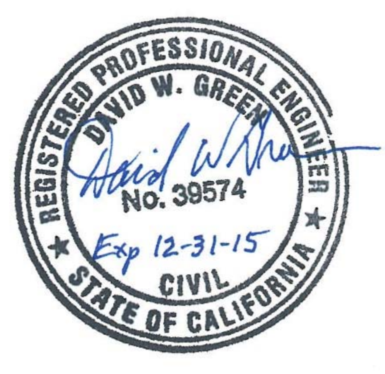
Preliminary Design Report

Dewatering/Truck Loadout Facility for the Regional Water Quality Control Plant

Prepared for

City of Palo Alto, California

August 2014



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Preliminary Design Report for the Regional Water Quality Control Plant (RWQCP)

Process

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Introduction

This technical memorandum (TM) summarizes flow and load projections for the two design conditions used as the basis for preliminary design of the Dewatering/Truck Loadout Facility at the Palo Alto Regional Water Quality Control Plant (RWQCP) and the process description: (1) unstabilized wastewater residuals (sludge) and (2) thermally hydrolyzed and anaerobically digested biosolids. The facility design is based on year 2045 load projections.

Raw Sludge and Biosolids Projections

The basis and development of raw sludge projections are presented in detail in the *Draft Palo Alto Regional Water Quality Control Plant Biosolids Facility Plan* (Biosolids Facility Plan) (CH2M HILL, April 2014). This section provides a summary of the projections as applicable to the preliminary design of the Dewatering/Truck Loadout Facility for operation with raw sludge.

Raw Sludge Projections

Table 1-1 presents projected annual average and maximum month thickened primary sludge (PS) and waste activated sludge (WAS) quantities for the RWQCP. Maximum month values were calculated using a 1.16 maximum month/average annual mass loading rate peaking factor.

TABLE 1-1
RWQCP Current and Projected Thickened Sludge Summary

		Annual Average			Maximum Month		
Parameter	**Unit**	**2010**	**2015**	**2045**	**2010**	**2015**	**2045**
PS total mass	ppd	30,740	31,923	39,440	35,658	37,031	45,750
PS flow	gpd	109,501	113,717	140,493	127,021	131,911	162,972
WAS total mass	ppd	12,200	12,737	16,178	14,151	14,775	18,766
WAS flow	gpd	43,457	45,371	57,628	50,410	52,631	66,848
TS mass	ppd	42,939	44,660	55,617	49,809	51,805	64,516
TS mass	dtpd	21.5	22.3	27.8	24.9	25.9	32.3
TS flow	gpd	152,958	159,088	198,121	177,431	184,542	229,820

TABLE 1-1
RWQCP Current and Projected Thickened Sludge Summary

Parameter	Unit	Annual Average			Maximum Month		
		2010	2015	2045	2010	2015	2045

Process assumptions:

Average PS concentration = 3.3%; Average PS VS fraction = 81%

Average WAS concentration = 3.3%; Average WAS VS fraction = 77%

dtpd = dry tons per day; gpd = gallons per day; ppd = pounds per day; PS = primary sludge; TS = total solids; VS = volatile solids; WAS = waste activated sludge.

Fat, Oil, and Grease/Scum and Food Scraps Projections

Table 1-2 presents projected fat, oil, and grease (FOG)/scum and food scrap quantities that will be processed at the RWQCP. The quantities are assumed constant for the planning period. The food scrap quantity presented in the table is the maximum quantity estimated for processing at the RWQCP based on excess digester capacity available with the thermal hydrolysis process and mesophilic anaerobic digestion (THP+MAD) system presented in the Biosolids Facility Plan.

TABLE 1-2
RWQCP Projected FOG/Scum and Food Scraps Summary

Parameter	Unit	FOG/Scum	Food Scraps
TS mass	ppd	2,200	18,863

Process assumptions:

FOG/scum: VS fraction = 94%; VS reduction = 90%

Food scraps: VS fraction = 85% and VS reduction = 80%

ppd = pounds per day; FOG = fats, oils, and grease; VS = volatile solids; TS = total solids.

Biosolids Projections

Table 1-3 presents projected annual average and maximum month biosolids mass loading rates for the RWQCP. The undigested (raw sludge) quantities will be processed in the new Dewatering/Truck Loadout Facility initially, until the thermal hydrolysis and anaerobic digestion system is commissioned. Although the design and construction dates for these new facilities are not definitive, it is expected that there will be several years of dewatering undigested wastewater residuals before the thermal hydrolysis and anaerobic digestion facilities are commissioned and operating. The facility is designed to process the thermally-hydrolyzed, anaerobically-digested biosolids, including, potentially, food scraps in the future.

TABLE 1-3
RWQCP Current and Projected Sludge/Biosolids Summary

Parameter	Unit	Annual Average			Maximum Month		
		2010	2015	2045	2010	2015	2045
TS mass (undigested sludge)	ppd	42,939	44,660	55,617	49,809	51,805	64,516
TS+FOG/scum mass (THP/digested)	ppd	18,704	19,454	24,227	21,697	22,566	28,103
TS+FOG/scum+FS mass (THP/digested)	ppd	24,559	25,241	29,586	27,283	28,074	33,114

Process assumptions:

Maximum month/annual average peaking factor = 1.16

ppd = pounds per day; TS = total solids; FOG = fats, oils, and grease; FS = food scraps; THP = thermal hydrolysis process.

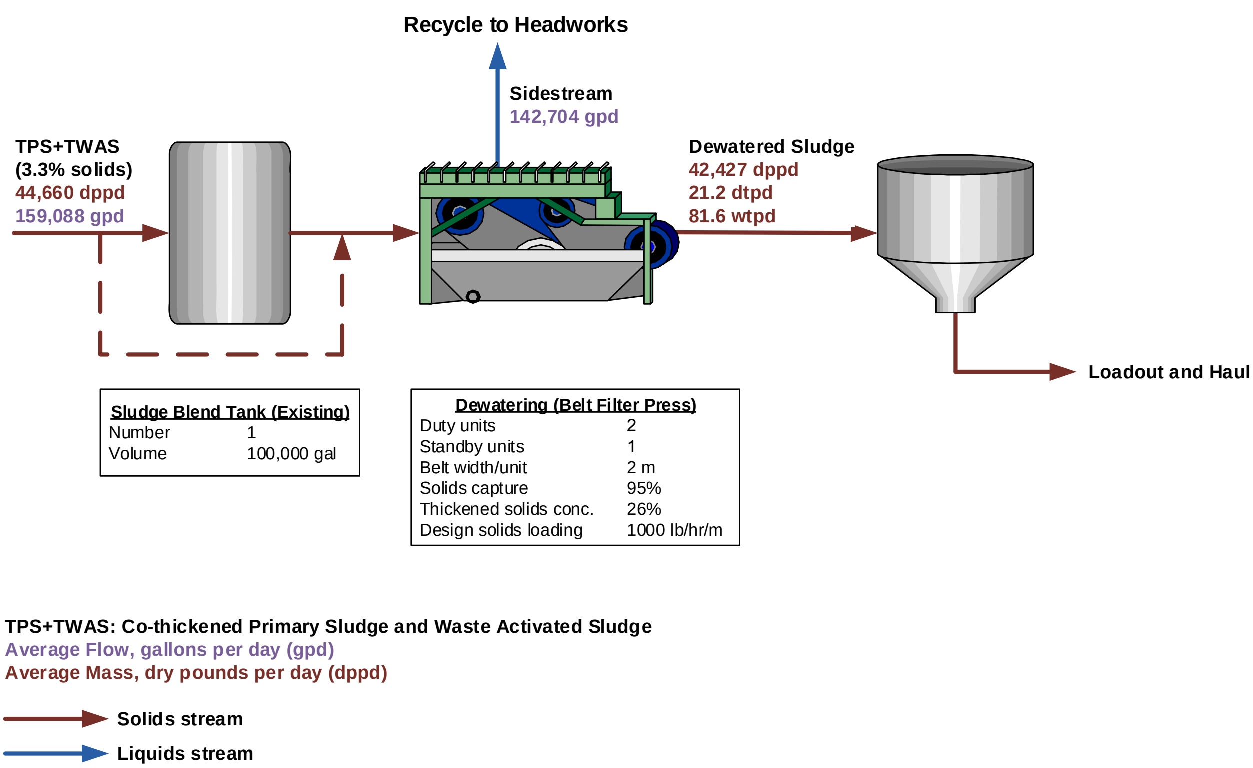
Process Description

New Dewatering/Truck Loadout Facility

PS and WAS are thickened in existing gravity thickeners to approximately 3 percent solids concentration. Thickened sludge is pumped via new thickened sludge pumps to the existing sludge blend tank. After the thickened sludge is blended, it is pumped to the new Dewatering/Truck Loadout Facility. There is provision to bypass the sludge blend tank to dewatering. Dewatered cake (undigested) is transferred via new screw conveyors to new cake storage bins for loadout. The new facility is designed to provide dewatering, storage, and loadout for thermal hydrolyzed and digested biosolids in the future. Refer to *Technical Memorandum 2: City of Palo Alto - Dewatering/Truck Loadout Facility, Preliminary Design Report for the Regional Water Quality Control Plant (RWQCP), Process Mechanical* (CH2M HILL, 2014).

Figure 1-1 shows the process flow diagram including mass/energy balance (for 2015 annual average condition) and key design criteria for the unit processes.

FIGURE 1-1
Process Flow Diagram for New Dewatering/Truck Loadout Facility Processing Raw Sludge
(CY = cubic yards; dppd = dry pounds per day; dtpd = dry tons per day; gpd = gallons per day; lb/hr/m = pounds per hour per meter; TPS = thickened primary sludge; TWAS = thickened waste activated sludge; wtpd = wet tons per day.)



Future Biosolids Processing Facilities including THP with MAD and Dewatering/Truck Loadout Facility

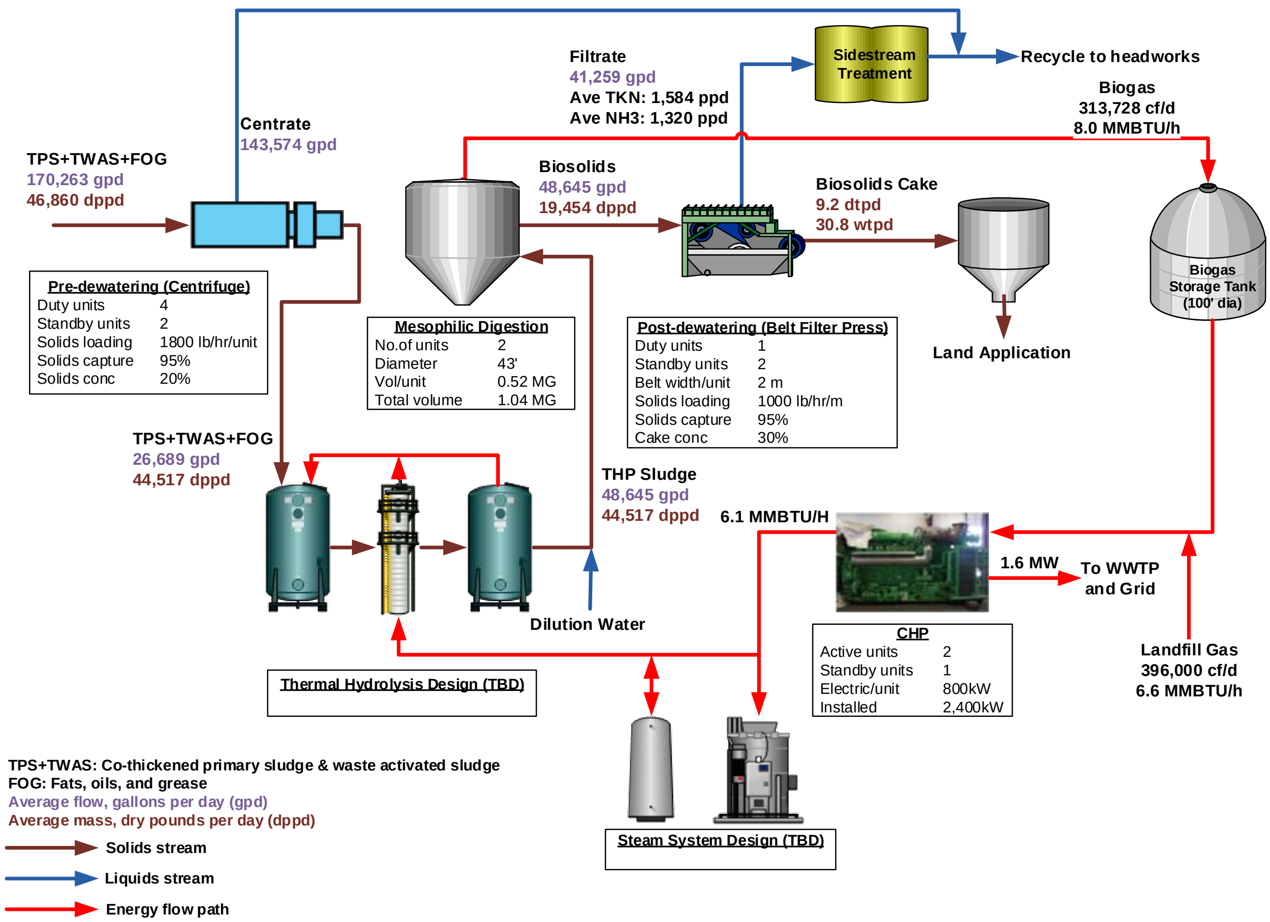
The future biosolids processing facility at the RWCQP is planned to include THP followed by MAD, and utilize the Dewatering/Truck Loadout Facility. PS, WAS, and FOG will be pre-dewatered together, and then undergo THP followed by MAD. If food waste is received by the plant in the future, the pre-processed food scraps would be combined with pre-dewatered PS, WAS, and FOG before being fed to THP. The digested solids are dewatered, and the resulting biosolids are a Class A product (exceptional quality). The biogas will be combined with landfill gas and routed to a combined heat and power system.

