum of 3 inches of well-aged, shredded hardwood mulch that has been stockpiled or stored for at least 12 months is provided.	Mulch will suppress weeds and maintain moisture for plant growth. Aging mulch kills pathogens and weed seeds and allows the beneficial microbes to multiply.
Media Layer		
☐	Media maintains a minimum filtration rate of 5 in/hr over lifetime of facility. A minimum initial filtration rate of 10 in/hr is recommended.	A high filtration rate through the media minimized clogging potential and allows flows to quickly enter the aggregate storage layer, thereby minimizing bypass.
☐	Media is a minimum 18 inches deep, meeting either of these two media specifications: City of San Diego Low Impact Development Design Manual, July 2011 (page B-18) or County of San Diego Low Impact Development Handbook, June 2014: Appendix G -Bioretention Soil Specification	A deep media layer provides additional filtration and supports plants with deeper roots.
☐	Media surface area is 3% of tributary impervious area or greater.	Greater surface area to tributary area ratios decrease loading rates per square foot and therefore increase longevity.
Filter Course Layer		

☐	A filter course is used to prevent migration of fines through layers of the facility. Filter fabric is not used.	Migration of media can cause clogging of the aggregate storage layer void spaces or subgrade. Filter fabric is more likely to clog.
☐	Filter course is washed and free of fines.	Washing aggregate will help eliminate fines that could clog the facility and impede infiltration.
☐	Filter course calculations assessing suitability for particle migration prevention have been completed.	Gradation relationship between layers can evaluate factors (e.g., bridging, permeability, and uniformity) to determine if particle sizing is appropriate or if an intermediate layer is needed.
Aggregate Storage Layer		
☐	Class 2 Permeable per Caltrans specification 68-1.025 is recommended for the storage layer. Washed, open-graded crushed rock may be used, however a 4-6 inch washed pea gravel filter course layer at the top of the crushed rock is required.	Washing aggregate will help eliminate fines that could clog the aggregate storage layer void spaces or subgrade.
☐	The depth of aggregate provided (12-inch typical) and storage layer configuration is adequate for providing conveyance for underdrain flows to the outlet structure.	Proper storage layer configuration and underdrain placement will minimize facility drawdown time.
Inflow, Underdrain, and Outflow Structures		
☐	Inflow, underdrains and outflow structures are accessible for inspection and maintenance.	Maintenance will prevent clogging and ensure proper operation of the flow control structures.
☐	Inflow velocities are limited to 3 ft/s or less or use energy dissipation methods. (e.g., riprap, level spreader) for concentrated inflows	High inflow velocities can cause erosion, scour and/or channeling.
☐	Curb cut inlets are at least 12 inches wide, have a 4-6 inch reveal (drop) and an apron and energy dissipation as needed.	Inlets must not restrict flow and apron prevents blockage from vegetation as it grows in. Energy dissipation prevents erosion.
☐	Underdrain outlet elevation should be a minimum of 3 inches above the bottom elevation of the aggregate storage layer.	A minimal separation from subgrade or the liner lessens the risk of fines entering the underdrain and can improve hydraulic performance by allowing perforations to

		remain unblocked.
☐	Minimum underdrain diameter is 6 inches	Smaller diameter underdrains are prone to clogging.
☐	Underdrains are made of slotted, PVC pipe conforming to ASTM D 3034 or equivalent or corrugated, HDPE pipe conforming to AASHTO 252M or equivalent.	Slotted underdrains provide greater intake capacity, clog resistant drainage, and reduced entrance velocity into the pipe, thereby reducing the chances of solids migration.
☐	An underdrain cleanout with a minimum 6-inch diameter and lockable cap is placed every 250 to 300 feet as required based on underdrain length.	Properly spaced cleanouts will facilitate underdrain maintenance.
☐	Overflow is safely conveyed to a downstream storm drain system or discharge point Size overflow structure to pass 100-year peak flow for on-line infiltration basins and water quality peak flow for off-line basins.	Planning for overflow lessens the risk of property damage due to flooding.

Conceptual Design and Sizing Approach for Storm Water Pollutant Control Only

To design bioretention with underdrain for storm water pollutant control only (no flow control required), the following steps should be taken:

1. Verify that siting and design criteria have been met, including placement requirements, contributing tributary area, maximum side and finish grade slopes, and the recommended media surface area tributary ratio.
2. Calculate the DCV per Appendix B based on expected site design runoff for tributary areas.
3. Use the sizing worksheet presented in Appendix B.5 to size biofiltration BMPs.

Conceptual Design and Sizing Approach when Storm Water Flow Control is Applicable

Control of flow rates and/or durations will typically require significant surface ponding and/or aggregate storage volumes, and therefore the following steps should be taken prior to determination of storm water pollutant control design. Pre-development and allowable post-project flow rates and durations should be determined as discussed in Chapter 6 of the Manual.

1. Verify that siting and design criteria have been met, including placement requirements, contributing tributary area, maximum side and finish grade slopes, and the recommended media surface area tributary ratio.

2. Iteratively determine the facility footprint area, surface ponding and/or aggregate storage layer depth required to provide detention storage to reduce flow rates and durations to allowable limits. Flow rates and durations can be controlled from detention storage by altering outlet structure orifice size(s) and/or water control levels. Multi-level orifices can be used within an outlet structure to control the full range of flows.
3. If bioretention with underdrain cannot fully provide the flow rate and duration control required by this manual, an upstream or downstream structure with significant storage volume such as an underground vault can be used to provide remaining controls.
4. After bioretention with underdrain has been designed to meet flow control requirements, calculations must be completed to verify if storm water pollutant control requirements to treat the DCV have been met.

APPENDIX H

DECARBONATOR COST EVALUATION

Estimated alkali chemical use with and without stripper (aka degasifier or decarbonator)

RO bypass (%)	Product Cl^- (mg/L)	Caustic (mg/L)	
		No stripper	Stripper
40	70	26	9
51	87	22	9
62	104	17	7

Estimated costs

Costs	Increase in Estimated Costs with Decarbonator	Increase in Estimated Costs Without Decarbonator
Constructed capital cost	$840K	Negligible
Annual power cost	$7k (pumping and blower)	Negligible
Annual chemical cost	$0K	$27K
Net Present Value	$960K	$520K

5% interest rate
30 year equipment lifespan
$0.13/Kwh, at 1% increase per year
$0.27/dry lb caustic, at 2% increase per year

Other considerations

Consideration	Decarbonator	Without Decarbonator
Chemical truck traffic	Less traffic	More traffic
Operation	Slight more complex	Slightly less complex
Maintenance	More maintenance	Less maintenance
WQ considerations (Avg WQ, 51% RO bypass)	Alkalinity: 123 mg/L-$CaCO_3$ TDS: 404 mg/L	Alkalinity: 139 mg/L-$CaCO_3$ TDS: 413 mg/L
Type of cost	Capital cost heavy	Chemical cost heavy
Clearwell excavation	Needed	Not needed

APPENDIX I

SPECIFICATION LIST

SANTA MARAGARITA CONJUNTIVE USE PROJECT
TECHNICAL SPECIFICATIONS
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SECTION NO.	**TITLE**
DIVISION 1	**GENERAL REQUIREMENTS**

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APPENDIX J

CHEMICAL SAFETY DATA SHEETS

- **SODIUM HYPOCHLORITE 12.5%**
- **SULFURIC ACID 93%**
- **THRESHOLD INHIBITOR 100%**
- **AMMONIUM HYDROXIDE 29%**
- **SODIUM HYDROXIDE 25%**
- **PHOSPHORIC ACID 85%**
- **FERRIC CHLORIDE 37%**
- **SODIUM BISULITE 38%**

SODIUM HYPOCHLORITE 12.5%

(545138)

ALLIED UNIVERSAL CORPORATION

Headquarters: 3901 NW 115th Avenue, Miami, Florida 33178 Phone: (305) 888 - 2623

MATERIAL SAFETY DATA SHEET

May be used to comply with OSHA's Hazard Communication Standard, 29 CFR § 1910.1200.

TODAY'S DATE: 09/06/07 MSDS NUMBER: 0001

24 HOUR EMERGENCY CHEMICAL SPILL OR RELEASE PHONE NUMBERS:

Allied Universal Corp.** at **1-305-483-7732** (Digital Beeper) and/or **CHEMTREC** at **1-800-424-9300

SECTION 1 CHEMICAL PRODUCT/COMPANY IDENTIFICATION

Sodium Hypochlorite

Product Names: Aqua Guard Chlorinating Sanitizer, Aqua Guard Bleach, Liquid Chlorine Solution, Liquid Bleach, Hypochlorite, Hypo and Chlorine Bleach.

Listed Strengths: 10.5%, 12.5% and 15% **CAS Number:** 7681-52-9

Date MSDS Revised: August 2007 (previous revision 11/04)

Product Use: Disinfectant and sanitizer, see product label for all approved uses & instructions.

NSF Approval: Yes. Certified to NSF/ANSI Standard 60. Maximum use in Potable Water is 84 mg/L for 12.5% bleach and 100 mg/L for 10.5% bleach.

NSF Non-Food Compounds Approval: Yes

SECTION 2 HAZARD INGREDIENTS/IDENTITY INFORMATION

Hazardous Ingredient(s): % (w/w) as Sodium Hypochlorite : 10.5-16%

Exposure Standards: None established for Sodium Hypochlorite, as Chlorine exposure standards are:

PEL (OSHA):	1 ppm as Cl_2	**STEL (OSHA):**	3 ppm as Cl_2
TLV (ACGIH):	0.5 ppm as Cl_2	**TWA (ACGIH):**	0.5 ppm as Cl_2
WEEL (AIHA):	2 mg/m3, 15 minute TWA as Cl_2	**STEL (ACGIH):**	1 ppm as Cl_2

Emergency Overview: May cause burns to the eyes, skin and mucous membranes.

SECTION 3 PHYSICAL/CHEMICAL CHARACTERISTICS

Alternate Name(s):	Bleach
Chemical Name:	Sodium Hypochlorite
Chemical Family:	Oxidizing Agent
Molecular Formula:	Na-O-Cl
Form:	Liquid
Appearance:	Water clear to a slight greenish-yellow, or light yellow aqueous solution
Odor:	Chlorine odor
pH:	11-14, dependent upon % weight as Sodium Hypochlorite
Vapor Pressure:	Not available
Vapor Density (Air=1):	Not available
Boiling Point:	Approximately 230º F (110º C)
Freezing Point:	14 F(8% w/w Cl_2 solution), 7 F(10% w/w Cl_2 solution), -3 F (12% w/w Cl_2 solution)
Solubility (Water):	Completely Soluble
Solubility (Other):	Reacts with Many Organic Solvents
Density:	Appx. 10 lbs. per gallon
Evaporation Rate:	Not Available
Specific Gravity:	1.126 (8% w/w Cl_2 solution), 1.163 (10% w/w Cl_2 solution), 1.202 (12% w/w Cl_2 solution), 1.25 (15% w/w Cl_2 solution)
Molecular Weight:	74.5

SECTION 4 STABILITY & REACTIVITY DATA

Chemical Stability	**Stable __X__**	**Unstable _____**

Incompatibility (Conditions to Avoid): Stability decreases with heat and light exposure.

Incompatibility (Materials to Avoid): May react violently with strong acids. Other incompatibles include strong caustics, ammonia, urea, reducing agents, organics, ether and oxidizable materials. Reaction with metals (nickel, iron, cobalt and copper) may produce oxygen gas, which supports combustion. May react with organohalogen compounds to

form spontaneously combustible compounds. May react explosively with nitro- and chloro-organic compounds as well as acids and reducing agents. Acidification liberates chlorine gas.		
Hazardous Decomposition or Byproducts: Chlorine gas. Decomposes with heat and reacts with acids. Hazardous gases/vapors produced are hypochlorous acid, chlorine and hydrochloric acid. Composition depends upon temperature and decrease in pH. Additional decomposition products, which depend on pH, temperature and time, are sodium chloride and chlorate, and oxygen.		
No Mechanical Shock or Impact	**No Static Discharge**	**Oxidizer: No if <12% by weight, Yes if > than 12% by weight**
Hazardous Polymerization	**May Occur _____**	**Will Not Occur __X__**

Note: Sodium Hypochlorite reacts violently with amines and ammonium salts. Solutions are reactive with common cleaning products such as toilet bowl cleaners, rust removers, vinegar, acids, organics and ammonia products to produce hazardous gases such as chlorine and other chlorinated species.

SECTION 5 POTENTIAL HEALTH EFFECTS AND FIRST AID INFORMATION

GENERAL: May cause immediate pain. Exposure to the skin may cause sensitization or other allergic responses. If the eye is not irrigated immediately after it has been exposed permanent eye damage may occur. Strict adherence to first aid measures following any exposure is essential. SPEED IS ESSENTIAL!

ROUTE(S) OF ENTRY AND POTENTIAL HEALTH EFFECTS	***EMERGENCY & FIRST AIDE PROCEDURES***
INHALATION: Strong irritating to mucous membranes in the nose, throat and respiratory tract. Prolonged contact can cause chronic irritation, pulmonary edema and central nervous system depression. Repeated inhalation exposure may cause impairment of lung function and permanent lung damage.	**If inhaled,** move expose person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. If breathing is difficult, have trained person administer oxygen. Call a poison control center or medical physician for further treatment advice. Have the product label or MSDS with you when calling or going for medical treatment.
SKIN CONTACT: Prolonged and repeated exposure to dilute solutions often causes irritation, redness, pain and drying and cracking of the skin. Human evidence has indicated that an ingredient in this product can cause skin sensitization. Depending upon the concentration and how soon after exposure the skin is washed with water, skin contact may cause burns and tissue destruction.	**If on skin or clothing,** take off all contaminated clothing and rinse skin immediately with plenty of water for 15-20 minutes. If irritation persists, repeat flushing. Do not transport victim unless the recommended irrigation period is completed unless flushing can be continued during transport. Call a poison control center or medical physician for treatment advice. Have the product label or MSDS with you when calling or going for medical treatment.
EYE CONTACT: Strongly irritating to eyes. Exposure to vapor can cause tearing, conjunctivitis and burning of the eyes. Eye contact may cause a corneal injury. The severity of the effects depend on the concentration and how soon after exposure the eyes are washed with water. In severe exposure cases, glaucoma, cataracts and permanent blindness may occur.	**If in eyes,** hold eye open and rinse slowly and gently with plenty of water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye for 10-15 minutes. Do not transport victim until the recommended flushing period is completed unless irrigation can be continued during transport. Call a poison control center or medical physician for further treatment advice. Have the product label and/or MSDS with you when calling or going to medical treatment.
INGESTION: Corrosive. Can cause severe corrosion of and damage to the gastrointestinal tract (including mouth, throat, and esophagus). Exposure is characterized by nausea, vomiting, abdominal pain, diarrhea, bleeding, and/or tissue ulceration.	**If swallowed,** call poison control center or medical physician immediately for treatment advice. Have the product label or MSDS with you when calling or going for medical treatment. Have exposed person sip a glass of water if able to swallow, and dilute immediately by giving milk, melted ice cream, starch paste or antacids such as milk of magnesia. Avoid sodium bicarbonate because of carbon dioxide release. DO NOT INDUCE VOMITING, LAVAGE OR ACIDIC ANTIDOTES unless told to do so by poison control center or medical physician. DO NOT give anything by mouth to an unconscious person. If spontaneous vomiting occurs, have victim lean forward with head down to avoid breathing in of vomitus, rinse mouth and administer more water.

NOTE TO PHYSICIAN(S): Pre-existing medical conditions may be aggravated by exposures affecting target organs. There are no known chronic effects. Probable mucosal damage may contraindicate the use of gastric lavage. In addition to the alkalinity of this product, the continued generation of chlorine gas after ingestion can damage further the stomach mucous, depending on the amount ingested. Consideration may be given to removal of the product from the stomach, taking care to avoid perforation of esophagus or stomach. An ounce of 1% sodium thiosulfate or milk of magnesia is helpful.

SECTION 6 TOXICOLOGICAL DATA

ANIMAL DATA: Inhalation 0.25-hour LC50 - 10.5 mg/L in rats; Acute Dermal LD50 - 10,000 mg/kg in rabbits; Acute Oral LD50 - 8910 mg/kg in rats

SUMMARY: The concentrated solution is corrosive to skin, and a 5% solution is a severe eye irritant. Solutions containing more than 5% available chlorine are classified by DOT corrosive (please see section 10 of this MSDS). Toxicity described in animals from single exposures by ingestion include muscular weakness, and hypoactivity. Repeated ingestion exposure in animals caused an increase in the relative weight of adrenal glands in one study, but no pathological changes were observed in two other studies. Long-term administration of compound in drinking water of rats caused depression of the immune system. No adverse changes were observed in an eight week dermal study of a 1% solution in guinea pigs. Tests in animals demonstrate no carcinogenic activity by either the oral or dermal routes. Tests in bacterial and mammalian cell cultures demonstrate mutagenic activity.

CARCINOGENICITY: None of the components present in this material at concentrations equal to or greater than 0.1% are listed by IARC, NTP, OSHA or ACGIH as carcinogen.

MUTAGENICITY: Sodium Hypochlorite has been shown to produce damage to genetic material when tested in vitro. Studies in vivo have shown no evidence of mutagenic potential for this material. It is judged that the risk of genetic damage is insignificant for sodium hypochlorite because of its biological activity, lack of mutagenicity in vivo, and failure to produce carcinogenic response.

SECTION 7 FIRE AND EXPLOSION HAZARD DATA

Flash Point: This product does not flash	**Flammable Limits (Lower):** Not Applicable	
Flammable Limits (Upper): Not Applicable	**Auto Ignition Temperature:** Not Applicable	
Decomposition Temperature: Not Applicable	**Rate of Burning:** Not Available	
Explosive Power: Not Available	**Sensitivity to Mechanical Impact:** Not expected to be sensitive to mechanical impact	**Sensitivity to Static Discharge:** Not expected to be sensitive to static discharge
Fire and Explosion Hazards: This material is non-flammable but is decomposed by heat and light, causing a pressure build-up which could result in an explosion. When heated, it may release chlorine gas or hydrochloric acid. Vigorous reaction with oxidizable or organic materials may result in fire.	**Extinguishing Media:** Use agents appropriate for surrounding fire. Foam, dry chemical, carbon dioxide, water fog or spray. If leak or spill has not ignited, use water spray to disperse the vapors and to protect persons attempting to stop the leak.	
Fire Fighting Procedures: Water spray should be used to cool containers and may be used to knock down escaping vapor. Remove storage vessels from the fire zone.	**Fire Fighting Protective Equipment:** Full protective clothing, including a NIOSH approved self-contained breathing apparatus, must be worn in a fire involving this material. Toxic gas vapors are produced upon decomposition.	

SECTION 8 ECOLOGICAL INFORMATION

The toxicity and corrosivity of this product is a function of concentration and the concentration's pH.

