CKTP Solids and Liquid Hauled-Waste Treatment Upgrades

Central Kitsap Treatment Plant

Basis of Design

December 2023

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Certificate of Engineer

This Basis of Design Report for the County of Kitsap has been prepared under the direction of the following Registered Professional Engineer.

12/11/2023

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Abbreviations

1W	potable, tepid water
2W	non-potable water
3D	three-dimensional
3W	high-pressure plant water
3WHP	plant effluent
°F	degree(s) Fahrenheit
AA	average annual
AACE	Association for the Advancement of Cost Engineering
AAF	average annual flow
ACH	air change(s) per hour
ACI	American Concrete Institute
ADA	Americans with Disabilities Act
ADS	Advanced Drainage Systems
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ANSI	American National Standards Institute
ASCE	American Society of Civil Engineers
ASHRAE	American Society for Heating, Refrigerating and Air-Conditioning Engineers
ASTM	American Society of Testing Materials
ATS	automatic transfer switch
AWG	American Wire Gauge
BNR	biological nutrient removal
BOD	basis of design
Btu	British thermal unit(s)
CELS	Central Emergency Lighting System
cfm	cubic foot/feet per minute
CHP	combined heat and power
CKTP	Central Kitsap Treatment Plant
County	Kitsap County
CST	centrate storage tank
CWA	Clean Water Act
CZM	Coastal Zone Management
d	day(s)
DAHP	Department of Archaeology and Historic Preservation
DB	Design-Build
dBA	decibel(s) (acoustic)
DBB	Design-Bid-Build
DBO	Design-Build Operate
DCD	(Kitsap County) Department of Community Development
DIG	digested sludge
DR	dimension ratio
Ecology	Washington State Department of Ecology
ECS	Environmental Composite Systems
EL	elevation
EMT	electrical metallic tubing
EPA	U.S. Environmental Protection Agency
EPDM	ethylene propylene diene terpolymer
EQ	equalization
ESA	Endangered Species Act
FEM	finite-element model
FOG	fats, oils, and grease
FP	fire protection water

fpm	foot/feet per minute
FRP	fiberglass-reinforced plastic
ft	foot/feet
ft^2	square foot/feet
ft^3	cubic foot/feet
gal	gallon(s)
GC/CM	General Contractor/Construction Manager
GDM	Geotechnical Design Memorandum
GEN	generator
gpd	gallon(s) per day
gpm	gallon(s) per minute
GT	gravity thickener
H_2S	hydrogen sulfide
HDPE	high-density polyethylene
HDR	HDR Engineering, Inc.
HEX	heat exchanger
HMI	human-machine interface
HOA	HAND/OFF/AUTO
hp	horsepower
HPA	Hydraulic Project Approval
hr	hour(s)
HRT	hydraulic retention time
HTWAS	hauled, thickened waste activated sludge
HVAC	heating, ventilation, and air conditioning
Hz	hertz
IBC	International Building Code
IC	interior communications
I&C	instrumentation and controls
ID	internal diameter
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
IFC	International Fire Code
IMC	International Mechanical Code
in.	inch(es)
I/O	input/output
IPS	in-plant pump station
ISA	International Society of Automation
IT	information technology
kV	kilovolt(s)
kVA	kilovolt-ampere(s)
kW	kilowatt(s)
kWh	kilowatt-hour(s)
lb	pound(s)
lb_f	pound(s) force
LED	light-emitting diode
LEL	lower explosive limit
LHW	liquid hauled waste
LHWS	*Liquid Hauled Waste Study*
LM	linear motion
m	meter(s)
MBH	thousand British thermal units per hour
MCC	motor control center
MCE	maximum considered earthquake
MG	million gallons
MH	maintenance hole

min	minute(s)
MLSS	mixed liquor suspended solids
mm	millimeter(s)
MM	maximum month
MMBtu	million British thermal units
MMF	maximum month flow
N/A	not applicable
NEC	National Electrical Code
NECA	National Electrical Contractors Association
NEMA	National Electrical Manufacturers Association
NEPA	National Environmental Policy Act
NETA	InterNational Electrical Testing Association
NFPA	National Fire Protection Association
NG	natural gas
NH_3	ammonia
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOC	Notice of Construction
NPDES	National Pollutant Discharge Elimination System
OCR	OPEN/CLOSE/REMOTE
O&M	operations and maintenance
OPCC	opinion of probable construction cost
OSHA	Occupational Safety and Health Act
PA	public announcement
PCN	process control narrative
PDB	Progressive Design-Build
Ph	phase
P&ID	process and instrumentation diagram
PLC	programmable logic controller
ppmv	part(s) per million by volume
PRC	Project Review Committee
PS	primary sludge
PSCAA	Puget Sound Clean Air Agency
PSE	Puget Sound Energy
psf	pound(s) per square foot
psi	pound(s) per square inch
psid	pound(s) per square inch differential
psig	pound(s) per square inch gauge
PVC	polyvinyl chloride
PWD	Public Works Division
Q1	first quarter
RACS	Raptor Acceptance Control System
RDT	rotary-drum thickener
RGS	rigid galvanized steel
RIO	remote input/output
rpm	revolution(s) per minute
s	second(s)
SCADA	supervisory control and data acquisition
scfm	standard cubic foot/feet per minute
SDI	Steel Deck Institute
SDR	standard dimension ratio
SEPA	State Environmental Policy Act
S.G.	specific gravity
SJI	Steel Joist Institute
SOP	standard operating procedure

SPB	solids-processing building
SRT	solids retention time
S&W	Shannon & Wilson
SWGR	switchgear
TBD	to be determined
TDH	total dynamic head
TEFC	totally enclosed, fan-cooled
TFR	transformer
TM	technical memorandum
TMS	The Masonry Society
TPO	thermoplastic polyolefin
TPS	thickened primary sludge
TPSD	decanted thickened primary sludge
TS	total solids
TSBT	thickened sludge blending tank
TSP	twisted shielded pair
TSS	total suspended solids
TVS	total volatile solids
TWAS	thickened waste activated sludge
UL	Underwriters Laboratories, Inc.
UPS	uninterruptible power supply
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
UV	ultraviolet
V	volt(s)
VAC	volt(s) alternating current
VAR	vector attraction reduction
Vd	volatile solids destruction
VFD	variable-frequency drive
VS	volatile solids
VSR	volatile solids reduction
VSS	volatile suspended solids
W	watt(s)
WAC	Washington Administrative Code
WAS	waste activated sludge
WB-40	40-inch wheelbase truck
w.c.	water column
WDFW	Washington Department of Fish and Wildlife
WECI	Whitney Equipment Company, Inc.
w.g.	water gauge
WGB	waste gas burner
WSEC	Washington State Energy Code
WWTP	wastewater treatment plant
XHHW-2	cross-linked polyethylene high heat-resistant water-resistant-2
y	wye

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Executive Summary

Kitsap County (County) has recently completed a facility planning effort (as part of an updated Wastewater General Sewer Plan) that includes significant recommendations for upgrades to the solids-processing portion of the Central Kitsap Treatment Plant (CKTP). CKTP currently uses two mesophilic anaerobic digesters (originally constructed in approximately 1977) to provide Class B biosolids meeting pathogen reduction (Washington Administrative Code [WAC] Section 173-308-170) and vector attraction reduction (VAR) (WAC 173-308-180) requirements as outlined for Class B biosolids per the U.S. Environmental Protection Agency (EPA) Part 503 Biosolids Rule (as implemented by the Washington State Department of Ecology [Ecology] Biosolids Permit for CKTP) (Ecology 2022).

This document serves as a basis of design (BOD) and engineering report (in compliance with WAC 173-240-060) for the improvements necessary to address the solids-processing deficiencies outlined as part of the facility planning effort, presented primarily in the *Central Kitsap WWTP Liquid Hauled Waste Study* (LHWS) technical memorandum (TM) focused on liquid hauled waste (LHW) (Murraysmith 2022). This TM is the basis for the solids flow and loading projects, which are used throughout this report and modified only where specifically noted.

ES-1 Background and Summary of Critical Issues

CKTP is a regional solids facility that processes the following types of sludge and solids through mesophilic anaerobic digestion:

- **Primary sludge (PS):** Primary solids collected through the primary clarifiers at CKTP.
- **Waste activated sludge (WAS):** Biological solids from secondary treatment that come from both CKTP and the County's smaller regional wastewater treatment plants (WWTPs): Manchester, Kingston, and Suquamish. The latter is referred to as hauled, thickened waste activated sludge (HTWAS). This waste can periodically include waste biosolids from other smaller regional facilities as allowed by CKTP staff.
- **Hauled septage:** CKTP is a regional facility for septage-hauling trucks, which can include septic tanks, portable toilets, and other raw sewage or septage wastes that are pretreated and processed through the digesters.
- **Fats, oils, and grease (FOG):** CKTP accepts grease loads from regional haulers for processing in the digesters. Currently grease loads are discharged into the primary scum pit and pumped to the digesters via that infrastructure.
- **Scum/foam:** Minor loads of primary and secondary scum are processed directly through the digesters.

CKTP has completed recent upgrades for its WAS-thickening (new building and equipment) and biosolids-dewatering systems (centrifuges), both of which have significant near-term capacity. However, the existing digestion facilities, septage- and

FOG-handling, and PS/septage sludge-thickening facilities are in poor condition, lack adequate capacity, are not compliant with current design standards, and lack redundancy. The critical needs, as partially noted in the LHWS (Murraysmith 2022) and further addressed in this report, are as follows:

- **Anaerobic digesters:** The digesters (two tanks, each 0.65 million gallons [MG]) are cast-in-place concrete with coated steel fixed covers and pumped mixing. The facility would not be code compliant with any modifications (with existing boilers in electrically classified spaces) and the equipment in many locations is at the end of its life. Exterior review of the tank structures indicates that the concrete is in relatively good condition. Coupled with the condition assessment is a need to expand the capacity of the digesters, as the current two-tank system (roughly 1.3 MG total) does not allow for a digester to be taken offline while still meeting minimum retention times for Class B solids (15 days) and does not provide the capacity for future projected loads over the next 20 years.
- **Primary sludge and septage thickening:** Currently, PS and septage are co-thickened in two gravity thickeners (GTs) prior to feeding to the digesters. These structures are in poor condition and require upgrade and replacement.
- **Septage receiving:** The existing septage-receiving station (which includes a custom-designed rock trap and screening, with odor control) experiences operational issues because of offloading of trash/debris, lacks any redundancy, can handle only one truck at a time, and does not provide any means to equalize loads or monitor their water quality (such as pH) and actual flow (metering) from the trucks.
- **FOG receiving:** There is currently no designed system specifically for offloading and screening of FOG. FOG is currently pumped, unscreened, to the digesters, via the existing primary scum wet well. No flow monitoring (metering) is provided.
- **In-plant pump station (IPS):** The existing IPS is a circular wet well with two submersible pumps that provides general service for tank overflows, thickener overflows, WAS-thickening filtrate, filter backwash, sanitation sewer, and miscellaneous drainage. Material is pumped back to the CKTP headworks. The wet well is currently heavily corroded and has difficulty in maintaining flows under certain conditions.
- **Maintenance building:** The current maintenance building is nearing the end of its useful life and is located in a portion of CKTP that is necessary for digestion and thickening expansion. Consequently, replacement of the maintenance building and expansion of the digestion and thickening facility are functionally part of the same project.

ES-2 Facility Process Design

The CKTP Hauled-Waste Upgrades project is intended to address the deficiencies noted previously and provide the necessary upgrades to allow CKTP to meet the requirements of the Ecology Biosolids Permit (Ecology 2022) and the Class B standards of its current solids-hauling operation through the planning horizon outlined in the LHWS (Murraysmith 2022) and Wastewater General Sewer Plan (year 2042 projections). This report outlines the overall project flows and loads, the BOD for each portion of the upgrade, and the standards that will be followed for the detailed design documents.

The design elements overall will provide a system that will comply with the Ecology *Criteria for Sewage Works Design* (Ecology 2023), referred to as the "Orange Book," as it relates to solids thickening and digestion—in particular, Chapter S (Residual Solids Management), with emphasis on Section S-2.2 (Solids Stabilization) and Section S-2.4 (Storage).

The primary elements of the new design will be composed of the following process systems detailed in this report and shown graphically in Figure ES-1-1:

- **Anaerobic digesters:** The existing two digesters and the associated central process control building will be refurbished, partially replaced, and upgraded to improve operation and allow for better compliance with National Fire Protection Association (NFPA) 820. Two additional digesters will be added to CKTP, doubling the digestion volume from 1.3 MG to approximately 2.8 MG. A separate control building will be constructed to house primary electrical distribution equipment as well as new boilers to supply heat to the digesters as well as the existing solids-processing building (SPB).
- **Primary sludge and septage thickening:** A new building will be constructed to provide mechanical co-thickening of PS and septage, effectively replacing the aging GTs.
- **Septage handling:** A new septage-handling facility, including screening, grit removal, and flow equalization (EQ), will be constructed to improve operations, flow monitoring, flow control, redundancy, and septage pretreatment.
- **FOG handling:** A new FOG-handling facility (dedicated building) will allow for controlled offloading of FOG, separating it from scum-handling infrastructure, and provide a means for screening and pretreatment.
- **In-plant pump station:** A new IPS will replace the current corroded system, sized for the updated flows.
- **Centrate storage:** As part of the removal of the existing GTs, one of the two tanks will be refurbished to serve as a storage tank for CKTP centrate flows. This will allow CKTP to reuse existing tankage as a means to better control the flow of ammonia (NH_3)-heavy centrate to the secondary treatment system and improve overall biological nutrient removal (BNR).
- **Odor control:** New inorganic biofilters will be installed to address odor control needs for the septage, FOG, thickening, and centrate facilities.
- **Maintenance building:** A new maintenance building will replace the existing structure, with the current maintenance building space used for new digestion and thickening facilities.