Figure 1-2 shows the process flow diagram including mass/energy balance (for 2015 annual average condition) and key design criteria for the unit processes. This does not include food scraps as it is a potential future process feedstock.

FIGURE 1-2

Process Flow Diagram for New Dewatering/Truck Loadout Facility with Future THP and MAD with Biogas-fueled CHP

(cf/d = cubic feet per day; CY = cubic yards; dppd = dry pounds per day; dtpd = dry tons per day; gpd = gallons per day; kW = kilowatts; lb/hr/m = pounds per hour per meter; m = meter; MG = million gallons; MMBtu/h = million British thermal units per hour; ppd = pounds per day; MW = megawatts; TKN = total Kjeldahl nitrogen, TPS = thickened primary sludge; TWAS = thickened waste activated sludge; wtpd = wet tons per day; WWTP = wastewater treatment plant.)



City of Palo Alto - Dewatering/Truck Loadout Facility

Preliminary Design Report for the Regional Water Quality Control Plant (RWQCP)

Process Mechanical

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PROJECT NUMBER:	468440

Introduction

This technical memorandum (TM) provides the basis for the unit process mechanical design for the proposed Dewatering/Truck Loadout Facility at the Palo Alto Regional Water Quality Control Plant (RWQCP). The basis of design presented with this TM is based on information from the *Draft Palo Alto Regional Water Quality Control Plant Biosolids Facility Plan* (Biosolids Facility Plan) (CH2M HILL, April 2014).

The proposed facility includes installation of three belt filter presses (BFPs), with space to install a future unit, to provide dewatering of undigested sludge (initial near-term design condition) as well as thermally hydrolyzed and digested biosolids (future long-term design condition). Additional unit process elements include conveyance of the dewatered cake to three storage bins, loading of the cake from the bins into trucks, and odor control (see Drawing 1, Dewatering Process Flow Diagram, and Drawing 2, Odor Control Process Flow Diagram, provided at the end of this Preliminary Design Report). The existing sludge blend tank will continue to be utilized. New dry polymer makedown systems and polymer solution feed pumps will be provided. A new scum concentrator will be provided in the Dewatering/Truck Loadout Facility to replace the existing unit.

Additional facility components include an electrical 12-kilovolt load center, backup diesel generator, and associated structural, mechanical, electrical, instrumentation and control (I&C), and heating, ventilating, and air conditioning systems (see Technical Memorandum (TM) 3: *City of Palo Alto – Dewatering/Truck Loadout Facility, Preliminary Design Report for the Regional Water Quality Control Plant (RWQCP), Combined Disciplines* (CH2M HILL, August 13, 2014).

The projected undigested sludge and biosolids production and the basis of design for the following mechanical features are discussed herein:

- Gravity thickeners (existing)
- BFP Feed Line and Blend Tank (existing)
- BFP feed pumps
- BFP dry polymer system and feed pumps
- BFPs
- Cake Conveyance System
- Dewatered Cake Storage Bins
- Scum Concentrator
- Odor Control

The basis of design information presented in this TM incorporates Palo Alto RWQCP staff input.

Belt Filter Press Requirements for Projected Undigested Sludge and Biosolids Production

The projected undigested sludge and biosolids production and corresponding BFP requirements are presented in Table 2-1 based on information from the Biosolids Facility Plan and *Technical Memorandum 1: City of Palo Alto – Dewatering/Truck Loadout Facility, Preliminary Design Report for the Regional Water Quality Control Plant (RWQCP)* (CH2M HILL, August 13, 2014).

The new Dewatering/Truck Loadout Facility will include dewatering, cake storage and truck loadout for the following two sludge/biosolids streams:

1. Near Term: Process a blended undigested primary sludge and trickling filter/waste activated sludge
2. Long Term: Process a thermal hydrolyzed anaerobically digested biosolids

TABLE 2-1

Projected Undigested Sludge and Biosolids Production and Belt Filter Press Requirements

Parameter	Units	2010	2015	2020	2025	2030	2035	2040	2045
Average TS Mass (Undigested)	**ppd**	**42,939**	**44,660**	**46,387**	**48,113**	**49,842**	**51,567**	**53,583**	**55,617**
BFP Meters Required – AA	meters	1.8	1.9	1.9	2.0	2.1	2.1	2.2	2.3
BFP Meters Required – MM	meters	2.1	2.1	2.2	2.3	2.4	2.5	2.6	2.7
BFP Meters Required – MW	meters	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.5
Average TS Mass (THP/Digested)	**ppd**	**18,704**	**19,454**	**20,206**	**20,958**	**21,711**	**22,463**	**23,341**	**24,227**
BFP Meters Required – MM	meters	0.9	0.9	1.0	1.0	1.0	1.1	1.1	1.2
BFP Meters Required – MW	meters	1.2	1.2	1.3	1.3	1.4	1.4	1.5	1.5
Average TS+FS Mass (THP/Digested)	**ppd**	**24,559**	**25,241**	**25,926**	**26,610**	**27,296**	**27,980**	**28,779**	**29,586**
BFP Meters Required – MM	meters	1.2	1.2	1.2	1.3	1.3	1.3	1.4	1.4
BFP Meters Required – MW	meters	1.5	1.6	1.6	1.7	1.7	1.7	1.8	1.8

MM/AA PF = 1.16
MW/AA PF = 1.5
BFP Design Loading Rate = 1,000 lb/h/m

AA = average annual; FS = food scraps; lb/h/m = pounds per hour per meter; MM = maximum month; MW = maximum week; PF = peaking factor; ppd = pounds per day; THP = thermal hydrolysis process; TS = total solids.

Existing Solids Processing Facilities Equipment Description

Primary sludge and trickling filter/waste activated sludge are co-thickened in two of four (one standby and one abandoned) gravity thickeners to approximately 3 percent solids concentration. The thickened sludge is pumped via progressing cavity pumps (two per thickener) to the blend tank (located outside the incinerator building) with a capacity of 100,000 gallons. The progressing cavity BFP feed pumps transfer the liquid sludge to three, 1.5-meter BFPs (28 years old), each with eight pressure rollers that dewater the undigested sludge to approximately 26 to 28 (27 average) percent solids concentration. Polymer use is very low at 2 to 4 pounds per dry ton (lb/dry ton).

BFP dewatered cake performance and low polymer dosing rate are a result of the following factors:

- Primary sludge dewaters better than waste activated sludge. The RWQCP primary sludge makes up 72 percent of the total sludge on a mass basis. Because the majority of the sludge is primary sludge, the polymer dosing rate is logically lower than normal.

- The RWQCP thickens the sludge to 3-4 percent dry solids before dewatering. The thickening process makes dewatering easier and therefore decreases polymer demand.
- The RWQCP liquid process is a fixed film/suspended growth system. The biological sludge from the RWQCP fixed film/suspended growth process tends to have a larger particle size and, therefore, dewaters better. Hence, this would have a positive effect on the polymer demand.

The dewatered sludge cake is transferred by screw conveyors, combined with a small scum sidestream, and then incinerated in multiple-hearth furnace incinerators. The existing scum concentrator will continue operation until shutdown of the existing Incineration Building, and a new concentrator will be located in the Dewatering/Truck Loadout Facility. The RWQCP processes approximately 18 dry tons per day and is permitted to process 32 dry tons per day in a single incinerator (with one redundant unit).

New Dewatering/Truck Loadout Facility Equipment Description and Sizing

Key equipment for the Dewatering/Truck Loadout Facility is presented below.

Gravity Thickeners

The three operational existing gravity thickeners (a fourth is abandoned) will continue to be used to co-thicken primary and waste activated sludge. The existing thickened sludge pumps (two per thickener) will be replaced with new similar pumps using the City's equipment replacement budget.

Belt Filter Press Feed Sludge Line and Blend Tank

The thickened sludge piping is routed in the pipe tunnel to the blend tank (located adjacent to the Incinerator Building) and to the existing BFPs in the Incinerator Building. The existing piping in the pipe tunnel will be kept in service and intact for this project, then reconfigured in the subsequent phase of the project to allow for demolition of the Incineration Building. As part of the future project to decommission and demolish the Incineration Building this piping will likely have to be replaced and rerouted.

The proposed thickened sludge transfer approach also includes keeping the existing 100,000-gallon blend tank (installed in 1999) in the current location and installing new feed lines, the first from the blend tank and the second to bypass the blend tank to the new dewatering facility. Currently, two 100 horsepower (hp) mixing pumps and one 40 hp blower with coarse bubble diffusers are used to mix the blend tank.

Scum Concentrator

A new scum concentrator will be installed in the new Dewatering/Truck Loadout Facility. The scum concentrator will be used to concentrate the scum to approximately 30 percent to 40 percent solids concentration. The concentrator will be sized similarly to the existing concentrator, for a peak feed rate of 75 gpm, and will include a primary concentration tank with skimmer mechanism, a thickened scum holding/heating tank, and a concentrated scum pump. Initially, the concentrated scum will be combined with the dewatered cake. Once thermal hydrolysis process/mesophilic anaerobic digestion (THP/MAD) is installed, scum will be blended with the thickened sludge upstream of THP and then hydrolyzed and anaerobically digested to extract its energy value.

The holding/heating tank will be heated with recirculated hot water using an integral heat exchange surface built into the tank. Once the future THP and anaerobic digestion process are constructed, hot water could be supplied from the planned combined heat and power (CHP) system. Prior to that, a small heating water boiler unit will be included in the Dewatering/Truck Loadout Facility to provide this function. The concentrated scum pump will be a progressing cavity style pump, similar to the existing scum pump.

Belt Filter Press Feed Pumps

The three existing BFP feed pumps will be replaced with new but larger BFP feed pumps and used to feed the undigested sludge (initially) and the thermally hydrolyzed digested biosolids (future) from the blend tank to the new BFPs. These will be progressing cavity type (similar to existing) and will be located outside on the existing pump foundations adjacent to the existing blend tank. New concrete pump pads will be needed. It is anticipated that the BFP feed pumps will be changed out one at a time during the construction phase to direct sludge pumping to the new dewatering facility while maintaining sludge pumping to the existing incinerator.

Variable frequency drives will be provided with these pumps to increase the operational flexibility. The BFP feed pumps will be sized at 1.3 times maximum month flow to meet the maximum week sludge production and to keep rotational speed less than 150 revolutions per minute to minimize long-term pump maintenance. The BFP feed pump design criteria are shown in Table 2-2.

TABLE 2-2
Belt Filter Press Feed Pumps—Design Criteria

Item	**Value**
Location	Outside (adjacent to existing blend tank)
Solids type	Initial: undigested thickened primary sludge and WAS Future: thermal hydrolyzed anaerobic digested biosolids
Feed solids concentration, %	Initial: 2 to 4 (average 3); future: 4 to 6 (average 5)
Number of units	Three (one for each operating BFP and space for one future)
Pump capacity, gpm	160 (1.30 times maximum flow of 120 gpm; normal flow is 80 to 120 (average 100)
Total dynamic head, feet	80 to 100 (estimated)
Horsepower	40 with variable frequency drives
Pump rotational speed (rpm)	Less than 150
Pump type	Progressing cavity
Manufacturers	Robbins & Myers (MOYNO), Netzsch

gpm = gallons per minute; rpm = revolutions per minute.