ECOTOXICOLOGICAL INFORMATION: Toxic to aquatic life. 96-hour LC50: fathead minnows: 0.090-5.9 mg/L, bluegill sunfish: 0.10-2.48 mg/L, shore crab: 1.418 mg/L, grass shrimp: 52.0 mg/L, scud: 0.145-4.0 mg/L, water flea: 2.1 mg/L.

ENVIRONMENTAL EFFECTS: Do not contaminate domestic or irrigation water supplies, lakes, streams, ponds, or rivers. May be an aesthetic nuisance due to color. Mammals and birds, exposed wildlife would be subject to skin irritation and burns due to the corrosive nature of this material.

SECTION 9 DISPOSAL CONSIDERATIONS

Treatment, storage, transportation, and disposal must be in accordance with applicable Federal, State, and Local regulations. Do not burn. Do not flush to surface water or sanitary sewer system. If pH of material is equal to or greater than a 12.5, the material is a RCRA Hazardous Waste D002, corrosive.

SECTION 10 TRANSPORT INFORMATION

U.S. DOT Basic Shipping Description: Hypochlorite Solutions, 8, UN1791, III
U.S. DOT Hazardous Substance: Yes, RQ 100 pounds (Sodium Hypochlorite)
U.S. DOT Marine Pollutant: No
U.S. DOT Required Label: Corrosive (see column 6, 49 CFR §172.101)
U.S. DOT Packaging Exception: Yes, if package meets the criteria of a limited quantity or consumer commodity as defined by 49 CFR §171.8, §173.144 and .154, and §172.312 and .316
N. AMERICAN EMERGENCY GUIDE PAGE NUMBER: 154
Transportation Emergency Phone Numbers: *CHEMTREC 1-800-424-9300*

SECTION 11 PRECAUTIONS FOR SAFE HANDLING AND STORAGE

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: Take all precautions to avoid personal contact. Keep container closed except when transferring material. Locate safety shower and eyewash station close to chemical handling area. Use normal good industrial hygiene and housekeeping practices, wash thoroughly after handling. Store in a cool, dry, well-ventilated area, away from incompatibles (minimum distance of 20-25 feet per NFPA Code 1) and direct sunlight. Keep container properly labeled at all times. Vented containers must be used and must be kept closed when not being used. Long-term storage is impossible without decomposition. Only use containers made from tinted glass, polyethylene & FRP. Keep out of reach of children.

PROCESS HAZARDS: Not Available

STORAGE TEMPERATURE: Store containers below 29°C and above freezing point. Do not expose sealed containers above 40°C. Try to store in the dark at the lowest possible temperature, but keep from freezing, to slow-down decomposition.

SECTION 12 EXPOSURE CONTROLS/PERSONAL PROTECTION

ENGINEERING CONTROLS: Full handling precautions should be taken at all times. Provide good room ventilation plus local exhaust at points of emission and low level floor exhaust in immediate handling area. Where engineering controls are not feasible, use adequate local exhaust ventilation wherever mist, spray or vapor may be generated.

PERSONAL PROTECTIVE EQUIPMENT:

Eye: Use chemical safety goggles when there is potential for contact (splashing), faceshield recommended – ANSI Z87.1

Skin: Gloves and protective clothing (apron, boots, and bodysuits) made from rubber, vinyl, neoprene or PVC. Standard work clothing closed at the neck and wrist while wearing impervious equipment.

Respiratory (*Specify Type*): A NIOSH/MSHA approved air purifying respirator with an acid gas cartridge or canister may be permissible under circumstances where airborne concentrations are expected to exceed exposure limits. Protection provided by air purifying respirators is limited. Use a positive pressure air supplied respirator if there is potential for uncontrolled releases, exposure levels are not known, or other circumstances where air purifying respirators may not provide adequate protection.

Other: Eyewash, shower station (ANSI Z358.1) must be provided within the immediate work area.

SECTION 13 ACCIDENTAL RELEASE MEASURES

Ventilate enclosed area. Collect product for recovery or disposal. For release to land, contain discharge by constructing dikes or applying inert absorbent; for release to water, utilize damming and/or water diversion to reduce the spread of contamination; and, for release to air, vapors may be suppressed by the use of a water fog. All run-off water must be captured for treatment and disposal. Collect contaminated soil and water, and absorbent for disposal. Notify applicable government authority if release is reportable or could adversely affect the environment. Please follow all Local, State and Federal Laws for clean-up and disposal of all contaminated material. **Deactivating Chemicals:** Sodium Sulfite, Sodium Thiosulfate and Sodium Bisulfite.

SECTION 14 REGULATORY INFORMATION

OSHA CLASSIFICATION, <u>29 CFR §1900-1910</u>:

Physical Hazards: Reactivity **Health Hazards**: Acute - Skin Sensitizer, Corrosive

CERCLA AND SARA REGULATIONS, <u>40 CFR §300-373</u>:

Reportable Quantity = 100 lb. **CERCLA Hazardous Material:** Yes

Title III Hazard Classifications: Acute - yes, Chronic - no, Fire - yes, Reactivity - yes & Sudden Release of Pressure - No. This product may be reportable under the requirements of 40 CFR §370.

SARA Extremely Hazardous Substance: No **SARA Toxic Chemical:** No **CA Prop 65:** No

FDA 21 CFR 178.1010: Yes, Approved as Sanitizer

NSF Whitebook (former USDA Approval) Listing: Aqua Guard Chlorinating Sanitizer 10.5% - 3D, B1, B2, D1, D2, G4, G7, GX, Q4, **Aqua Guard Bleach 12.5% -** 3D, B1, B2, D1, D2, G4, GX, Q4

EPA "CLEAN AIR ACT": This product does not contain nor is it manufactured with ozone depleting substances. It is not defined as a Hazardous Air Pollutant per 40 CFR 112.

EPA Pesticide: The 10.5% and 12.5% sodium hypochlorite products are registered with the U.S. EPA as a pesticide, as required under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). It is a violation of Federal law to use this product for pesticidal applications in a manner inconsistent with the FIFRA labeling.

NPCA-HMIS RATING: HEALTH: 3 FLAMMABILITY: 0 REACTIVITY: 2

NFPA RATING:NONE AT THIS TIME

SECTION 15 REFERENCES

Suppliers' Material Safety Data Sheets and EPA Labeling Requirements
Olin and OxyChem Sodium Hypochlorite Handbook
Chlorine Institute Sodium Hypochlorite Pamphlet #96
Chlorine Institute Product Stewardship Bulletins for Sodium Hypochlorite

SULFURIC ACID 93%

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1 Product identifier

Trade name : SULFURIC ACID 93% TECHNICAL

1.2 Relevant identified uses of the substance or mixture and uses advised against

no data available

1.3 Details of the supplier of the safety data sheet

Company : Eco Services Operations LLC
CN 9803
Cranbury, NJ 08512
Phone number : 844 812-1812

1.4 Emergency telephone

FOR EMERGENCIES INVOLVING A SPILL, LEAK, FIRE, EXPOSURE OR ACCIDENT CONTACT: CHEMTREC 800-424-9300 within the United States and Canada, or 703-527-3887 for international collect calls.

SECTION 2: Hazards identification

Although OSHA has not adopted the environmental portion of the GHS regulations, this document may include information on environmental effects.

2.1 Classification of the substance or mixture

HCS 2012 (29 CFR 1910.1200)

Skin corrosion, Category 1A	H314: Causes severe skin burns and eye damage.
Serious eye damage, Category 1	H318: Causes serious eye damage.
Specific target organ systemic toxicity - single exposure, Category 3, Respiratory system	H335: May cause respiratory irritation.

2.2 Label elements

HCS 2012 (29 CFR 1910.1200)

Pictogram :

Signal Word : Danger

Hazard Statements:

H314	Causes severe skin burns and eye damage.
H335	May cause respiratory irritation.

Precautionary Statements:

Prevention

P261	Avoid breathing dust/ fume/ gas/ mist/ vapors/ spray.
P264	Wash skin thoroughly after handling.
P271	Use only outdoors or in a well-ventilated area.
P280	Wear protective gloves/ protective clothing/ eye protection/ face protection.

Response

P301 + P330 + P331	IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P303 + P361 + P353	IF ON SKIN (or hair): Remove/ Take off immediately all contaminated clothing. Rinse skin with water/ shower.
P304 + P340	IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
P305 + P351 + P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P310	Immediately call a POISON CENTER or doctor/ physician.
P363	Wash contaminated clothing before reuse.

Storage

P403 + P233	Store in a well-ventilated place. Keep container tightly closed.
P405	Store locked up.

Disposal

P501	Dispose of contents/ container to an approved waste disposal plant.

2.3 Other hazards which do not result in classification

Water Reactive

H402: Harmful to aquatic life.
H411: Toxic to aquatic life with long lasting effects.

SECTION 3: Composition/information on ingredients

3.1 Substance

Not applicable, this product is a mixture.

3.2 Mixture

Hazardous Ingredients and Impurities

Chemical Name	Identification number CAS-No.	Concentration [%]
Sulfuric acid	7664-93-9	93

Non Hazardous Ingredients and Impurities

Chemical Name	Identification number CAS-No.	Concentration [%]
Water	7732-18-5	7

SECTION 4: First aid measures

4.1 Description of first-aid measures

If inhaled	:	Remove victim from exposure and then have him lie down in the recovery position. In case of shortness of breath, give oxygen. If victim has stopped breathing: administer CPR (cardio-pulmonary resuscitation) Immediate medical attention is required.
Skin contact	:	In case of contact, immediately flush skin with plenty of water for at least 30 minutes. Remove all contaminated apparel under the shower. Wash off with plenty of water. Do not attempt to neutralize with chemical agents Immediate medical attention is required.
Eye contact	:	In case of contact, immediately flush eyes with plenty of water for at least 30 minutes. Immediate medical attention is required.
Ingestion	:	Do NOT induce vomiting. If victim is conscious: Rinse mouth with water. Do not leave the victim unattended. Risk of product entering the lungs on vomiting after ingestion. Lay victim on side. Never give anything by mouth to an unconscious person. Immediate medical attention is required.

4.2 Most important symptoms and effects, both acute and delayed

Risks	:	Inhalation of product may aggravate existing chronic respiratory problems such as asthma, emphysema or bronchitis Skin contact may aggravate existing skin disease

4.3 Indication of any immediate medical attention and special treatment needed

Notes to physician	:	All treatments should be based on observed signs and symptoms of distress in the patient. Consideration should be given to the possibility that overexposure to materials other than this product may have occurred.

SECTION 5: Firefighting measures

Flash point	:	Not applicable
Autoignition temperature	:	no data available
Flammability / Explosive limit	:	no data available

5.1 Extinguishing media

Suitable extinguishing media	:	Dry chemical

5.2 Special hazards arising from the substance or mixture

Specific hazards during fire fighting	:	Not combustible. Strong oxidizer. Contact with other material may cause fire. Reacts violently with water. Corrosive or suffocating vapors are released. On combustion or on thermal decomposition (pyrolysis), releases: Sulfur oxides

5.3 Advice for firefighters

Special protective equipment for fire-fighters	:	Firefighters should wear NIOSH/MSHA approved self-contained breathing apparatus and full protective clothing. Acid-resistant protective clothing
Specific fire fighting methods	:	Fight fire with normal precautions from a reasonable distance.

SECTION 6: Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

Personal precautions, protective equipment and emergency procedures	:	The product must only be handled by specifically trained employees.

6.2 Environmental precautions

Environmental precautions	:	Do not flush into surface water or sanitary sewer system. Collect contaminated fire extinguishing water separately. This must not be discharged into drains. Spills may be reportable to the National Response Center (800-424-8802) and to state and/or local agencies Site should have a spill plan to ensure that adequate safeguards are in place to minimize the impact of episodic releases.

6.3 Methods and materials for containment and cleaning up

Recovery	:	Stop leak if safe to do so. Dam up with sand or inert earth (do not use combustible materials).
Decontamination / cleaning	:	Pump or collect any free spillage into an appropriate closed container. (see Section 7: Handling and Storage) Exercise caution during neutralization as considerable heat may be generated Carefully neutralize the remainder using: soda ash Soak up with inert absorbent material. Scrape up. Keep in suitable, closed containers for disposal.

6.4 Reference to other sections

Reference to other sections	:	7. HANDLING AND STORAGE

SECTION 7: Handling and storage

7.1 Precautions for safe handling

Technical measures	:	Do not breathe mist or vapors. Avoid contact with the skin and the eyes. When diluting, always add the product to water. Never add water to the product. Reacts violently with: bases.
Hygiene measures	:	Personal hygiene is an important work practice exposure control measure and the following general measures should be taken when working with or handling this materials: 1) Do not store, use, and/or consume foods, beverages, tobacco products, or cosmetics in areas where this material is stored. 2) Wash hands and face carefully before eating, drinking, using tobacco, applying cosmetics, or using the toilet. 3) Wash exposed skin promptly to remove accidental splashes or contact with material.

7.2 Conditions for safe storage, including any incompatibilities

Storage conditions

Recommended	:	Keep tightly closed. Store in an area: dry well-ventilated diked

Storage stability

Storage temperature	:	< 104 °F (< 40 °C)
Other data	:	Corrosion rates increase at elevated temperatures.

7.3 Specific end use(s)

no data available

SECTION 8: Exposure controls/personal protection

Introductory Remarks:
These recommendations provide general guidance for handling this product. Because specific work environments and material handling practices vary, safety procedures should be developed for each intended application. While developing safe handling procedures, do not overlook the need to clean equipment and piping systems for maintenance and repairs. Waste resulting from these procedures should be handled in accordance with Section 13: Disposal Considerations.

Assistance with selection, use and maintenance of worker protection equipment is generally available from equipment manufacturers.

8.1 Control parameters

Ingredients with workplace control parameters

Ingredients	Value type	Value	Basis
Sulfuric acid	TWA	1 mg/m3	NIOSH
Sulfuric acid	TWA	0.2 mg/m3	ACGIH
	Form of exposure : Thoracic fraction Pulmonary function, Classification refers to sulfuric acid contained in strong inorganic acid mists, Suspected human carcinogen		
Sulfuric acid	TWA	1 mg/m3	OSHA Z-1
Sulfuric acid	TWA	1 mg/m3	OSHA Z-1-A
Sulfuric acid	TWA	0.2 mg/m3	Eco Services

NIOSH IDLH (Immediately Dangerous to Life or Health Concentrations)

Ingredients	CAS-No.	Concentration
Sulfuric acid	7664-93-9	15 milligram per cubic meter

8.2 Exposure controls

Control measures

Engineering measures : Where engineering controls are indicated by use conditions or a potential for excessive exposure exists, the following traditional exposure control techniques may be used to effectively minimize employee exposures :

Effective exhaust ventilation system

Personal protective equipment

Respiratory protection : When respirators are required, select NIOSH/MSHA approved equipment based on actual or potential airborne concentrations and in accordance with the appropriate regulatory standards and/or industrial recommendations.

Recommended Filter type: Acidic gas/vapor type

Eye protection : Eye and face protection requirements will vary dependent upon work environment conditions and material handling practices. Appropriate ANSI Z87 approved equipment should be selected for the particular use intended

		for this material. Eye contact should be prevented through the use of: Wear protective eye glasses for protection against liquid splashes (goggles)
Skin and body protection	:	Wear as appropriate: Face-shield Acid-resistant protective clothing Acid resistant boots.
Hygiene measures	:	Personal hygiene is an important work practice exposure control measure and the following general measures should be taken when working with or handling this materials: 1) Do not store, use, and/or consume foods, beverages, tobacco products, or cosmetics in areas where this material is stored. 2) Wash hands and face carefully before eating, drinking, using tobacco, applying cosmetics, or using the toilet. 3) Wash exposed skin promptly to remove accidental splashes or contact with material.
Protective measures	:	Ensure that eyewash stations and safety showers are close to the workstation location.

SECTION 9: Physical and chemical properties

Physical and Chemical properties here represent typical properties of this product. Contact the business area using the Product information phone number in Section 1 for its exact specifications.

9.1 Information on basic physical and chemical properties

Appearance	:	Form : oily Physical state: liquid Color: colorless
Odor	:	odorless
Odor Threshold	:	no data available
pH	:	1.0 (1 % (m/v))
Melting point/range	:	-26 °F (-32 °C)
Boiling point/boiling range	:	529 °F (276 °C) (760 mmHg (1,013.25 hPa))
Flash point	:	Not applicable
Evaporation rate (Butylacetate = 1)	:	no data available
Flammability (solid, gas)	:	no data available
Flammability (liquids)	:	no data available

Flammability / Explosive limit	:	no data available
Autoignition temperature	:	no data available
Vapor pressure	:	< 1 mmHg (1.33 hPa) (104 °F (40 °C))
Vapor density	:	no data available
Specific Gravity	:	1.836 (61 °F (16 °C))
Solubility	:	Water solubility : miscible
Partition coefficient: n-octanol/water	:	no data available
Thermal decomposition	:	no data available
Viscosity	:	no data available
Explosive properties	:	no data available
Oxidizing properties	:	no data available

9.2 Other information

Molecular weight	:	98.08 g/mol
Reactions with water / air	:	Reacts violently with water.

SECTION 10: Stability and reactivity

10.1 Reactivity

no data available

10.2 Chemical stability

Chemical stability	:	Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions

Hazardous polymerization does not occur.

10.4 Conditions to avoid

no data available

10.5 Incompatible materials

Materials to avoid : Water
Strong reducing agents
Halogenated compounds
Bases
metals
Nitrogen oxides (NOx)

10.6 Hazardous decomposition products

Decomposition products : On combustion or on thermal decomposition (pyrolysis), releases:
Sulfur oxides

SECTION 11: Toxicological information

11.1 Information on toxicological effects

Acute toxicity

Acute oral toxicity
Sulfuric acid
LD50 Oral : 2,140 mg/kg - Rat
Gavage
Published data

Acute inhalation toxicity
Sulfuric acid : LC50 - 4 h (aerosol) : 0.375 mg/l - Rat , male and female
Toxicity secondary to corrosive effects at site of contact.
Published data

LC50 - 4 h (aerosol) : 0.85 mg/l - Mouse , male and female
Toxicity secondary to corrosive effects at site of contact.
Published data

(Mist) Humans
Symptoms: Potential health effects, Respiratory disorders, Symptoms may be delayed., Cough, Risk of delayed pulmonary edema.
Effects of breathing high concentration of respirable particles may include:
May cause irritation of respiratory tract.
Lung irritation
Published data

Acute dermal toxicity
Sulfuric acid : Not classified as hazardous for acute toxicity according to GHS
Not applicable
Corrosive
internal evaluation

Acute toxicity (other routes of administration) : no data available

Skin corrosion/irritation
Skin irritation

Sulfuric acid	:	Causes severe burns. Published data

Serious eye damage/eye irritation
Eye irritation

Sulfuric acid	:	Risk of serious damage to eyes. Published data

Respiratory or skin sensitization
Sensitization

Sulfuric acid	:	Local lymph node assay Not applicable Corrosive The product is not considered to be sensitizing by skin contact. internal evaluation

Mutagenicity
Genotoxicity in vitro

Sulfuric acid	:	Mutagenicity (Salmonella typhimurium - reverse mutation assay) with and without metabolic activation negative Method: OECD Test Guideline 471 Published data Chromosome aberration test in vitro Strain: Chinese hamster ovary cells with and without metabolic activation positive Effects observed are due to the reduced pH in the test medium. Published data Product is not considered to be genotoxic
Genotoxicity in vivo	:	no data available

Carcinogenicity

Carcinogenicity

Sulfuric acid : inhalation (mist)

Animal studies
Unpublished reports
Published data
No carcinogenic effects have been observed

Note: IARC Classification: Group 1
mists from strong inorganic acids

IARC and NTP classified "occupational exposure to strong inorganic acid mists containing sulfuric acid" as a known human carcinogen. ACGIH has also classified “sulfuric acid as contained in strong inorganic acid mists” as a suspected human carcinogen. There is still a debate on the studies reviewed by these agencies. We disagree with IARC’s conclusion, in that more recent studies have failed to find association between “occupational exposure to strong inorganic acid mist containing sulfuric acid.” and laryngeal or lung cancer. In fact, in 2012 IARC revised their classification dropping the “containing sulfuric acid” wording. Lifetime animal studies in hamsters, rats, and guinea pigs were conducted by the EPA and NIEHS and were all negative. However, they were not formally published by the agencies and not considered by IARC or NTP.