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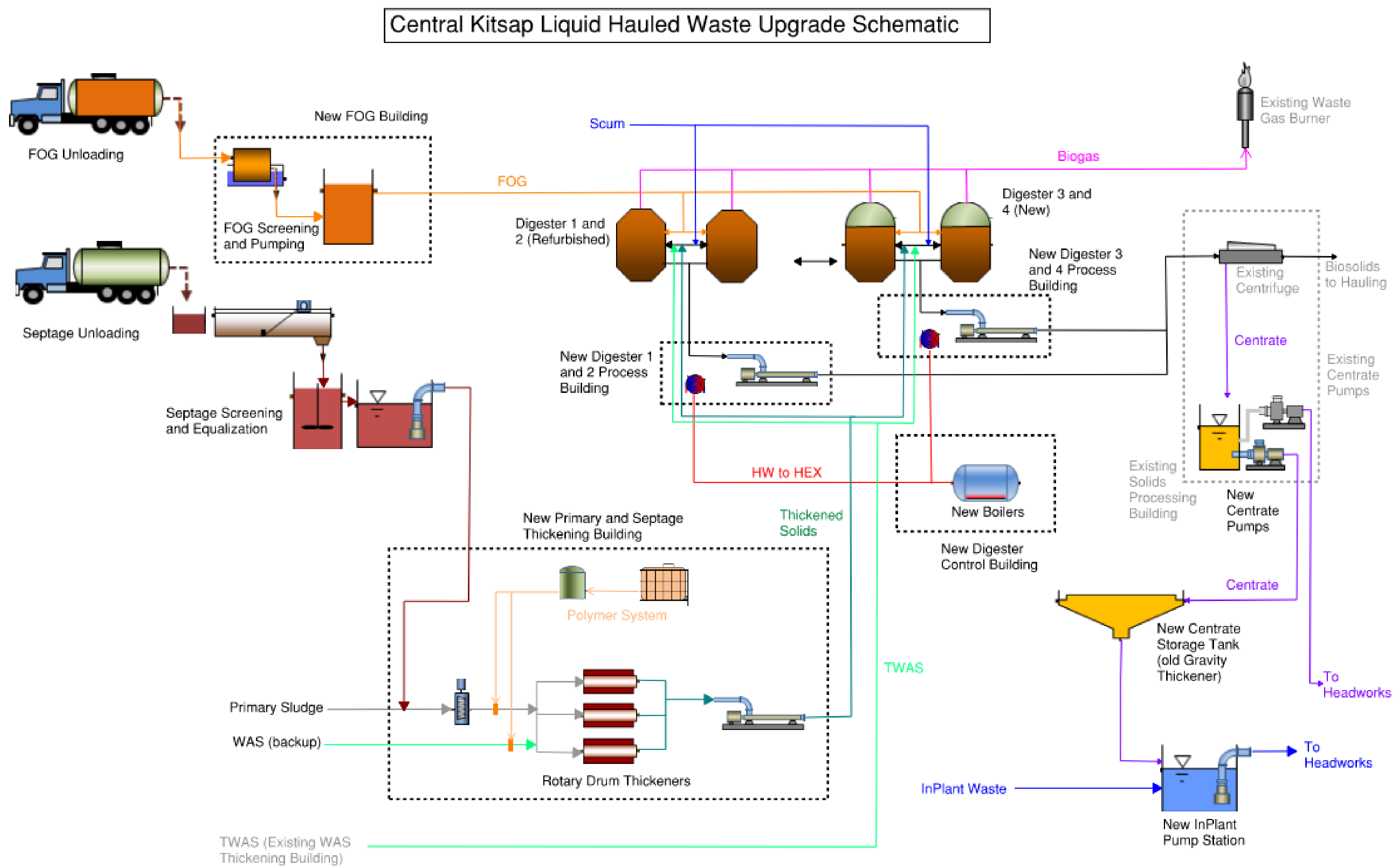

Figure ES-1-1. Process schematic for CKTP liquid hauled-waste upgrades

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ES-3 Process Design Criteria

To determine solids process improvement design criteria, each solid stream's historical and projected flows and loads were evaluated by comparing facility plan projections, aforementioned recorded data, and CKTP staff information. Development of the design flows and loads is detailed in the main TM, but is summarized in Table ES-1 for each PS stream. The table presents the raw loading of the applicable streams prior to any treatment (receiving, thickening, digestion). In general, the design values assumed in this report meet or exceed the values provided in the LHWS facility planning document (Murraysmith 2022). In the case of WAS and HTWAS, the loading values are higher than those in the facility plan (to add some additional conservative safety factor). Flows, for PS and WAS as examples, may decrease over time because of an assumption of more concentrated (higher solids percentage) pumping from the clarifiers, as noted in the TM.

Table ES-1. Design flows and loads for solids streams

Stream	Parameter	Current		2028		2042	
		AA	MM	AA	MM	AA	MM
PS	Flow (gpd)	125,800	147,200	96,600	110,800	98,500	110,400
	Load (lb/d)	5,300	6,200	6,100	7,000	8,300	9,300
WAS	Flow (gpd)	152,600	200,100	121,100	156,700	156,700	201,800
	Load (lb/d)	4,500	5,900	5,100	6,600	6,600	8,500
Septage	Flow (gpd)	23,000	33,000	28,500	40,900	52,100	75,000
	Load (lb/d)	4,100	5,900	5,100	7,300	9,300	13,400
FOG	Flow (gpd)	1,800	5,300	2,400	6,500	3,500	11,200
	Load (lb/d)	300	900	400	1,100	600	1,900
HTWAS	Flow (gpd)	4,600	7,400	5,300	8,400	6,300	9,900
	Load (lb/d)	1,800	2,900	2,100	3,300	2,500	3,900

AA = average annual; MM = maximum month.

Based on the flows noted above, the following sections summarize the primary sizing criteria for each main process area. The overall facility mass balance is included schematically in Appendix F, with the individual portions of the process discussed below. The maintenance building is addressed separately as part of the architectural design criteria.

ES-3.1 Septage and FOG Receiving

Septage receiving and treatment improvements will include the following:

- Two new 6-inch-diameter truck connections
- A new septage influent box with manual bar screen
- Two new screening systems with grit removal
- Residual grease removal

- Monitoring equipment and instrumentation
- Septage EQ tanks, wet well, and submersible pumps
- Wash water at applicable points throughout the receiving and treatment process including the influent box, manual bar screen, septage-screening equipment, and EQ tanks (hot water is current not assumed for the design of septage receiving, but can be added as an extension from the FOG building if desired)

The improvements will also include two bypass configurations to allow septage receiving under emergency conditions. Flow from the EQ tanks will be pumped to the new PS and septage thickening building prior to feeding to the anaerobic digesters. The process and instrumentation diagrams (P&IDs) for the new septage system are provided on Drawings P-510 through P-513 in Appendix F. Figure ES-1-2 provides a cross section of the septage process with influent box and offloading station, through the screening/grit system, to the EQ tank. The screening equipment shown was selected as part of a workshop process with CKTP staff (Appendix C).

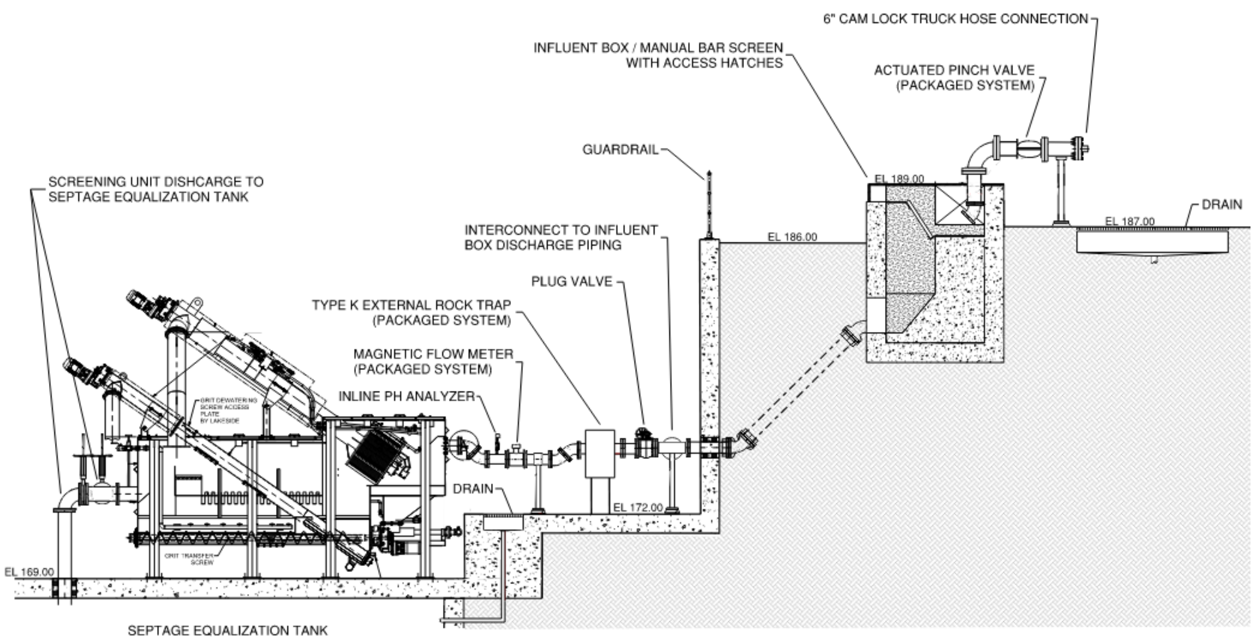

Figure ES-1-2. Septage-receiving station layout

FOG will be received through a new FOG building that will include an offloading connection for trucks, screening equipment, a receiving tank, and heat-traced piping to allow for flow to be directed to the anaerobic digesters.

Equipment used in support of the FOG receiving and treatment improvements includes the following:

- FOG offloading:
  - Control plug valve
- FOG building:
  - External rock trap

- Magnetic flow meter
- Inline pH sensor
- FOG-screening system
- FOG-receiving tank with ultrasonic level element
- FOG feed pumps
- Inline diaphragm seal with pressure element
- Associated glass-lined and heat-traced ductile-iron piping and valves
- Utility room (hot water)
- Electrical room

The P&IDs for the new FOG treatment system are provided on Drawings P-520 and P-521 in Appendix F. Figure ES-1-3 shows the primary treatment equipment that will be used for screening the FOG (the SAVI BEAST unit), selected as part of the workshop process with CKTP staff (Appendix C).

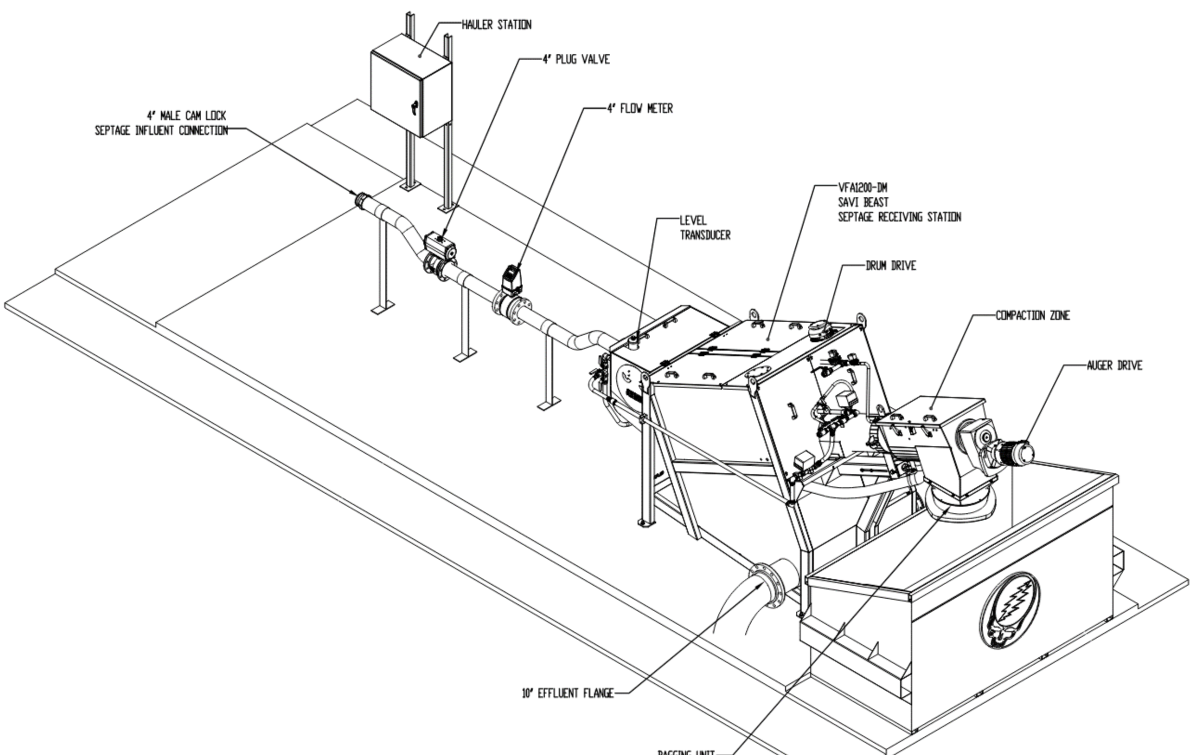

Figure ES-1-3. VFA1200-DM SAVI BEAST isometric

ES-3.2 Solids Thickening (Primary Sludge and Septage)

Solids-thickening improvements will be implemented for PS, septage, and WAS before digestion. This new thickening system will replace the existing GTs, which have reached the end of their useful life. Though there is an existing WAS rotary-drum thickener (RDT), which was recently installed and has been working well, a redundant unit was not installed as part of prior solids improvements, so CKTP staff requested that redundancy for WAS thickening be included as part of this project. A workshop with CKTP staff (Appendix B) was conducted to confirm design flows and loads and elect a preferred thickening technology. The selection of RDTs for PS and septage was the preferred approach, which will allow the new thickening system to use similar equipment to the existing WAS RDT (a common technology approach across CKTP) and allow for the new facility to provide redundancy for the existing WAS RDT.

The new PS and septage thickening building will house the following equipment:

- Three new RDTs for thickening of PS and septage (with capability of a unit acting as redundancy backup for WAS). PS and septage will be co-thickened under most circumstances, but may be thickened separately.
- Influent flow control and solids concentration monitoring of each stream fed to the thickening equipment.
- Thickened sludge pumping from the RDTs to the anaerobic digesters.
- Polymer system with non-potable water for makedown of emulsion polymer used in the thickening process. The polymer system will be designed to be capable of feeding two different polymers at the same time in the event that both PS/septage and WAS are being thickened at the same time.
- Electrical room for power feed and monitoring/control of thickening building equipment.

The thickening building RDTs and associated equipment are shown on Drawings P-550 to P-554 in Appendix F. The polymer system is shown on Drawings P-560 through P-562.

The RDT technology consists of a set of rotating stainless-steel drum screens that allow liquids to drain freely from polymer-dosed sludge. The unit includes a flocculation tank ahead of the RDT, with a polymer injection ring on the influent piping. As flow enters the flocculation tank, it is mixed with polymer, develops a stable floc structure within the tank, then overflows in the rotary drum, where water can freely drain as the solids are slowly rotated toward the discharge. Spray bars clean the screen during operation. Filtrate is drained back to the CKTP headworks and discharged solids enter a hopper for the thickened sludge pumps that will take the material to the digesters. See Figure ES-1-4.

The selected RDT is from FKC (model RST-775X3600L). This unit is the same size (flow and throughput) as the current WAS RDT model, which allows for redundancy for WAS flows. Operation of the units should allow CKTP staff to operate either one or two RDTs for the expected PS and septage loads through the 2042 design year.