Belt Filter Press Dry Polymer System

A dry polymer feed system will be provided for the new BFPs and will be located in the polymer room on the first floor of the new Dewatering/Truck Loadout Facility. Big-bag (up to 3,000 pounds) sacks provided by the polymer vendor will be used to store concentrated dry polymer. The dry polymer system will make up polymer solution in two batches and will be transferred via two progressing cavity type transfer pumps to two polymer aging/feed tanks. Four polymer feed pumps (one for each BFP plus one standby) and three post-dilution systems (one for each BFP) will be provided. For dilution, plant process water (W4) at 80 pounds per square inch gauge (psig) will be utilized.

The polymer solution will be pumped by polymer feed pumps to the mixing valves located in the feed sludge line prior to flocculation tanks provided with each BFP. The polymer feed pumps will be paced based on the speed of the BFP feed pump providing sludge to the associated BFP for more accurate polymer feed control. Piping from the polymer feed pumps will provide the option of a least two injection points into the BFP feed pipe at a sludge/polymer mixing check valve prior to the flocculating tank, to optimize flocculation of the digested biosolids. A flocculation tank with a variable speed mixer will be provided for each BFP to allow additional time to mix the polymer with the sludge. The use of a flocculation tank has significantly reduced the amount of polymer needed at several European THP facilities since the THP/MAD material is quite thick and typically needs more time to react with the polymer. Flocculation tanks are being installed at the District of Columbia Water BFP Facility for THP/MAD material. The flocculation tank could also reduce the amount of polymer consumption for the raw sludge.

The dry polymer system will be sized based on 2020 undigested maximum month sludge production using a maximum polymer dose of 20 lb/dry ton and 2045 thermal hydrolyzed digested maximum month biosolids production based on a maximum polymer dose of 30 lb/dry ton based on performance data from European THP facilities using BFPs. The dry polymer system will also be sized with 10:1 turndown and polymer feed pumps for the initial 2015 undigested average annual sludge production using a 2 to 4 lb/dry ton. The proposed BFP dry polymer feed system design criteria are shown in Table 2-3.

TABLE 2-3
Belt Filter Press Polymer Feed System—Design Criteria

Item	Value
Location	Dewatering/Truck Loadout Facility – ground floor
Number of polymer solution feed pumps / post-dilution systems	Four pumps / 3 post dilution systems (space one future unit)
Active polymer content, percent	100
Polymer use, lb/dry ton	Initial: 2 to 4 current, 10 average, and 20 maximum for undigested primary and WAS; future: 20 average and 30 maximum for thermally hydrolyzed digested biosolids
Polymer use, pounds per day	Initial: 518 active pounds per day (22 pounds per hour) at 2015 maximum month undigested sludge production Future: 515 active pounds per day (22 pounds per hour) at 2045 maximum month sludge production
Polymer solution feed pump rate, gallons per minute diluted (assume 0.25 to 0.5% solution)	0.7 to 16 with 10:1 turndown
Dilution water (W4) rate, gallons per hour	300 to 3,000
Horsepower	3
Storage type	Big bags (up to 3,000 pounds)
Batch and aging/feed storage tank	Polypropylene
Volume of mixing and aging/feed storage tanks, gallons	1,500
Type of polymer transfer and feed pumps	Progressing cavity
Sludge/Polymer Mixing Devices	Sludge/Polymer Mixing Valve and Flocculation Tank with Mixer with VFD
Polymer system manufacturer and model no.	Velodyne Model D3000F with MS3000P polymer feed pumps, or equal

Belt Filter Presses

Three new 2-meter-wide, high-solids BFPs with 14 pressure rollers will be provided for dewatering undigested sludge (initially) and biosolids (future), and will be operated 24 hours per day, 7 days per week. The number and size of the BFPs is based on providing two operating and one standby 2-meter wide presses to process year 2020 maximum month/maximum week undigested sludge production (see requirement for 2.2/2.9 meters of BFP width in Table 2-1). In the future, one operating and two standby presses will be used to dewater year 2045 maximum month/maximum week production of thermally hydrolyzed digested biosolids including food scraps (see requirement for 1.4/1.8 meters of BFP width in Table 2-1).

BFPs are successfully used to dewater thermally hydrolyzed digested biosolids throughout Europe. BFPs can achieve equal to or greater cake solids concentration compared to centrifuges with much lower power and polymer consumption. The typical cake solids concentration achieved by BFPs on thermally hydrolyzed digested biosolids is 28 to 32 percent (average of 30 percent), although some BFPs have achieved 34 to 35 percent cake solids on this material. BFPs produce a much more granular cake solids material from thermally hydrolyzed digested biosolids compared to centrifuges that should result in a superior Class A product for use for soil blending, land reclamation, and/or agricultural land application.

The industry has standardized around 2-meter BFPs and the capital cost for a 2-meter-wide BFP is only slightly more than the capital cost of 1.5-meter-wide BFPs. The arrangement of the BFPs in the new building was based on an evaluation of the space requirements for BFP models from various manufacturers. This included space for future installation of one additional BFP. Critical to this arrangement was maintaining a vertical chute at the discharge of each BFP to the intake of the screw conveyors and access to the BFPs and screw conveyors for anticipated maintenance.

Initial screening of candidate BFP vendors based on experience, BFP configuration (including number of rollers), and performance guarantees on recent projects led to a short list of two manufacturers, Andritz and Ashbrook, and specific models. Critical to the performance of BFPs is the amount of surface area in the gravity, wedge, and pressure zones. Typically, the larger the surface area, the drier the cake solids concentration produced. The new BFPs with larger gravity and wedge zones and 14 rollers (versus 8 on the existing BFPs) should produce a drier cake solids concentration. A summary of BFP performance criteria considered in this evaluation are shown in Table 2-4.

TABLE 2-4
Belt Filter Press Gravity, Wedge, and Pressure Zone Areas

Belt Filter Presses – Design Criteria	Ashbrook HS 2.0 Winklepress Model 97 (WK) - 14 Rollers	Andritz SMX-S14 - 14 Rollers
Gravity Zone (square feet)	108	91
Wedge Zone (square feet)	84	155
Pressure Zone (square feet)	234	177
Total	426	456
Suggested minimum in specification	426	

The design criteria for the BFPs are shown in Table 2-5.

TABLE 2-5
Belt Filter Presses—Design Criteria

Item	Value
Location	Dewatering/Truck Loadout Facility—second floor
Biosolids feed (initial), percent	Undigested primary and WAS: 2 to 4 (3 average)
Biosolids feed (future), percent	Thermal hydrolyzed digested biosolids: 4 to 6 (5 average)
Number of units	3 + space for future fourth unit
Hydraulic loading, gallons per minute	Initial: 65 to 100 (average 83); future: 100 to 140 (average 120)
Solids loading, pounds per hour	Initial: 1,000 to 1,500 (average 1,250) at 3% solids; future: 2,500 to 3,500 (average 3,000) at 5% solids
Dewatered cake, %	Initial: 26 to 30 (average 28); future: 28 to 32 (average 30)
Minimum solids capture efficiency, %	94
Minimum polymer dosage, lb/dry ton	Initial: current 2 to 4; average: 20; future: 20
Maximum polymer dosage, lb/dry ton	Initial: 20; future: 30
Upper drive, hp	3
Lower drive, hp	3
Belt washwater (W4) pump	Manufacturer to provide booster pump (80 psig W4 supply)
Model	Ashbrook HS 2.0 Winklepress 97, Andritz SMX-14

The filtrate from the BFPs will flow by gravity to the existing drain system, which will transfer the filtrate to the head of the RWQCP for treatment. The dewatered cake will be discharged via a vertical side hopper to a series of screw conveyors, which are located on the second floor of the Dewatering/Truck Loadout Facility. BFP spare parts storage including a rack for roller storage is provided via fenced enclosures on the first floor. The BFP washwater booster pumps will be located on the second floor adjacent to the BFPs.

One concern with using BFPs to dewater thermally hydrolyzed biosolids is the high (typically 80 to 120 parts per million) concentrations of ammonia that are typically generated above the BFP head space (ammonia is lighter than air). The principal concern with the ammonia is worker safety when working around the BFP units (not offsite odor). It is assumed that the entire BFP room will be ventilated at 8-12 air changes per hour (ACH) to control odor and to address this issue. As an alternative, enclosures could be included with each BFP to reduce the amount of foul air to be treated (as installed at the District of Columbia Water and Sewer Authority Blue Plains Advanced Wastewater Treatment Plant and used at many European THP installations to dewater thermally hydrolyzed digester biosolids). The majority of the BFP maintenance is performed outside of the enclosures. Integral BFP enclosures and larger glass enclosures that surround the BFP should be evaluated during the design phase of the project.

Cake Conveyance System

Enclosed horizontal collection screw conveyors will be used to transfer the dewatered cake from the BFPs to enclosed inclined transfer screw conveyors. The transfer screw conveyors will transfer the material either directly to Storage Bins 1 and 3 or to the enclosed horizontal, reversible, crossover screw conveyor that will discharge the material into the cake Storage Bin 2 using a motor operated slide gate. The troughs and screw will be manufactured of type 304 stainless steel for corrosion resistance. The design will include the flexibility of conveying dewatered cake from any one of three BFPs to any one of three cake storage bins. In addition, two motor-operated slide gates on the crossover screw conveyor will be provided to drop chutes in order to bypass the cake bins and discharge directly to loadout trucks during bin maintenance.

Screw conveyors are simple, reliable, and proven and have been used extensively for transferring dewatered cake. They are currently used at the RWQCP. Screw conveyors are enclosed for easy odor control and housekeeping. They can be reliable with proper operation and maintenance. If kept to less than a 15 degree incline, screw conveyors do not significantly alter the cake consistency. Conservative sizing criteria have been used for the screw conveyors (maximum trough fill of 10 percent and slow rotating speeds) to reduce these issues. Spare parts for each screw conveyor (including bearings, motors, and spare screws) will be provided to minimize downtime. The screw conveyor design criteria are summarized in Table 2-6.

TABLE 2-6
Screw Conveyor—Design Criteria

Item	Value
Location	Adjacent to BFPs; exterior, above the cake storage bins
Cake solids concentration, %	28 to 32
Number of units	Five (two horizontal collection, two inclined transfer, and one reversible crossover)
Capacity, cubic feet per hour	500 at maximum of 10% trough fill factor
Screw diameter, inches	18
Horsepower	5 for horizontal collection; 7.5 for inclined transfer; 5 for horizontal reversible crossover
Conveyor type	Shafted or shaftless
Trough and screw materials of construction	Type 304 stainless steel
Number of motor-operated slide gates on crossover conveyor	Five
Manufacturer	RDP Technologies, Custom Conveyor, Spirac, or JDV

Dewatered Cake Storage Bins

Three elevated cake storage bins will be provided for storage of the dewatered cake before loading into trucks. Cake storage bins are proven, can be reliable with proper operation and maintenance, and allow for easy odor control. The storage bins will be located along the north side of the Dewatering/Truck Loadout Facility. The three cake storage bins are sized to provide 2 days of storage for annual average dewatered cake production of the undigested sludge (initial) and 3 days of storage for annual average dewatered cake production conditions of future THP/mesophilic anaerobic digestion biosolids material. Bins are proposed to be constructed of A-36 structural steel with three-layer epoxy paint coating. During final design, tank construction alternatives should be evaluated including bolted steel with fusion bonded epoxy coating and stainless steel (eliminates factory and field finishing and future recoating by the City).

The cake storage bins provide a wide spot and allow for decoupling of the dewatering and conveyance facility operation from the truck loading operation. A contractor will be providing the truck hauling services for the RWQCP and will typically have daily pickup in the morning hours (4 to 5 a.m.) to avoid Bay Area traffic congestion. The layout of the cake storage bins and the truck loading bay is estimated based on standard Travis Alumatech trailer specifications (41.33 feet length) provided by Synagro. During the course of design, other truck types will be considered to determine the final dimensions and bin spacing. Each cake storage bin is fitted with two discharge points (for a total of six) to provide even distribution of dewatered cake material along the trailer length without the need to move the trailer.

Each cake storage bin will be provided with a twin-screw conveyor “live bottom” discharger to facilitate removal of the dewatered cake from the bin. Alternatively the discharger could be provided as a sliding frame mechanism with a single screw conveyor. Two discharge gates will be provided on opposite ends of each live bottom mechanism, providing a total of six drop points along the length of the drive-through. Each discharge point will include an adjustable rubber chute between the bottom of the silos and the sludge hauling trucks that automatically adjust to the level of sludge cake material in the truck bed to prevent splashing and minimize washdown and housekeeping requirements. These adjustable chutes also include an odor extraction arrangement for easier odor control.