Ingredients	CAS-No.	Rating	Basis
Strong inorganic acid mists containing sulfuric acid		Group 1: Carcinogenic to humans	IARC
Strong inorganic acid mists containing sulfuric acid		Suspected human carcinogen	ACGIH
Strong inorganic acid mists containing sulfuric acid		Known to be human carcinogen	NTP
Sulfuric acid	7664-93-9	Suspected human carcinogen	ACGIH

This product does not contain any ingredient designated as probable or suspected human carcinogens by:

OSHA
NTP
IARC

Toxicity for reproduction and development

Toxicity to reproduction / fertility

Sulfuric acid : Effects on fertility
fetotoxic effect
no observed effect

Developmental Toxicity/Teratogenicity

Sulfuric acid : Rabbit
Application Route: inhalation (mist)
NOAEC teratogenicity: 19.3 mg/m3

Method: OECD Test Guideline 414
no teratogenic effects have been observed

Mouse
Application Route: inhalation (mist)
NOAEC teratogenicity: 19.3 mg/m3

Method: OECD Test Guideline 414
no teratogenic effects have been observed
Published data

STOT

STOT-single exposure

Sulfuric acid
Routes of exposure: inhalation (mist)
Target Organs: Respiratory Tract
Toxicology Assessment:
May cause respiratory irritation.

STOT-repeated exposure

Sulfuric acid : Toxicology Assessment:
The substance or mixture is not classified as specific target organ toxicant, repeated exposure., internal evaluation

Sulfuric acid : inhalation (mist) 28 d - Rat
LOAEC: 0.3 mg/m3
Target Organs: Larynx
Method: OECD Test Guideline 412
Symptoms: Local irritation
Unpublished reports

inhalation (mist) 78 Weeks - Monkey
LOAEC: 0.38 mg/m3
Target Organs: Respiratory Tract
Symptoms: Local irritation, Respiratory disorders
Published data

Repeated inhalation of aerosols may cause adverse effects on health

Experience with human exposure

Experience with human exposure : Inhalation

Sulfuric acid : Target Organs: Respiratory Tract

Target Organs: Nose
Symptoms: Burning sensations in the nose and throat.
Breathing difficulties
Dental erosion
Mist
At high concentrations:
Irritating to the respiratory system and mucous membranes.
Published data

Carcinogenicity

Sulfuric acid : Carcinogenicity classification not possible from current data.

Teratogenicity

Sulfuric acid : Did not show teratogenic effects in animal experiments.

Aspiration toxicity

Aspiration toxicity

Sulfuric acid : Not applicable

SECTION 12: Ecological information

12.1 Toxicity

Aquatic Compartment

Acute toxicity to fish

Sulfuric acid : LC50 - 96 h : 16 - 28 mg/l - Lepomis macrochirus (Bluegill sunfish)
static test

Non neutralized product
pH 3.5 - 3.25
Harmful to fish.
Published data

Acute toxicity to daphnia and other aquatic invertebrates.

Sulfuric acid : EC50 - 48 h : > 100 mg/l - Daphnia magna (Water flea)
static test Method: OECD Test Guideline 202
Fresh water
Neutralized product
Not harmful to aquatic invertebrates. (EC50 > 100 mg/L)
Unpublished reports

EC50 - 24 h : 29 mg/l - Daphnia magna (Water flea)
Method: ISO 6341
Non neutralized product
Harmful to aquatic invertebrates.
Published data

Toxicity to aquatic plants

Sulfuric acid	:	NOEC : 0.13 mg/l - Algae field study pH 5.6 Non neutralized product Published data ErC50 - 72 h : > 100 mg/l - Desmodesmus subspicatus (green algae) Growth inhibition Method: OECD Test Guideline 201 Neutralized product Unpublished reports

Chronic toxicity to fish

Sulfuric acid	:	NOEC: 0.13 mg/l - 10 Months - Salvelinus fontinalis (brown trout) flow-through test pH 5.6 Fresh water Non neutralized product Published data

Ecotoxicity assessment

Acute aquatic toxicity

Sulfuric acid	:	If the product is not neutralized, it may cause adverse effects to aquatic organisms due to its acidity. Neutralization will reduce ecotoxic effects.

Chronic aquatic toxicity

Sulfuric acid	:	If the product is not neutralized, it may cause adverse effects to aquatic organisms due to its acidity.

12.2 Persistence and degradability

Biodegradability

Biodegradability

Sulfuric acid	:	Not applicable, inorganic substance

Stability

Stability in water

Sulfuric acid	:	Product dissociates rapidly to corresponding ions on contact with water.

12.3 Bioaccumulative potential

Partition coefficient: n-octanol/water

Sulfuric acid	:	Not applicable, inorganic substance

Bioconcentration factor (BCF)

Sulfuric acid	:	Not relevant internal evaluation

12.4 Mobility in soil

no data available

12.5 Results of PBT and vPvB assessment

Results of PBT and vPvB assessment

Sulfuric acid	:	This substance is not considered to be persistent, bioaccumulating, and toxic (PBT)., This substance is not considered to be very persistent and very bioaccumulating (vPvB).

12.6 Other adverse effects

Environment assessment

Sulfuric acid	:	Not classified as Dangerous for the Environment

SECTION 13: Disposal considerations

13.1 Waste treatment methods

Product Disposal

Advice on Disposal	:	Chemical additions, processing or otherwise altering this material may make the waste management information presented in this MSDS incomplete, inaccurate or otherwise inappropriate. Please be advised that state and local requirements for waste disposal may be more restrictive or otherwise different from federal laws and regulations. Consult state and local regulations regarding the proper disposal of this material.
Waste Code	:	EPA: Hazardous Waste – YES RCRA: D002 - Corrosive waste – (C) D003 - Reactive waste – (R)

SECTION 14: Transport information

Transportation status: IMPORTANT! Statements below provide additional data on listed transport classification.
The listed Transportation Classification does not address regulatory variations due to changes in package size, mode of shipment or other regulatory descriptors.

DOT

14.1 UN number	UN 1830
14.2 Dangerous Good Description	UN 1830 SULFURIC ACID, 8, II
14.3 Transport hazard class	8
14.4 Packing group	
Packing group	II
Label(s)	8
ERG No	137
14.5 Environmental hazards	NO
Marine pollutant	

14.6 Special precautions for user

This product contains one or more ingredients identified as a hazardous substance in Appendix A of 49 CFR 172.101. The product quantity, in one package, which triggers the RQ requirements under 49 CFR for each hazardous substance is shown.

Reportable quantities : RQ substance: Sulfuric acid
RQ limit for substance: 1,000 lb

TDG

14.1 UN number UN 1830

14.2 Dangerous Good Description UN 1830 SULFURIC ACID, 8, II

14.3 Transport hazard class 8

14.4 Packing group
Packing group II
Label(s) 8
ERG No 137

14.5 Environmental hazards NO
Marine pollutant

IMDG

14.1 UN number UN 1830

14.2 Dangerous Good Description UN 1830 SULPHURIC ACID, 8, II

14.3 Transport hazard class 8

14.4 Packing group
Packing group II
Label(s) 8
EmS F-A , S-B

14.5 Environmental hazards NO
Marine pollutant

14.6 Special precautions for user
For personal protection see section 8.

IATA

14.1 UN number UN 1830

14.2 Dangerous Good Description UN 1830 SULPHURIC ACID, 8, II

14.3 Transport hazard class	8
14.4 Packing group	
Packing group	II
Label(s):	8
Packing instruction (cargo aircraft)	855
Max net qty / pkg	30.00 L
Packing instruction (passenger aircraft)	851
Max net qty / pkg	1.00 L
14.5 Environmental hazards	NO
Marine pollutant	

14.6 Special precautions for user

For personal protection see section 8.

Note: The above regulatory prescriptions are those valid on the date of publication of this sheet. Given the possible evolution of transportation regulations for hazardous materials, it would be advisable to check their validity with your sales office.

SECTION 15: Regulatory information

15.1 Notification status

United States TSCA Inventory	: YES (positive listing) On TSCA Inventory
Canadian Domestic Substances List (DSL)	: YES (positive listing) All components of this product are on the Canadian DSL.
Australia Inventory of Chemical Substances (AICS)	: YES (positive listing) On the inventory, or in compliance with the inventory
Japan. CSCL - Inventory of Existing and New Chemical Substances	: YES (positive listing) On the inventory, or in compliance with the inventory
Korea. Korean Existing Chemicals Inventory (KECI)	: YES (positive listing) On the inventory, or in compliance with the inventory
China. Inventory of Existing Chemical Substances in China (IECSC)	: YES (positive listing) On the inventory, or in compliance with the inventory

15.2 Federal Regulations

SARA 311/312 Hazards

Fire Hazard	no
Reactivity Hazard	yes
Sudden Release of Pressure Hazard	no
Acute Health Hazard	yes
Chronic Health Hazard	no

SARA 313 : The following components are subject to reporting levels established by SARA Title III, Section 313:
Sulfuric acid 7664-93-9 93 %

SARA 302 : The following components are subject to reporting levels established by SARA Title III, Section 302:

Ingredients	CAS-No.	Threshold planning quantity	Remarks
Sulfuric acid	7664-93-9	1000 lb	

EPCRA - Emergency Planning and Community Right-to-Know

CERCLA Reportable Quantity

Ingredients	CAS-No.	Reportable quantity
Unlisted hazardous wastes - Characteristic of Corrosivity		100 lb
Unlisted hazardous wastes - Characteristic of Reactivity		100 lb
Sulfuric acid	7664-93-9	1000 lb

SARA 304 Reportable Quantity

Ingredients	CAS-No.	Reportable quantity
Sulfuric acid	7664-93-9	1000 lb

SARA 302 Reportable Quantity

Ingredients	CAS-No.	Reportable quantity
Sulfuric acid	7664-93-9	1000 lb

15.3 State Regulations

California Prop 65 : WARNING! This product contains a chemical known in the State of California to cause cancer.
Strong inorganic acid mists containing sulfuric acid

This product does not contain any chemicals known to the State of California to cause cancer, birth, or any other reproductive defects.

SECTION 16: Other information

NFPA-Classification

Health	:	3 serious
Flammability	:	0 minimal
Instability or Reactivity	:	2 moderate

HMIS-Classification

Health	:	3 serious
Flammability	:	0 minimal
Reactivity	:	2 moderate

Further information

Date Prepared	:	11/20/2014
Further information	:	Product classified under the US GHS format.

Key or legend to abbreviations and acronyms used in the safety data sheet

TWA	:	8-hour, time-weighted average
ACGIH	:	American Conference of Governmental Industrial Hygienists
OSHA	:	Occupational Safety and Health Administration
WHMIS	:	Workplace Hazardous Materials Information System
NTP	:	National Toxicology Program
IARC	:	International Agency for Research on Cancer
SAEL	:	Solvay Acceptable Exposure Limit
NIOSH	:	National Institute for Occupational Safety and Health
NFPA	:	National Fire Protection Association
HMIS	:	Hazardous Materials Identification System (Paint & Coating)

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information, and belief at the date of its publication. Such information is only given as a guidance to help the user handle, use, process, store, transport, dispose, and release the product in satisfactory safety conditions and is not to be considered as a warranty or quality specification. It should be used in conjunction with technical sheets but do not replace them. Thus, the information only relates to the designated specific product and may not be applicable if such product is used in combination with other materials or in another manufacturing process, unless otherwise specifically indicated. It does not release the user from ensuring he is in conformity with all regulations linked to its activity.

THRESHOLD INHIBITOR 100%

SAFETY DATA SHEET

AMERICAN WATER CHEMICALS, INC.
1802 CORPORATE CENTER LANE
PLANT CITY, FL 33563

IDENTITY **AWC A-109**

Section I Company and Product Identification

AMERICAN WATER CHEMICALS, INC. 1802 Corporate Center Lane Plant City, FL 33563	Telephone Number: (813)-246-5448 Chemtrec phone Number: In the U.S.: 1-800-424-9300 International: 1-703-527-3887 CONTRACT #: CCN1259
Date Prepared: 11/21/03	Date Revised: April 2015

Trade Name	AWC A-109
Product Family	RO, NF Scale Inhibitor

Section II – Hazards Identification

Signal Word : WARNING **Acute Toxicity: Oral, Category 5 May be harmful if swallowed.** **Skin Corrosion/Irritation, Category 5 May be harmful in contact with skin** **Inhalation: Category 5 May be harmful if inhaled**	
GHS Hazard Phrases	H303 + H313:May be harmful if swallowed or in contact with skin H333: May be harmful if inhaled.
GHS Precaution Phrases	P103: Read label before use
GHS Response Phrases	P311: Call a poison center/doctor/…if you feel unwell
GHS Storage and Disposal Phrases	Please refer to section 7 for storage and section 13 for Disposal information

Route(s) of Entry:	**Inhalation? Y**	**Skin? Y**	**Ingestion? Y**
Health Hazards (Effects of Acute and Chronic Overexposure)			
Inhalation: May be harmful if inhaled**.**			
Eye Contact: May cause eye irritation.			
Skin Contact: May be slightly irritating to skin			
Ingestion (Swallowing): May be harmful if swallowed			

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Section III - Hazard Ingredients/Composition Information

Hazardous Components (Chemical Name)	CAS #	%	EC #	Risk Phrases
N/A`	N/A	N/A	N/A	

Section IV – First Aid Procedures

Inhalation: Immediately remove to fresh air. Get medical attention if nasal, throat or lung irritation develops.
Eye Contact: Remove contact lenses. Hold eyelids apart. Immediately flush with plenty of low pressure water for at least 15 minutes. Call a physician. Remove material from skin and clothing.
Skin Contact: Immediately flush skin with plenty of water while removing contaminated clothing and shoes. Thoroughly wash before reuse or discard. Wash skin with soap and water until clean. Get medical help if irritation occurs.
Ingestion (Swallowing): If conscious, immediately give several glasses of water or milk. Do not induce vomiting. (Do not give food to an unconscious person). Take immediately to hospital or physician.

MOST IMPORTANT SYMPTOMS	
Symptoms/Injuries	May be slightly irritating to skin.
Symptoms/Injuries after eye contact	May be irritating to eyes.
Symptoms/Injuries after ingestion	Significant adverse health effects are not expected to develop if only small amounts (less than a mouthful) are swallowed.

Section V - Fire Fighting Measures

Flash Point (Method Used) None	**Flammable Limits**: NE
Extinguishing Media: Water spray, foam, dry chemical, or carbon dioxide	
Auto ignition temp: Noncombustible.	
Special Fire Fighting Procedures and Protective Equipment: Do not enter fire area without proper protective equipment, including respiratory protection. Use water spray or fog for cooling exposed containers. Exercise caution when fighting any chemical fire. Avoid (reject) fire-fighting water to enter environment.	
Unusual Fire and Explosion Hazard: Decomposes in a fire giving off irritant fumes.	
Hazardous Decomposition or Combustion Byproducts: Elemental oxides.	

Section VI – Accidental Release Measures

Steps to Be Taken in Case Material is Released or Spilled: Steps to Be Taken in Case Material is Released or Spilled: Ventilate area. Use specified protective equipment. Contain and absorb on absorbent material. Place in waste disposal container. Flush area with water. Wet area may be slippery. Spread sand/grit.

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Additional Information: Planning ahead is essential for handling spills. Proper equipment and trained employees should be readily available to correct a spill situation. Prevent entry to sewers and public waters. Notify authorities if liquid enters sewers and public waters. Avoid release to the environment.

Section VII - Handling and Storage

Precautions to Be taken in Handling (General):	Use appropriate protective wear.Observe all recommended safety precautions until container is cleaned, reconditioned or destroyed. The reuse of this material's container for non industrial purposes is prohibited and any reuse must be in consideration of the data provided in this material safety data sheet.
Precautions for safe storage and any incompatibilities	Keep container closed when not in use. Protect from freezing. Do not store in elevated temperatures.

Section VIII – Exposure Controls and Personal Protection

Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	TWA8 ACGIH	STEL ACGIH	Other Limits Recommended
None has been established	None	None	None	NA

Primary Route of Exposure: Body contact.	
Target Organs: None Known	
Respiratory Protection: Approved NIOSH respirator.	
Skin Protection: Rubber or plastic-impervious and/or waterproof.	
Protective Gloves: Rubber, nitrile, neoprene, PVL.	**Eye Protection**: Splash proof safety goggles.
Other Protective Clothing or Equipment: Eye wash facility and safety shower in immediate area. Rubber boots. Rubbers over leather shoes are not recommended.	

Section IX - Physical/Chemical Characteristics

Boiling Point: > 100°C (212°F)	**Percent Volatile**: NE
Viscosity : (Brookfield) @ 25°C: < 100 cps	**Specific Gravity** (H_2O = 1): 1.24 ± 0.05
Solubility in Water: Complete	**pH**: 2 ± 0.05
Appearance and Odor: Clear colorless to light yellow liquid with characteristic odor.	

NR: NOT REQUIRED, NE: NOT ESTABLISHED, NA: NOT APPLICABLE

Section X – Stability & Reactivity Data

Stability: Stable under normal conditions.