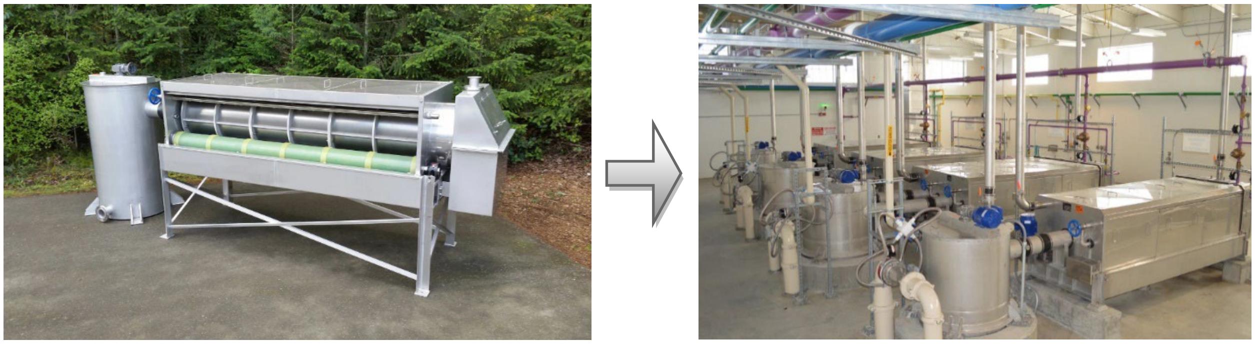

Figure ES-1-4. Example RDT pre- and post-installation

Figure ES-1-5 shows a general layout of the proposed PS and septage thickening building.

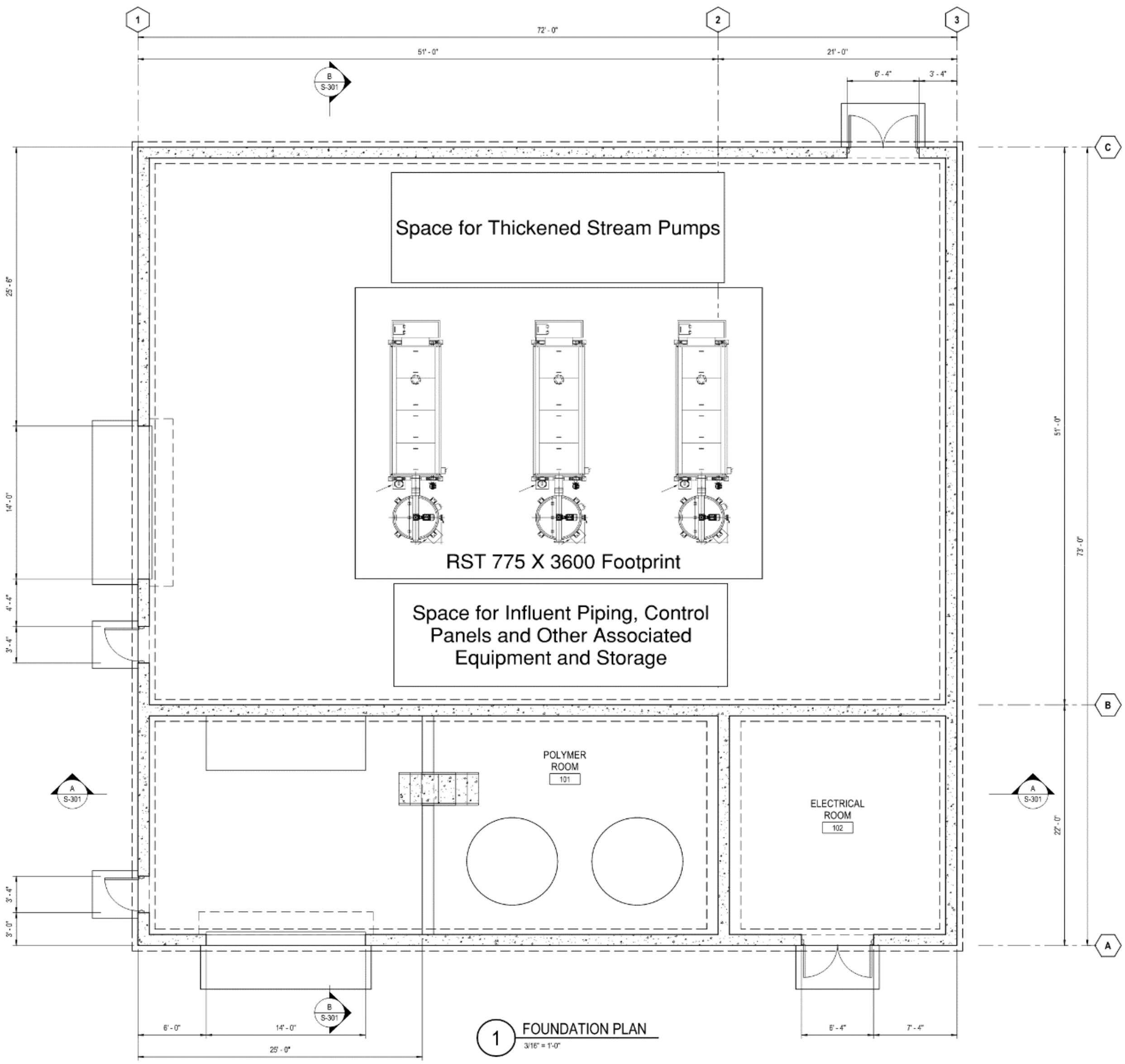

Figure ES-1-5. Proposed thickener layout plan view

Table ES-1 and Table ES-2 provide a summary of the operating scenarios for the thickeners and the estimated sizing based on number of units online, flow and concentration of the feed streams, and assumed factor of safety.

Table ES-1. Thickener analysis scenarios and results for PS and septage

Scenario	Description
Turndown	Turndown conditions evaluate thickener minimum turndown requirements against proposed flows and loads as the thickener needs a minimum flow and load to work. This scenario considers “worst-case” conditions where no septage is being processed and PS is especially thick. Opposite to other evaluated scenarios, this scenario lists maximum required operating hours needed to maintain a flow and load above minimum turndown requirements. This scenario describes operational adjustments required for a unique “lowest flow and load” situation.
2023 average	2023 average conditions evaluate thickener performance under current septage and PS flows and loads. A key part of this assumption includes the dilute nature of the PS. If primary clarifiers are operated to promote a higher PS TS, flow and required operating hours decrease significantly as shown in 2028 average conditions. The higher PS flows in turn require more time to process septage flows and loads.
2028 average	2028 average conditions evaluate thickener performance under 2028 septage and PS flows and loads. A key part of this assumption includes the thicker nature of the PS. The thicker PS allows septage to be processed quicker than in 2023 despite increased flows and loads.
2042 adjusted MM	2042 MM conditions evaluate thickener performance under 2042 MM septage and PS flows and loads. This design condition is key to ensuring that thickeners can perform at a high level for an extended period (typically 1 month). A key part of this assumption includes use of 2042 AAFs for 2042 MM septage flow and load. This approach was selected per CKTP advisement as described in previous sections. Additionally, if septage is processed 22 hours per day, 7 days per week, and PS is processed 24 hours per day, 7 days per week, one unit can process all flows and loads for this design condition.
2042 peak design	2042 peak conditions evaluate maximum thickener performance under worst-case PS flows and loads. This design condition is meant to evaluate max thickener performance and compare those conditions to observed flow and load trends. PS is assumed to be thicker, but slightly more dilute than preferred to conservatively estimate PS hydraulic flows. Septage flows and loads are then increased to the maximum amounts allowed by the thickeners to understand what peaking factors would be seen under those conditions. Peak conditions are ultimately composed of a 2042 Peak:AA solids peaking factor of 6.3 and a liquid peaking factor of 1.6 at a TS of 4.8%. As expected, and as indicated in the peaking factor values, the thickening equipment is primarily hydraulically limited. In evaluating recorded data, the maximum solids peaking factor experienced was about 3.7 with an associated liquid peaking factor of 1.5 and TS of 5.4%. The maximum liquid peaking factor experienced was about 2.9 with an associated solids peaking factor of 2.28 and TS of 1.8%. Evaluation of these recorded events would suggest that a solids peaking factor of 6.3 would not be likely but a liquid peaking factor of 1.6 with an associated TS of ~5.0% is likely for peak day conditions. Though peak conditions are generally unlikely, the proposed equipment and layout would perform well for the estimated worse-case conditions.

Table ES-2. Thickener flow, load, operation, and other criteria for PS and septage thickening

Scenario	Turndown	2023 average			2028 average			2042 adjusted MM			2042 peak design		
Stream	Primary	Septage	Primary	Combined	Septage	Primary	Combined	Septage	Primary	Combined	Septage	Primary	Combined
Year	2023	2023	2023	2023	2028	2028	2028	2042	2042	2042	2042	2042	2042
Condition	AA	AA	AA	AA	Adjusted AA	AA	Adjusted AA	Adjusted MM	MM	Adjusted MM	Peak	Peak	Peak
Flow (gpd)	31,519	23,000	125,800	148,800	28,000	96,600	124,600	52,100	110,400	162,500	143,500	110,400	253,900
Load (lb/d)	5,310	4,100	5,300	9,400	5,000	6,100	11,100	9,300	9,300	18,600	58,700	9,300	68,000
S.G.	1.01	1.02	1.01	1.02	1.02	1.01	1.02	1.02	1.01	1.02	1.02	1.01	1.02
% TS	2.00%	2.10%	0.50%	0.75%	2.10%	1.25%	1.53%	2.10%	1.25%	1.56%	2.10%	1.00%	1.45%
Dilution (water: XX)	-	2:1	-	-	2:1	-	-	2:1	-	-	2:1	-	-
Adjusted % TS	2.00%	0.70%	0.50%	0.57%	0.70%	1.25%	0.93%	0.70%	1.25%	0.90%	0.70%	1.00%	0.80%
Adjusted flow (gpd)	31,519	69,000	125,800	194,800	84,000	57,900	141,900	156,300	88,300	244,600	225,000	110,407	335,407
Selected unit	RST-775X3600L												
Number of units	1	1			1			2			2		
Rated flow (gpm)	62	250			250			375			375		
Rated solids load (lb/hr)	470	1,895			1,895			3,791			3,791		
Safety factor	75%	75%			75%			75%			75%		
Design flow (gpm)	62	188			188			375			375		
Design solids load (lb/hr)	353	1,421			1,421			5,686			5,686		
Required minimum operating hours													
5 days per week	11	24	24	-	15	24	-	17	24	-	22	24	-
7 days per week	8	13	24	-	10	24	-	11	24	-	14	24	-
Recommended operational metrics													
Hours per day	8	16	24	-	14	24	-	18	24	-	20	24	-
Days per week	7	5	7	-	5	7	-	5	7	-	5	7	-
Flow (gpm)	66	101	87	187	140	40	180	203	61	263	292	77	368
Solids load (lb/hr)	664	544			849			1,206			1,383		

ES-3.3 Anaerobic Digestion

CKTP currently has two 0.65 MG anaerobic digesters that were constructed in 1977 and have fixed steel covers that were replaced in 1992. Both digesters are typically operated continuously, and removing one digester from service significantly compromises CKTP's solids-handling operations and its ability to receive LHW, in particular, hauled septage.

Current influent flows to each digester are monitored from three sources:

- Gravity thickener (co-thickened PS and septage)
- Thickened sludge blending tank (TSBT) (includes CKTP thickened waste activated sludge [TWAS] and TWAS hauled from other Kitsap County WWTPs)
- Grease (hauled, which also accounts for negligible amounts of scum as FOG hauls are currently discharged to the primary clarifier scum pits)

The proposed digester improvements considered the 2028 and 2042 flows and loads projections retrieved from the Central Kitsap WWTP LHWS (Murraysmith 2022), as discussed in Section 2. The thickened flows and loads for septage and PS were calculated based on the predicted performance of the RDTs, planned to replace the existing GTs, assuming a thickened sludge concentration of 6 percent and solids capture of 100 percent to be conservative.

The projected digester influent flows, total solids (TS) and volatile solids (VS) loadings, and approximate TS percent per solids stream are presented in Table ES-3. These values served as design criteria for the new digester facilities. Scum from clarifiers will continue being routed to digesters, but based on current operations primary and secondary clarifier scum flows are negligible and infrequent and were not considered for projections.

Table ES-3. Design digester influent flows and loads, 2028 and 2042 projections

Scenario	Turndown	2023 average			2028 average			2042 adjusted MM			2042 peak design		
Stream	Primary	Septage	Primary	Combined	Septage	Primary	Combined	Septage	Primary	Combined	Septage	Primary	Combined
Year	2023	2023	2023	2023	2028	2028	2028	2042	2042	2042	2042	2042	2042
Condition	AA	AA	AA	AA	Adjusted AA	AA	Adjusted AA	Adjusted MM	MM	Adjusted MM	Peak	Peak	Peak
Flow (gpd)	31,519	23,000	125,800	148,800	28,000	96,600	124,600	52,100	110,400	162,500	143,500	110,400	253,900
Load (lb/d)	5,310	4,100	5,300	9,400	5,000	6,100	11,100	9,300	9,300	18,600	58,700	9,300	68,000
S.G.	1.01	1.02	1.01	1.02	1.02	1.01	1.02	1.02	1.01	1.02	1.02	1.01	1.02
% TS	2.00%	2.10%	0.50%	0.75%	2.10%	0.75%	1.05%	2.10%	1.00%	1.35%	4.81%	1.00%	3.16%
Dilution (water:XX)	-	2:1	-	-	2:1	-	-	2:1	-	-	2:1	-	-
Diluted % TS	2.00%	0.70%	0.50%	0.57%	0.70%	0.75%	0.73%	0.70%	1.00%	0.83%	1.60%	1.00%	1.49%
Diluted flow (gpd)	31,519	69,000	125,800	194,800	84,000	96,600	180,600	156,300	110,400	266,700	430,500	110,400	540,900
Selected unit	RST-775X3600L												
Number of units	1	1			1			2			2		
Rated flow (gpm)	62	250			250			375			375		
Rated load (lb/hr)	470	1,895			1,895			3,791			3,791		
Safety factor	75%	75%			75%			75%			75%		
Design flow (gpm)	62	188			188			375			375		
Design load (lb/hr)	353	1,421			1,421			2,843			2,843		
Required minimum operating hours													
5 days per week	11	24	24	-	16	24	-	13	24	-	-	-	-
7 days per week	8	13	24	-	12	24	-	9	24	-	24	24	-
Recommended operational metrics													
Hours per day	**8**	**16**	**24**	**-**	**16**	**24**	**-**	**14**	**24**	**-**	**24**	**24**	**-**
Days per week	**7**	**5**	**7**	**-**	**5**	**7**	**-**	**5**	**7**	**-**	**7**	**7**	**-**
Flow (gpm)	**66**	**101**	**87**	**187**	**140**	**40**	**188**	**203**	**61**	**263**	**299**	**77**	**375**
Load (lb/hr)	**664**	**544**			**849**			**1,206**			**2,843**		

The proposed improvements for the digester facilities use the 2042 maximum month (MM) flows and loads projections as design criteria. This will allow CKTP to accommodate nearly double the current average flow rate and solids loading, with a design, as outlined in this report, that provides improved thickening, feed controls, monitoring, and redundancy for the different solids sources.