An automatic truck loading system will be provided to load a truck in 10 minutes (if all three bins are used) to 20 minutes (if two bins are used). Load cells mounted on each leg of the cake storage bins will be utilized to monitor bin inventory and discharge rate. An elevated platform will be provided in the drive-through bay including a truck loading system control panel to enable the operator to setup, initiate, and monitor the truck loadout process. Depending upon the size of the truck being loaded, the operator may discharge from two or three cake storage bins. The truck loading area will be surrounded by a curb to contain sludge that may drop on the floor. A washdown hose station will be provided to wash sludge to a trench drain located under the truck. The trench drain will be large enough to accommodate a shovel for cleaning, and discharge from the trench drain will be piped to the RWQCP main drain. The design criteria for the cake storage bins is shown in Table 2-7.

TABLE 2-7
Dewatered Cake Storage Bins—Design Criteria

Item	Value
Location	Exterior; north side of the Dewatering/Truck Loadout Facility
Number	Three
Volume of bin, cubic yards	55 each/165 total for three
Diameter, feet	14
Height, feet	16 usable/20 total
Power requirements, hp	56 total for each storage bin (two 25 hp discharge screw conveyor motors, and two 3 hp slide gate motors)—total of 168 hp for three bins
Bin materials of construction	A-36 structural steel with three-layer epoxy painted coating
Bin manufacturers	Schwing Bioset, Bioset Enviro or Custom Conveyor (live bottom)

Odor Control

Some biosolids processes emit odors that, if left unmitigated, pose a significant risk to offsite odor impacts as well as safety concerns at the source itself. As mentioned earlier, thermally hydrolyzed digested biosolids can produce very high ammonia levels at BFPs. Odor control will be provided for containing all significant odor sources, ventilating those sources to meet all applicable standards and requirements, and extracting and treating the odorous air in a robust and easy to operate treatment system. Odor control systems will be configured to achieve an odor goal at the plant fence line of 5 dilutions to threshold (D/T) and 99 percent compliance based on a 1 hour average, meeting the Bay Area Air Quality Management District (BAAQMD) regulatory requirement.

The following is a list of odor emission sources that will be ventilated and treated:

- Truck loadout bay: ventilated at 12 ACH
- BFP room: ventilated at 8–12 ACH (8 ACH if entire room ventilated and 12 ACH if glass enclosures provided)
- Cake storage bins: ventilated at 12 ACH
- Sludge blend tank: ventilated at 12 ACH
- Screw conveyors: ventilated to maintain a scour velocity of 500 feet per minute minimum or 12 ACH, whichever is greater

The selected treatment system includes a humidifier/ammonia scrubber, long-life engineered media biofilter, and dispersion stack. This system will accommodate both the short-term raw sludge dewatering and loadout as well as longer-term thermally hydrolyzed digested biosolids related odors. In addition, this technology approach is generally considered “green” when compared to other technologies, is considered a robust technology, is easy to operate, is familiar to City of Palo Alto staff, and handles complex odors well. Finally, this technology approach is considered BACT (Best Available Control Technology) and T-BACT (Best Available Control Technology for Toxics) according to BAAQMD Regulation 2, Rule 2, Section 206. This technology approach can be expanded to accommodate future THP unit processes. A detailed comparison of viable technologies considering both financial and non-financial criteria should be conducted during the design phase of the project.

The raw sludge dewatering and loadout odors will be generally characterized as hydrogen sulfide with other organic reduced sulfur compounds and are expected to be relatively strong. Conversely, the thermally hydrolyzed digested biosolids related odors will be generally characterized as high in ammonia but with weaker cake odors (based on research conducted on similar THP facilities). Areas represented as high odor strength sources will be treated in a pre-treatment ammonia scrubber/humidification system followed by a long-life engineered media biofilter and then discharged out a dispersion stack. Areas represented as lower odor strength sources (e.g., truck loadout bay) will be blended with treated biofilter discharge air and routed out the stack. This combination of vapor phase treatment plus dispersion provides a tailored robust approach at a reduced footprint and cost. Space should be made available for a future carbon system in case truck loadout odors are stronger than anticipated. Conversely, sodium hypochlorite can be dosed upstream of BFPs to depress odors (as is currently done) if odor levels prove higher than anticipated. Initially, humidification packed bed towers will be operated as humidification units only but will be provided with all required nozzles and accessories for converting the units into sulfuric acid ammonia scrubbers in the future if needed. Water only packed bed scrubbers can remove approximately 50 percent of ammonia while sulfuric acid scrubbers can remove greater than 98 percent of ammonia. Long-life engineered media biofilters require less footprint versus soil-based or organic-based biofilters; specific footprints are approximately one quarter the size of soil-based biofilters and one half the size of organic-based biofilter. The odor control facilities design criteria are summarized in Table 2-8.

TABLE 2-8
Odor Control Facilities—Design Criteria

Item	Value
Location	Adjacent to the Dewatering/Truck Loadout Facility
Type	Ammonia scrubber, long-life engineered media biofilter, dispersion stack
Foul air flow capacity (cubic feet per minute)	12,000 to be treated via biofilter; 7,000 exhausted out truck loadout bay; 19,000 to be discharged out stack
Biofilter size	25 feet by 40 feet per cell
Number of biofilter cells	Two
Depth of media, feet	5
Biofilter empty bed gas residence time, seconds	45 (minimum)
Biofilter media manufacturers	Biorem, ECS
Number of biofilter fans	Two (one duty, one standby)
Biofilter fan requirements, hp	25 each
Number of truck loadout fans	Two (one duty, one standby)
Truck loadout fan requirements, hp	7.5 each
Fan manufacturers	Hartzell, New York Blower

City of Palo Alto – Dewatering/Truck Loadout Facility

Preliminary Design Report for the Regional Water Quality Control Plant (RWQCP)

Combined Disciplines

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DATE:	August 13, 2014
PROJECT NUMBER:	468440

Introduction

This technical memorandum (TM) presents the design criteria and preliminary design considerations for the typical engineering disciplines excluding process engineering, which is discussed in *Technical Memorandum 2: City of Palo Alto – Dewatering/Truck Loadout Facility, Preliminary Design Report for the Regional Water Quality Control Plant (RWQCP), Process Mechanical* (CH2M HILL, August 13, 2014).

Drawing 3 presents the conceptual site plan and Drawing 4 presents the facility plans and section for the preliminary design of the Dewatering/Truck Loadout Facility (provided at the end of this Preliminary Design Report).

Architectural/Structural

The architectural/structural basis of design is based on information from the *Draft Palo Alto Regional Water Quality Control Plant Biosolids Facility Plan* (Biosolids Facility Plan) (CH2M HILL, April 2014).

The architectural design concept for the Dewatering/Truck Loadout Facility is to provide a functional structure that presents an image of quality and good design, using durable, low maintenance, and corrosion-resistant materials. The new facility will be designed to be code-compliant and to present an architectural image that fits within the context of the site. Facility height is designed to be a maximum of 50 feet to comply with current zoning requirements.

Codes and Standards

The strength, serviceability, and quality of materials used to construct the project will be designed to meet the requirements of the following codes and standards:

- 2013 California Building Code (CBC), Part 2 of Title 24
- 2013 California Fire Code (CFC), Part 9 of Title 24
- 2013 California Energy Conservation Code (CEC), Part 6 of Title 24
- 2013 California Green Buildings Standards Code (CalGreen), Part 11 of Title 24

- National Fire Protection Association (NFPA) 820 : Standard for Fire Protection in Wastewater Treatment and Collection Facilities
- California Occupational Safety and Health Administration (CALOHSA)

Overview of Facilities

The design program for this building includes installation of three belt filter presses (BFPs) with space to install a future unit to provide dewatering of raw sludge (initial) and thermal hydrolysis digested biosolids (future), conveyance of the resulting cake to three storage bins, loading of the cake from the bins into trucks in a new Dewatering/Truck Loadout Facility with a robust system for odor control.

The new Dewatering/Truck Loadout Facility building will be a two story, cast-in-place concrete structure and contain space for truck loadout, HVAC room, polymer storage, electrical room, belt filter press area, and other miscellaneous support areas. The structure will consist of an auger-cast pile foundation system and concrete structural floor slab. The walls will be constructed of an appropriate system for a facility of this kind. The roof will be a membrane type roofing over rigid insulation on the roof structure. Removable skylights will be provided over the BFPs for the purpose of facilitating future removal/replacement, and to facilitate the future installation of the fourth BFP. These skylights will also provide light into the room, reducing the need for electric lights during the daytime.

It still needs to be determined if the dewatered cake storage bins will be self-supported or supported from the roof of the drive-through bay. This will need to be coordinated with the manufacturer and the type of building structure as part of final design. Additionally, the access walkway for the cake storage bins will either need to be supported from the hopper superstructure or the building itself.

Preliminary Code Analysis

- Occupancy: Group F-2
- Construction Type: IIB (non-combustible; sprinklered)
- Allowable Area, Height, and Number of Stories: 23,000 sf, 55 ft, 3 stories.
- Actual Area, Height, and Number of Stories: 10,200 sf, 50 ft, 2 stories.

Tunnel

The pipe tunnel that runs to the existing Incineration Building lies directly below the proposed Dewatering/Truck Loadout Facility location. The pile foundation system will allow the structure to be constructed over the top of the existing tunnel in a manner that will not place any additional stresses on the tunnel, and will allow it to remain in use. The floor system will utilize a system of concrete grade beams and slabs spanning over the tunnel. A void form will be placed on top of the tunnel lid. The void form will allow the two structures (new Dewatering/Truck Loadout Facility and existing tunnel) to act independently from each other. It is anticipated that the void will be up to 12 inches deep and that the floor structure will be up to 2 feet 0 inches thick. This will place the finished floor up to 3 feet 0 inches above the top of the existing tunnel lid, or approximately 2 feet 0 inches higher than existing grade.

Accessibility

The new Dewatering/Truck Loadout Facility will be designed to meet the requirements of the Chapter 11 of the CBC.

Major Exterior Systems

Exterior surfaces and finishes will be selected for low maintenance and corrosion resistance. Major components will be as follows:

- Roof – Single-ply membrane roofing over rigid insulation on metal deck.
- Walls– Exterior walls will be designed to meet the project requirements as established. Options for walls include cast-in-place concrete, load bearing CMU, and precast concrete panels supported from steel frame structure. These options and other combinations of materials will be considered and evaluated during final design. Walls will be insulated as required to comply with the California Energy Code.

- Doors and Frames – Steel hollow metal with galvanize coating, factory primer and field paint. Facility entry will have aluminum storefront with anodized finish.
- Door Hardware – Heavy-duty mortise type; stainless steel. Panic devices at electrical room. Access control will be provided at main entry to the building. All doors to have door position switches.
- Overhead Coiling Doors – galvanized steel with polyvinylidene fluoride factory finish. Operation to be motorized.
- Windows – Aluminum with double-pane insulated glass and Low-E coating.
- Louvers – Drainable blade type with insect screen, aluminum with factory finish.
- Signage – Selected exterior doors will have door signs; hazardous material signs will be provided as required by code.
- Colors – Color scheme to be determined.

Major Interior Systems

Interior surfaces and finishes will be selected for appropriateness to the individual spaces. Consideration will be given to the need for washdown, corrosion resistance, slip resistance, light reflectance, comfort, and maintenance. Major components will be as follows:

- Floors – Concrete with appropriate finish:
  - Resilient flooring in Control Room and Sample Test Area
  - Clear hardener in areas subject to vehicular traffic
  - Clear sealer at dry work areas.
- Walls (Process Areas) – Painted.
- Walls (Non-process Areas) – Painted gypsum wallboard over metal stud furring.
- Ceilings –Epoxy painted metal structure and metal deck at industrial spaces. Suspended 2x2 acoustical ceiling in Control Room, Entry Hallway, and Sample Test Area.
- Doors and Frames – Steel hollow metal with galvanized coating, factory primer and field paint.
- Safety Equipment – fire extinguishers will be located near egress doors, a first-aid cabinet will be provided at a central location, and hearing protection kits will be provided at all building entrances.
- Signage – selected rooms will be provided with door nameplates; hazardous material signs will be provided, as required by code.

Site/Civil

The site will include an electrical generator and transformer located adjacent to the facility to the east. A new odor control facility will be located to the east of the generator / transformer area.

The site is located adjacent to the existing grit building to the south, paved access roads to the west and north, and undeveloped land to the east currently planned for plant expansion.

An existing process utilities tunnel crosses the site through the area of the proposed structure.

Refer to Drawing 3, Conceptual Site Plan, for the proposed site configuration. The area of the proposed site, including the area for the new generator/ transformer and odor control building is approximately 0.40 acre.