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PLANT CITY, FL 33563

Conditions to avoid: Do not expose to extreme temperatures.
Incompatibility (Materials to Avoid): May react with strong oxidizers
Hazardous Decomposition Products: None known
Hazardous Polymerization: Does not occur
Condition to avoid: None known
Additional Information: none

Section XI– Toxicological Information

Available data on closely related material indicates the following: ORAL LD50(Rats): >2,400 mg/kg (Estimated value) DERMAL LD50(Rabbits): >7,940 mg/kg (Estimated value) EYE IRRITATION: Not established SKIN IRRITATION: Not established
Mutagenic: Not listed.
Teratogenic: Not listed.
Reproductive Toxicity: Not listed.
Primary Route of Exposure: Body contact.
Target Organs: Not Listed

Section XII – Ecological Information

Available data on closely related material indicates the following:
Aquatic Toxicity:
Daphnia Magna 48 Hr acute toxicity LC_{50}=2700 mg/L, no effect level = 1540 mg/L
Fathead Minnow 96 Hr acute toxicity, no effect level = 5000 mg/L
Biodegradation:
BOD-28 = 1 mg/g
BOD-5 = 1 mg/g
COD = 116 mg/g
TOC = 26 mg/g

Section XIII - Disposal Consideration

Waste Disposal Method:
Waste Disposal Method: Water contaminated with this product may be sent to a sanitary sewer treatment facility, in accordance with any local agreement, a permitted waste treatment facility or discharge under a permit. Product as is- Incinerate or land dispose in an approved land fill.
If this undiluted product is discarded as a waste, the US RCRA hazardous waste identification number is not applicable.
The state and local requirements for waste disposal may be more restrictive or otherwise different from federal

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regulations. Consult state and local regulations regarding the proper disposal of this material.

Section XIV - Transport information

D.O.T. Proper Shipping Name: N/A	D.O.T. Hazard Class: N/A D.O.T. LABEL: N/A
ID No: N/A	Packing Group: N/A

Section XV - Regulatory information

Workplace Classification: This product is considered non-hazardous under the OSHA Hazard Communication Standard (29CFR1 910.1200).
This product is not a “controlled product” under the Canadian Workplace Hazardous Materials Information System (WHMIS).
SARA TITLE III: Section 311/312 Categorizations (40CFR370): This product is not a hazardous chemical under 29CFR 1910.1200, and therefore is not covered by Title III of SARA.
SARA TITLE III: Section 313 information (40CFR372): This product does not contain a chemical which is listed in section 313 at or above de minimis concentrations.
CERCLA Information (40CFR302.4): Releases of this material to air, land or water are not reportable to the National Response Center under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or to state and local emergency planning committees under the Superfund Amendments and Reauthorization Act (SARA) Title III Section 304.
US. Toxic Substances Control Act (TSCA): All components of this product are in compliance with the inventory listing requirements of the U.S. Toxic Substances Control Act (TSCA) Chemical Substance Inventory.
Australian Inventory of Chemical Substances: All components of this product are listed in the Australian Inventory of Chemical Substances (AICS).
Potable Water Approval: This product is NSF/ANSI Standard 60 certified. Maximum use level = 10mg/L

Section XVI - Other information

NFPA RATINGS:

Health	Flammability	Reactivity
1	0	0

The data contained in this material safety data sheet has been prepared based upon an evaluation of the ingredients contained in the product, their concentrations in the product and potential interactions. The information is offered in good faith and is believed to be accurate. It is furnished to the customer who is urged to study it carefully to become aware of hazards, if any, in the storage, handling, use and disposal of the product; and to insure his employees are properly informed and advised of all safety precautions required.

AMMONIUM HYDROXIDE 29%

Ammonium Hydroxide, 28-30% w/w

Safety Data Sheet

according to Federal Register / Vol. 77, No. 58 / Monday, March 26, 2012 / Rules and Regulations

Date of issue: 07/06/1998 Revision date: 06/26/2013 Supersedes: 05/22/2013 Version: 1.2

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product identifier

Product form	:	Substance
Substance name	:	Ammonium Hydroxide, 28-30% w/w
CAS No	:	1336-21-6
Product code	:	LC11050
Formula	:	NH4OH
Synonyms	:	ammonia hydrate, 28%-30% / Ammonia solution, relative density between 0.880 and 0.957 at 15 °C in water, with more than 10% but not more than 35% ammonia / ammonia,aqua 25%<=conc<35% / ammonia,liquor,25%<=conc<35% / ammonia, solutions, 28%-30% / ammoniawater, 28%-30% / aqua ammonia, solution, 28%-30% / spirit of hartshorn, 28%-30%
BIG no	:	26353

1.2. Relevant identified uses of the substance or mixture and uses advised against

Use of the substance/mixture : Chemical raw material
Food industry: additive
Solvent

1.3. Details of the supplier of the safety data sheet

LabChem Inc
Jackson's Pointe Commerce Park Building 1000, 1010 Jackson's Pointe Court
16063 Zelienople, PA - USA
T 412-826-5230 - F 724-473-0647
info@labchem.com - www.labchem.com

1.4. Emergency telephone number

Emergency number : CHEMTREC: 1-800-424-9300 or 011-703-527-3887

SECTION 2: Hazards identification

2.1. Classification of the substance or mixture

GHS-US classification

Acute Tox. 4 (Oral) H302
Skin Corr. 1A H314
Aquatic Acute 1 H400

2.2. Label elements

GHS-US labelling

Hazard pictograms (GHS-US) :

GHS05 GHS07 GHS09

Signal word (GHS-US) : Danger

Hazard statements (GHS-US) : H302 - Harmful if swallowed
H314 - Causes severe skin burns and eye damage
H400 - Very toxic to aquatic life

Precautionary statements (GHS-US) : P260 - Do not breathe mist, spray, vapours
P264 - Wash exposed skin thoroughly after handling
P270 - Do no eat, drink or smoke when using this product
P273 - Avoid release to the environment
P280 - Wear eye protection, face protection, protective clothing, protective gloves
P301+P312 - IF SWALLOWED: call a POISON CENTER or doctor/physician if you feel unwell
P301+P330+P331 - IF SWALLOWED: Rinse mouth. Do NOT induce vomiting
P303+P361+P353 - IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower
P304+P340 - IF INHALED: Remove person to fresh air and keep comfortable for breathing
P305+P351+P338 - If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
P310 - Immediately call a POISON CENTER/doctor/…
P330 - If swallowed, rinse mouth
P363 - Wash contaminated clothing before reuse
P391 - Collect spillage
P405 - Store locked up
P501 - Dispose of contents/container to comply with local, state and federal regulations

2.3. Other hazards

Other hazards not contributing to the classification : None.

2.4. Unknown acute toxicity (GHS US)

No data available

SECTION 3: Composition/information on ingredients

3.1. Substances

Substance type : Multi-constituent

Name	Product identifier	%	GHS-US classification
Water	(CAS No) 7732-18-5	70 - 72	Not classified
Ammonium Hydroxide, 28-30% w/w	(CAS No) 1336-21-6	28 - 30	Acute Tox. 4 (Oral), H302 Skin Corr. 1A, H314 Aquatic Acute 1, H400

Full text of H-phrases: see section 16

3.2. Mixture

Not applicable

SECTION 4: First aid measures

4.1. Description of first aid measures

First-aid measures general : Check the vital functions. Unconscious: maintain adequate airway and respiration. Respiratory arrest: artificial respiration or oxygen. Cardiac arrest: perform resuscitation. Victim conscious with laboured breathing: half-seated. Victim in shock: on his back with legs slightly raised. Vomiting: prevent asphyxia/aspiration pneumonia. Prevent cooling by covering the victim (no warming up). Keep watching the victim. Give psychological aid. Keep the victim calm, avoid physical strain. Depending on the victim's condition: doctor/hospital.

First-aid measures after inhalation : Remove the victim into fresh air. Respiratory problems: consult a doctor/medical service.

First-aid measures after skin contact : Wash immediately with lots of water (15 minutes)/shower. Do not apply (chemical) neutralizing agents. Remove clothing while washing. Do not remove clothing if it sticks to the skin. Cover wounds with sterile bandage. Consult a doctor/medical service. If burned surface > 10%: take victim to hospital.

First-aid measures after eye contact : Rinse immediately with plenty of water for 15 minutes. Cover eyes aseptically. Do not apply neutralizing agents. Take victim to an ophthalmologist.

First-aid measures after ingestion : Rinse mouth with water. Immediately after ingestion: give lots of water to drink. Do not induce vomiting. Immediately consult a doctor/medical service. Call Poison Information Centre (www.big.be/antigif.htm). Take the container/vomit to the doctor/hospital. Ingestion of large quantities: immediately to hospital.

4.2. Most important symptoms and effects, both acute and delayed

Symptoms/injuries after inhalation : Dry/sore throat. Coughing. Irritation of the respiratory tract. Irritation of the nasal mucous membranes. Nausea. Headache. EXPOSURE TO HIGH CONCENTRATIONS: Possible oedema of the upper respiratory tract. Possible inflammation of the respiratory tract. Possible laryngeal spasm/oedema. FOLLOWING SYMPTOMS MAY APPEAR LATER: Risk of lung oedema. Risk of pneumonia. Respiratory difficulties. Possible esophageal perforation.

Symptoms/injuries after skin contact : Caustic burns/corrosion of the skin.

Symptoms/injuries after eye contact : Irritation of the eye tissue. Permanent eye damage.

Symptoms/injuries after ingestion : Risk of aspiration pneumonia. Nausea. Vomiting. AFTER ABSORPTION OF HIGH QUANTITIES: Blue/grey discolouration of the skin. Blood in stool. Blood in vomit. Possible esophageal perforation. FOLLOWING SYMPTOMS MAY APPEAR LATER: Shock.

Chronic symptoms : ON CONTINUOUS/REPEATED EXPOSURE/CONTACT: Coughing. Irritation of the respiratory tract. Irritation of the eye tissue. Redness of the eye tissue. Possible inflammation of the respiratory tract. Respiratory difficulties. Affection of the nasal septum.

4.3. Indication of any immediate medical attention and special treatment needed

Obtain medical assistance.

SECTION 5: Firefighting measures

5.1. Extinguishing media

Suitable extinguishing media : EXTINGUISHING MEDIA FOR SURROUNDING FIRES: All extinguishing media allowed.

Unsuitable extinguishing media : No unsuitable extinguishing media known.

5.2. Special hazards arising from the substance or mixture

Fire hazard : DIRECT FIRE HAZARD. Non combustible.

Explosion hazard : INDIRECT EXPLOSION HAZARD. Reactions with explosion hazards: see "Reactivity Hazard".

Reactivity : On heating: release of toxic/corrosive/combustible gases/vapours (ammonia). On burning: release of toxic and corrosive gases/vapours (nitrous vapours). Concentrated solution violent to explosive reaction with many compounds e.g.: with (some) halogens compounds, with (strong) oxidizers and with (some) acids.

5.3. Advice for firefighters

Firefighting instructions : Cool tanks/drums with water spray/remove them into safety. Do not move the load if exposed to heat. Dilute toxic gases with water spray. Take account of toxic fire-fighting water. Use water moderately and if possible collect or contain it.

Protection during firefighting : Do not enter fire area without proper protective equipment, including respiratory protection.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

6.1.1. For non-emergency personnel

Protective equipment : Gas-tight suit. Corrosion-proof suit.

Emergency procedures : Keep upwind. Mark the danger area. Consider evacuation. Close doors and windows of adjacent premises. No naked flames. Keep containers closed. Wash contaminated clothes.

6.1.2. For emergency responders

Protective equipment : Equip cleanup crew with proper protection.

Emergency procedures : Stop leak if safe to do so. Ventilate area.

6.2. Environmental precautions

Prevent soil and water pollution. Prevent spreading in sewers.

6.3. Methods and material for containment and cleaning up

For containment : Contain released substance, pump into suitable containers. Consult "Material-handling" to select material of containers. Plug the leak, cut off the supply. Dam up the liquid spill. Try to reduce evaporation. Dilute toxic gases/vapours with water spray. Take account of toxic/corrosive precipitation water.

Methods for cleaning up : Damaged/cooled tanks must be emptied. Take up liquid spill into absorbent material, e.g.: sand/earth or powdered limestone. Scoop absorbed substance into closing containers. See "Material-handling" for suitable container materials. Carefully collect the spill/leftovers. Take collected spill to manufacturer/competent authority. Clean contaminated surfaces with an excess of water. Wash clothing and equipment after handling.

6.4. Reference to other sections

No additional information available

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Precautions for safe handling : Comply with the legal requirements. Remove contaminated clothing immediately. Clean contaminated clothing. Use corrosionproof equipment. Thoroughly clean/dry the installation before use. Do not discharge the waste into the drain. Keep away from naked flames/heat. Observe strict hygiene. Keep container tightly closed. Measure the concentration in the air regularly. Carry operations in the open/under local exhaust/ventilation or with respiratory protection. Exhaust gas must be neutralised.

Hygiene measures : Wash hands and other exposed areas with mild soap and water before eating, drinking or smoking and when leaving work. Wash contaminated clothing before reuse.

7.2. Conditions for safe storage, including any incompatibilities

Storage conditions : Keep container closed when not in use.

Incompatible products : Strong acids. silver nitrate.

Maximum storage period : 365 days

Storage temperature : < 38 °C

Heat and ignition sources : KEEP SUBSTANCE AWAY FROM: heat sources.

Prohibitions on mixed storage : KEEP SUBSTANCE AWAY FROM: oxidizing agents. (strong) acids. halogens.

Storage area : Store at ambient temperature. Keep out of direct sunlight. Store in a dark area. Keep container in a well-ventilated place. Keep locked up. Provide for a tub to collect spills. Meet the legal requirements.

Special rules on packaging : SPECIAL REQUIREMENTS: closing. clean. opaque. correctly labelled. meet the legal requirements. Secure fragile packagings in solid containers.

Packaging materials : SUITABLE MATERIAL: synthetic material. glass. MATERIAL TO AVOID: aluminium. copper. tin. zinc. nickel. bronze.

7.3. Specific end use(s)

No additional information available

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

Ammonium Hydroxide, 28-30% w/w (1336-21-6)		
USA ACGIH	ACGIH TWA (mg/m³)	17 mg/m³
USA ACGIH	ACGIH TWA (ppm)	25 ppm
USA ACGIH	ACGIH STEL (mg/m³)	24 mg/m³
USA ACGIH	ACGIH STEL (ppm)	35 ppm
USA OSHA	OSHA PEL (TWA) (mg/m3)	35 mg/m³
USA OSHA	OSHA PEL (TWA) (ppm)	50 ppm

8.2. Exposure controls

Appropriate engineering controls : Provide adequate general and local exhaust ventilation. Emergency eye wash fountains and safety showers should be available in the immediate vicinity of any potential exposure.

Materials for protective clothing : GIVE EXCELLENT RESISTANCE: butyl rubber. GIVE GOOD RESISTANCE: neoprene. nitrile rubber. viton. tetrafluoroethylene. GIVE LESS RESISTANCE: PVC. GIVE POOR RESISTANCE: natural rubber. polyethylene. PVA.

Hand protection : Gloves.

Eye protection : Protective goggles.

Skin and body protection : Head/neck protection. Corrosion-proof clothing.

Respiratory protection : Gas mask with filter type K. High vapour/gas concentration: self-contained respirator.

Thermal hazard protection : None necessary.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Physical state : Liquid

Appearance : Liquid.

Molecular mass : 35.05 g/mol

Colour : Colourless.

Odour : Irritating/pungent odour.

Odour threshold : 5 - 50 ppm

pH : 11.7 (3.5 %)

pH solution : 3.5 %

Relative evaporation rate (butylacetate=1) : No data available

Melting point : No data available

Freezing point : No data available

Boiling point : 27 °C

Flash point : Not applicable

Self ignition temperature : Not applicable

Decomposition temperature : No data available

Flammability (solid, gas) : No data available

Vapour pressure : No data available

Relative vapour density at 20 °C : No data available

Relative density : 0.88 - 0.91

Density : 0.89

Solubility : Water: Complete

Log Pow : -1.3

Log Kow : No data available

Viscosity, kinematic : No data available

Viscosity, dynamic : No data available

Explosive properties : No data available

Oxidising properties : No data available

Explosive limits : Not applicable

9.2. Other information

Minimum ignition energy : Not applicable

VOC content : Not applicable

Other properties : Clear. Physical properties depending on the concentration. Volatile. Substance has basic reaction.

SECTION 10: Stability and reactivity

10.1. Reactivity

On heating: release of toxic/corrosive/combustible gases/vapours (ammonia). On burning: release of toxic and corrosive gases/vapours (nitrous vapours). Concentrated solution violent to explosive reaction with many compounds e.g.: with (some) halogens compounds, with (strong) oxidizers and with (some) acids.

10.2. Chemical stability

Stable under normal conditions.

10.3. Possibility of hazardous reactions

Reacts vigorously with strong oxidizers and acids.

10.4. Conditions to avoid

High temperature. Incompatible materials.

10.5. Incompatible materials

May react violently with acids.

10.6. Hazardous decomposition products

Gaseous ammonia.

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Acute toxicity : Harmful if swallowed.

Ammonium Hydroxide, 28-30% w/w (1336-21-6)	
LD50 oral rat	350 mg/kg

Water (7732-18-5)	
LD50 oral rat	≥ 90000 mg/kg

Skin corrosion/irritation	:	Causes severe skin burns and eye damage. pH: 11.7 (3.5 %)
Serious eye damage/irritation	:	Not classified pH: 11.7 (3.5 %)
Respiratory or skin sensitisation	:	Not classified
Germ cell mutagenicity	:	Not classified
Carcinogenicity	:	Not classified
Reproductive toxicity	:	Not classified
Specific target organ toxicity (single exposure)	:	Not classified
Specific target organ toxicity (repeated exposure)	:	Not classified
Aspiration hazard	:	Not classified
Symptoms/injuries after inhalation	:	Dry/sore throat. Coughing. Irritation of the respiratory tract. Irritation of the nasal mucous membranes. Nausea. Headache. EXPOSURE TO HIGH CONCENTRATIONS: Possible oedema of the upper respiratory tract. Possible inflammation of the respiratory tract. Possible laryngeal spasm/oedema. FOLLOWING SYMPTOMS MAY APPEAR LATER: Risk of lung oedema. Risk of pneumonia. Respiratory difficulties. Possible esophageal perforation.
Symptoms/injuries after skin contact	:	Caustic burns/corrosion of the skin.
Symptoms/injuries after eye contact	:	Irritation of the eye tissue. Permanent eye damage.
Symptoms/injuries after ingestion	:	Risk of aspiration pneumonia. Nausea. Vomiting. AFTER ABSORPTION OF HIGH QUANTITIES: Blue/grey discolouration of the skin. Blood in stool. Blood in vomit. Possible esophageal perforation. FOLLOWING SYMPTOMS MAY APPEAR LATER: Shock.
Chronic symptoms	:	ON CONTINUOUS/REPEATED EXPOSURE/CONTACT: Coughing. Irritation of the respiratory tract. Irritation of the eye tissue. Redness of the eye tissue. Possible inflammation of the respiratory tract. Respiratory difficulties. Affection of the nasal septum.