Based on the original process control workshop (Appendix A), it was determined to expand the digestion system per the following features:

- Rehabilitate two existing 0.65 MG digesters and add two new digesters of the same volume (four digesters total) to allow for one tank out of service to still provide 75 percent of the volumetric capacity
- Allow for feeding of any solids streams to any digester
- Configure the digesters to provide for parallel (one-stage) or series (two-stage) operation

With rehabilitation, the intent is to slightly increase the active volume of the existing digesters to 0.7 MG each, and use the same volume for the new digesters. The final system would have a maximum volume capacity of 2.8 MG.

Table ES-4 summarizes the mass-balance performance estimated for the digesters using a conservative volatile solids reduction (VSR) value based on past performance of the CKTP system at similar hydraulic retention times (HRTs). In general, the system has extended HRTs of 34 to 71 days with all four tanks in operation. With one tank out of service, at worst-case future maximum month flow (MMF) conditions, the HRT is still approximately 25 days, well above the 15 days minimum requirement for Class B solids.

Table ES-4. Mass balance for proposed digesters per 2028 and 2042 projected flows and solid loads

Digester operation	Parameter	2028		2042	
		AAF	MMF	AAF	MMF
Parallel operation (normative)					
4 digesters in operation	Influent flow per digester (gpd)	9,903	14,153	14,303	20,878
	Influent solids loading per digester (lb/d)	4,700	6,325	6,825	9,250
	Influent VS per digester (lb/d)	4,005	5,395	5,815	7,895
	HRT (days)	**70.69**	**49.46**	**48.94**	**33.53**
	VS loading rate (lb/ft^3/d)	**0.043**	**0.058**	**0.062**	**0.084**
	VSR (%)	50%	50%	50%	50%
	Effluent solids loading per digester (lb/d)	2,698	3,628	3,918	5,303
	Effluent VS per digester (lb/d)	2,003	2,698	2,908	3,948
3 digesters in operation, 1 offline	Influent flow per digester (gpd)	13,203	18,870	19,070	27,837
	Influent solids loading per digester (lb/d)	6,267	8,433	9,100	12,333
	Influent VS per digester (lb/d)	5,340	7,193	7,753	10,527
	HRT (days)	**53.02**	**37.10**	**36.71**	**25.15**
	VS loading rate (lb/ft^3/d)	**0.057**	**0.077**	**0.083**	**0.112**
	VSR (%)	50%	50%	50%	50%
	Effluent solids loading per digester (lb/d)	3,597	4,837	5,223	7,070
	Effluent VS per digester (lb/d)	2,670	3,597	3,877	5,263

The rehabilitated and new digesters will be designed using the following process equipment assumptions, which were selected as part of a comparison workshop with CKTP staff (Appendix B):

- **Digester mixing system:** Pumped mixing using an internal nozzle system to distribute high-velocity flow through the digester and maintain a fully mixed tank with provisions to break down any foam accumulation.
- **Digester covers:** Two fixed steel covers and two gas-holding membrane covers, with the latter used to allow for biogas storage that can provide smoother operation of any secondary biogas uses as well as the existing waste gas burner (WGB).
- **Feed control valves:** Each solids input stream (FOG, PS/septage, WAS, and scum) will have separate flow control and automatic valve control to each of the four

digesters, allowing CKTP staff to easily rotate feeding between tanks and better control the solids balance across the system.

- **Heat exchangers (HEXs) and pumps:** Use spiral-type HEX units coupled with rotary-lobe pumps for internal digester recirculation loops, with progressive-cavity pumps for transferring flow from the digesters to the dewatering building or from one digester to another. Support boilers will be located in the new digester control building.

The digesters will be arranged on site as shown in Figure ES-1-6. Each pair of digesters will include a new central process (pumping) building that will house the pump systems, HEXs, and flow control valves.

Figure ES-1-6. Proposed digester area layout

The digester P&IDs with schematic process layout (Appendix F) are shown on Drawings P-610, P-620 through P-623, P-630, and P-640 through P-644.

ES-3.4 Miscellaneous Process Support Systems

Along with the core process systems discussed in the previous sections, the following is a short summary of the additional process support systems (detail in Section 6 of this report) that are included in the design to support operation of the newly upgraded solids process equipment:

- **In-plant pump station:** A new submersible pump station to replace the existing IPS that is corroded and at the end of its useful life. The new IPS will include centrate recycle, an upsized force main from 4-inch diameter to 6-inch diameter, and two new Flygt submersible pumps (rated for 500 gallons per minute [gpm]).
- **Centrate storage tank (CST):** One of the two existing GTs will be repurposed and refurbished (concrete repair, interior coating, new cover system) to function as a holding tank for centrate produced from the CKTP centrifuge dewatering system. The tank will be capable of holding roughly 250,000 gallons (gal) of centrate to allow for a slower, more steady feeding of recirculate ammonia-nitrogen to the secondary treatment process than is currently available. Flow from the tank will be adjusted through an automated flow control valve and flow meter.
- **Odor control:** Inorganic biofilters will be provided for odor control on three of the PS systems designed as part of this project: (1) new RDTs for thickening, (2) septage and FOG receiving, and (3) the CST and IPS. The first two systems will be designed primarily for removal of hydrogen sulfide (H_2S), and the latter system for removal of NH_3 as well as H_2S. Each of the three systems will be independent, will be located near the source of the odor, and will allow for containment and treatment of residual odor from tanks and equipment.

ES-4 Design Support Disciplines

The following section provides a short summary of the design disciplines that will support the process design as indicated in the previous sections. Further details for each discipline are located in the indicated sections.

HVAC (Section 7)

Heating, ventilation, and air conditioning (HVAC) design will be provided for each of the following buildings, including air exchange rates to supplement the classification systems outlined in Section 10 and supportive of NFPA 820 compliance:

- Digester control building
- Digesters 1 and 2 process (pump) building
- Digesters 3 and 4 process (pump) building
- PS and septage thickening building
- FOG building

The new digester control building will house a new boiler and hot water pump system (natural gas [NG]–fired) that will primarily support heating of the new digesters, but will also provide heat for the existing SPB.

CKTP water utilities will be provided at each process area, including non-potable water (2W), hot water (FOG building and polymer room), and plant effluent (3WHP) for washdown.

Drainage and plumbing systems will be provided in each building, with the digester process buildings including a new sump system on the lower level to collect and pump drainage to the IPS.

Architectural (Section 8)

The architectural approach for the CKTP Hauled-Waste Upgrades facility buildings will be to provide an overall, cohesive design aesthetic that can be applied to all the new CKTP structures. To accomplish this, a coordinated palette of architectural forms, materials, textures, and colors will be used to establish a contemporary aesthetic that will be commensurate for contemporary commercial waste facilities. Although the individual buildings and structures will house different functions, the goal is that the structural and architectural design will incorporate similar construction techniques and expressions for all the new structures that will be applied consistently, regardless of size and functions. The intent is to establish a design approach that can be carried forward in future projects as CKTP continues to expand.

Appendix D includes the preliminary proposal and architectural concepts for the new maintenance building.

The process buildings (listed below) will be classified as Type IIB construction and F-1 occupancies. The exterior materials will be the same as the maintenance building. Because of their sizes and occupancy types, it is not expected that these buildings will be sprinklered.

- Digester control building
- Digesters 1 and 2 process (pump) building
- Digesters 3 and 4 process (pump) building
- PS and septage thickening building
- FOG building

Structural (Section 9)

Structural design for the project will follow the 2021 International Building Code (IBC) and use current geotechnical data that are being obtained for the project, with the summary loads as shown in Section 9.

- Structural design of new digesters will be performed according to American Concrete Institute (ACI) CODE-350.3-20 *Code Requirements for Seismic Analysis and Design of Liquid-Containing Concrete Structures (ACI 350.3-20) and Commentary*.
- Structural analysis of existing digesters and the new centrate tank (existing GT) will be performed according to ACI CODE-350.3-20 *Code Requirements for Seismic Analysis and Design of Liquid-Containing Concrete Structures (ACI 350.3-20) and Commentary*.
- Structural design of the process buildings will be performed according to IBC 2021, ACI 318-19, The Masonry Society (TMS) 402, TMS 602, American Institute of Steel Construction (AISC) 360-16, Steel Joist Institute (SJI) 100-20, and Steel Deck Institute (SDI) RD-2017.
- Structural design of the maintenance building will be performed according to IBC 2021, ACI 318-19, TMS 402, TMS 602, AISC 360-16, SJI 100-20, and SDI RD-2017.

Electrical (Section 10)

CKTP includes electrical system modifications for existing systems and facilities, including the relocation of existing electrical components and equipment. The modifications and improvements to the electrical system are described in this section.

A double-ended motor control center (MCC) will be installed at each of the following locations: PS and septage thickening building, FOG building, and digester control building. Each of these areas will have an electrical room and each MCC will be installed in the associated electrical room. The MCCs are configured such that scheduled maintenance will not result in full MCC shutdowns; each of the two MCC sections can be shut down independently of each other.

The existing service from Puget Sound Energy (PSE) for CKTP will remain in place as is. The existing service is received from PSE at 12.47 kilovolts (kV) at switchgear (SWGR) 2940, which was installed as part of the 2016 Resource Recovery project. A new PSE service will be established for the new maintenance facility and will originate from a utility pole on Brownsville Highway.

A new standby generator output will be routed through existing automatic transfer switch (ATS)-1 in the existing SWGR 2961. The new standby generator is proposed to be 600 kilowatts (kW) to match the existing generator.

Materials of construction, area classifications, and codes applicable for design are detailed in Section 10.

Instrumentation and Controls (Section 11)

The intention of the instrumentation and controls (I&C) installed in CKTP is to monitor and control treatment processes. There are various types of instrumentation (mostly installed in-pipe to monitor the process directly), while controls consist mostly of valves and motors to open/close or start/stop to allow or deny the process to proceed, as well as the electronics that process what is going on. Details and general preferences for both instrumentation and controls are detailed in Section 11.

The primary component of the control systems at CKTP will be programmable logic controllers (PLCs). The County has standardized on Rockwell Automation's CompactLogix PLCs using model 1769-L33ER processors as its main processor. The County's preference is to use solely full PLC racks, with no remote input/output (RIO) racks. See Appendix K for details on the County's control system hardware requirements. The overall preference is that each major building or process will be monitored and controlled by an individual PLC.

Process control narratives (PCNs) for each major system included in this design are outlined in detail in Section 11.

Civil Design (Section 12)

Appendix H provides preliminary site layouts (buildings and process areas with major process pipeline routing) that include proposed locations for the following:

- Digester control building
- Digesters 1, 2, 3, and 4

- Digesters 1 and 2 process (pump) building
- Digesters 3 and 4 process (pump) building
- PS and septage thickening building
- FOG building
- Septage-receiving area
- Odor control
- Centrate storage tank
- Maintenance building

Design standards for the overall civil construction (including grading, paving, and stormwater management) are included in Section 12.

ES-5 Sequencing, Coordination, and Cost

Permitting

Through the preliminary planning and design effort, the project team developed a summary of necessary permits associated with the proposed upgrades. The management of the permitting process included a strategic and integrated approach. This approach included engaging regulatory agencies early and often regarding the project and fostering a close relationship throughout the process, to help to avoid unexpected requirements and delays in the approval of permits. A summary of the permit requirements is provided in Section 13.

Delivery Method

General Contractor/Construction Manager (GC/CM) is a collaborative delivery method in which the County hires a design engineer and a GC/CM under separate contracts. The County elected to pursue permission from the Project Review Committee (PRC) as the next step in the pursuit of using GC/CM. The PRC controls the ability of agencies in the state of Washington to use alternative project delivery methods. CKTP staff, along with HDR Engineering, Inc. (HDR), presented to the PRC on September 28, 2023, and received unanimous approval to use the GC/CM process for the project.

Sequencing

To facilitate construction of the new digesters, the existing maintenance building will need to be demolished and the new process facilities may be phased to prioritize the new digesters and thickening building as the most critical pieces of the new process train. A new maintenance building will be constructed to serve CKTP staff. Phasing of the new maintenance building construction is currently under discussion because of uncertainties with permitting new construction.

Opinion of Probable Cost

Through this BOD development, HDR has prepared an opinion of probable construction cost (OPCC) for the expected CKTP upgrades. The level of detail and contingency for the OPCC follow the Association for the Advancement of Cost Engineering (AACE) International Recommended Practice 18R-97 guidelines for a Class 4 estimate, which includes preliminary elements and has an accuracy range of -15 percent to -30 percent on the low side and +20 percent to +50 percent on the high side.

The OPCC is intended to be used as a check that the project is within the assumed budget and is based on the best judgment of experienced professionals generally familiar with the industry. However, because of the uncertainty of labor/materials prices and market/bidding conditions, the OPCC is not guaranteed to be the same as the actual construction cost.

The total OPCC for the proposed upgrades, as defined herein and detailed in Appendix M, is $98,557,000.

1 Introduction

Kitsap County (County) has recently completed a facility planning effort (as part of an updated Wastewater General Sewer Plan) that includes significant recommendations for upgrades to the solids-processing portion of the Central Kitsap Treatment Plant (CKTP). CKTP currently uses two mesophilic anaerobic digesters (originally constructed in approximately 1977) to provide Class B biosolids meeting pathogen reduction (Washington Administrative Code [WAC] Section 173-308-170) and vector attraction reduction (VAR) (WAC 173-308-180) requirements as outlined for Class B biosolids per the U.S. Environmental Protection Agency (EPA) Part 503 Biosolids Rule (as implemented by the Washington State Department of Ecology [Ecology] Biosolids Permit for CKTP) (Ecology 2022). These biosolids are then dewatered through an existing centrifuge system and hauled for land application in eastern Washington (Natural Selection Farms, Yakima County).

This document serves as a basis of design (BOD) and engineering report (in compliance with WAC 173-240-060) for the improvements necessary to address the solids-processing deficiencies outlined as part of the facility planning effort, presented primarily in the *Central Kitsap WWTP Liquid Hauled Waste Study* (LHWS) technical memorandum®) focused on liquid hauled waste (LHW) (Murraysmith 2022). This TM is the basis for the solids flow and loading projects, which are used throughout this report and modified only where specifically noted.

1.1 Background

CKTP is a regional solids facility that processes the following types of sludge and solids through mesophilic anaerobic digestion:

- **Primary sludge (PS):** Primary solids collected through the primary clarifiers at CKTP.
- **Waste activated sludge (WAS):** Biological solids from secondary treatment that come from both CKTP as well as the County's smaller regional wastewater treatment plants (WWTPs): Manchester, Kingston, and Suquamish. This waste can periodically include waste biosolids from other smaller regional facilities as allowed by CKTP staff.
- **Hauled septage:** CKTP is a regional facility for septage-hauling trucks, which can include septic tanks, portable toilets, and other raw sewage or septage wastes that are pretreated and processed through the digesters.
- **Fats, oils, and grease (FOG):** CKTP accepts grease loads from regional haulers for processing in the digesters. Currently grease loads are discharged into the primary scum pit and pumped to the digesters via that infrastructure.
- **Scum/foam:** Minor loads of primary and secondary scum are processed directly through the digesters.