Facilities Configuration

The footprint positions the dewatered cake storage bins on the north side of the building, parallel to the facilities access road. A paved entry and exit haul truck lane will be routed through the cake storage bin drive-through bay area off the south side of the plant access road. Road radii will be designed to allow for safe turning.

Grading and Stormwater

The finished floor elevation for the Dewatering/Truck Loadout Facility will be a minimum of 3 feet above the top of the existing process utilities tunnel and at an elevation that creates positive slope away from the building. It is anticipated that existing grade is 12 inches above the top of the existing utilities tunnel. It will be required to build-up grade in the area of the tunnel to match new finished floor elevation.

Surface rain water will sheet-flow away the building in the direction of the existing stormwater collection system. Roof drainage will discharge to ground on splash blocks or hard piped to an existing collection system. The truck drive-through bay entry and exit access lane will slope away at a maximum grade of 2 percent.

Pavement

The pavement for the loadout bay entry and exit access lane will be reinforced concrete with doweled joints. Sidewalks will be Portland cement concrete.

Site Utilities

Excluding the facility process lines, civil site utilities will include potable and non-potable water, fire protection, sanitary sewer and stormwater. New utilities in the area of the existing utility tunnel will be coordinated and routed in a manner that eliminates conflicts and allows for proper access to the process system.

Fencing and Bollards

No fencing is required. Bollards will be used throughout the site for protection from accidental damage.

Erosion Control

California Best Management Practices for control of erosion and sediment transfer will be used throughout project construction.

Codes and Standards

- California Building Code (BSC), Title 24.
- State of California, Caltrans – Standard Specification, current edition.
- State of California, Erosion and Sediment Control, Best Practices (BMPs).

HVAC Design Approach

BFP Room

The BFP Room ventilation system will be configured to makeup the air removed from the space by the odor control systems and to satisfy the push-pull requirements of NFPA 820. The system will consist of a makeup air unit mounted in the HVAC Room to provide filtered makeup air to the space. Cooling for this space will be provided by ventilation only. Supplemental heating and cooling will not be provided.

Electrical Room

The Electrical Room ventilation system will be configured to provide cooling for the electrical equipment. The system will consist of an air handling unit with the capability for full outside economization mounted in the HVAC Room. Cooling for this space will be provided by either chilled water or DX refrigeration. Supplemental heating will not be provided. Cooling will be provided by an air cooled chiller or remote condensing unit.

Polymer Room

This ventilation system will be configured to provide cooling for the process equipment and to provide a minimal air change rate. The system will consist of a makeup air unit mounted in the HVAC Room to provide filtered makeup air to the space. Cooling for this space will be provided by ventilation only. Supplemental heating and cooling will not be provided. An exhaust fan will be provided to exhaust this room.

Truck Drive-Through

The Truck Drive-Through ventilation system will be configured to makeup the air removed from the space by the odor control systems and to satisfy the push-pull requirements of NFPA 820. The system will consist of a makeup air unit mounted in the HVAC Room to provide filtered makeup air to the space. Cooling for this space will be provided by ventilation only. Supplemental heating and cooling will not be provided.

Scum, Hot Water System, and Washwater Booster Pump Room

This ventilation system will be configured to provide cooling for the process equipment and to provide a minimal air change rate. The system will consist of a makeup air unit mounted in the HVAC Room to provide filtered makeup air to the space. Cooling for this space will be provided by ventilation only. Supplemental heating and cooling will not be provided. An exhaust fan will be provided to exhaust this room.

Control Room and Sample Test Area

The ventilation system for the Control Room will be configured to provide full air conditioning and code required outside air ventilation rates. The system will consist of a heat pump type air handling unit with the capability for full outside economization located in the HVAC Room.

The Sample Test Area will be ventilated with outside air to provide cooling and to make up exhaust taken from the sample test area.

HVAC Room

This ventilation system will be configured to provide cooling for the HVAC equipment and to provide a minimal air change rate. The system will consist of a makeup air unit mounted in the HVAC Room to provide filtered makeup air to the space. Cooling for this space will be provided by ventilation only. Supplemental heating and cooling will not be provided.

Fire Protection Design Approach

Fire Suppression Sprinkler Systems

The current facility size and occupancy does not require automatic fire suppression sprinkler systems. An increase in the facility size to more than 12,000 square feet would require the installation of an automatic fire suppression sprinkler system.

Fire Hydrant Coverage

This facility is required to be provided with yard hydrant coverage. In a facility of Type IIB construction and building area ranging from 9,801 to 12,600 square feet, the required yard hydrant spacing is 450 feet maximum average or as required by the Authority Having Jurisdiction, whichever is more stringent, and without automatic fire sprinklers within the facility, a minimum total of 2,250 gallons per minute of water will be required to be delivered from three separate fire hydrants for a duration of not less than 2 hours. All three of these hydrants would be required to be located in proximity to this facility. There is only one existing hydrant close enough to qualify for usage. Two additional hydrants will be required to be installed unless automatic fire suppression sprinklers are added to the facility. The availability of water for hydrant protection will have to be verified.

If the building size were increased to greater than 12,000 square feet, it would be required to be provided with automatic fire sprinklers and the hydrant requirement would be reduced to not less 1,500 gallons per minute for a duration of 2 hours and could be provided from a single yard hydrant.

Fire Alarm Systems

The current facility does not require a fire alarm system based upon facility size, occupancy, or occupant load. A fire alarm system will be provided for this facility to provide the required NFPA 72 supervised signaling required under the provisions of NFPA 820.

NFPA 820 Requirements

Supervised Signaling

Chapter 7 of NFPA 820 requires remote monitoring of NFPA 820 required ventilation and gas detection systems. HVAC equipment associated with the required ventilation will be monitored for proper operation and provided through the plant SCADA system.

Remote Monitoring

Chapter 7 of NFPA 820 requires remote alarm indication for ventilation failure and gas detection alarms. The environmental monitoring system will provide an interface to the plant SCADA system for transmission of both a system alarm and a system trouble condition for remote annunciation.

Space and Entry Alarms

Chapter 7 of NFPA 820 requires both space and entry alarms for ventilation failure and gas detection conditions. The interior alarms will be both audible and visual. The entry alarms can be a go/no-go type warning light system. The alarms will be active at any time that the ventilation systems are not properly functioning and upon gas detection or gas detector failure.

Electrical

This section discusses electrical design scope and criteria to be used for final design of the City of Palo Alto – Dewatering/Truck Loadout Facility for the Palo Alto Regional Water Quality Control Plant (RWQCP).

Existing Infrastructure/Systems

15-kilovolt Primary Voltage Distribution System. Service to the plant is provided and metered by Palo Alto Utilities Department by means of dual (redundant) medium voltage feeders that distribute power via a 15-kilovolt (kV) loop throughout the site. Various pad-mounted switches then provide for feeders to individual facilities where they are transformed to low voltage distribution equipment to power facility and process loads.

Existing Facilities and Equipment that Require Modification. The existing Solids Incineration Building is planned to be decommissioned and demolished at a future time and under a separate project. The following facilities and equipment are currently fed from the Solids Incineration Building electrical system and will need to be re-fed and connected to the Dewatering/Truck Loadout Facility electrical system under this project prior to decommissioning and demolition of the Solids Incineration Building:

1. Maintenance Building & Warehouse Facility: A new 400 amp, 480 volt feeder circuit breaker will be provided in the new Dewatering/Truck Loadout Facility main motor control center (MCC). Conduits from the MCC will be stubbed beyond the facility footings and capped for future extension of a new concrete encased feeder to the Maintenance Building & Warehouse Facility under a future separate project.
2. Chlorination Station Facility: A new 600 amp, 480 volt feeder circuit breaker will be provided in the new Dewatering/Truck Loadout Facility main MCC. Conduits from the MCC will be stubbed beyond the facility footings and capped for future extension of a new concrete encased feeder to the Chlorination Station Facility under a future separate project.
3. Blend Tank Pumping Equipment: New motor controllers, control circuits, and motor feeders are required for each of the blend tank pumping equipment items.

Project Electrical Scope

Dewatering Building Main Electrical Power. A new pad-mounted, 15-kV, 4-way switch will be provided to replace the existing 3-way switch SW1594X near the Recycled Water Plant. A new oil-filled, pad-mounted transformer with integral primary fused switch and 480Y/277-volt (V), 3-phase, 4-wire secondary windings will be provided near the Dewatering/Truck Loadout Facility to feed the Dewatering/Truck Loadout Facility electrical distribution system. The transformer will be sized to accommodate all Dewatering/Truck Loadout Facility project loads as well as all existing facility loads associated with feeding of the Maintenance Building/Warehouse Facility, the Chlorination Station Facility, and the Blend Tank Pumping Equipment, plus an additional 30 percent spare future capacity. A new 15-kV feeder will be routed from the new 4-way, pad-mounted switch SW1594X to the pad-mounted transformer at the new Dewatering Building to supply primary voltage to the transformer.

Standby Power. A permanently installed standby diesel engine generator set sized to provide backup of the electrical system will be provided in a weatherproof enclosure in the vicinity of the Dewatering/Truck Loadout Facility. The generator will be sized to handle 100 percent of the loads for the Dewatering/Truck Loadout Facility as well as 100 percent of the loads to the existing facilities powered from the Dewatering/Truck Loadout Facility including the Maintenance Building/Warehouse Facility, Chlorination Station Facility, and the Blend Tank Pumping Equipment, plus 30 percent spare future capacity. The generator will also be sized to accommodate all potential motor starting scenarios and harmonic issues that may be possible at the facility main bus. A permanently installed load bank will be provided and installed near the generator for periodic generator testing. The load bank will be sized for 100 percent of the generator capacity. Fuel storage will be provided by means of a sub-base fuel tank and will be sufficient to satisfy the owner’s standard 24 hour run time hours of full load generator operation. The generator circuit breaker will be an electronic breaker with long-time, short-time, instantaneous, ground fault (LSIG) trip and will selectively coordinate with Dewatering/Truck Loadout Facility downstream electrical distribution equipment over current protective devices. The generator will be provided with a remote shutdown switch for code compliance and to enhance safety due to potential arc flash hazards. The transfer scheme will include fully automatic start up and power transfer to the generator source upon utility source failure with manual-only retransfer back to utility power source initiated by plant operators by means of a toggle switch control station. The generator control system will include full Ethernet capabilities for monitoring engine/generator parameters through the plant SCADA system.

Facility Electrical Distribution System. The service entrance rated automatic transfer switch (ATS) and motor control center that will be provided are described below.

Service Entrance Rated ATS. A 4-pole service entrance rated ATS will be provided with integral normal power main circuit breaker and will have the integral capability to lock out both normal and standby source incoming power. The normal power main circuit breaker will be an electronic breaker with LSIG and be capable of being electrically operated from a remote location to enhance safety due to potential arc flash hazards. The circuit breaker will also be provided with a remotely activated arc flash maintenance mode system complete with audible and visual annunciation to modify the breaker’s trip settings to minimize available arc flash incident energy during times when maintenance/testing must be performed on electrical equipment while energized. The ATS will feed the facility MCC. Windows will be placed on the ATS enclosure for viewing critical bus connections and for infrared scan testing without opening the enclosure. The ATS will be capable of fully automatic transfer from utility power to standby power as well as from standby power back to utility power even though the owner has elected to utilize manual toggle switch retransfer back to utility power.

MCC. A main MCC will be provided with 480Y/277-V, 3-phase, 4-wire main incoming connections to feed all other facility equipment and loads as well as the existing facilities and equipment indicated above. The main facility MCC will include integral feeder circuit breakers as required to feed various project loads, a main surge protective device (SPD) and control units (motor starters, variable frequency drives [VFDs], electronic soft starters, etc.) as required by the process equipment. At the designers’ discretion, the MCC may also include other integrally-mounted items such as transformers, panelboards, reactors, filters, terminal enclosures, etc., or, these additional items can be individually-mounted separately from the MCC. Windows will be placed on the MCC enclosure for viewing critical main incoming bus connections and for infrared scan testing without opening the enclosure. Main and feeder circuit breakers 400 amp and larger will be electronic trip with LSIG. Re-feed of existing equipment and project loads and circuits will be provided as follows:

- **Re-feed Existing Equipment:** The main facility MCC will provide overcurrent protection for feeders and control for equipment control circuits as required to operate the existing facilities and equipment indicated above. Underground feeders will be provided in concrete encased duct banks.
- **Project Loads and Circuits:** The facility distribution system will supply power for all facility loads including power and control for process equipment; heating, ventilation, and air conditioning (HVAC) equipment; lighting and lighting controls; monitoring and alarms; and other facility loads. Appropriate control devices and circuits, panelboards, transformers, etc., will be provided and housed in the facility main electrical room unless mounting location is determined to be more appropriate outside the electrical room for some specific items.