SECTION 12: Ecological information

12.1. Toxicity

Ecology - general	:	Dangerous for the environment.
Ecology - water	:	Water pollutant (surface water). Affects the self-cleaning capacity of surface water. Ground water pollutant. Maximum concentration in drinking water: 0.50 mg/l (ammonium) (Directive 98/83/EC). Highly toxic to fishes. Toxic to invertebrates (Daphnia). May cause eutrophication. Highly toxic to plankton. pH shift. Inhibition of activated sludge.

Ammonium Hydroxide, 28-30% w/w (1336-21-6)	
LC50 fishes 1	0.16 - 1.1 mg/l (96 h; Salmo gairdneri (Oncorhynchus mykiss); SOLUTION >=50%)
LC50 other aquatic organisms 1	1 - 10 mg/l (96 h; SOLUTION >=50%)
LC50 fish 2	0.75 - 3.4 mg/l (96 h; Pimephales promelas; SOLUTION >=50%)
TLM fish 1	47 ppm (48 h; Salmo gairdneri (Oncorhynchus mykiss); COOL WATER)
TLM fish 2	34 ppm (48 h; Salmo gairdneri (Oncorhynchus mykiss); WARM WATER)
TLM other aquatic organisms 1	20 ppm (100 h; Daphnia magna)
Threshold limit other aquatic organisms 2	0.0012 mg/l (Oncorhynchus gorbuscha; SOLUTION >=50%)

12.2. Persistence and degradability

Ammonium Hydroxide, 28-30% w/w (1336-21-6)	
Persistence and degradability	Readily biodegradable in water. Ozonation in water. Biodegradable in the soil. No (test)data on mobility of the components of the mixture available. Ozonation in the air.

12.3. Bioaccumulative potential

Ammonium Hydroxide, 28-30% w/w (1336-21-6)	
Log Pow	-1.3
Bioaccumulative potential	Bioaccumulation: not applicable.

12.4. Mobility in soil

No additional information available

12.5. Other adverse effects

No additional information available

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Waste disposal recommendations : Recycle/reuse. Remove for physico-chemical/biological treatment. Remove to an authorized incinerator equipped with an afterburner and a flue gas scrubber with energy recovery. Use appropriate containment to avoid environmental contamination.

Additional information : LWCA (the Netherlands): KGA category 02. Hazardous waste according to Directive 2008/98/EC.

Ecology - waste materials : Avoid release to the environment.

SECTION 14: Transport information

In accordance with ADR / RID / ADNR / IMDG / ICAO / IATA

14.1. UN number

UN-No.(DOT) : 2672

DOT NA no. UN2672

14.2. UN proper shipping name

DOT Proper Shipping Name : Ammonia solutions

relative density between 0.880 and 0.957 at 15 degrees C in water, with more than 10 percent but not more than 35 percent ammonia

Department of Transportation (DOT) Hazard Classes : 8 - Class 8 - Corrosive material 49 CFR 173.136

Hazard labels (DOT) : 8 - Corrosive substances

Packing group (DOT) : III - Minor Danger

DOT Special Provisions (49 CFR 172.102) : IB3 - Authorized IBCs: Metal (31A, 31B and 31N); Rigid plastics (31H1 and 31H2); Composite (31HZ1 and 31HA2, 31HB2, 31HN2, 31HD2 and 31HH2). Additional Requirement: Only liquids with a vapor pressure less than or equal to 110 kPa at 50 C (1.1 bar at 122 F), or 130 kPa at 55 C (1.3 bar at 131 F) are authorized, except for UN2672 (also see Special Provision IP8 in Table 2 for UN2672).
IP8 - Ammonia solutions may be transported in rigid or composite plastic IBCs (31H1, 31H2 and 31HZ1) that have successfully passed, without leakage or permanent deformation, the hydrostatic test specified in 178.814 of this subchapter at a test pressure that is not less than 1.5 times the vapor pressure of the contents at 55 C (131 F).
T7 - 4 178.274(d)(2) Normal............. 178.275(d)(3)
TP1 - The maximum degree of filling must not exceed the degree of filling determined by the following: (image) Where: tr is the maximum mean bulk temperature during transport, and tf is the temperature in degrees celsius of the liquid during filling.

DOT Packaging Exceptions (49 CFR 173.xxx) : 154

DOT Packaging Non Bulk (49 CFR 173.xxx) : 203

DOT Packaging Bulk (49 CFR 173.xxx) : 241

Marine pollutant : P

14.3. Additional information

Other information : No supplementary information available.

State during transport (ADR-RID) : as liquid.

Overland transport

Packing group (ADR) : III

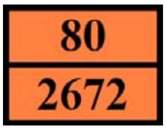
Class (ADR) : 8 - Corrosive substances

Hazard identification number (Kemler No.) : 80

Classification code (ADR) : C5

Danger labels (ADR) : 8 - Corrosive substances

Orange plates :



Tunnel restriction code : E

Transport by sea

DOT Vessel Stowage Location : A - The material may be stowed ‘‘on deck’’ or ‘‘under deck’’ on a cargo vessel and on a passenger vessel.

DOT Vessel Stowage Other : 40 - Stow ‘‘clear of living quarters’’,52 - Stow ‘‘separated from’’ acids,85 - Under deck stowage must be in mechanically ventilated space

EmS-No. (1) : F-A

EmS-No. (2) : S-B

Air transport

DOT Quantity Limitations Passenger aircraft/rail (49 CFR 173.27) : 5 L

DOT Quantity Limitations Cargo aircraft only (49 CFR 175.75) : 60 L

SECTION 15: Regulatory information

15.1. US Federal regulations

Ammonium Hydroxide, 28-30% w/w (1336-21-6)	
Listed on the United States TSCA (Toxic Substances Control Act) inventory	
RQ (Reportable quantity, section 304 of EPA's List of Lists) :	1000 lb

Ammonium Hydroxide, 28-30% w/w (1336-21-6)	
Listed on the United States TSCA (Toxic Substances Control Act) inventory	
RQ (Reportable quantity, section 304 of EPA's List of Lists) :	1000 lb

15.2. International regulations

CANADA

Ammonium Hydroxide, 28-30% w/w (1336-21-6)	
Listed on the Canadian DSL (Domestic Sustances List) inventory.	
WHMIS Classification	Class E - Corrosive Material

Ammonium Hydroxide, 28-30% w/w (1336-21-6)	
Listed on the Canadian DSL (Domestic Sustances List) inventory.	
WHMIS Classification	Class E - Corrosive Material

EU-Regulations

No additional information available

Classification according to Regulation (EC) No. 1272/2008 [CLP]

Skin Corr. 1B H314
Aquatic Acute 1 H400

Full text of H-phrases: see section 16

Classification according to Directive 67/548/EEC or 1999/45/EC

C; R34
N; R50

Full text of R-phrases: see section 16

15.2.2. National regulations

Ammonium Hydroxide, 28-30% w/w (1336-21-6)
Listed on the Canadian Ingredient Disclosure List

Ammonium Hydroxide, 28-30% w/w (1336-21-6)
Listed on the Canadian Ingredient Disclosure List

15.3. US State regulations

No additional information available

SECTION 16: Other information

Training advice : Users of breathing apparatus must be trained.

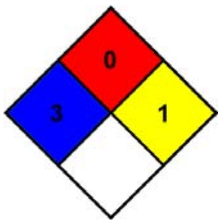
Full text of H-phrases: see section 16:

Acute Tox. 4 (Oral)	Acute toxicity (oral), Category 4
Aquatic Acute 1	Hazardous to the aquatic environment — AcuteHazard, Category 1
Skin Corr. 1A	Skin corrosion/irritation, Category 1A
H302	Harmful if swallowed
H314	Causes severe skin burns and eye damage
H400	Very toxic to aquatic life

NFPA health hazard : 3 - Short exposure could cause serious temporary or residual injury even though prompt medical attention was given.

NFPA fire hazard : 0 - Materials that will not burn.

NFPA reactivity : 1 - Normally stable, but can become unstable at elevated temperatures and pressures or may react with water with some release of energy, but not violently.



HMIS III Rating

Health : 3 Serious Hazard - Major injury likely unless prompt action is taken and medical treatment is given

Flammability : 0 Minimal Hazard

Physical : 1 Slight Hazard

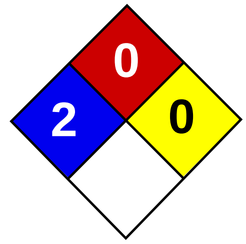
Personal Protection : H

SDS US (GHS HazCom 2012)

Information in this SDS is from available published sources and is believed to be accurate. No warranty, express or implied, is made and LabChem Inc assumes no liability resulting from the use of this SDS. The user must determine suitability of this information for his application.

SODIUM HYDROXIDE 25%

Science Lab.com
Chemicals & Laboratory Equipment



Health	2
Fire	0
Reactivity	0
Personal Protection	

Material Safety Data Sheet
Sodium Hydroxide, 25% MSDS

Section 1: Chemical Product and Company Identification

Product Name: Sodium Hydroxide, 25%

Catalog Codes: SLS4210

CAS#: Mixture.

RTECS: Not applicable.

TSCA: TSCA 8(b) inventory: Sodium hydroxide; Water

CI#: Not applicable.

Synonym:

Chemical Name: Not applicable.

Chemical Formula: Not applicable.

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call:
1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Sodium hydroxide	1310-73-2	25
Water	7732-18-5	75

Toxicological Data on Ingredients: Sodium hydroxide LD50: Not available. LC50: Not available.

Section 3: Hazards Identification

Potential Acute Health Effects:
Very hazardous in case of skin contact (corrosive, irritant), of eye contact (irritant), of ingestion. Hazardous in case of inhalation. Liquid or spray mist may produce tissue damage particularly on mucous membranes of eyes, mouth and respiratory tract. Skin contact may produce burns. Inhalation of the spray mist may produce severe irritation of respiratory tract, characterized by coughing, choking, or shortness of breath. Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.

Potential Chronic Health Effects:
Non-corrosive for skin. Non-irritant for skin. Non-sensitizer for skin. Non-permeator by skin. Non-irritating to the eyes. Non-hazardous in case of ingestion. Non-hazardous in case of inhalation. CARCINOGENIC EFFECTS: Not available. MUTAGENIC EFFECTS: Not available. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available. The substance is toxic to lungs, mucous membranes. Repeated or prolonged exposure to the substance can produce target organs damage. Repeated or prolonged contact with spray mist may produce chronic eye irritation and severe

skin irritation. Repeated or prolonged exposure to spray mist may produce respiratory tract irritation leading to frequent attacks of bronchial infection.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. Immediately flush eyes with running water for at least 15 minutes, keeping eyelids open. Finish by rinsing thoroughly with running water to avoid a possible infection. Cold water may be used.

Skin Contact:
If the chemical got onto the clothed portion of the body, remove the contaminated clothes as quickly as possible, protecting your own hands and body. Place the victim under a deluge shower. If the chemical got on the victim's exposed skin, such as the hands : Gently and thoroughly wash the contaminated skin with running water and non-abrasive soap. Be particularly careful to clean folds, crevices, creases and groin. Cold water may be used. If irritation persists, seek medical attention. Wash contaminated clothing before reusing.

Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek medical attention.

Inhalation: Allow the victim to rest in a well ventilated area. Seek immediate medical attention.

Serious Inhalation:
Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.

Ingestion:
Do not induce vomiting. Loosen tight clothing such as a collar, tie, belt or waistband. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek immediate medical attention.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: Non-flammable.

Auto-Ignition Temperature: Not applicable.

Flash Points: Not applicable.

Flammable Limits: Not applicable.

Products of Combustion: Not available.

Fire Hazards in Presence of Various Substances: Not applicable.

Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available.

Fire Fighting Media and Instructions: Not applicable.

Special Remarks on Fire Hazards: Not available.

Special Remarks on Explosion Hazards: Not available.

Section 6: Accidental Release Measures

Small Spill:

Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container. If necessary: Neutralize the residue with a dilute solution of acetic acid.

Large Spill:
Corrosive liquid. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not get water inside container. Do not touch spilled material. Use water spray curtain to divert vapor drift. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal. Neutralize the residue with a dilute solution of acetic acid. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:
Keep container dry. Do not breathe gas/fumes/ vapour/spray. Never add water to this product In case of insufficient ventilation, wear suitable respiratory equipment If you feel unwell, seek medical attention and show the label when possible. Avoid contact with skin and eyes Keep away from incompatibles such as acids.

Storage:
Alkalis may be stored in heavy duty gauge steel containers. Corrosive materials should be stored in a separate safety storage cabinet or room.

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value.

Personal Protection:
Face shield. Full suit. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves. Boots.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
Sodium hydroxide CEIL: 2 (mg/m3) from ACGIH [1995] Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Liquid.

Odor: Odorless.

Taste: Alkaline. Bitter. (Strong.)

Molecular Weight: Not applicable.

Color: Clear Colorless.

pH (1% soln/water): Basic.

Boiling Point: The lowest known value is 100°C (212°F) (Water).

Melting Point: Not available.

Critical Temperature: Not available.

Specific Gravity: Weighted average: 1.15 (Water = 1)

Vapor Pressure: The highest known value is 17.535 mm of Hg (@ 20°C) (Water).

Vapor Density: The highest known value is 0.62 (Air = 1) (Water).

Volatility: Not available.

Odor Threshold: Not available.

Water/Oil Dist. Coeff.: Not available.

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water.

Solubility: Easily soluble in cold water.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Not available.

Incompatibility with various substances: Extremely reactive or incompatible with acids.

Corrosivity:
Highly corrosive in presence of aluminum. Slightly corrosive to corrosive in presence of glass.

Special Remarks on Reactivity: Not available.

Special Remarks on Corrosivity: Not available.

Polymerization: No.

Section 11: Toxicological Information

Routes of Entry: Eye contact. Inhalation. Ingestion.

Toxicity to Animals:
LD50: Not available. LC50: Not available.

Chronic Effects on Humans: The substance is toxic to lungs, mucous membranes.

Other Toxic Effects on Humans:
Very hazardous in case of skin contact (corrosive, irritant), of ingestion. Hazardous in case of inhalation.

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans: Not available.

Special Remarks on other Toxic Effects on Humans: Not available.

Section 12: Ecological Information

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The product itself and its products of degradation are not toxic.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:

Section 14: Transport Information

DOT Classification: CLASS 8: Corrosive liquid.

Identification: : Sodium hydroxide, solution (Sodium hydroxide) : UN1824 PG: II

Special Provisions for Transport: Not available.

Section 15: Other Regulatory Information

Federal and State Regulations:
Pennsylvania RTK: Sodium hydroxide Massachusetts RTK: Sodium hydroxide TSCA 8(b) inventory: Sodium hydroxide; Water

Other Regulations: OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200).

Other Classifications:

WHMIS (Canada):
CLASS D-2A: Material causing other toxic effects (VERY TOXIC). CLASS E: Corrosive liquid.

DSCL (EEC): R35- Causes severe burns.

HMIS (U.S.A.):

Health Hazard: 2

Fire Hazard: 0

Reactivity: 0

Personal Protection:

National Fire Protection Association (U.S.A.):

Health: 2

Flammability: 0

Reactivity: 0

Specific hazard:

Protective Equipment:
Gloves. Full suit. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate. Face shield.

Section 16: Other Information

References: Not available.

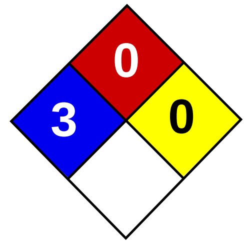
Other Special Considerations: Not available.

Created: 10/10/2005 12:05 PM

Last Updated: 05/21/2013 12:00 PM

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume *no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no event shall ScienceLab.com be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if ScienceLab.com has been advised of the possibility of such damages.*

PHOSPHORIC ACID 85%



Health	3
Fire	0
Reactivity	0
Personal Protection	

Material Safety Data Sheet
Phosphoric acid, 85% MSDS

Section 1: Chemical Product and Company Identification

Product Name: Phosphoric acid, 85%

Catalog Codes: SLP5569, SLP4555, SLP1732

CAS#: Mixture.

RTECS: Not applicable.

TSCA: TSCA 8(b) inventory: Phosphoric Acid; Water

CI#: Not available.

Synonym: Phosphoric Acid 85%; Phosphoric Acid; Orthophosphoric acid

Chemical Name: Not applicable.

Chemical Formula: Not applicable.

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call:
1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Phosphoric Acid	7664-38-2	85-88
Water	7732-18-5	12-15

Toxicological Data on Ingredients: Phosphoric Acid: ORAL (LD50): Acute: 1530 mg/kg [Rat]. DERMAL (LD50): Acute: 2740 mg/kg [Rabbit]. DUST (LC50): Acute: >850 mg/m 1 hours [Rat].

Section 3: Hazards Identification

Potential Acute Health Effects:
Very hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, . Hazardous in case of skin contact (corrosive, permeator), of eye contact (corrosive). Slightly hazardous in case of inhalation (lung sensitizer). Liquid or spray mist may produce tissue damage particularly on mucous membranes of eyes, mouth and respiratory tract. Skin contact may produce burns. Inhalation of the spray mist may produce severe irritation of respiratory tract, characterized by coughing, choking, or shortness of breath. Severe over-exposure can result in death. Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.

Potential Chronic Health Effects:
CARCINOGENIC EFFECTS: Not available. MUTAGENIC EFFECTS: Not available. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available. The substance may be toxic to blood, liver, skin, eyes, bone marrow. Repeated

or prolonged exposure to the substance can produce target organs damage. Repeated or prolonged contact with spray mist may produce chronic eye irritation and severe skin irritation. Repeated or prolonged exposure to spray mist may produce respiratory tract irritation leading to frequent attacks of bronchial infection. Repeated exposure to a highly toxic material may produce general deterioration of health by an accumulation in one or many human organs.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention immediately.

Skin Contact:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Cold water may be used.Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.

Serious Inhalation:
Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.

Ingestion:
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If large quantities of this material are swallowed, call a physician immediately. Loosen tight clothing such as a collar, tie, belt or waistband.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: Non-flammable.

Auto-Ignition Temperature: Not applicable.

Flash Points: Not applicable.

Flammable Limits: Not applicable.

Products of Combustion: Not available.

Fire Hazards in Presence of Various Substances: of metals

Explosion Hazards in Presence of Various Substances: Non-explosive in presence of open flames and sparks, of shocks.

Fire Fighting Media and Instructions: Not applicable.

Special Remarks on Fire Hazards:
Reacts with metals to liberate flammable hydrogen gas. Formation of flammable gases with aldehydes, cyanides, mercaptins, and sulfides.

Special Remarks on Explosion Hazards: Mixtures with nitromethane are explosive. (Phosphoric Acid)

Section 6: Accidental Release Measures

Small Spill:
Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container. If necessary: Neutralize the residue with a dilute solution of sodium carbonate.

Large Spill:
Corrosive liquid. Poisonous liquid. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not get water inside container. Do not touch spilled material. Use water spray curtain to divert vapor drift. Use water spray to reduce vapors. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal. Neutralize the residue with a dilute solution of sodium carbonate. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:
Do not ingest. Do not breathe gas/fumes/ vapor/spray. Never add water to this product. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, combustible materials, metals, alkalis. May corrode metallic surfaces. Store in a metallic or coated fiberboard drum using a strong polyethylene inner package.