CKTP has completed recent upgrades for its WAS-thickening (new building and equipment) and biosolids-dewatering systems (centrifuges), both of which have significant near-term capacity. However, the existing digestion facilities, septage- and

FOG-handling, and PS/septage sludge-thickening facilities are in poor condition, lack adequate capacity, are not compliant with current design standards, and lack redundancy. The critical needs, as partially noted in the LHWS (Murraysmith 2022) and further addressed in this report, are as follows:

- **Anaerobic digesters:** The digesters (two tanks, each 0.65 million gallons [MG]) are cast-in-place concrete with coated steel fixed covers and pumped mixing. A central control building between the existing tanks includes the biogas boilers, controls, pumps, heat exchangers (HEXs), and ancillary equipment. Exterior review of the tank structures indicates that the concrete is in relatively good condition; however, much of the equipment is at the end of its useful life and the roof, doors, and insulated paneling are in poor condition. In addition, the cover seals required emergency repairs in 2022 (because of leaking biogas) and are considered a high-risk point of failure. The facility was constructed prior to the introduction of National Fire Protection Association (NFPA) 820: *Standard for Fire Protection in Wastewater Treatment and Collection Facilities*. Consequently, the interior classification of the equipment, including the location of diesel-fired boilers within a space that shares a common wall with the digester, is no longer permitted and presents a safety hazard that requires remediation as part of the equipment upgrade. Coupled with the condition assessment is a need to expand the capacity of the digesters, as the current two-tank system (roughly 1.3 MG total) does not allow for a digester to be taken offline while still meeting minimum retention times for Class B solids (15 days) and does not provide the capacity for future projected loads over the next 20 years.
- **Primary sludge and septage thickening:** Currently, PS and septage are co-thickened in two gravity thickeners (GTs) prior to feeding to the digesters. The GTs include a central control building with grit removal (for septage). These structures were constructed at the same time as the existing anaerobic digesters, with walk-in covers, and most of the central control building and equipment are in poor condition.
- **Septage receiving:** The existing septage-receiving station (which includes a custom-designed rock trap and screening, with odor control) has created some operational issues because of offloading of trash/debris, lacks any redundancy, can handle only one truck at a time, and does not provide any means to equalize loads or monitor their water quality (such as pH) and actual flow (metering) from the trucks. Septage loads are a significant portion of the overall solids loading to CKTP and require significant integration into the overall process stream. Current septage loads are routed from the offloading station, through a wet well in the solids-processing building (SPB), to the existing GTs. The septage pumps within the SPB have reached the end of their useful life.
- **FOG receiving:** There is currently no designed system specifically for offloading and screening of FOG. FOG is currently pumped, unscreened, to the digesters, via the existing primary scum wet well. No flow monitoring (metering) is provided.
- **In-plant pump station (IPS):** The existing IPS is a circular wet well with two submersible pumps that provides general service for tank overflows, thickener overflows, WAS-thickening filtrate, filter backwash, sanitation sewer, and miscellaneous drainage. Material is pumped back to the CKTP headworks. The wet

well is currently heavily corroded and has difficulty in maintaining flows under certain conditions.

- **Maintenance building:** The current maintenance building is nearing the end of its useful life and is located in a portion of CKTP that is necessary for digestion and thickening expansion. Consequently, replacement of the maintenance building and expansion of the digestion and thickening facility are functionally part of the same project.

1.2 Project Overview

The CKTP Hauled-Waste Upgrades project is intended to address the deficiencies noted in the previous section and provide the necessary upgrades to allow CKTP to meet the requirements of the Ecology Biosolids Permit (Ecology 2022) and the Class B standards of its current solids-hauling operation through the planning horizon outlined in the LHWS (Murraysmith 2022) and Wastewater General Sewer Plan (year 2042 projections). This report outlines the overall project flows and loads, the BOD for each portion of the upgrade, and the standards that will be followed for the detailed design documents.

The design elements overall will provide a system that will comply with the Ecology *Criteria for Sewage Works Design* (Ecology 2023), referred to as the “Orange Book,” as it relates to solids thickening and digestion—in particular, Chapter S (Residual Solids Management), with emphasis on Section S-2.2 (Solids Stabilization) and Section S-2.4 (Storage).

The primary elements of the new design will be composed of the following process systems detailed in this report and shown graphically in Figure 1-1:

- **Anaerobic digesters:** The existing two digesters and the associated central process control building will be refurbished, partially replaced, and upgraded to improve operation and allow for better compliance with NFPA 820. Two additional digesters will be added to CKTP, doubling the digestion volume from 1.3 MG to 2.8 MG. A separate control building will be constructed to house primary electrical distribution equipment as well as new boilers to supply heat to the digesters as well as the existing SPB.
- **Primary sludge and septage thickening:** A new building will be constructed to provide mechanical co-thickening of PS and septage, effectively replacing the aging GTs.
- **Septage handling:** A new septage-handling facility, including screening, grit removal, and flow equalization (EQ), will be constructed to improve operations, flow monitoring, flow control, redundancy, and septage pretreatment.
- **FOG handling:** A new FOG-handling facility (dedicated building) will allow for controlled offloading of FOG, separating it from scum-handling infrastructure, and provide a means for screening and pretreatment.
- **In-plant pump station:** A new IPS will replace the current corroded system, sized for the updated flows.
- **Centrate storage:** As part of the removal of the existing GTs, one of the two tanks will be refurbished to serve as a storage tank for CKTP centrate flows. This will allow

CKTP to reuse existing tankage as a means to better control the flow of ammonia (NH_3)-heavy centrate to the secondary treatment system and improve overall biological nutrient removal (BNR). This upgrade was recommended as an optimization project in previous work (HDR 2022) and fits within the structure of this project given the planned removal of the GTs from service.

- **Odor control:** New inorganic biofilters will be installed to address odor control needs for the septage, FOG, thickening, and centrate facilities.
- **Maintenance building:** A new maintenance building will replace the existing structure, with the current maintenance building space used for new digestion and thickening facilities.

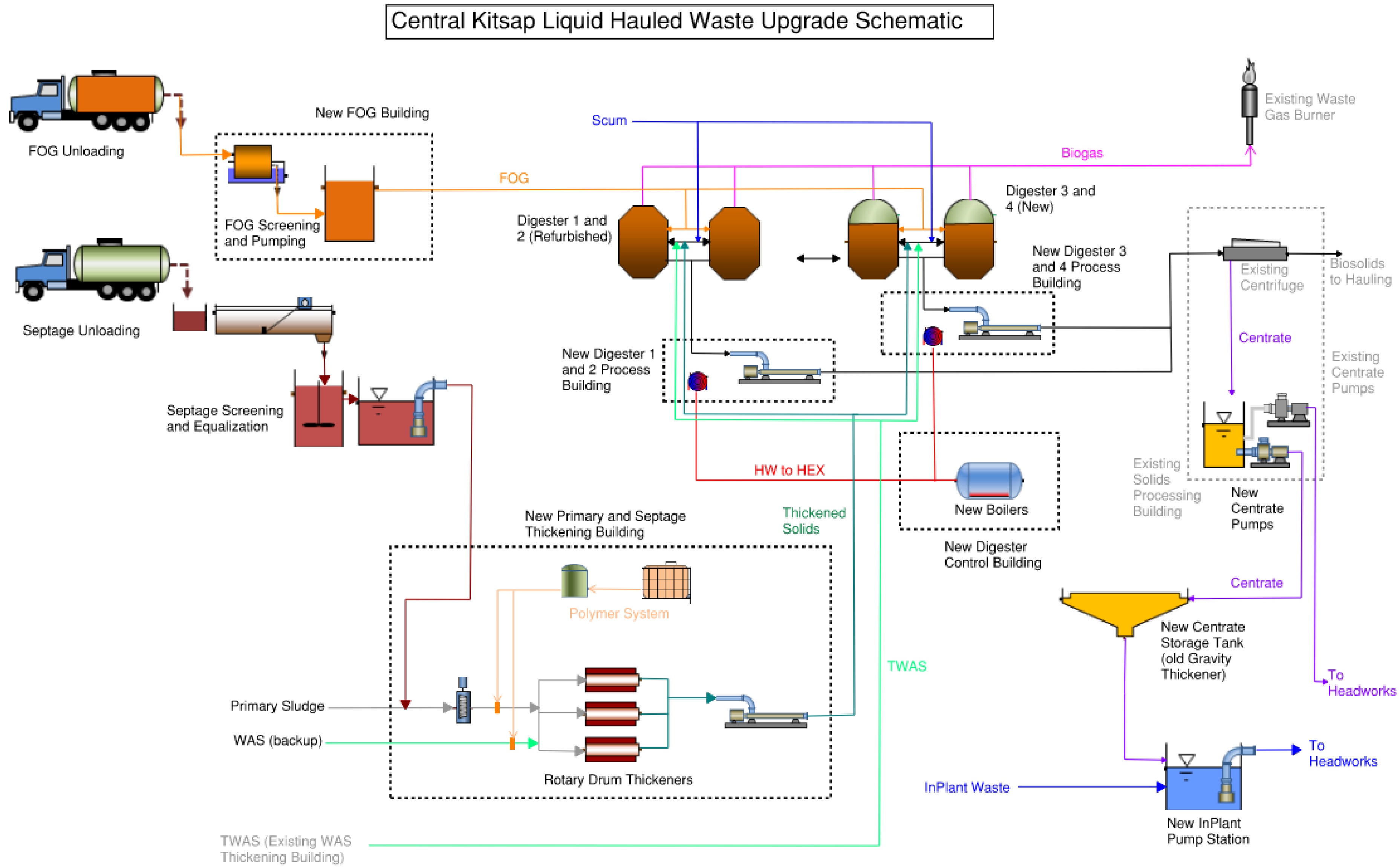

Figure 1-1. Process schematic for CKTP liquid hauled-waste upgrades

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As part of the development of this report, detailed design workshops were conducted with CKTP staff to determine sizing, layout, and equipment selections for the primary treatment processes noted above. The summary results of these workshops are included in the appendices and are referenced in the main text of the report. The report itself only summarizes the BOD that was developed from those workshops, with details of the options reviewed and selection process itself included for documentation.

The new buildings and process areas that address the key upgrades listed above are summarized below and are detailed in the applicable sections that follow.

- Digesters 1 and 2 (north set, west to east)
- Digesters 3 and 4 (south set, north to south)
- Digesters 1 and 2 process building
- Digesters 3 and 4 process building
- Digester control building:
  - Electrical room
  - Boiler room
- PS and septage thickening building:
  - Electrical room
  - Polymer room
  - Thickening room
  - Odor control
- FOG building:
  - Electrical room
  - Utility room
  - FOG-handling room
  - Odor control
- Septage-receiving station:
  - Odor control
- Septage EQ tanks 1 and 2:
  - Septage EQ wet well
  - Septage EQ valve vault
- Centrate storage tank (CST):
  - CST flow control vault
  - Odor control
- IPS:
  - IPS wet well

  - IPS valve vault
- Maintenance building

1.3 Engineering Report Requirements

Table 1-1 provides a summary checklist of the content required in this report, per compliance with WAC 173-240-060. Each piece of content is noted as either not applicable (N/A) (based on the extent of this project) or the relevant section(s) where the content is located is noted for ease of reference.

Table 1-1. Location of relevant engineering report content per WAC 173-240-060

Content	Section (if applicable)
Owner name, address, telephone number, and Owner’s authorized representative.	Kitsap County 12351 Brownsville Hwy NE Poulsbo, WA 98370 (360) 337-5631 Nick Martin, PMP
Project description including existing and proposed service areas.	Executive Summary, Section 1
Statement of quantity and quality of wastewater, including any industrial wastes (existing and expected future).	Section 2
The degree of treatment required based upon applicable permits and rules, the receiving body of water, the amount and strength of wastewater to be treated, and other influencing factors.	Section 1
Description of receiving water, applicable water quality standards, and how water quality standards will be met outside of the applicable dilution zone.	N/A
Treatment process proposed, degree of treatment, method of disposal, evaluation of alternatives and reasons why they are unacceptable.	Section 1 (overall schematic) Section 3 (FOG and septage) Section 4 (thickening) Section 5 (digestion) Section 6 (misc. systems)
Basic design data, sizing calculations, expected efficiencies of each process and entire plant, and character of effluent anticipated.	Section 2 (overall design criteria) Section 3 (FOG and septage) Section 4 (thickening) Section 5 (digestion) Section 6 (misc. systems)
Discussion of the various sites available, advantages and disadvantages of site(s) recommended. Proximity of residences or developed areas. Relationship of 25-year and 100-year flood to plant and plant processes.	N/A
Flow diagram showing general layout of various processes, location of effluent discharge, and hydraulic profile of system and any hydraulic-related portions.	Section 1.2
Discussion of infiltration and inflow problems, overflows and bypasses, and proposed corrections and controls.	N/A
Discussion of special provisions for treating industrial wastes, including pretreatment requirements for significant industrial sources.	N/A
Detailed outfall analysis or other disposal method selected.	N/A
Discussion of the method of final sludge disposal and alternatives considered.	N/A
Provision for future needs.	Section 2

Content	Section (if applicable)
Staffing and testing requirements for the facilities.	Section 1.2
An estimate of the costs and expenses of the proposed facilities, method of assessing costs and expenses; total amount shall include both capital costs and operations and maintenance (O&M) costs for the life of project and presented in terms of total annual cost and present worth.	Section 13
Statement regarding compliance with applicable state or local water quality management plan or plan adopted under the Federal Water Pollution Control Act as amended.	Section 1
Statement regarding compliance with the State Environmental Policy Act (SEPA) and the National Environmental Policy Act (NEPA), if applicable.	Section 13

Projects that use land application, including seepage lagoons, irrigation, and subsurface disposal:
• Soils and their permeability
• Geohydrologic evaluation of factors such as:
  • Depth to groundwater and groundwater movement during different times of the year
  • Water balance analysis of the proposed discharge area
  • Overall effects of the proposed facility upon the groundwater in conjunction with any other land application facilities that may be present
• Availability of public sewers
• Reserve areas for additional subsurface disposal
	N/A

Projects funded by EPA shall, in addition to the requirements of subsection (3) or (4) of this section, follow EPA facility plan guidelines contained in the EPA publication, "Guidance for Preparing a Facility Plan" (MCD-46), and shall indicate how the special requirements contained in 40 CFR 35.719-1 will be met.	N/A

Source: Washington State Legislature 2023.

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2 Facility Design Criteria

Facility design criteria were developed in collaboration with CKTP staff during multiple workshops and review trials. Process flow diagrams were developed based on as-built drawings and proposed process improvements. The layout for facility improvements was informed by CKTP staff input and estimated sizing requirements for equipment, code requirements, etc. Historical and projected solids flow and load data were analyzed to determine facility design criteria for the project planning period. Data from CKTP staff, the LHWS (Murraysmith 2022), and prior HDR Engineering, Inc. (HDR) analysis informed solids flow and load estimates for current and future conditions for PS, WAS, septage and other hauled septage-type streams, FOG, and hauled thickened waste activated sludge (HTWAS). Additionally, rheology testing was conducted to characterize solids for process design criteria. This section describes available historical data, selected and projected facility design values, and rheology testing results.