Alternative Evaluation Option—Provision of Electrical Power to Existing Facilities

An analysis will be performed for the following alternate scenario to re-feed power to the existing facilities indicated above:

> Remote mounting of Blend Tank Pumping Equipment VFDs: The existing blend tank pumping equipment items are reasonably close to the Dewatering/Loadout Facility and new power and control supply circuit lengths should be acceptable for connection to the Dewatering/Truck Loadout Facility electrical equipment without excessive oversizing of conductors due to voltage drop. Even so, the circuit lengths should be evaluated for potential standing wave issues where equipment is fed by VFDs and an analysis should be provided for mounting the VFDs closer to the motors to eliminate standing wave issues in motor feeders if they are found to be significant.

Applicable Codes, Standards, and Regulations

The following codes and standards apply:

- California Title 24
- Illuminating Engineering Society (IES)
- Institute of Electronics and Electrical Engineers (IEEE)
- International Fire Code (IFC)
- National Electrical Code (NEC), 201, (as amended by the 2013 California Electrical Code)
- National Electrical Manufacturers Association (NEMA)
- National Fire Protection Association (NFPA) 101-HB 85: Life Safety Code, 2012
- NFPA 820: Standard for Fire Protection in Wastewater Treatment and Collection Facilities
- Occupational Safety and Health Administration (OSHA)
- Underwriters Laboratories, Inc. (UL)

Design Criteria

Basic Goals. The basic goals of the design criteria are as follows:

1. Develop robust, safe, reliable, and maintainable electrical systems.
2. Promote a consistent and uniform design approach and standardize the types and quality level of equipment specified.
3. Establish a uniform basis for specifications and drawings.
4. Provide a means of incorporating client input on items of preference and experience.

Code Issues. Sizing of the Dewatering/Truck Loadout Facility Electrical Room must be verified once all equipment served by the Dewatering/Truck Loadout Facility electrical system has been identified and sized, the building supply and generator have been sized, and all control devices (VFDs, motor starters, control panels, etc.) are known. Minimum clearances between enclosures will be strictly maintained as indicated in NEC 110 and, where possible, larger clearances (5 feet or so where possible) from equipment enclosure front panels will be provided to enhance safety and viable working space.

Basis of Design

General Electrical

Hazardous and Corrosive Area Definition

It is anticipated that all building spaces will be unclassified either by definition or by HVAC air changes per NFPA 820. It is anticipated that no building space will be classified as highly corrosive. Verify and confirm classifications during final design as the design unfolds and provide equipment and wiring methods accordingly.

Listed and Labeled Equipment

Electrical equipment, materials, or services to be provided will have an attached label, symbol, or other identifying mark of an organization that is concerned with product evaluation, compliance with appropriate standards, and performance of the equipment. Typically, this is the UL label/listing or similar agency approved by the NEC and local authorities having jurisdiction. In situations where a UL (or other approved agency) label or listing cannot be provided for equipment because of a lack of UL standards, then testing will be performed by an organization that is acceptable to the authority having jurisdiction.

Metering

Provide an integrally mounted digital power monitor/meter, Electro Industries Nexus 1500 (sole source, no substitutes), in the MCC. Install the meter current transformers (CTs) to read power on the incoming main buss of the MCC. Provide a meter with compatible network communication protocol for programmable logic controller (PLC)/supervisory control and data acquisition (SCADA) system communications.

Panelboards

New panelboards will be suitable for use at industrial facilities, with copper bussing, molded case breakers, and integral surge protection devices. Panelboards mounted in dry locations will be provided with door-in-door covers. Circuit breakers 400 amps and larger will be electronic trip with LSIG.

Motor Control

Motors will be controlled either by full voltage across the line starters with integral motor circuit protector disconnects, or with VFDs with thermal magnetic circuit breaker disconnects. Starters and VFDs of 125 horsepower (hp) and less will generally be placed in MCC buckets. For starters larger than NEMA size 3 (50 hp), solid-state reduced voltage starters (soft-start) will be provided. MCCs will be connected to the plant PLCs for control and monitoring.

Large VFDs will be separately mounted in stand-alone enclosures, located in the electrical room (unless a specific requirement exists dictating they should be mounted near the driven equipment).

VFDs will be provided with line and load reactors where motor feeder lengths are less than 100 cable feet. DV/DT filters will be considered where longer motor circuit cable runs are anticipated to eliminate the damaging influences of cumulative standing wave effects. Drives greater than 30 hp will be provided with passive harmonic filters or other appropriate technology for mitigation of cumulative harmonics on the main facility bus.

Equipment Identification

Instrumentation and control (I&C) tag numbers from process and instrumentation diagrams will be used for motors, I&C devices, and other process equipment shown on electrical drawings.

This same numbering method will be used to create unique tags for major electrical distribution equipment including switchboards, generator, ATSs, panelboards, transformers, disconnect switches, control panels, VFDs, motor starters, and other equipment in separately-mounted enclosures.

Raceway Systems

Separate duct banks and manhole networks will be used for the following systems:

- 12-kV power distribution
- 480-V power wiring and 120-V control wiring
- Communications systems, including low voltage signals and fiber optic cabling

Raceways will be exposed in process and/or other non-finished areas.

Raceways will be concealed in walls and ceilings in control rooms, offices, and areas that have finished interiors.

Polyvinyl chloride (PVC) coated rigid galvanized steel conduit will be used in exposed corrosive interior areas and all exterior areas.

PVC Schedule 40 conduit will be used for underground conduit either direct buried or in concrete encased duct banks.

Rigid galvanized steel conduit will be used when exposed or concealed in interior non-corrosive process and non-process areas.

Flexible, nonmetallic, liquid-tight conduit 4-inch or smaller in size will be used for connections to motors, transformers, etc., as required. Fittings will be PVC-coated in wet or corrosive areas.

Wire and Cable

It is recommended that all new wiring be provided with XHHW-2 type insulation. Alternatively, type THHN/THWN-2 insulation could be used for No. 10 American Wire Gauge (AWG) and smaller conductors and type XHHW-2 insulation could be used for No. 8 AWG and larger conductors.

Enclosures

NEMA 1 enclosures will be used for equipment in electrical rooms and finished areas. NEMA 12 enclosures will be used for electrical equipment in dry industrial locations. NEMA 4X enclosures will be used for exterior and interior corrosive locations.

Distribution System Protection

General

Equipment will be selected with adequate bus bracing and interrupting capacity to accommodate available short circuit fault current values at the point in the system where it is used. Series rated criteria will not be used.

Phase and ground fault protective devices will be set to coordinate the electrical system. The primary goal of coordination is to disconnect that portion of the system that is malfunctioning with as little disturbance to the rest of the system as possible.

Short Circuit, Coordination, and Arc Flash Studies

A preliminary analysis of the available short circuit levels will need to be made to ensure equipment ratings can be specified appropriately.

Final short circuit and coordination studies based on actual equipment purchased will be made (by the contractor or other Professional Engineer registered in the State of California) to establish the range of protective device settings that will result in reasonable selectivity of device operation for both three-phase and ground faults.

An arc flash study will be performed to establish arc flash levels and create arc flash labels for electrical distribution equipment. The study will be performed by a third party Licensed Professional Engineer in State of California hired by the contractor. The scope of the study will include all new equipment, and any existing equipment that is modified or re-fed as part of the project.

Motor Protection and Control

General

Each motor will be provided with a suitable controller and devices that will protect the equipment and perform the functions required.

MCC-type construction will be used, except for where standalone motor starters or VFDs are more appropriate.

Motor Control

Motor control circuits will be designed at 120 V and an individual control power transformer with 120-V control voltage will be provided in each MCC bucket.

Electrical motor starter controls will consist of red and green lights, pushbuttons, or switches, devices such as timers and auxiliary relaying connected with process control as required, safety interlock logic, and other non-process controls (motor protection shutdowns and trouble alarms) as required.

AC Induction Motors

- Alternating current (AC) induction motors will be the premium efficiency type.
- Motors will have a 1.15 service factor. VFD driven motors will be allowed to have a 1.0 service factor.
- NEMA design letter to fit the application (usually NEMA design B), and locked rotor kVA Code G or lower.
- Motors will be cast iron.
- Motor windings will be copper wire. Aluminum windings are not acceptable.
- Motors in exterior or exposed areas will be provided with 115-V space heaters to prevent moisture condensation.
- Motors operated by VFDs will be specified as inverter duty rated with shaft grounding rings and insulated bearings and will meet all requirements of NEMA MG1, Section IV, Parts 30 and 31.

Grounding

Grounding Electrode System

A main facility ground bus will be provided mounted on the electrical room wall adjacent to the ATS and MCC. Grounding electrodes will be provided and connected to the main facility ground bus as follows: A concrete encased electrode, effectively grounded steel building members (if provided), a ground ring counterpoise (if a lightning protection system is provided), an incoming metal water pipe (if provided), and others per NEC 250 if provided. A grounding electrode conductor will be connected to the service entrance ATS where all main service equipment grounding and bonding will be provided including bonding of the source neutral conductor. Bonding of all metal systems will be provided per NEC 250.

Equipment Grounding

A separate ground conductor sized in accordance with NEC requirements will be installed in all raceways including power feeders, branch circuits, controls, lighting, receptacle loads, etc.

Shields of shielded instrumentation cables will be grounded to the ground bus at the power supply for the analog or low voltage discrete signal circuit. Shielded instrumentation cables will not be grounded at more than one point.

Lighting

General Requirements

Design of general interior and exterior lighting and task lighting will be provided per owner direction and specification. All luminaires and exit signs will utilize LED sources. Illuminated exit signs and emergency egress lighting as required by code will also be provided. Lighting control will be designed per applicable codes and owner direction. Lighting will conform to all applicable energy codes.

Lightning Protection

No lightning protection system will be provided.

Final Design Issues

The following issues will be investigated and final design solutions will be provided in consultation with the owner:

- Verify space allocation for major equipment.
- Coordinate with the owner for design preferences for equipment and methods.
- Determine how temporary construction power will be provided.
- Coordinate new site conduit and duct bank routing with existing site conditions.
- Investigate existing conditions before final design solutions to avoid conflicts.

Instrumentation and Control

Control System

General

The I&C system will include the necessary process monitoring and control functions to continuously monitor and control the facility. The I&C system will be consist of the following major components: three belt filter press package system PLCs, a scum concentrator package system PLC, a polymer package system PLC, a sludge load out package system PLC, an odor control package system PLC, a master PLC, and a SCADA workstation located in the Control Room.

The package system PLCs will all be connected to the master PLC with either Ethernet or hardwire to allow monitoring and control of the entire facility from the SCADA workstation. In addition to the package system PLCs all necessary signals to control and/or monitor any ancillary instrumentation or systems and the following existing equipment will be networked or hardwired to the master PLC: the existing sludge blend tank, the existing blend tank mix pumps, and the existing belt press feed pumps.

The I&C system will include all necessary field instrumentation, panel instrumentation, PLC components and software, and SCADA equipment and software to allow effective, efficient, reliable manual and automatic facility control and monitoring. Prime operation will be through the distributed I&C system. Sufficient local control, indication, and alarming will be provided to allow safe equipment and facility operation in the event of a PLC or SCADA system failure.

Reference Standards

The following organizations have generated standards that will be used as guides in assuring quality and reliability of components and systems, govern nomenclature, and define parameters of configuration and construction:

- International Society of Automation (ISA)
- National Institute of Standards and Technology (NIST)
- Underwriters Laboratories, Inc. (UL)
- American Water Works Association (AWWA)
- National Electrical Manufacturer’s Association (NEMA)
- Occupational Safety and Health Administration (OSHA)
- American National Standards Institute (ANSI)
- National Fire Protection Association (NFPA)
- Scientific Apparatus Manufacturer’s Association (SAMA)
- National Fire Protection Association (NFPA) 79, Annex “D” Standards
- Institute of Electrical and Electronic Engineers (IEEE)
- National Electrical Code (NEC)

Instrumentation and Controls Design

Communications

The master PLC and SCADA will be networked with the existing RWQCP SCADA system via Ethernet communication protocol over fiber optic.

Programmable Logic Controller Design Criteria

The master PLC as well as the package system PLCs and I/O modules shall be Allen-Bradley ControlLogix in accordance to the City’s standards to allow integration with the existing RWQCP SCADA system.

SCADA Design Criteria

The SCADA software shall be GE Intelligent Platforms Proficy iFix 5.8 in accordance to the City’s standards to allow integration with the existing RWQCP SCADA system.

Environmental Conditions

This section describes the environmental conditions that will be applied to all components of the control systems as required.