Storage: Keep container tightly closed. Keep container in a cool, well-ventilated area.

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protection:
Face shield. Full suit. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves. Boots.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
Phosphoric Acid TWA: 1 STEL: 3 (mg/m3) from ACGIH (TLV) [United States] TWA: 1 STEL: 3 (mg/m3) from OSHA (PEL) [United States] TWA: 1 STEL: 3 (mg/m3) from NIOSH TWA: 1 STEL: 3 (mg/m3) [Mexico]Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Liquid. (Syrupy liquid Viscous liquid.)

Odor: Odorless.

Taste: Acid.

Molecular Weight: Not applicable.

Color: Clear Colorless.

pH (1% soln/water): Acidic.

Boiling Point: 158°C (316.4°F)

Melting Point: 21°C (69.8°F)

Critical Temperature: Not available.

Specific Gravity: 1.685 @ 25 C (Water = 1)

Vapor Pressure: 0.3 kPa (@ 20°C)

Vapor Density: 3.4 (Air = 1)

Volatility: Not available.

Odor Threshold: Not available.

Water/Oil Dist. Coeff.: Not available.

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water.

Solubility:
Easily soluble in hot water. Soluble in cold water.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Incompatible materials

Incompatibility with various substances: Reactive with oxidizing agents, combustible materials, metals, alkalis.

Corrosivity:
Extremely corrosive in presence of copper, of stainless steel(304), of stainless steel(316). Highly corrosive in presence of aluminum. Non-corrosive in presence of glass.

Special Remarks on Reactivity:
Reacts with metals to liberate flammable hydrogen gas. Incompatible with sodium tetrahydroborate producing a violent exothermic reaction. Heat generated with: alcohols, glycols, aldehydes, amides, amines, azo-compounds, carbamates, caustics, esters, ketones, phenols and cresols, organophosphates, epoxides, combustible materials, unsaturated halides, organic peroxides. Formation of flammable gases, with aldehydes, cyanides, mercaptins, and sulfides. Formation of toxic fumes with cyanides, fluorides, halogenated organics, sulfides, and organic peroxides. Do not mix with solutions containing bleach or ammonia. Incompatible with nitromethane, chlorides + staiinless steel. (Phosphoric Acid)

Special Remarks on Corrosivity:
Minor corrosive effect on bronze. Severe corrosive effect on brass. Corrosive to ferrous metals and alloys.

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Absorbed through skin. Dermal contact. Eye contact. Inhalation. Ingestion.

Toxicity to Animals:
Acute oral toxicity (LD50): 1530 mg/kg [Rat]. Acute dermal toxicity (LD50): 2740 mg/kg [Rabbit].

Chronic Effects on Humans: May cause damage to the following organs: blood, liver, skin, eyes, bone marrow.

Other Toxic Effects on Humans:
Extremely hazardous in case of inhalation (lung corrosive). Very hazardous in case of skin contact (irritant), of ingestion, . Hazardous in case of skin contact (corrosive, permeator), of eye contact (corrosive).

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans: Not available.

Special Remarks on other Toxic Effects on Humans:

Acute Potential Health Effects: Skin: Corrosive and causes severe skin irritation and can cause severe skin burns. May affect behavior (somnolence or excitement) if absorbed through skin. Eyes: Corrosive. Liquid or vapor causes severe eye irritation and can cause severe eye burns leading to permanent corneal damage or chemical conjunctivitis. Ingestion: May be harmful if swallowed. Causes irritation and burns of the gastrointestinal (digestive) tract. Causes severe pain, nausea, vomiting, diarrhea hematemesis, gastrointestinal hemmorrhaging, and shock. May cause corrosion and permanent tissue destruction of the esophagus and digestive tract. May affect behavior and urinary system, liver (hepatocellular damage, hepatic enzymes increased), blood (blood dyscrasia). May also

Section 12: Ecological Information

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are less toxic than the product itself.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:
Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

DOT Classification: Class 8: Corrosive material

Identification: : Phosphoric acid (Phosphoric Acid) UNNA: 1805 PG: III

Special Provisions for Transport: Not available.

Section 15: Other Regulatory Information

Federal and State Regulations:
Connecticut hazardous material survey.: Phosphoric Acid Illinois toxic substances disclosure to employee act: Phosphoric acid Illinois chemical safety act: Phosphoric acid New York release reporting list: Phosphoric acid Rhode Island RTK hazardous substances: Phosphoric acid Pennsylvania RTK: Phosphoric acid Minnesota: Phosphoric acid Massachusetts RTK: Phosphoric acid Massachusetts spill list: Phosphoric acid New Jersey: Phosphoric acid New Jersey spill list: Phosphoric acid Louisiana spill reporting: Phosphoric acid California Director's list of hazardous substances: Phosphoric acid TSCA 8(b) inventory: Phosphoric Acid; Water SARA 313 toxic chemical notification and release reporting: Phosphoric acid CERCLA: Hazardous substances.: Phosphoric acid: 5000 lbs. (2268 kg)

Other Regulations: OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200).

Other Classifications:

WHMIS (Canada): CLASS E: Corrosive liquid.

DSCL (EEC):
R34- Causes burns. S26- In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. S45- In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

HMIS (U.S.A.):

Health Hazard: 3

Fire Hazard: 0

Reactivity: 0

Personal Protection:

National Fire Protection Association (U.S.A.):

Health: 3

Flammability: 0

Reactivity: 0

Specific hazard:

Protective Equipment:
Gloves. Full suit. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate. Face shield.

Section 16: Other Information

References: Not available.

Other Special Considerations: Not available.

Created: 10/10/2005 08:47 PM

Last Updated: 05/21/2013 12:00 PM

FERRIC CHLORIDE 37%

Revision Date: June 13, 2012

NAPCO CHEMICAL COMPANY, INC.

Water and Wastewater Treatment Chemicals * Feed Systems * Test Kits

P.O. Box 1239 Spring, TX 77383-1239 * (281)651-6800 * 1 (800) 929-5976

Material Safety Data Sheet

1. PRODUCT IDENTIFICATION

Product Name: **Ferric Chloride 37-45%**

Synonyms: Iron (III) Chloride Solution

Distributed By: NAPCO Chemical Company, Inc.
P.O. Box 1239
Spring, TX 77383

Telephone: 1 (281) 651-6800

Fax: 1 (281) 651-6868

E-mail:

Emergency Contact: CHEMTREC (24 Hrs) at 1 (800) 424-9300
United States, Canada, Puerto Rico, and Virgin Islands

Physical Description: Reddish brown liquid with a slight iron odor

2. HAZARD IDENTIFICATION

Emergency Overview:

DANGER! CORROSIVE

Causes severe skin burns and eye damage.

Harmful if swallowed

Harmful if inhaled

Affects the Liver

3. PRODUCT INGREDIENTS

Components		Percent (%)
Ferric Chloride		37-45
CAS Number:	7705-08-0	
Water		Balance
CAS Number:	7732-18-5	

4. FIRST AID MEASURES

Eye Contact:	Immediately flush eyes with water for at least 15 minutes. Hold eyelids open to ensure adequate flushing. Get immediate medical attention.
Skin Contact:	Remove contaminated clothing and shoes. Wash affected skin area with soap and water. Delayed skin damage is possible if product is not completely washed off. Get immediate medical attention.
Inhalation:	Remove to fresh air. Get immediate medical attention.
Ingestion:	If ingested, dilute swallowed material by drinking water. DO NOT INDUCE VOMITING. Never give anything by mouth to an unconscious person. Get immediate medical attention.
Other Instructions:	Rescue personnel must wear appropriate protective equipment during removal of victim from contaminated area.

5. FIRE-FIGHTING MEASURES

Flash Point:	Not applicable
Auto ignition Temperature:	Not applicable
Flammable Limits, in Air:	
LEL (%)	Not applicable
UEL (%)	Not applicable
Extinguishing Media:	Use water spray, dry chemical, foam, water, or carbon dioxide
Special Fire Fighting Procedure:	In the event of a fire, wear NIOSH approved, positive pressure, self-contained breathing apparatus (SCBA) and full protective clothing. Evacuate all non-essential personnel from the danger area.
Unusual Fire and Explosion Hazards:	None
Hazardous Combustion Products:	Not considered to be a fire hazard. Irritating hydrogen chloride fumes may form in a fire.

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions:	Restrict access to keep out unauthorized or unprotected personnel. Stay upwind of spilled material. Wear appropriate PPE during all cleanup activities. Avoid inhalation and direct contact.
Environmental Precautions:	Keep spilled material away from sewage/drainage systems and waterways. This product contains a U.S. EPA Reportable Quantity (RQ) substance. If amounts exceeding the Reportable Quantity are released, notification of the National Response Center is required (800)424-8802. See section 15.

Methods for clean-up: All cleanup personnel must be properly trained. Confine the spill and remove incompatible materials and ignition sources. Ensure adequate ventilation. Secure the source of the leak if conditions are safe. Neutralize spill and collect using an appropriate absorbent material such as clay or vermiculite. Place waste in an appropriate container for disposal. Use care during cleanup to avoid exposure to the material and injury from broken containers.

7. HANDLING AND STORAGE

Handling: Use with adequate ventilation. Wear proper PPE. Avoid contact with bare metals other than titanium. Keep away from heat and strong alkalis such as caustic soda. Avoid breathing vapors and/or mists.

Storage: Store in closed, properly labeled containers. Protect from heat, physical damage, ignition sources and incompatible materials such as strong alkalis. Have emergency equipment for fires and spills readily available.

8. EXPOSURE CONTROLS & PERSONAL PROTECTION

Eye Protection: Wear chemical splash goggles or face shield. Do not wear contact lenses.

Skin Protection: Minimize contact with product. Wear chemical resistant coveralls, boots, gloves, apron and/or suitable long sleeve clothing.

Respiratory Protection: Good general ventilation should be sufficient to control airborne levels of vapor and mist. If airborne concentrations exceed the published exposure limits, use NIOSH/MSHA approved, full face respirator as appropriate. Wear an approved supplied air respirator if there is a potential for an uncontrolled release, exposure levels are not known, or in other circumstances where air-purifying respirators may not provide adequate protection.

Engineering Controls: Ensure adequate ventilation. Emergency eyewash and safety shower facilities should be available in the immediate work area.

Required Work/ Hygiene Procedure: Wash hands thoroughly after handling. Do not eat, drink or smoke in work area. If unusual exposures are expected, an industrial hygiene review of work practices, engineering controls and PPE is recommended.

Exposure Guidelines:

Ferric Chloride		37-45%
ACGIH TLV	1 mg/m^3 , 8-hr TWA	
OSHA TLV	1 mg/m^3 , 8-hr TWA	
NIOSH	1 mg/m^3 , 8-hr TWA	

9. PHYSICAL PROPERTIES

Physical Form:	Liquid
Color:	Reddish brown
Odor:	slight iron or acidic
Molecular Weight:	162.204 g/mol ($FeCl_3$)
Boiling Point:	230 ^oF (110 ^oC)
Freezing Point:	-15 ^oF at 37% solution
Solubility in Water:	Complete
Specific Gravity:	1.432 at 17.5 ^oC (40% solution)
Vapor Density:	No information available
Evaporation Rate:	1 (Butyl Acetate = 1)
Vapor Pressure:	Negligible
% Volatile:	Not applicable
pH:	< 2.0

The physical data included above are typical values and should not be construed as a specification.

10. STABILITY AND REACTIVITY

Stability:	This product is stable.
Conditions to Avoid:	Avoid contact with all common metals and with strong alkalis.
Hazardous Decomposition:	May release hydrogen chloride gat at elevated temperatures.
Hazardous Polymerization:	Not expected to occur.

11. TOXICOLOGY INFORMATION

Primary Exposure: Eye, skin contact, inhalation, and ingestion

Potential Health Effects:

Eye Contact:	Can causes severe eye damage
Skin Contact:	Can cause skin irritation and burns.
Inhalation:	Inhalation may cause irritation of the respiratory tract.
Ingestion:	Harmful if swallowed. Ingestion may cause severe liver and/or kidney damage and may be fatal.

Carcinogenicity: The components of this product are not classified as carcinogenic by OSHA, NTP, or IARC.

Medical Concerns: Asthma, other respiratory conditions and skin disorders may be aggravated by overexposure.

Toxicological Data:

Sodium Hypochlorite

Oral LD50 (Rat):	450 mg/kg (anhydrous)
Dermal LD50 (Rabbit):	No data available

12. ECOLOGICAL INFORMATION

Ecotoxicity: Fat Head Minnow LC50 > 1000 ppm ; Daphnia Magna LC50 > 1000 ppm

Biodegradability: No data available

13. DISPOSAL CONSIDERATIONS

Disposal Method: This product must be disposed of in accordance with Federal, state and local environmental regulations. Discarded materials may be considered hazardous waste due to pH and corrosivity.

It is the responsibility of the product user to determine at the time of disposal whether a material containing, or derived from, this product should be classified as hazardous waste.

14. TRANSPORTATION INFORMATION

Proper Shipping Name: Ferric chloride, Solution

Hazard Label: Corrosive

Hazard Class: 8

UN/NA Number: UN2582

Packing Group: III

EPA Reportable Quantity (RQ) 1000 Lbs.

Marine Pollutant: No

Emergency Response Guide: 154

15. REGULATORY INFORMATION

U.N. GHS Classification & Labeling Information

Classification: Corrosive
Harmful

Risk Phrases: R22 - Harmful if swallowed
R34 - Causes Burns

NFPA 704 Information:

Health Rating:	3
Flammability Rating:	0
Reactivity Rating:	2
Other Hazards:	

U.S. Federal Regulatory Information:

EPA Clean Air Act:	Not Listed
EPA Clean Water Act:	Listed
EPA FIFRA:	Registered as a pesticide product.
TSCA:	Complies
RCRA:	This product as supplied is a hazardous waste.
CERCLA RQ:	Hazardous Substance 1000 Lbs.
SARA Title III § 302:	None
SARA Title III § 311/312:	Acute Health Hazard
SARA Title III § 313:	Not listed

16. OTHER INFORMATION

All information appearing herein is based up data obtained from the manufacturer and/or recognized technical sources.

This information is furnished without warranty, expressed or implied, except that it is accurate to the best knowledge of NAPCO Chemical Company, Inc. at the time it was prepared. NAPCO Chemical Company, Inc. assumes no liability whatsoever for the accuracy of completeness of the information contained herein. Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, NAPCO Chemical Company, Inc. cannot guarantee that these are the only hazards that exist. NAPCO Chemical Company, Inc. assumes no legal responsibility for loss, damage or expense arising out of, or in any way connected with the handling, storage, use or disposal of this product.

SODIUM BISULFITE 38%

Section 1 – CHEMICAL PRODUCT AND COMPANY INFORMATION

MANUFACTURED FOR:
Two Rivers Terminal, LLC
PO Box 2327
Pasco, WA 99302

EMERGENCY TELEPHONE NO.:
DAYS: (509) 547-7776
24 Hour Emergency HAZMAT Response: (800) 229-5252
EPA National Response Center: (800) 424-8802

PRODUCT NAME: Sodium Bisulfite, 38-40% Solution
PRODUCT SYNONYMS: Sodium Bisulfite, Aqueous Solution; Sodium Hydrogen Sulfite; Sulfurous acid, monosodium salt; Sodium acid Sulfite
CHEMICAL NAME/CLASS: Sodium Bisulfite
PRODUCT USE: Various Industrial and Agricultural Applications

Section 2 - -COMPOSITION/INFORMATION ON INGREDIENTS

INGREDIENT NAME	CAS REGISTRY NUMBER	TYPICAL WT %
Sodium Bisulfite	7631-90-5	38-40%
Water	7732-18-5	60-62%

Section 3 – HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

APPEARANCE: Clear Colorless to Pale Yellow Solution
ODOR: Distinctive Acidic Sulfur-like odor of SO_2
PHYSICAL FORM: Liquid
SIGNAL WORD: Danger

EMERGENCY OVERVIEW: Danger! Contains material, which causes damage to the following organs: mucous membranes, respiratory tract, skin, eye, lens or cornea. Incompatible with acids or oxidizers (acidification will liberate sulfur dioxide gas) Thermal decomposition products are corrosive and /or toxic and include oxides of sulfur.

	ACGIH (TLV)(2003)	NIOSH REL (2001)	OSHA PEL (1989)
Sodium Bisulfite	5 mg/m^3 (TWA)	5 mg/m^3 (TWA-10 hrs)	5 mg/m^2 (TWA)

SYMPTOMS OF OVEREXPOSURE BY ROUTE OF EXPOSURE: The primary routes of overexposure for this material are via inhalation and contact with skin and eyes. The following paragraphs describe the symptoms of overexposure to this material.

INHALATION: Product is irritating to the nose, throat and respiratory tract

CONTACT WITH SKIN: Sodium Bisulfite may cause symptoms of skin irritation such as reddening, swelling, rash scaling or blistering.

CONTACT WITH EYES: Vapors from this product are irritating to eyes, This product causes irritation, redness and pain. May cause burns if left untreated.

INGESTION: May cause allergic reaction in some asthmatics. Ingestion of large amounts may cause nausea, gastrointestinal upset and abdominal pain. May cause central nervous system(:CNS) depression, nausea and vomiting, diarrhea, violent colic and death.

ACUTE: The primary hazard associated with this product is the potential for moderate irritation of skin, eyes, and other contaminated tissue. Ingestion of this product can be harmful or fatal.

HEALTH: 2 REACTIVITY: 0 FLAMMABILITY: 0 ENVIRONMENT: 0

(0=Insignificant 1=Slight 2=Moderate 3=High 4=Extreme)

Section 4 – FIRST AID MEASURES

Contaminated individuals must be taken for medical attention if any adverse reaction occurs. Rescuers should be taken for medical attention, if necessary. Take a copy of MSDS to health professional with contaminated individual. **Precaution: Effects of exposure may be delayed.**

SKIN EXPOSURE: Flush skin with running water for a minimum of 20 minutes. Start flushing while removing contaminated clothing. Obtain medical attention IMMEDIATELY. Do not transport victim unless recommended flushing period is complete or flushing can continue during transport.

For minor Skin contact, avoid spreading material on unaffected skin. Discard heavily contaminated clothing and shoes in a manner which limits further exposure, otherwise, wash clothing separately before reuse.

EYE EXPOSURE: Immediately flush eyes with running water for a minimum of 20 minutes. Hold eyelids open during flushing. If irritation persists, repeat flushing. Obtain medical attention IMMEDIATELY. Do not transport victim unless recommended flushing period is complete or flushing can continue during transport.

INHALATION: Move victim to fresh air. Give artificial respiration ONLY if breathing has stopped. Give Cardiopulmonary Resuscitation (CPR) if there is no breathing AND no pulse. Obtain medical attention IMMEDIATELY.