2.1 Historical Solids Loading Data

Data primarily from CKTP staff and the facility plan informed historical flow and load estimates in this section. Data were generally available from January 2019 to March 2023 with some exceptions such as for septage data, which were provided for 2021 and 2022. Other data gaps and the basis of each solids stream estimate are described below. For clarity, solids stream flows and loads are summarized on one or two consecutive pages.

2.1.1 Historical PS Flows and Loads

PS flow and load data were not available, but CKTP staff has stated that PS pumps currently operate at about 75 gallons per minute (gpm) continuously throughout the day or about 108,000 gallons per day (gpd). Existing GTs exclusively process septage and PS so a mass balance for the GTs was conducted to estimate PS loads. GT daily flow and weekly total solids (TS) data were available from 2021–2022. Estimated septage loading, described in Section 2.1.3, was subtracted from GT effluent solids load to estimate PS solids loading. To estimate flows from these loads, an average PS TS value of 0.57 percent from recent testing was used to better represent current operating conditions that create a relatively dilute PS (Appendix E). Data were evaluated if GT effluent flow and TS and septage load values were available for the same day. Negative or statistically anomalous values were omitted for clarity. Though this approach provides context for available data and mass-balance dynamics, it is highly variable and will not be used for design. Figure 2-1 depicts the estimated PS flows and loads based on a TS of 0.57 percent. There is a gap in data from July to October 2022 because of lack of consistent flow and load data to meet the data alignment criteria.

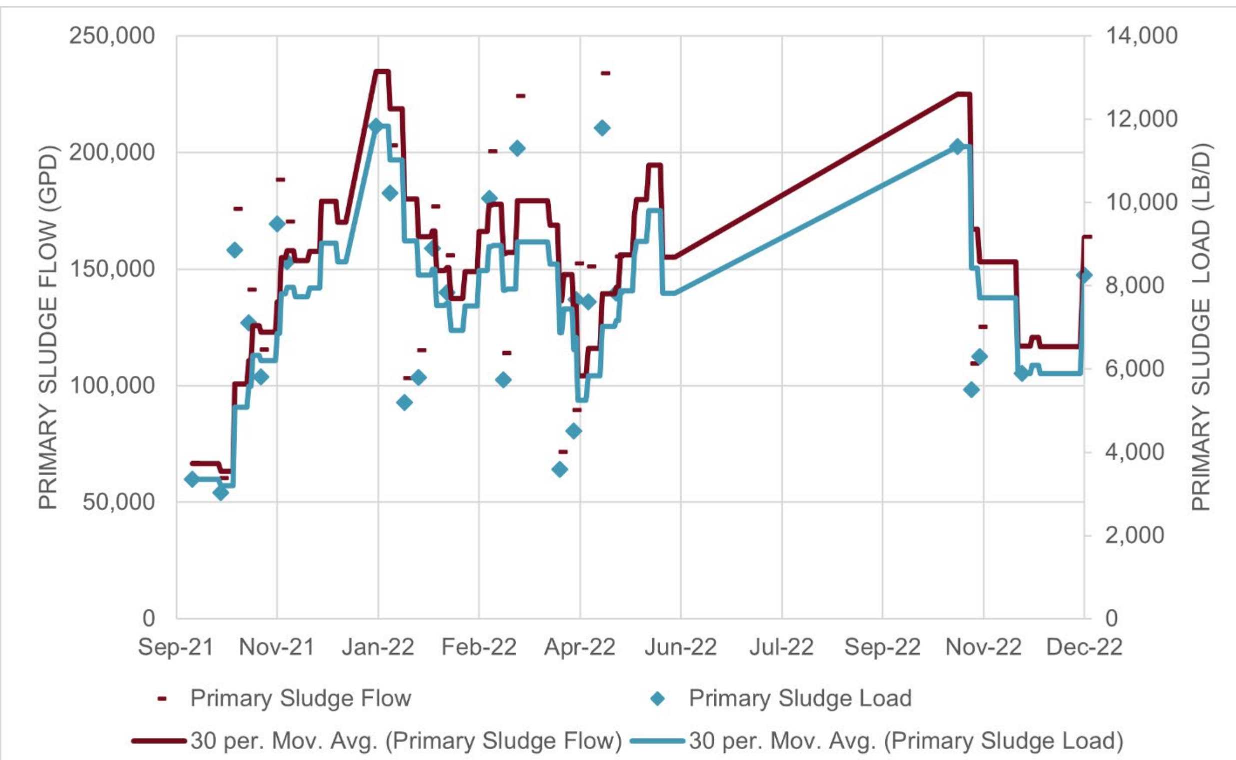

Figure 2-1. Primary sludge flows and loads

2.1.2 Historical WAS Flows and Loads

CKTP staff provided daily WAS flow and concentration data from 2019 to March 2023. Test results for WAS TS resulted in an average of 0.41 percent whereas calculated TS from flow and concentration data yielded an average of 0.30 percent (Appendix E). Figure 2-2 depicts estimated WAS flows and loads. Figure 2-3 depicts estimated WAS percent TS based on provided data.

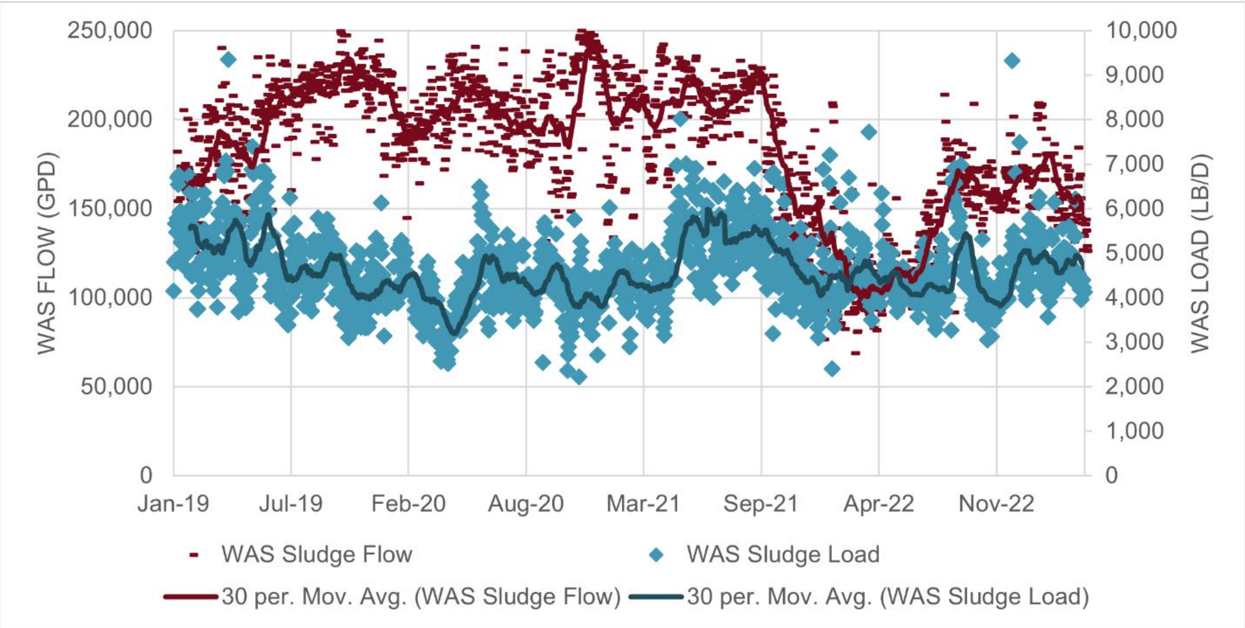

Figure 2-2. WAS flows and loads

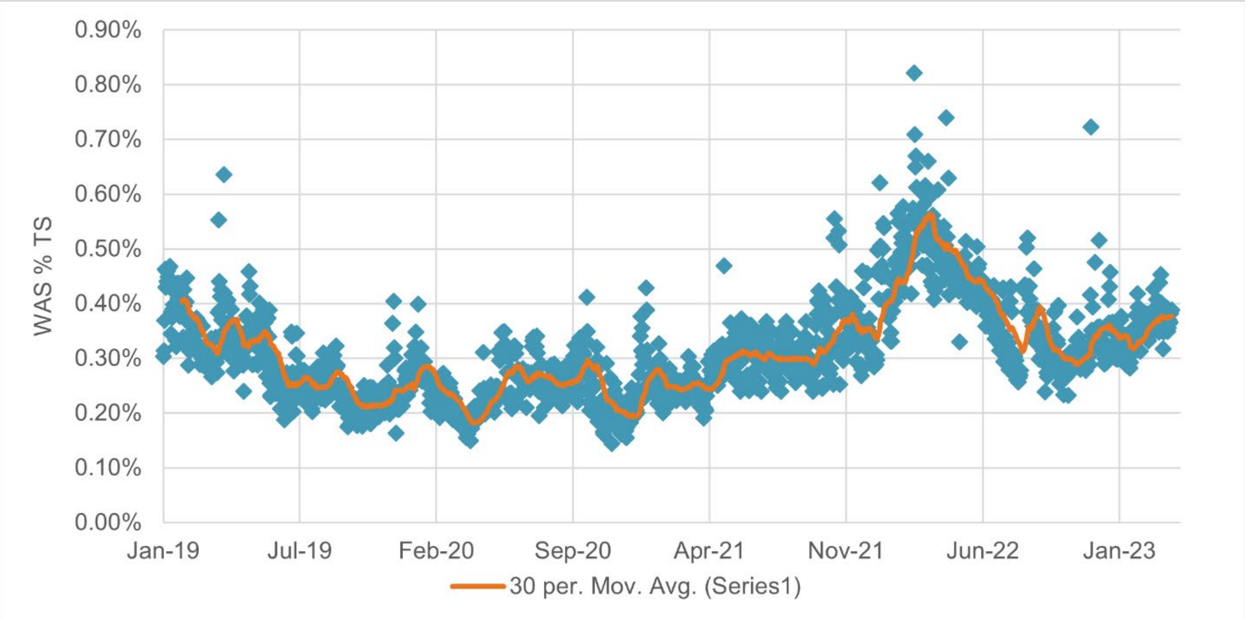

Figure 2-3. WAS estimated percent TS

2.1.3 Historical Septage Flows and Loads

Septage flow and solids data were provided from 2021 to 2022. Daily septage-processing data included the date, company name, cost, type of septage, and volume processed. Weekly TS and volatile solids (VS) values were determined by CKTP staff to characterize septage further. Though the data set provides a relatively comprehensive picture of septage activity, total daily septage flow is not metered but rather it is assumed to be the cumulative volume of each truck processed each day whether or not the truck is completely full. It is assumed that this approach does not underestimate septage flows and loads and incentivizes septage haulers to completely fill trucks before processing.

Various septage types defined in the databases provided include septage, portable toilet, grease, biosolids, “other,” and “blank.” It was assumed that all septage types defined should be used to evaluate current septage flow and load conditions except for grease, which was assumed to be the FOG waste stream that would not undergo thickening.

Biosolids were noted by CKTP staff to sometimes include hauled biosolids from other facilities, such as TWAS, that were not combined with other hauled and on-site TWAS in the thickened sludge blending tank (TSBT). Biosolids accounted for an average flow of 2,000 gallons per day or, assuming a TS of 5%, about 90 lb/d of solids. Though a fraction of these biosolids could be counted as HTWAS, they have been historically counted in the septage database. Biosolids flow and loading accounts for about 9% of daily average septage flow and 1% of daily average septage solids loading. Despite these discrepancies, the biosolids data was included in the total septage flow and load analysis because typical operations do not record the flow or load as being sent specifically to the TSBT and, in the future, these biosolids will be processed through the septage receiving station. Impacts of this assumption on hauled TWAS flows and loads are discussed in section 2.1.5.

Figure 2-4 depicts solids TS and VS. Figure 2-5 depicts total daily volume processed by septage type. Figure 2-6 depicts total flow and load data with load data having been determined by TS data points and associated flow for that same day. Recorded data do not reflect receipt of any septage flows or loads for December 2021 and only biosolids were received from August to September 2022. For clarity, recorded zero values were removed from graphs.