Classified Field Locations

The equipment located in classified areas will be designed to meet the classification of the area in accordance with the NEC, Class 1, Division 1 or Class 1, Division 2, as required.

Corrosive Locations

The equipment located in areas that are subject to corrosive fumes or spills will be designed using materials for use in these corrosive areas.

Corrosive area locations for PLCs, panels, etc., will be avoided wherever possible.

Equipment Enclosures

All equipment enclosures will meet the following NEMA requirements:

- NEMA 12: General Purpose Indoor Areas (e.g., control rooms)
- NEMA 4: Outdoor Areas or Indoor Areas where watertight enclosures are required (i.e., for washdown)
- NEMA 4X: Outdoor Corrosive Areas or Indoor Corrosive Areas
- NEMA 7: Explosive (Hazardous) Areas (or other NEC compliant systems for hazardous areas)

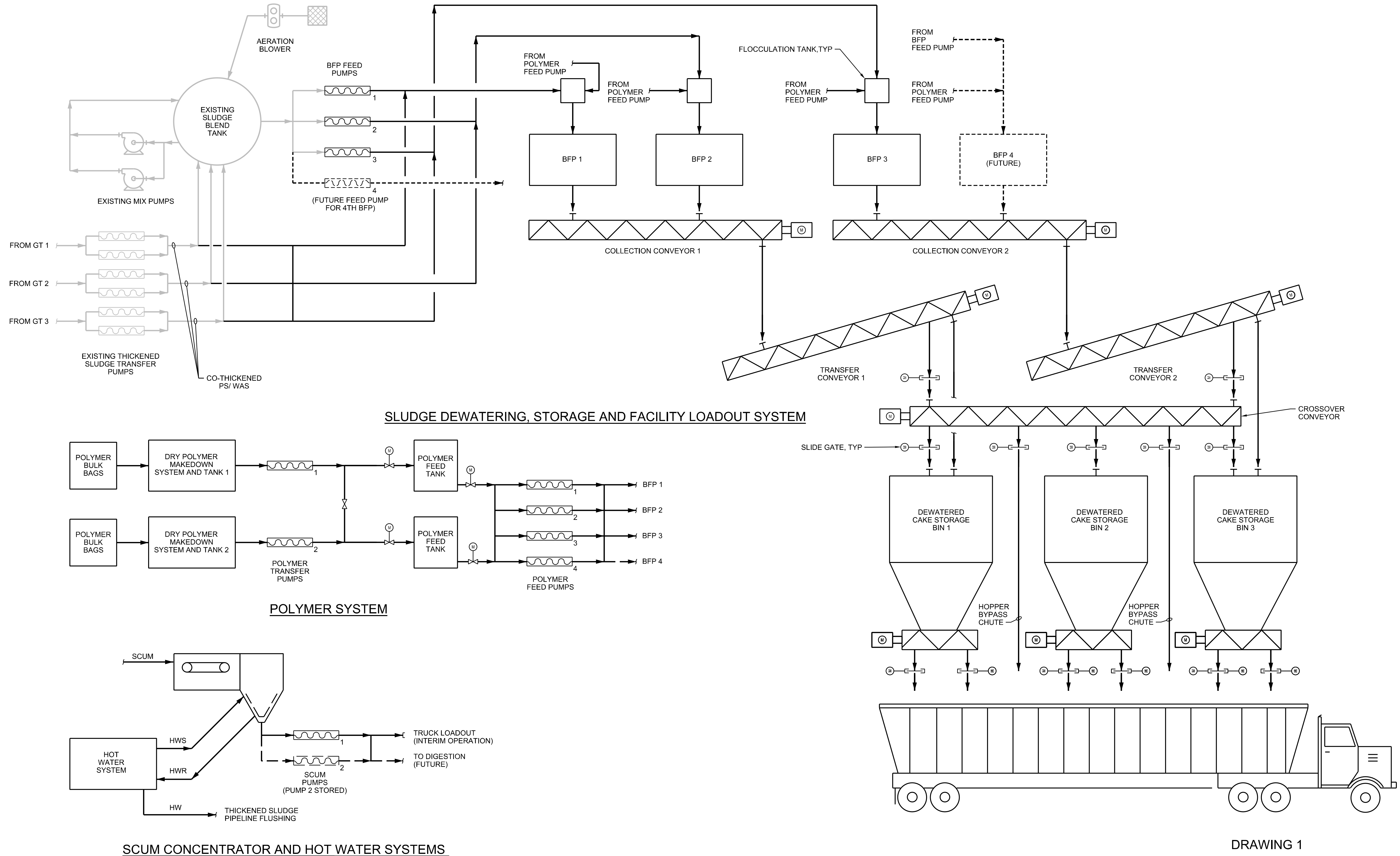
Sunshields

All outdoor field instruments and panels will be equipped with sunshields to allow viewing of the displays and/or to shield the instrument enclosures from the heating effects of direct sunlight. In addition, outdoor instrument displays will be north-facing where possible to prevent direct sun exposure.

Cameras

Cameras will be provided for monitoring truck loading activity in the loadout bay, and for remote monitoring of the sludge distribution on the gravity deck of each of the BFPs. Standards for these visual monitoring systems will meet City standards and be defined during the design phase.