INGESTION: Have victim rinse mouth thoroughly with water. DO NOT INDUCE VOMITING. If victim is alert, have them drink 4 – 8oz (120-240 ml) of water. If vomiting occurs naturally, have victim rinse mouth with water again. Obtain medical attention and bring this MSDS. Never induce vomiting or give diluents (milk or water) to someone who is unconscious, having convulsions, or unable to swallow.

Section 5 – FIRE FIGHTING MEASURES

FLASH POINT: Not Applicable. Product is non-flammable

AUTOIGNITION TEMPERATURE: Not Applicable.

FLAMMABLE LIMITS (in air by volume, %): Lower (LEL): Not applicable.
Upper (UEL): Not applicable.

FIRE EXTINGUISHING MATERIALS:

Carbon Dioxide:	YES	Foam:	YES
Dry Chemical:	YES		

UNUSUAL FIRE AND EXPLOSION HAZARDS: This product is a moderate irritant and presents a potential contact hazard to firefighters. When involved in a fire, this material may decompose and produce toxic fumes of sulfur dioxide. Move product from fire area if you can without risk. Do not use water directly on material. Avoid breathing vapors, keep upwind.

SPECIAL FIRE-FIGHTING PROCEDURES: Incipient fire responders should wear eye protection. Structural fire fighters must wear Self-Contained Breathing Apparatus and full protective equipment. Chemical resistant clothing may be necessary. If this product is involved in a fire, fire run-off water should be contained to prevent possible environmental damage. Neutralize runoff with lime, soda ash or other suitable neutralizing agents. Rinse all contaminated equipment thoroughly with water before returning to service.

Section 6 – ACCIDENTAL RELEASE MEASURES

IN CASE OF SPILL OR LEAK: Stop the leak, if possible. Ventilate the space involved. Use appropriate personal protection equipment. Dike spill with inert material (sand, earth, etc.). Prevent waterway contamination. Collect run-off and transfer to drums or tanks for later disposal. Consult with regulatory specialists to determine appropriate state or local reporting requirements, for assistance in waste characterization and/or hazardous waste disposal and other requirements listed in pertinent environmental permits.

Deactivating Material: Alkali material such a dilute sodium hydroxide, Lime, limestone, sodium carbonate (soda ash), sodium bicarbonate, dilute aqua ammonia. Sulfur dioxide may be released during neutralization.

Note – Clean-up material may be a RCRA Hazardous Waste on disposal
Spills are subject to CERCLA reporting requirements: RQ = 5000 lbs.

Section 7 – HANDLING AND STORAGE

WORK PRACTICES AND HYGIENE PRACTICES: Wear appropriate Personal Protection Equipment. As with all chemicals, avoid getting this product on you or in you. Wash hands after handling this product. Do not eat, drink, smoke or apply cosmetics while handling this product. All work practices should minimize the generation of spills, splashes and aerosols. Remove contaminated clothing immediately. **Do not expose to strong acids as this will liberate sulfur dioxide gas.**

STORAGE AND HANDLING PRACTICES: All employees who handle this material should be trained to handle it safely. Avoid breathing dust or mists generated by this product. Use in a well-ventilated location. Open containers slowly, on a stable surface. Containers of this product must be properly labeled. Empty containers may contain residual product, therefore, empty containers should be handled with care. Store containers in a cool, dry location, away from direct sunlight, or sources of intense heat. Keep container tightly closed when not in use. Inspect all incoming containers before storage, to ensure containers are properly labeled and not damaged.

PROTECTIVE PRACTICES DURING MAINTENANCE OF CONTAMINATED EQUIPMENT: Follow practices indicated in Section 6 (Accidental Release Measures). Make certain that application equipment is locked and tagged-out safely, if necessary. Collect all spills, residues, rinsates and dispose of according to applicable U.S. Federal, State, or local procedures, or the applicable Canadian standards.

Section 8 – EXPOSURE CONTROL, PERSONAL PROTECTION

VENTILATION AND ENGINEERING CONTROLS: Use adequate local or general ventilation where necessary to maintain the concentrations well below the recommended occupational exposure limits. Ensure the eyewash stations and safety showers are proximal to the work area.

RESPIRATORY PROTECTION: A NIOSH/MSHA approved air purifying respirator equipped with acid gas/fume, dust, mist cartridges for concentrations up to 50 mg/m^3 or 20 ppm as sulfur dioxide. A full-face air-supplied respirator if concentrations are for up to and higher than 100 ppm sulfur dioxide

EYE PROTECTION: Wear safety glasses or splash goggles and face shield, to prevent contact with this product. As a general rule, do not wear contact lenses when handling.

HAND PROTECTION: Wear appropriate (neoprene, PVC, rubber) gloves for routine handling of the material to prevent contact.

BODY PROTECTION: Coverall, boot and/or other acid resistant protective clothing. Where there is a danger of spilling or splashing, acid resistant aprons or suits should be worn.

Section 9 – PHYSICAL AND CHEMICAL PROPERTIES

VAPOR DENSITY: Highest known 0.62 (Air=1)
BULK DENSITY: Not Applicable
SOLUBILITY IN WATER: Miscible in all proportions
VAPOR PRESSURE: 32 mmHg@20°C, 78 mmHg @ 37.7°C
ODOR THRESHOLD: No Data
SPECIFIC GRAVITY: 1.3
EVAPORATION RATE (n-BuAc = 1): Not Applicable.
FREEZING POINT or RANGE: Approximately 6°C (43°F)
BOILING POINT: 104°C (220°F)
pH @ 15°C (59°F): 3.8-5.2
LOG WATER/OIL DISTRIBUTION COEFFICIENT: Not available

APPEARANCE AND COLOR: Clear, colorless to light yellow liquid with distinctive odor
HOW TO DETECT THIS SUBSTANCE (warning properties): Pungent odor of sulfur dioxide

Section 10 – STABILITY AND REACTIVITY

STABILITY: Under normal conditions: On exposure to air the product will lose some sulfur dioxide and gradually oxidize to sulfate. Under fire conditions: Decomposes to oxides of sulfur.

DECOMPOSITION PRODUCTS: Thermal decomposition products may include toxic and hazardous oxides of sulfur.

MATERIALS WITH WHICH SUBSTANCE IS INCOMPATIBLE: Strong oxidizers, may cause exothermic reaction. Lewis or mineral acids (acidification will cause the release of Sulfur Dioxide).

HAZARDOUS POLYMERIZATION: Will not occur.

CONDITIONS TO AVOID: High Temperature, sparks, open flames and all other sources of ignition, Temperatures at or near boiling point causes evolution of Sulfur Dioxide.

Section 11 – TOXICOLOGICAL INFORMATION

Ingredient	Test	Result	Route	Species
Sodium Bisulfite Sol'n	LD50	2000 mg/kg	Oral	Rat

CARCINOGENICITY: Sodium Bisulfite is not classified by NPT (National Toxicology Program), not regulated as a carcinogenic by OSHA, and has been evaluated by IARC as a Group 3 (are not classified as to their carcinogenicity to humans), ACGIH classifies it as an A4 = Not classifiable as a human carcinogen.

REPRODUCTIVE EFFECTS: Not Available.

MUTAGENICITY: Evidence of mutagenic activity in bacteria, microorganisms, and DNA.

TERATOGENICTY: Not Available

Section 12 – ECOLOGICAL INFORMATION

Ingredient	Species	Period	Result
Sodium Bisulfite Sol'n	Mosquito fish (LC50)	96 hour	240 ppm

Products of Biodegradation: Oxides of Sulfur (SO2, SO3), Also some Metal Oxides.

Toxicity of Products: These Products of degradation are toxic.

Section 13 – DISPOSAL CONSIDERATIONS

Consult with environmental engineer or professional to determine of neutralization is appropriate and for handling procedures for residual material. Note: Chemical additions to, processing of; or otherwise altering this material may make this waste management information incomplete, inaccurate, or otherwise inappropriate. Furthermore, state and local waste disposal requirements may be more restrictive or otherwise different from federal laws and regulation.

Section 14 – TRANSPORT INFORMATION

United States (Under DOT)

Shipping Name: RQ, Bisulfites, aqueous solutions, n.o.s.
Hazard Class or Division: 8
Product Identification No. (PIN): UN 2693
Packing Group: III
Reportable Quantity (RQ): RQ = 5000 lbs (2270 kg)

Canada (Under TC)

Shipping Name: Bisulfite, aqueous solution, n.o.s. (sodium bisulfite)
Classification: 8
Product Identification No. (PIN): UN 2693
Packing Group: III

Section 15 – REGULATORY INFORMATION

UNITED STATES:

SARA TITLE III HAZARD CATEGORIES AND LISTS

Category		List	
Acute (Immediate) Health	Yes	Extremely Hazardous Substance (40CFR 355, SARA title III Section 302)	N/A
Chronic (Delayed) Health	No	CERCLA Hazardous Substance (40CFR 302.4)	Yes
Fire	No	Toxic Chemical (40CFR 372.65, SARA Title III Section 313)	Yes
Reactivity	No		
Sudden Release of Pressure	No		

Reprotable Quantity (RQ): RQ = 5000 lb

TSCA Inventory Status: Reported/Included

Right-To-Know: Illinois, Massachusetts, New Jersey, Pennsylvania

CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT (PROPOSITION 65): No

CANADIAN:

INGREDIENTS LISTED ON DSL..YES

WHMIS CLASSIFICTION..Class D-2B Material Causing Toxic Effects (TOXIC)

WHMIS HEALTH EFFECTS INDEX..Corrosive Material, Sensitizing Material

WHMIS Ingredient Disclosure List: .... Confirmed A; Meets criteria for disclosure at 1% or greater.

APPENDIX K

DETAILED COST ESTIMATE

COSTS BREAKDOWN

PROJECT CONSTRUCTION COSTS BREAKDOWN

The construction cost of the project is based on the 30% design drawings found in Appendix A. It assumes the project will be constructed by June 2018 with the construction midpoint of June 2017.

Table I-1 displays the construction costs, which include mobilization, overhead and profit and bonds. The construction contingency costs of 30% are allocated among the project features.

Table I-1 Project Construction Costs[1, 2]

Project Element	Construction Costs
Fallbrook Water Treatment Plant (WTP)	$27,728,000
WTP Connect and Distribution Sys Improvements	$ 5,497,000
Gheen Pump Station and Red Mtn. Zone Improvement	$ 4,195,000
Total Construction Cost	**$37,420,000**
Optional Bid 4 MG Tank at the Gheen Site	$ 5,656,000
Optional Bid Red Mtn. Zone Pipeline N. of Gheen Site	$ 1,110,000
Subtotal Optional Bid Items	**$ 6,766,000**
Total Construction Costs w/ Bid Options (2015 Dollars)	**$44,186,000**
Total Project Cost with 3.0% Inflation to June 2017	**$46,877,000**

1. Costs have been rounded to the nearest thousand.
2 The construction period is estimated to be 2 years. Based on this construction schedule, costs have been calculated using the compound interest method to the midpoint of construction using an interest rate of 3.0 percent.

The table above presents costs for project elements by combining detailed costs provided in this appendix. The breakdown of these combinations is described below.

Table I-2 Breakdown of Detailed Cost Combinations

Project Element	Portions of Appendix I Costs			
	WTP	Pipeline[1]	Gheen PS	4 MG
Fallbrook Water Treatment Plant (WTP)	100%			
WTP Connect and Distribution Sys Improvements		78%		
Gheen Pump Station and Red Mtn. Zone Improvement		6%	100%	
Optional Bid 4 MG Tank at the Gheen Site				100%
Optional Bid Red Mtn. Zone Pipeline N. of Gheen Site		16%		

1. Pipeline cost percentages have been determined by comparing the linear footages of each segment.

The cost presented is a Class 3 Association for the Advancement of Cost Estimating (AACE) estimate reflecting an accuracy range of +40% to -20%.

WATER TREATMENT PLANT

Santa Margarita Conjunctive Use Project
Engineer's Opinion of Probable Cost - 30% Design

Item	Article	Quantity	Unit	Unit Price	Extension
	Water Treatment Plant				
	General				
1	Mobilization, Demobilization, and Permits (4%)	1	LS	$783,000	$783,000
2	Insurance and Bonds	1	LS	$978,000	$978,000
3	Excavation Support System	1	LS	$10,000	$10,000
4	Stormwater BMPs	1	LS	$20,000	$20,000
5	Utility Potholing	15	EA	$500	$7,500
				Subtotal:	***$1,798,500***
	Civil Site Demolition & Improvements				
6	Clearing and Grubbing	100,000	SF	$0.40	$40,000
7	Demolish Storage Barn	1	LS	$50,000	$50,000
8	Excavation	2,500	CY	$12	$30,000
9	Fill and Backfill	6,750	CY	$24	$162,000
10	Imported Material	4,300	CY	$65	$279,500
11	Surplus Material Export	2,500	CY	$45	$112,500
12	Concrete Paving - 6" Thick	55,000	SF	$21	$1,155,000
13	Concrete Curb and Gutter	700	LF	$27	$18,900
14	Concrete Ditch	500	LF	$32	$16,000
15	Energy Dissipator	2	EA	$2,700	$5,400
16	Pipe Bollard	20	EA	$450	$9,000
17	Asphalt Concrete	1,300	TON	$130	$169,000
18	Aggregate Base	1,450	TON	$60	$87,000
19	Signage, Pavement Striping, and Markers	1	LS	$5,000	$5,000
20	Dewatering	1	LS	$10,000	$10,000
				Subtotal:	***$2,149,300***
	Gravity Sewer and Forcemain				
21	PVC Gravity Sewer - 15-inch	1,250	LF	$400	$500,000
22	Sewer Manhole - 5' Diameter	7	EA	$19,500	$136,500
23	C905 PVC Pipe - 14-inch	1,425	LF	$200	$285,000
				Subtotal:	***$921,500***
	Brine Line				
24	C900 PVC Pipe - 6-inch	1,725	LF	$155	$267,375
				Subtotal:	***$267,375***
	Misc Mechanical Improvements				
25	ORP Analyzer	1	EA	$4,100	$4,100
26	Free Chlorine Analyzer	5	EA	$27,000	$135,000
27	Total Chlorine Analyzer	1	EA	$27,000	$27,000
28	Chem Secondary Containment Conc Coating	1	LS	$20,000	$20,000
29	Ventilation System	1	LS	$45,000	$45,000
30	Surge Control System	1	EA	$100,000	$100,000
				Subtotal:	***$331,100***

Item	Article	Quantity	Unit	Unit Price	Extension
	Flow Control Facility				
31	10" Plunger Valve	1	EA	$60,000	$60,000
32	Flow Meter - 14-inch Magnetic	1	EA	$17,000	$17,000
33	16" Globe CLA-VAL	1	EA	$36,000	$36,000
34	16" Steel CML&C Pipe & Fittings	110	LF	$240	$26,400
35	Outlet Structure for overflow	1	LS	$10,000	$10,000
36	24" Steel CML&Painted Pipe & Fittings	75	LF	$290	$21,750
37	Butterfly Valve - 24", Class 150	3	EA	$24,000	$72,000
38	Concrete Pad	1	LS	$15,000	$15,000
39	Pipe Support -12 inch	6	EA	$2,100	$12,600
				Subtotal:	***$270,750***
	Equalization Tank, Piping & Appurtenances				
40	Equalization Tank	143,000	GAL	$0.90	$128,700
41	24" Steel CML&C Pipe & Fittings	1,370	LF	$320	$438,400
42	Butterfly Valve - 24", Class 150	3	EA	$24,000	$72,000
43	Concrete Encasement	15	CY	$320	$4,800
				Subtotal:	***$643,900***
	IM Vessels - Equipment, Piping and Valves				
44	Horizontal Pressure Filter	5	EA	$595,000	$2,975,000
45	Butterfly Flow Control Valve - 10", Class 150	10	EA	$7,500	$75,000
46	Butterfly Flow Control Valve - 8", Class 150	10	EA	$6,500	$65,000
47	Backwash Centrifugal Pump - 40 HP	2	EA	$90,000	$180,000
48	Backwash Flow Control Valve - 6"	2	EA	$10,000	$20,000
49	Backwash Back Pressure Valve - 12 inch	1	EA	$27,000	$27,000
50	12.6 gph Chlorine Pump, Motor, Drive, etc	2	EA	$36,000	$72,000
51	14" Discharge Header	1	EA	$18,000	$18,000
52	20" Steel CML&C Pipe & Fittings	70	LF	$240	$16,800
53	CML&Epoxy Coated Steel Pipe & Fittings - 20-inch	400	LF	$260	$104,000
54	CML&Epoxy Coated Steel Pipe & Fittings - 14-inch	50	LF	$200	$10,000
55	CML&Epoxy Coated Steel Pipe & Fittings - 10-inch	90	LF	$170	$15,300
56	Butterfly Valve - 14", Class 150	3	EA	$10,000	$30,000
57	Butterfly Valve - 8", Class 150	3	EA	$6,500	$19,500
58	Pump Control Valve	2	EA	$10,000	$20,000
59	Flow Meter - 14-inch Magnetic	1	EA	$17,000	$17,000
60	Concrete Pads - for filters, pumps and valves	7,300	SF	$21	$153,300
61	Pipe Support -14 inch	3	EA	$1,500	$4,500
				Subtotal:	***$3,822,400***
	RO Process Building and Pretreatment Chemicals - Equipment, Piping and Valves				
62	Cartridge Filter, RO Feed	3	EA	$108,700	$326,100
63	Butterfly Valve, 10-in Class 150	6	EA	$7,500	$45,000
64	Combination Air Valve Assembly, 1-in	8	EA	$1,500	$12,000
65	PVC Ball Valve, 1-in	17	EA	$100	$1,700
66	PVC Ball Valve, 2-in	15	EA	$250	$3,750
67	Sch. 80 PVC Piping, 1-in	25	LF	$30	$750
68	Sch. 80 PVC Piping, 2-in	90	SF	$60	$5,400