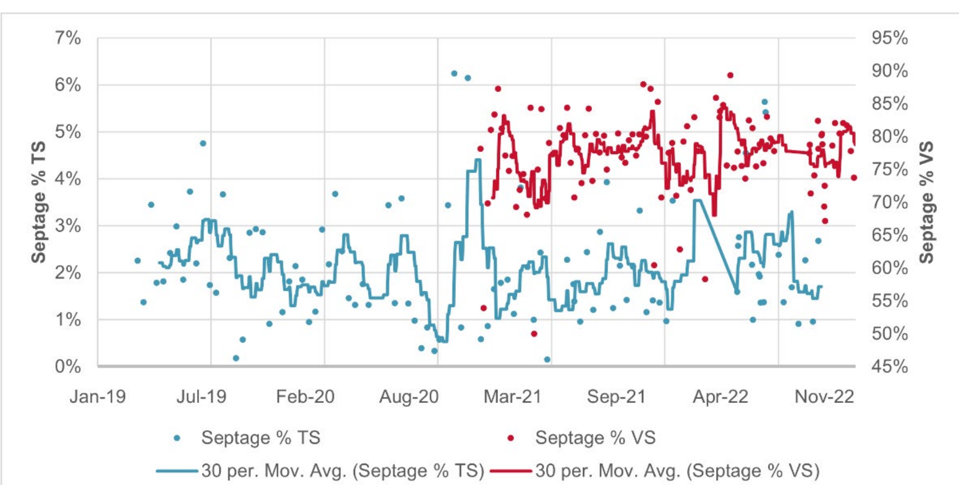

Figure 2-4. Septage percent TS and percent VS

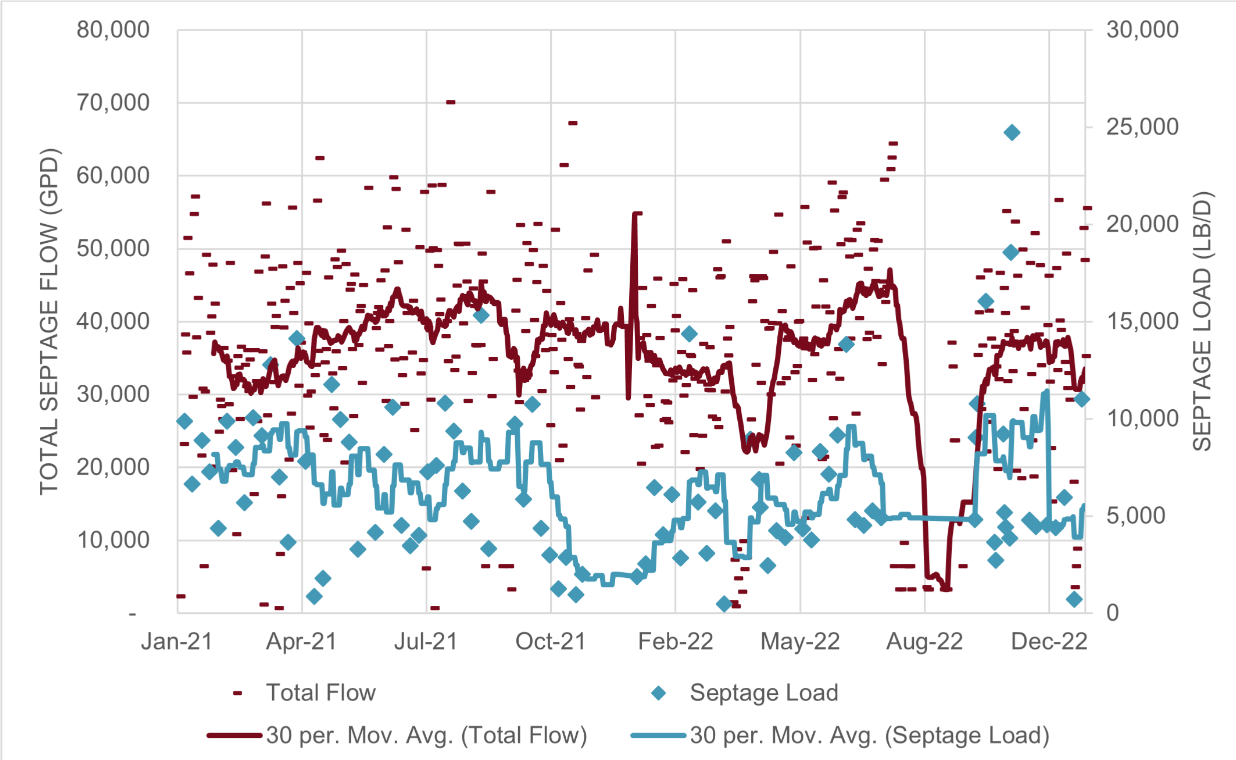

Figure 2-5. Septage flow and load

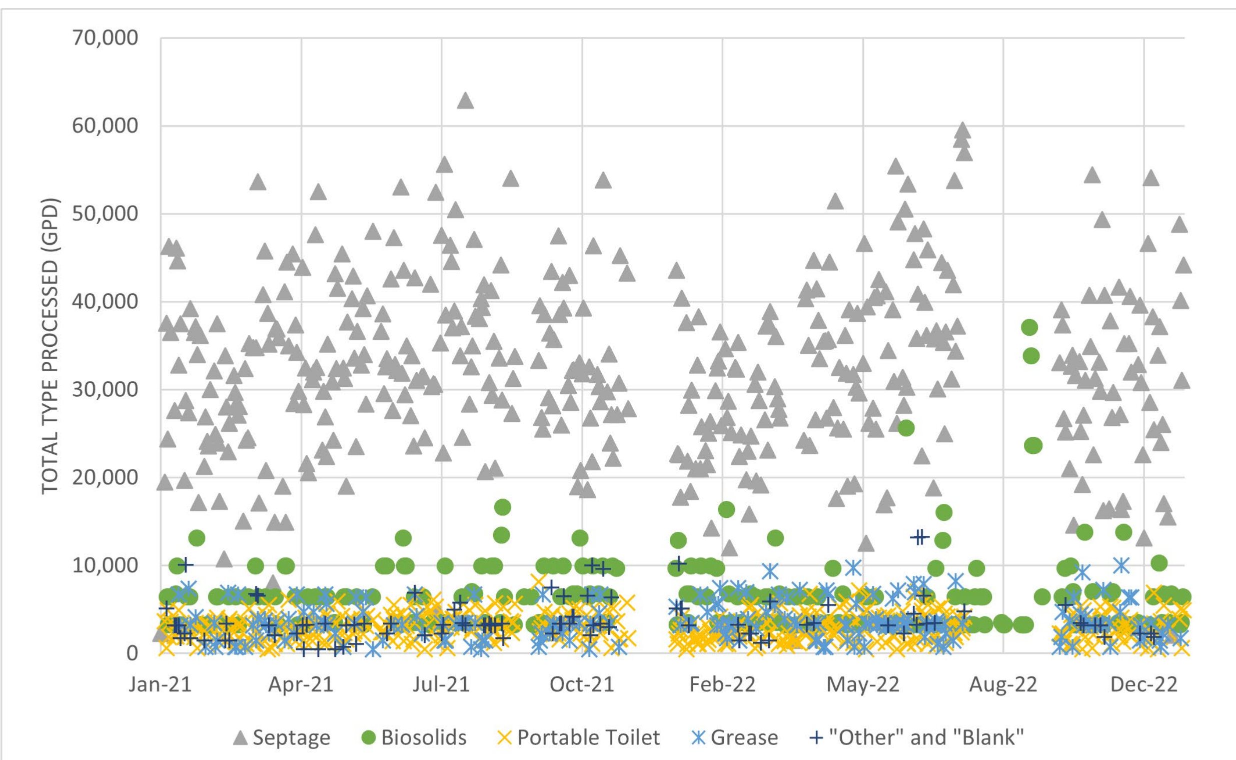

Figure 2-6. Septage flows by type

2.1.4 Historical FOG Flows and Loads

As part of the septage flow and solids data from 2021 to 2022, FOG flow data were included. Various septage types were labeled in the provided septage databases with the type labeled as “grease” being defined as the received FOG flows. TS data were not provided for FOG but, per the facility plan, a value of 1.81 percent was assumed to estimate FOG loading. Figure 2-7 depicts FOG flow and load data. For clarity, recorded zero values were removed from graphs.

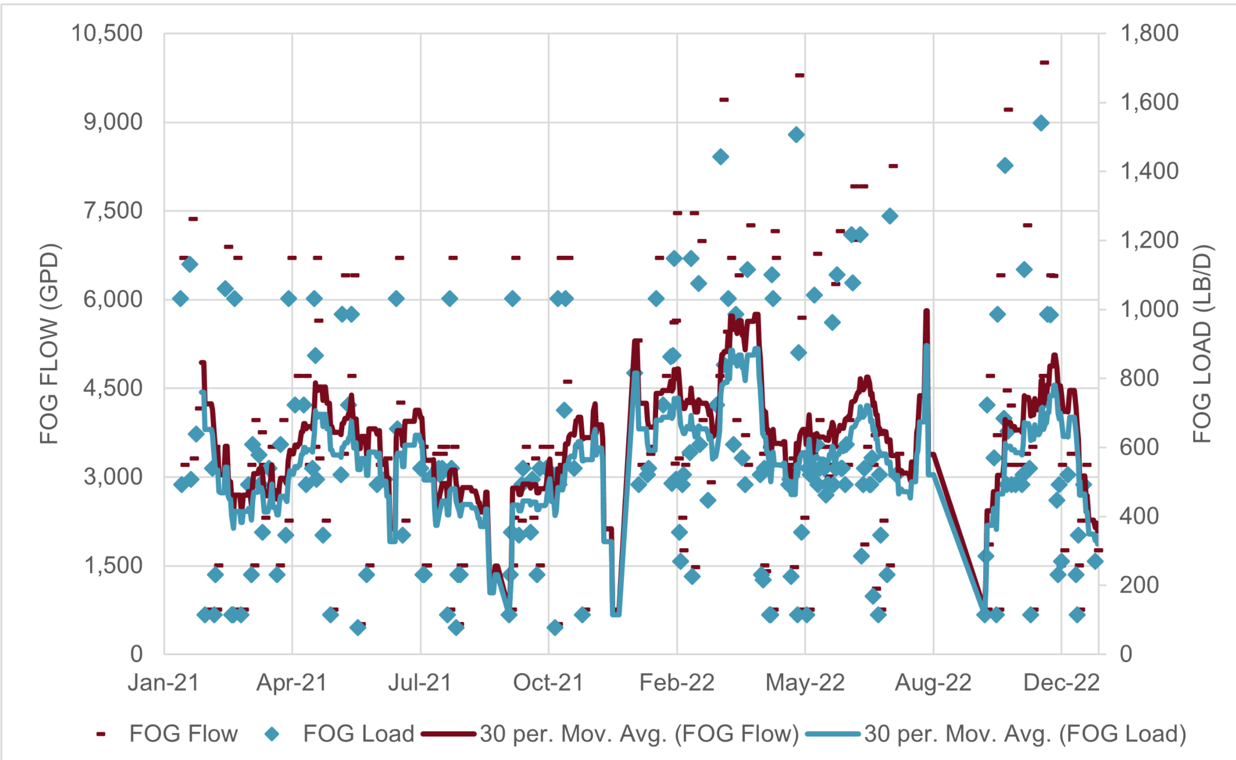

Figure 2-7. FOG flows and loads

2.1.5 Historical HTWAS Flows and Loads

HTWAS data was provided for the Kingston plant from April 2015 to June 2023 and for the Suquamish and Manchester plants from January 2020 to June 2023. Averages from 2020 to 2023 indicate HTWAS from all three facilities was delivered three times per week at a flow and load of 4,300 gpd and 1,960 lb/d, respectively, with a TS of about 5.2%. Figure 2-8 summarizes results from provided satellite plant data.

TSBT flow and TS data was also provided. Because the TSBT receives only HTWAS and CKTP TWAS, a mass-balance estimate of HTWAS solids loading was conducted. Daily TSBT flow and weekly TS data from 2019 to 2023 were evaluated in parallel with aforementioned WAS load estimates, adjusted to 95 percent of original value to account for WAS solids-thickening impacts, to determine estimated HTWAS loads. An assumed TS of 5.25 percent, which is comparable to TSBT average TS of 5.36 percent, was used to estimate associated HTWAS flows. Though this approach provides additional context for available data and mass-balance dynamics, it is highly variable and will not be used for design. Figure 2-9 depicts estimated HTWAS flows and loads.

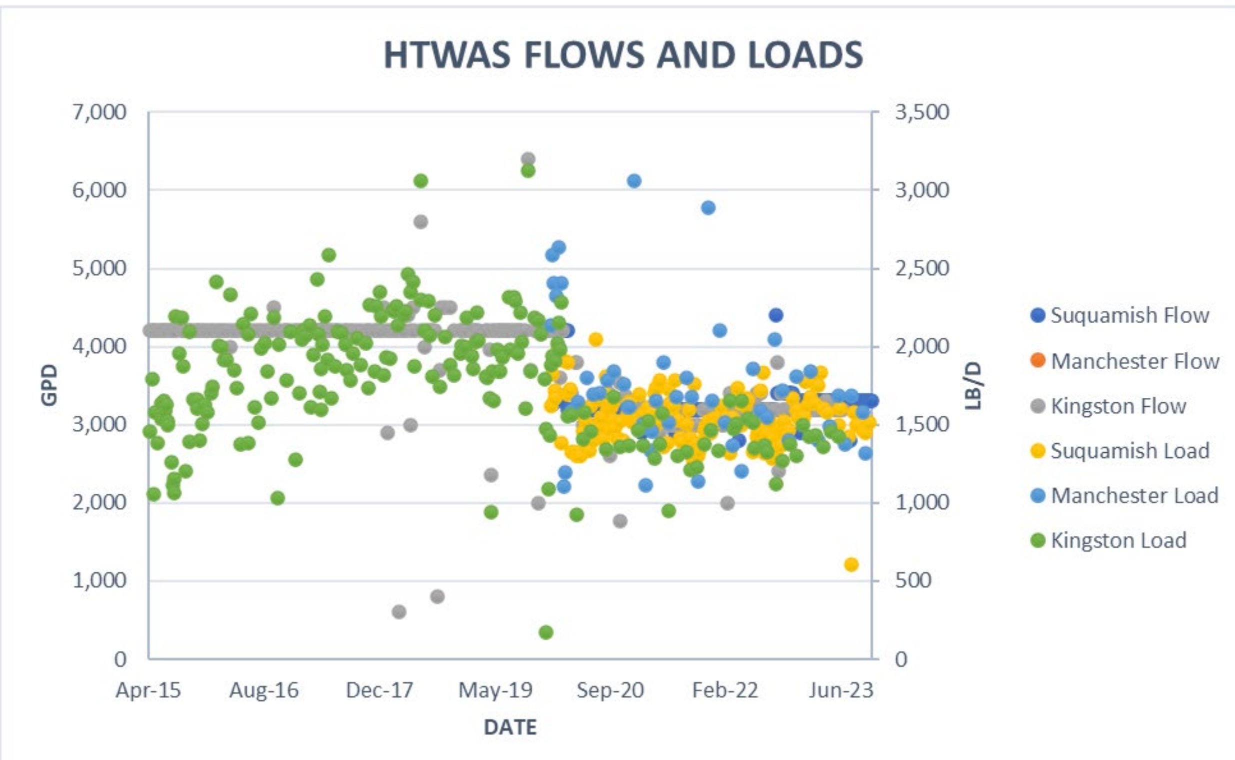

Figure 2-8. Recorded HTWAS flows and loads from satellite plants

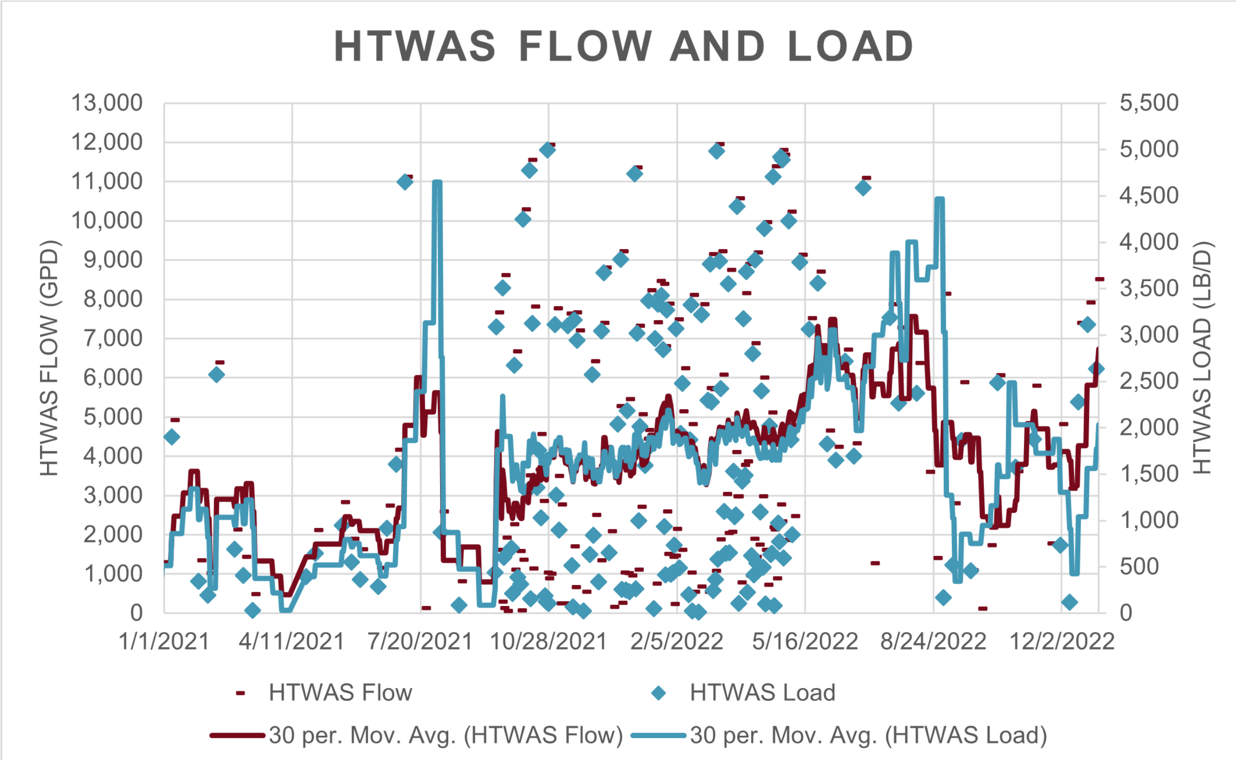

Figure 2-9. Estimated HTWAS flows and loads

2.2 Projected and Elected Solids Design Flows and Loads

To determine solids process improvement design criteria, each solid stream's historical and projected flows and loads were evaluated by comparing facility plan projections, aforementioned recorded data, and CKTP staff information. This section describes the basis of each data category's values for each stream: facility plan, recorded data, and design values. For all streams, design flow and load values were rounded up to the nearest hundredth. For clarity, each solids stream flows and loads are summarized on one or two consecutive pages. Table 2-1 below summarizes the selected design values for each stream. The table presents the raw loading of the applicable streams prior to any treatment (receiving, thickening, digestion).