Drawings



DRAWING 1

CITY OF PALO ALTO - DEWATERING / TRUCK LOADOUT FACILITY

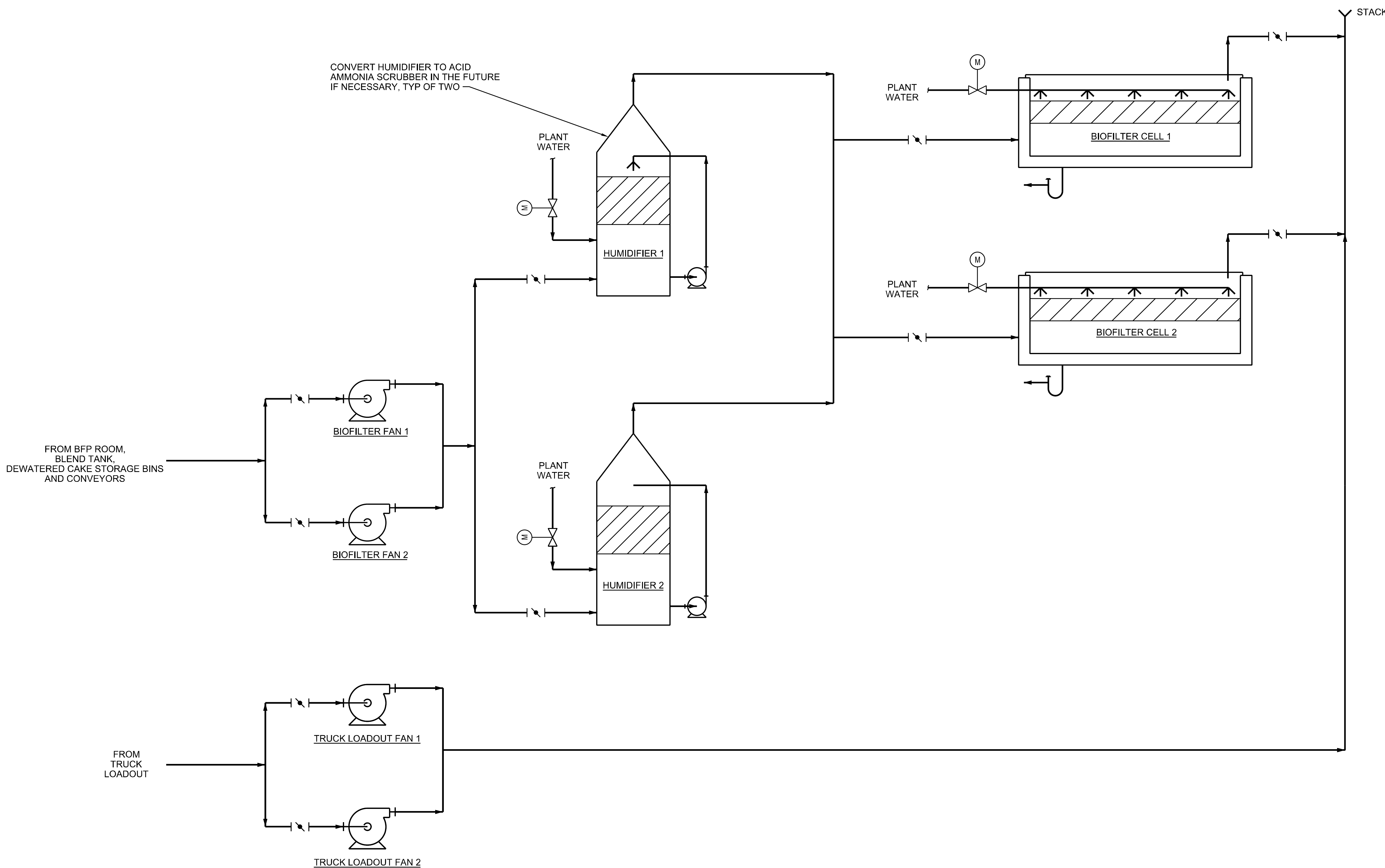
PRELIMINARY DESIGN REPORT FOR THE REGIONAL WATER QUALITY CONTROL PLANT

DEWATERING PROCESS FLOW DIAGRAMS

NTS

CH2MHILL

Process Flow Diagrams.dgn



DRAWING 2

CITY OF PALO ALTO - DEWATERING / TRUCK LOADOUT FACILITY

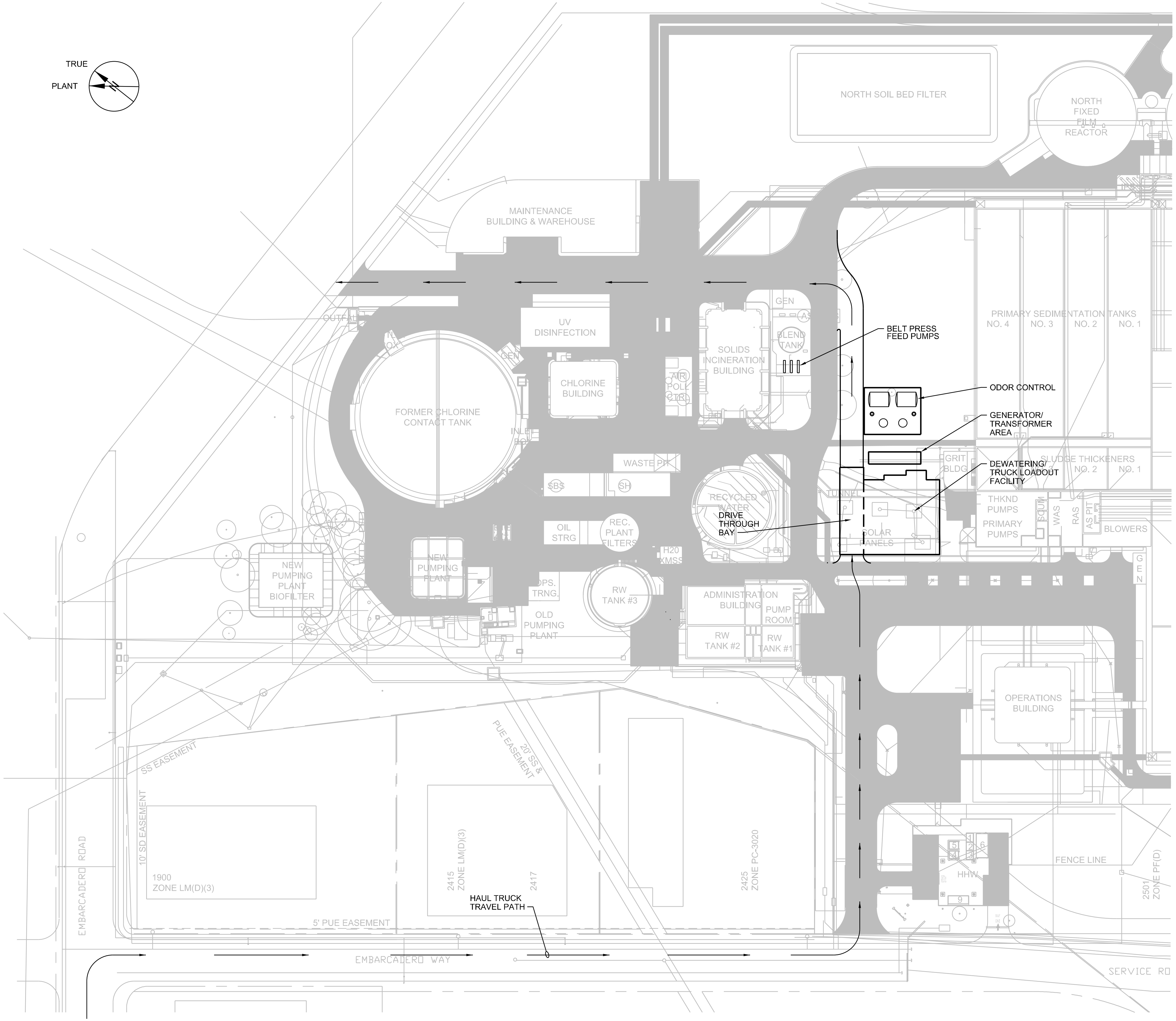
PRELIMINARY DESIGN REPORT FOR THE REGIONAL WATER QUALITY CONTROL PLANT

ODOR CONTROL PROCESS FLOW DIAGRAM

NTS

CH2MHILL®

Odor Control Flow Diagram.dgn



DRAWING 3

CITY OF PALO ALTO - DEWATERING / TRUCK LOADOUT FACILITY

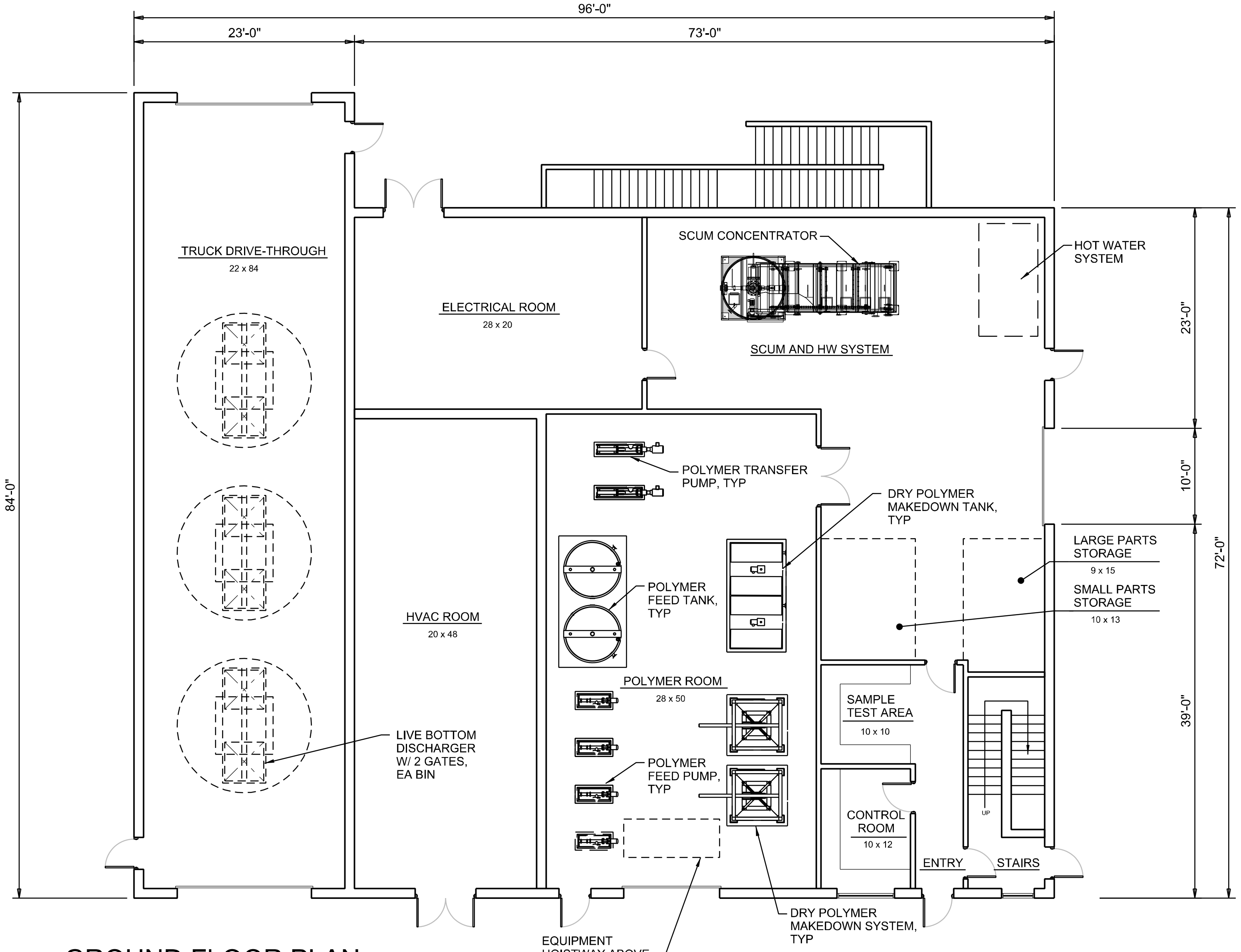
PRELIMINARY DESIGN REPORT FOR THE REGIONAL WATER QUALITY CONTROL PLANT

CONCEPTUAL SITE PLAN

SCALE 1" = 50'-0"

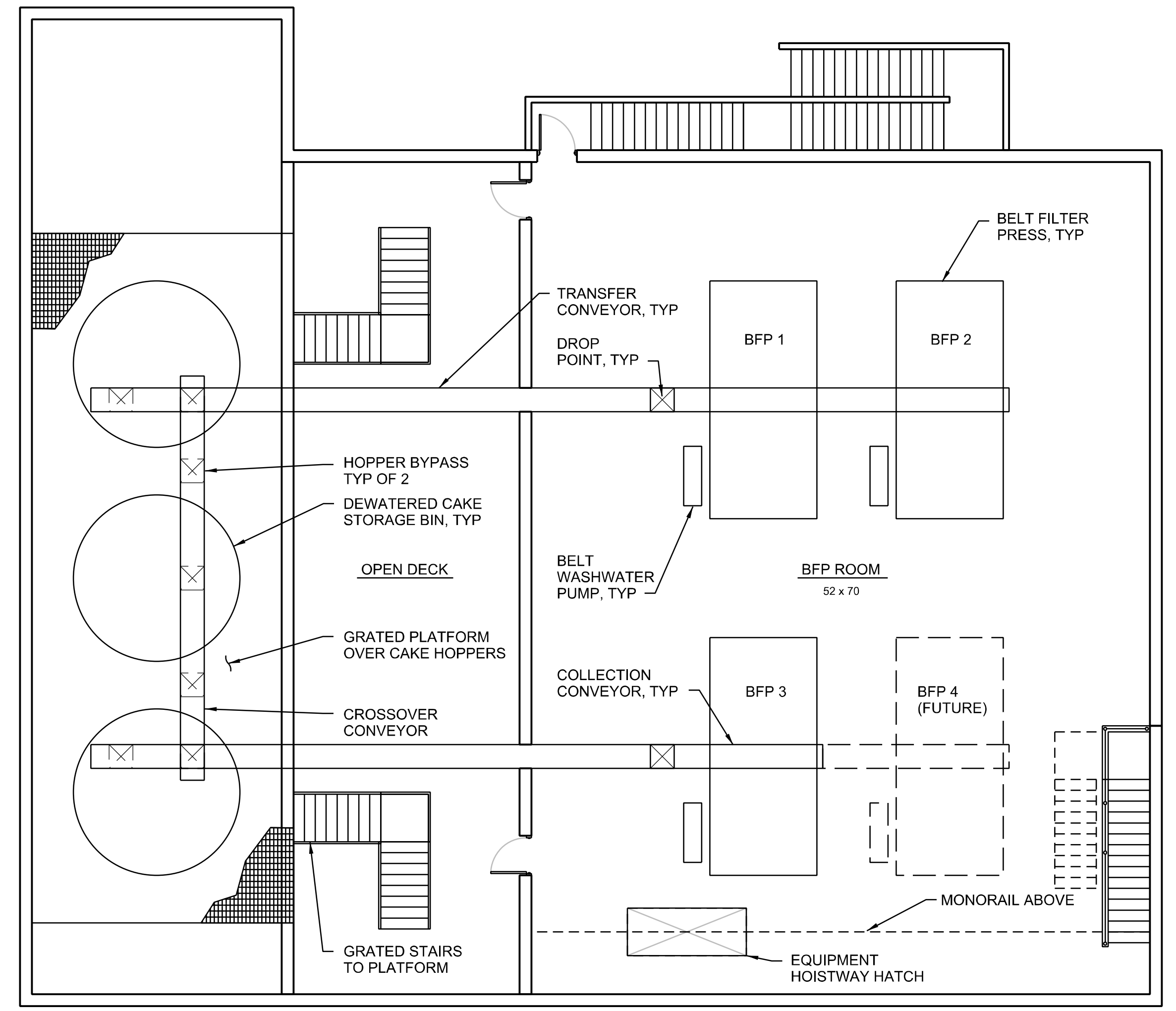
CH2MHILL®

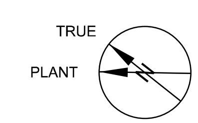
Site Plan Alternative 1.dgn



GROUND FLOOR PLAN

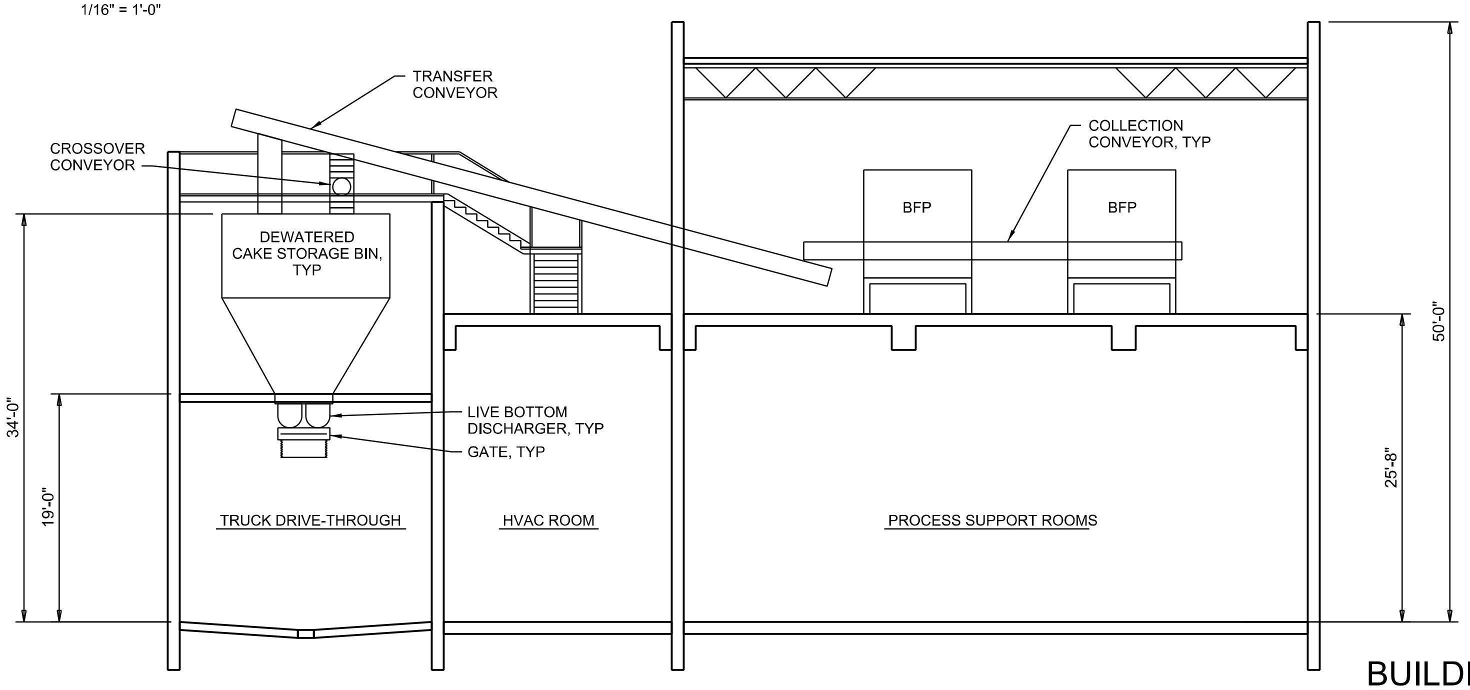
1/16" = 1'-0"





SECOND FLOOR / ROOF PLAN

1/16" = 1'-0"



BUILDING SECTION

1/16" = 1'-0"

DRAWING 4

CITY OF PALO ALTO - DEWATERING / TRUCK LOADOUT FACILITY

PRELIMINARY DESIGN REPORT FOR THE REGIONAL WATER QUALITY CONTROL PLANT

FACILITY PLANS AND SECTION

SCALE AS SHOWN

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