Item	Article	Quantity	Unit	Unit Price	Extension
69	FRP Piping, 150-psi Rated, 10-in	12	LF	$190	$2,280
70	FRP Piping, 150-psi Rated, 12-in	140	LF	$240	$33,600
71	Combination Air Valve Assembly, 2-in	1	EA	$6,000	$6,000
72	Static Mixer, FRP, 12-in	1	EA	$2,800	$2,800
73	Sch. 80 CPVC Piping, 6-in	225	LF	$160	$36,000
74	Sch. 80 CPVC Piping, 4-in	100	LF	$130	$13,000
75	Sch. 80 PVC Piping, 6-in	80	LF	$130	$10,400
76	Sch. 80 PVC Piping, 4-in	80	LF	$100	$8,000
77	Butterfly Valve, 6-in Class 150	10	EA	$4,800	$48,000
78	Butterfly Valve, 4-in Class 150	3	EA	$3,500	$10,500
79	Butterfly Valve, 2-in Class 150	7	EA	$2,000	$14,000
80	Butterfly Valve, 8-in Class 150, Electric Actuated	3	EA	$11,500	$34,500
81	Buttefly Valve, 8-in Class 150	4	EA	$6,500	$26,000
82	Vertical Turbine Pump and Motor, 125 HP	3	EA	$145,000	$435,000
83	Check Valve, 6-in Class 150	4	EA	$4,500	$18,000
84	Butterfly Valve, 8-in Class 150 (High Performance)	3	EA	$10,000	$30,000
85	RO Train Cost	3	EA	$625,000	$1,875,000
86	Inter-Stage Booster Pump and Motor, 10 HP	3	EA	$50,000	$150,000
87	Thermoplastic Eductor, 2-in	1	EA	$600	$600
88	Flanged Immersion Heater, 100 kW	1	EA	$25,000	$25,000
89	FRP Tank, 3,375 Gallons	1	EA	$25,000	$25,000
90	Horizontal Centrifugal Pump and Motor, 40 HP	2	EA	$30,000	$60,000
91	Cartridge Filter, RO CIP	1	EA	$27,000	$27,000
92	Horizontal Steel Storage Tank, Lined, 1,000 Gal.	1	EA	$15,000	$15,000
93	Desiccant Dryer, 2-in	1	EA	$1,700	$1,700
94	PVDF Lined Ductile Iron Valve, 2-in	6	EA	$1,100	$6,600
95	PVDF Lined Ductile Iron Valve, 3/4-in	17	EA	$700	$11,900
96	PVDF Body Diaphragm Valve, 1-in	2	EA	$350	$700
97	PVDF Body Diaphragm Valve, 1/2-in	6	EA	$300	$1,800
98	Chemical Pump, Motor, Drive and Accessories	2	LS	$20,000	$40,000
99	Chemical Service Plug Valve with Actuator	2	EA	$5,000	$10,000
100	PVDF Fused Piping	20	LF	$100	$2,000
101	Alloy 20 Injection Piping	40	LF	$250	$10,000
102	Alloy 20 Chemical Injector	1	EA	$3,900	$3,900
103	Vertical FRP Storage Tank, 565 Gallons	1	EA	$4,500	$4,500
104	Polypropylene Body Diaphragm Valve, 2-in	6	EA	$400	$2,400
105	Polypropylene Body Diaphragm Valve, 1-in	2	EA	$300	$600
106	Polypropylene Body Diaphragm Valve, 1/2-in	6	EA	$150	$900
107	Stainless Steel Diaphragm Valve, 1/2-in	17	EA	$400	$6,800
108	Chemical Pump, Motor, Drive and Accessories	2	LS	$18,000	$36,000
109	Polypropylene Fused Piping	20	LF	$90	$1,800
110	Stainless Steel Injection Piping	40	LF	$200	$8,000
111	Stainless Steel Chemical Injector	1	EA	$3,500	$3,500
				Subtotal:	***$3,453,480***

Item	Article	Quantity	Unit	Unit Price	Extension
	RO Break Tank, Bypass, Booster Pumps & Piping				
112	RO Booster Centrifugal Pump - 60 HP	2	EA	$58,500	$117,000
113	RO Booster Centrifugal Pump - 50 HP	1	EA	$30,000	$30,000
114	16" Steel CML&C Pipe & Fittings	205	LF	$240	$49,200
115	16" Discharge Header	1	EA	$18,000	$18,000
116	Bypass Butterfly Valve - 14", Class 150	1	EA	$10,000	$10,000
117	Bypass Butterfly Valve - 8", Class 150	1	EA	$6,500	$6,500
118	Bypass Butterfly Valve - 6", Class 150	1	EA	$4,800	$4,800
119	Flow Meter - 14-inch Magnetic	1	EA	$17,000	$17,000
120	Flow Meter - 6-inch Magnetic	1	EA	$11,000	$11,000
121	RO Break Tank	169,000	GAL	$0.90	$152,100
122	Butterfly Valve - 12", Class 150	2	EA	$8,500	$17,000
123	Butterfly Valve - 10", Class 150	2	EA	$7,500	$15,000
124	Butterfly Valve - 8", Class 150	2	EA	$6,500	$13,000
125	Pump Control Valve	3	EA	$10,000	$30,000
126	Concrete Pad	340	SF	$21	$7,140
127	Pipe Support -12 inch	2	EA	$1,200	$2,400
128	Pipe Support - 8 inch	1	EA	$1,000	$1,000
				Subtotal:	***$501,140***
	Product Water Pumps & Clear Well				
129	Product Water Tank (Clear Well)	119,000	GAL	$0.90	$107,100
130	Product Water Vertical Turbine Pump - 250 HP	4	EA	$150,000	$600,000
131	Pump Control Valve	4	EA	$10,000	$40,000
132	Pump Suction Header - 24-inch CML&Epoxy	1	EA	$28,000	$28,000
133	Concrete Vault	1	LS	$30,000	$30,000
134	16" Steel CML&C Pipe & Fittings	205	LF	$240	$49,200
135	CML&Epoxy Coated Steel Pipe & Fittings - 16-inch	40	LF	$220	$8,800
136	Butterfly Valve - 24", Class 150	4	EA	$24,000	$96,000
137	Butterfly Valve - 12", Class 150	4	EA	$8,500	$34,000
138	Butterfly Valve - 10", Class 150	4	EA	$7,500	$30,000
139	Flow Meter - 16-inch Magnetic	1	EA	$18,000	$18,000
140	Concrete Encasement	7	CY	$320	$2,240
				Subtotal:	***$1,043,340***
	Waste Wash Water Pumps & Appurtenances				
141	Decant Vertical Turbine Pump - 7.5 HP	2	EA	$70,000	$140,000
142	Decant Vertical Turbine Pump - 3 HP	1	EA	$56,000	$56,000
143	Sludge Submersible Pump - 2 HP	1	EA	$35,000	$35,000
144	Plug Valve - 2-inch	4	EA	$6,500	$26,000
145	8" Steel CML&C Pipe & Fittings	50	LF	$180	$9,000
146	6" Steel CML&C Pipe & Fittings	20	LF	$160	$3,200
147	2" Steel Pipe & Fittings	550	LF	$120	$66,000
148	Butterfly Valve - 8", Class 150	1	EA	$6,500	$6,500
149	Butterfly Valve - 6", Class 150	3	EA	$4,800	$14,400
150	Pump Control Valve	3	EA	$10,000	$30,000
151	Rock Excavation	760	CY	$191	$145,160

Item	Article	Quantity	Unit	Unit Price	Extension
152	Concrete Structure	1	LS	$54,000	$54,000
				Subtotal:	***$585,260***
	Drying Bed Modifications				
153	Fill Sand Channels with Concrete	1	LS	$25,000	$25,000
154	Rehabilitate Gates	1	LS	$10,000	$10,000
				Subtotal:	***$35,000***
	Oxidation & Regeneration Systems				
155	7500-gal Sodium Hypochlorite Tank	1	EA	$56,000	$56,000
156	225 gph Chem Pump, Motor, Drive, Accessories	2	EA	$100,000	$200,000
157	31.3 gph Chem Pump, Motor, Drive, Accessories	1	EA	$40,000	$40,000
158	3.5 gph Chem Pump, Motor, Drive, Accessories	1	EA	$20,000	$20,000
159	Piping, Valves, Misc Appurtenances	1	LS	$100,000	$100,000
				Subtotal:	***$416,000***
	Quenching System				
160	1000-gal Sodium Bisulfite Tank	1	EA	$30,000	$30,000
161	2.8 gph Chem Pump, Motor, Drive, Accessories	1	EA	$19,000	$19,000
162	0.28 gph Chem Pump, Motor, Drive, Accessories	1	EA	$18,000	$18,000
163	Piping, Valves, Misc Appurtenances	1	LS	$30,000	$30,000
				Subtotal:	***$97,000***
	Disinfection System				
164	500-gal SS Ammonium Hydroxide Press Vessel	1	EA	$58,000	$58,000
165	11.3 gph Chem Pump, Motor, Drive, Accessories	1	EA	$36,000	$36,000
166	1.2 gph Chem Pump, Motor, Drive, Accessories	2	EA	$19,000	$38,000
167	0.12 gph Chem Pump, Motor, Drive, Accessories	1	EA	$18,000	$18,000
168	Piping, Valves, Misc Appurtenances	1	LS	$30,000	$30,000
				Subtotal:	***$180,000***
	Stabilization System				
169	9000-gal Sodium Hydroxide (NaOH) Tank	1	EA	$70,000	$70,000
170	500-gal Steel Lined Phosphoric Acid (H_3PO_4) Tank	1	EA	$10,000	$10,000
171	43 gph NaOH Pump, Motor, Drive, Accessories	2	EA	$50,000	$100,000
172	5.2 gph NaOH Pump, Motor, Drive, Accessories	2	EA	$22,000	$44,000
173	1.1 gph H_3PO_4 Pump, Motor, Drive, Accessories	2	EA	$18,000	$36,000
174	0.12 gph H_3PO_4 Pump, Motor, Drive, Accessories	2	EA	$17,000	$34,000
175	Piping, Valves, Misc Appurtenances	1	LS	$130,000	$130,000
				Subtotal:	***$424,000***
	Waste Wash Water Coagulant Reclaim System				
176	500-gal Ferric Chloride Tank	1	EA	$5,000	$5,000
177	64.8 gph Chem Pump, Motor, Drive, Accessories	2	EA	$70,000	$140,000
178	Piping, Valves, Misc Appurtenances	1	LS	$160,000	$160,000
				Subtotal:	***$305,000***
	Structural Improvements				
179	RO Building	6,350	SF	$400	$2,540,000
180	Chemical Facility Concrete	1	LS	$75,000	$75,000
181	Chemical Facility Metal Roof, etc	5,000	SF	$60	$300,000
				Subtotal:	***$2,915,000***

Item	Article	Quantity	Unit	Unit Price	Extension
	Electrical Improvements				
182	Electrical Gear	1	LS	$612,604	$612,604
183	Electrical Field Work	1	LS	$266,747	$266,747
184	SCADA/I&C Field Work	1	LS	$289,215	$289,215
				Subtotal:	***$1,168,566***

Subtotal, Construction:	*$21,328,611*
30% Contingency:	*$6,398,583*
Total w/Contingency:	***$27,728,000***

Notes:

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PIPELINES

Santa Margarita Conjunctive Use Project
Engineer's Opinion of Probable Cost - 30% Design
June 16, 2015

Item	*Article*	*Quantity*	*Unit*	*Unit Price*	*Extension*
	Pipelines				
1	Mobilization, Demobilization, and Permits (4%)	1	LS	$198,000	$198,000
2	Insurance and Bonds	1	LS	$248,000	$248,000
3	Excavation Support System	1	LS	$46,000	$46,000
4	Traffic Control	1	LS	$45,000	$45,000
5	Stormwater BMPs	1	LS	$25,000	$25,000
6	Utility Potholing	100	EA	$500	$50,000
7	Clearing and Grubbing	3,000	SF	$2.00	$6,000
8	24" Steel CML&C Pipe - WTP	939	LF	$320	$300,342
9	24" Steel CML&C Pipe - Palomino	7,970	LF	$320	$2,550,400
10	20" Steel CML&C Pipe - Palomino	20	LF	$280	$5,600
11	24" Steel CML&C Pipe - Gheen Site South	684	LF	$320	$218,880
12	24" Steel CML&C Pipe - Gheen Site North	1,818	LF	$320	$581,760
13	20" Steel CML&C Pipe - Gumtree	82	LF	$280	$22,960
14	12" Steel CML&C Pipe	21	LF	$200	$4,200
15	10" Steel CML&C Pipe	18	LF	$190	$3,420
16	8" Steel CML&C Pipe	16	LF	$180	$2,880
17	6" Steel CML&C Pipe	35	LF	$160	$5,600
18	Butterfly Valve - 24", Class 150	13	EA	$24,000	$312,000
19	Butterfly Valve - 20", Class 150	2	EA	$18,000	$36,000
20	Gate Valve - 16", Class 150	5	EA	$15,000	$75,000
21	Gate Valve - 12", Class 150	5	EA	$8,500	$42,500
22	Gate Valve - 10", Class 150	4	EA	$6,500	$26,000
23	Gate Valve - 8", Class 150	5	EA	$5,500	$27,500
24	Gate Valve - 6", Class 150	12	EA	$4,000	$48,000
25	Combination Air Valve Assembly (6")	10	EA	$10,000	$100,000
26	Blow-Off Assembly (6")	10	EA	$6,000	$60,000
27	Reconnect Water Service	29	EA	$1,000	$29,000
28	Reconnect Fire Hydrant	3	EA	$1,000	$3,000
29	Over-Excavation and Rock Backfill	110	CY	$130	$14,300
30	Asphalt Concrete (4")	1,222	TON	$130	$158,850
31	Aggregate Base (6")	1,551	TON	$60	$93,085
32	Portland Cement Concrete (4")	600	SF	$12	$7,200
33	Signage, Pavement Striping, and Markers	1	LS	$5,000	$5,000
34	Dewatering	1	LS	$15,000	$15,000
35	Abandon Existing 12" Water Main	3,720	LF	$10	$37,200
				Subtotal:	*$5,403,677*
				30% Contingency:	*$1,621,103*
				Total Construction:	***$7,025,000***

Notes:

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GHEEN PUMP STATION AND SITE IMPROVEMENTS

Santa Margarita Conjunctive Use Project
Engineer's Opinion of Probable Cost - 30% Design
June 2015

Item	*Article*	*Quantity*	*Unit*	*Unit Price*	*Extension*
	Gheen Pump Station & Yard Piping				
	Demolition & Improvements				
1	Mobilization, Demobilization, and Permits (4%)	1	LS	$107,000	$107,000
2	Insurance and Bonds	1	LS	$133,000	$133,000
3	Excavation Support System	1	LS	$20,000	$20,000
4	Stormwater BMPs	1	LS	$10,000	$10,000
5	Clearing and Grubbing	60,000	SF	$0.40	$24,000
6	Remove Existing Tree	45	EA	$800	$36,000
7	Demolish Martin Reservoir	1	LS	$175,000	$175,000
8	Excavation	7,500	CY	$12	$90,000
9	Fill and Backfill	1,500	CY	$24	$36,000
10	Surplus Material Export	6,000	CY	$45	$270,000
11	Crushed Rock, 3/4-inch	1,600	CY	$65	$104,000
12	Utility Potholing	10	EA	$500	$5,000
				Subtotal:	***$1,010,000***
	Pump Station				
13	Building - Pump Station	855	SF	$400	$342,000
14	Vertical Turbine Pump w/200 HP Motor	2	EA	$131,000	$262,000
15	Check Valve, Swing, 10-inch	2	EA	$16,400	$32,800
16	Pump Suction Header - 24-inch CML&C	1	EA	$28,000	$28,000
17	20" Steel CML&C Pipe & Fittings	35	LF	$280	$9,800
18	4" Steel CML&C Pipe & Fittings	20	LF	$140	$2,800
19	Butterfly Valve - 20", Class 150	2	EA	$18,000	$36,000
20	Butterfly Valve - 10", Class 150	2	EA	$7,500	$15,000
21	Butterfly Valve - 4", Class 150	1	EA	$3,100	$3,100
22	Flow Meter - 16-inch Magnetic	1	EA	$18,000	$18,000
23	4-inch Air Valve for Vertical Turbine Pump	2	EA	$8,000	$16,000
24	1-inch Air Release Valve	2	EA	$1,100	$2,200
25	4-inch Air Release Valve	1	EA	$4,400	$4,400
26	CML&Epoxy Coated Steel Pipe & Fittings - 16-inch	26	LF	$220	$5,720
27	CML&Epoxy Coated Steel Pipe & Fittings - 10-inch	12	LF	$170	$2,040
28	Drain Piping - 3-inch PVC	25	LF	$45	$1,125
29	Pipe Support - 10 inch	4	EA	$1,100	$4,400
30	Pipe Support - 16 inch	3	EA	$1,500	$4,500
31	Floor Drain	2	EA	$550	$1,100
32	Floor Sump	1	EA	$540	$540
33	Concrete Encasement	30	CY	$320	$9,600
34	Ventilation System	1	LS	$21,400	$21,400
35	Surge Control System	1	EA	$96,000	$96,000
36	Electrical & Instrumentation	1	LS	$301,697	$301,697
37	Systems Start-up and Testing	1	LS	$38,000	$38,000
				Subtotal:	***$1,258,222***

Item	Article	Quantity	Unit	Unit Price	Extension
	Pipelines				
38	24" Steel CML&C Pipe & Fittings	886	LF	$320	$283,520
39	16" Steel CML&C Pipe & Fittings	184	LF	$240	$44,160
40	Butterfly Valve - 24", Class 150	8	EA	$24,000	$192,000
41	Butterfly Valve - 16", Class 150	1	EA	$14,000	$14,000
42	Globe Check Valve - 24"	1	EA	$38,400	$38,400
43	Globe Check Valve - 16"	1	EA	$25,900	$25,900
44	Asphalt Concrete	135	TON	$130	$17,550
45	Aggregate Base	147	TON	$60	$8,820
46	Concrete Curb and Gutter	90	LF	$27	$2,430
47	Signage, Pavement Striping, and Markers	1	LS	$5,000	$5,000
48	Site Restoration	1	LS	$5,000	$5,000
				Subtotal:	***$636,780***
				Subtotal, Construction:	*$2,905,002*
				30% Contingency:	*$871,501*
				Total w/Contingency:	***$3,777,000***

Notes:

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4MG GHEEN STORAGE TANK

Santa Margarita Conjunctive Use Project
Engineer's Opinion of Probable Cost - 30% Design

Item	Article	Quantity	Unit	Unit Price	Extension
	Gheen Site - Bid Alternate 4MG Tank				
1	Mobilization, Demobilization, and Permits (4%)	1	LS	$160,000	$160,000
2	Insurance and Bonds	1	LS	$200,000	$200,000
3	Excavation Support System	1	LS	$6,000	$6,000
4	Utility Potholing	3	EA	$500	$1,500
5	Tank Subdrain	13,700	SF	$8.00	$109,600
6	Welded Steel Tank - AWWA D100	4,000,000	GAL	$0.90	$3,600,000
7	Globe Check Valve - 24"	1	EA	$38,400	$38,400
8	Globe Check Valve - 16"	1	EA	$25,900	$25,900
9	Butterfly Valve - 24", Class 150	1	EA	$24,000	$24,000
10	Butterfly Valve - 16", Class 150	1	EA	$14,000	$14,000
11	Miscellaneous Piping & Valving	1	LS	$75,000	$75,000
12	Energy Dissipator	1	LS	$8,000	$8,000
13	Pipe Bollard	5	EA	$450	$2,250
14	Concrete Paving - 6" Thick	2,160	SF	$21	$45,360
15	Signage, Pavement Striping, and Markers	1	LS	$5,000	$5,000
16	Electrical & Instrumentation	1	LS	$35,000	$35,000
				Subtotal, Construction:	*$4,350,010*
				30% Contingency:	*$1,305,003*
				Total w/Contingency:	***$5,656,000***

Notes:

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