Table 2-1. Summary of selected flow and load design values

Stream	Parameter	Current		2028		2042	
		AA	MM	AA	MM	AA	MM
PS	Flow (gpd)	125,800	147,200	96,600	110,800	98,500	110,400
	Load (lb/d)	5,300	6,200	6,100	7,000	8,300	9,300
WAS	Flow (gpd)	152,600	200,100	121,100	156,700	156,700	201,800
	Load (lb/d)	4,500	5,900	5,100	6,600	6,600	8,500
Septage	Flow (gpd)	23,000	33,000	28,500	40,900	52,100	75,000
	Load (lb/d)	4,100	5,900	5,100	7,300	9,300	13,400
FOG	Flow (gpd)	1,800	5,300	2,400	6,500	3,500	11,200
	Load (lb/d)	300	900	400	1,100	600	1,900
HTWAS	Flow (gpd)	4,600	7,400	5,300	8,400	6,300	9,900
	Load (lb/d)	1,800	2,900	2,100	3,300	2,500	3,900

AA = average annual; MM = maximum month.

2.2.1 PS Flow and Load Selection

PS specific gravity (S.G.) was assumed to be 1.01 for all categories. Table 2-2 and Table 2-3 summarize the facility plan, recorded data, and design values selected. Note that in Table 2-2 the design flows are assumed to decrease, not because the load decreases, but due to the fact that CKTP will begin to thicken primary sludge in the primary clarifiers over time in order to reduce hydraulic loading to the thickening process. Currently, primary sludge is pumped at a thinner rate (see footnotes in Table 2-3), but CKTP staff have demonstrated they can effectively thicken to 1-2 percent in the clarifier, which will allow for better performance of the new thickening equipment.

Table 2-2. PS current and future flows (gpd)

Data category	Current		2028		2042	
	AA	MM	AA	MM	AA	MM
Facility plan	75,890	88,150	87,100	99,900	118,500	132,800
Recorded data	105,700	122,900	122,200	140,000	168,000	187,900
Design[a]	**125,800**	**147,200**	**96,600**	**110,800**	**98,500**	**110,400**

a. Flows decrease in the future because assumed TS increases with increasing solids loading. See Table 2-3 for more information.

Table 2-3. PS current and future loads (lb/d)

Data category	Current		2028		2042	
	AA	MM	AA	MM	AA	MM
Facility plan[a]	5,310	6,180	6,100	7,000	8,300	9,300
Recorded data[b]	5,075	5,900	5,900	6,700	8,100	9,000
Design[c]	**5,300**	**6,200**	**6,100**	**7,000**	**8,300**	**9,300**

a. TS of 0.83% calculated from facility plan flows and loads.
b. TS of 0.57% assumed from dilute PS tests (Appendix E).
c. TS of 0.50% assumed for current, 0.75% for 2028, and 1.00% for 2042.

Facility Plan Values

Facility plan future primary average annual (AA) and maximum month (MM) values were determined from facility plan report tables with TS calculated from flows and loads in all cases. Current AA and MM values were backprojected using a linear trend.

Recorded Data

Recorded data for PS values were initially estimated in Section 2.1.1 but because of high variability in the data, an alternative approach was taken. Daily GT average flow and weekly average TS values were used to determine average daily GT effluent load and then the 5-day average daily septage flow and load was deducted to estimate PS load. A TS of 0.57 percent was used to calculate current AA and MM loads. Future AA and MM loads were linearly projected using facility plan trends and flows were determined using the same TS for current AA and MM.

Design Values

Design values for current PS were based primarily on facility plan projections. Current AA and MM loads reflected the aforementioned facility plan back-projection using a TS of 0.50 percent to determine associated flows. For future conditions, facility plan projected loads were used with an assumed TS of 1.25 percent to determine flows.

2.2.2 WAS Flow and Load Selection

WAS specific gravity was assumed to be 1.01 for all categories. Table 2-4 and Table 2-5 summarize the facility plan, recorded data, and design values selected. Note that the design assumes a higher solids loading that than the facility plan (Table 2-5), making the approach in this memorandum more conservative, but the design flow (Table 2-4) is relatively similar to the facility plan and recorded data, as it is assumed that WAS thickening will be slightly improved to 0.5 percent (as noted in the footnotes in Table 2-5) over time via changes in the operation of the secondary clarifiers and operation of the secondary system at a higher level of suspended solids (3,000 mg/L or more) for BNR operation.

Table 2-4. WAS current and future flows (gpd)

Data category	Current		2028		2042	
	AA	MM	AA	MM	AA	MM
Facility plan	118,174	148,453	134,625	168,182	180,687	223,425
Recorded data	129,862	170,146	146,313	189,876	192,375	245,119
Design[a]	**152,600**	**200,100**	**121,100**	**156,700**	**156,700**	**201,800**

a. Flows decrease in the future because assumed TS increases with increasing solids loading. See Table 2-3 for more information.

Table 2-5. WAS current and future loads (lb/d)

Data category	Current		2028		2042	
	AA	MM	AA	MM	AA	MM
Facility plan[a]	2,986	3,751	3,402	4,250	4,566	5,646
Recorded data[b]	4,485	5,876	5,053	6,558	6,644	8,465
Design[c]	**4,500**	**5,900**	**5,100**	**6,600**	**6,600**	**8,500**

a. TS of 0.30% calculated from facility plan flows and loads.
b. TS of 0.41% determined from average of testing results (Appendix E).
c. TS of 0.35% assumed for current conditions and TS of 0.5% assumed for future conditions as a product of MLSS increasing to support BNR.

Facility Plan Values

Facility plan loads for current AA and MM were backprojected from future facility plan values using a linear trend. Future facility plan load values were used. A TS of 0.30 percent was used for current and future conditions to estimate WAS flow.

Recorded Data

Recorded data for WAS are described in Section 2.1.2. Current AA and MM flow were based on the overall average of recorded 2021–2022 data whereas MM was based on the maximum of a 30-day running average for the same data. A TS of 0.41 percent was assumed based on recent test results (Appendix E). Future AAF and MMF were linearly projected based on facility plan flow values above.

Design Values

The 4 years of WAS flow and concentration data provided more dependable and conservative estimates of WAS flow and load then facility plan estimates. For current AA and MM WAS loads, recorded values were used in conjunction with an assumed TS of 0.35 percent to estimate current flows. Future AA and MM loads were composed of projected recorded data. To estimate future flows, a TS of 0.50 percent was used.

2.2.3 Septage Flow and Load Selection

Septage specific gravity was assumed to be 1.02 for all categories. Table 2-6 and Table 2-7 summarize the facility plan, recorded data, and design values selected.

Table 2-6. Septage current and future flows (gpd)

Data category	Current		2028		2042	
	AA	MM	AA	MM	AA	MM
Facility plan	23,000	32,680	30,270	43,010	52,420	74,470
Recorded data	22,920	32,960	28,390	40,900	51,850	74,750
Selected	**23,000**	**33,000**	**28,500**	**40,900**	**52,100**	**75,000**

Table 2-7. Septage current and future loads (lb/d)

Data category	Current		2028		2042	
	AA	MM	AA	MM	AA	MM
Facility plan[a]	4,040	5,740	5,300	7,560	9,210	13,090
Recorded data[b]	4,090	5,890	5,070	7,305	9,260	13,350
Selected[b]	**4,100**	**5,900**	**5,100**	**7,300**	**9,300**	**13,400**

a. TS of about 2.07% calculated from facility plan flows and loads.
b. TS of 2.10% determined from recorded average from 2021–2022.

Facility Plan Values

Facility plan current and future septage AA and MM values were gathered from facility plan report tables with TS calculated from flows and loads in all cases.

Recorded Data

Recorded data for septage values are described in Section 2.1.3. Current AAF was determined based on the AA of recorded data whereas MM was based on the maximum of a 30-day running average. Because septage is received only during business hours, or 5 days per week, AAs incorporate zero values every weekend. TS was determined from the average of recorded data for current and future conditions. Current data were projected using the facility plan's estimated annual increase of 4.4 percent to estimate 2028 and 2042 AA and MM flows and loads.

Design Values

Design values for current septage were based primarily on facility plan values with an increased TS of 2.10 percent to represent average recorded conditions. CKTP staff has recommended that the maximum septage load for 2042 MM be assumed to be the facility plan's 2042 AA load because it is expected that there is not enough developable land to reach the facility plan projected load for 2042 MM. To maintain conservative estimates consistent with the facility plan, this adjustment was not made for design values in this section. CKTP staff recommendations to use lower 2042 MM conditions are discussed further in thickening equipment design considerations in Section 4.

2.2.4 FOG Flow and Load Selection

FOG specific gravity was assumed to be 1.02. Table 2-8 and Table 2-9 summarize the facility plan, recorded data, and design values selected.

Table 2-8. FOG current and future flows (gpd)

Data category	Current		2028		2042	
	AA	MM	AA	MM	AA	MM
Facility plan	1,540	4,830	2,030	6,350	3,520	11,000
Recorded data	1,340	5,820	1,950	7,600	3,640	12,920
Selected	**1,800**	**5,300**	**2,400**	**6,500**	**3,500**	**11,200**

Table 2-9. FOG current and future loads (lb/d)

Data category	Current		2028		2042	
	AA	MM	AA	MM	AA	MM
Facility plan[a]	270	850	360	1,120	620	1,940
Recorded data[b]	210	900	300	1,170	560	1,990
Selected[c]	**300**	**900**	**400**	**1,100**	**600**	**1,900**

a. TS of 2.07% calculated from facility plan flows and loads.
b. TS of 1.81% determined from facility plan written description of FOG.
c. TS of 2.00% selected for design.

Facility Plan Values

Facility plan current and future FOG AA and MM values were gathered from facility plan report tables with TS calculated from flows and loads in all cases.

Recorded Data

Recorded data for FOG values are described in Section 2.1.4. Current AAF was determined based on the AA of recorded data whereas MM was based on the maximum of a 30-day running average. Because FOG is received only during business hours, or 5 days per week, AAs incorporate zero values every weekend. TS was assumed to be 1.81 percent per the facility plan. Current data were projected using the facility plan linear load trends to estimate 2028 and 2042 AA and MM flows and loads.

Design Values

Design values for current septage were based primarily on facility plan values with an assumed TS of 2.00 percent. This TS adjustment is closer to facility plan table values as compared to the written or reported TS value of 1.81 percent. Because FOG is received only during business hours, or 5 days per week, AAs incorporate zero values every weekend.

2.2.5 HTWAS Flow and Load Selection

HTWAS specific gravity was assumed to be 1.05. Table 2-10 and Table 2-11 summarize the facility plan, recorded data, and design values selected.

Table 2-10. HTWAS current and future flows (gpd)

Data category	Current		2028		2042	
	AA	MM	AA	MM	AA	MM
Facility plan	1,773	2,752	2,079	3,261	2,937	4,685
Recorded data	4,000	6,310	4,670	7,240	5,500	8,540
Selected	**4,600**	**7,400**	**5,300**	**8,400**	**6,300**	**9,900**

Table 2-11. HTWAS current and future loads (lb/d)

Data Category	Current		2028		2042	
	AA	MM	AA	MM	AA	MM
Facility plan[a]	796	1,235	933	1,463	1,318	2,102
Recorded data[b]	1,839	2,900	2,146	3,331	2,531	3,928
Selected[b]	**1,800**	**2,900**	**2,100**	**3,300**	**2,500**	**3,900**

a. TS of 5.12% calculated from facility plan flows and loads.
b. TS of 5.25% selected for recorded and design values.

Facility Plan Values

Facility plan current and future HTWAS AA and MM values were gathered from facility plan report tables with TS calculated from flows and loads in all cases.

Recorded Data

Current AA load was determined based on the average of daily TSBT flow and weekly TSBT TS data from 2019–2023 less the average current WAS load described in Section

2.2.2. Current MM load was determined using the MM:AA peaking factor from the facility plan. Flows were calculated using an assumed TS of 5.25 percent as this value was approximately the average of facility plan values and recorded TSBT TS of 5.36 percent. Recorded data satellite plants was comparable to TSBT mass balance estimates but because the TSBT mass balance potentially incorporates non-satellite hauled biosolids loads it was the preferred method for recorded values. Current data were projected using the facility plan linear load trends to estimate 2028 and 2042 AA and MM flows and loads.

Design Values

For current AA and MM HTWAS loads, recorded values were used in conjunction with an assumed TS of 5.25 percent to estimate current flows. Future AA and MM loads employed projected recorded data. Though design values are higher than prior facility plan estimates, the provided data and additional mass balance comparison suggest a required increase in estimated current flows and loads.

2.3 Rheology Testing and Analysis

When pumping thickened solids (typically streams in which the solids content is more than 2 percent), the fluid begins to exhibit a variable response to the shear forces of the pump. As opposed to water, a Newtonian fluid that maintains a consistent viscosity, thickened solids behave as non-Newtonian fluids in which viscosity varies with shear stress. This can greatly affect line pressures and pump sizing. Because of the high solids content of thickened solids streams at CKTP, field characterization of rheological properties for each solid stream was conducted to develop criteria for non-Newtonian process design.

2.3.1 Rheology Testing Background

HDR owns and operates an in-house Brookfield DVNext rheometer that can collect various data by applying torque to a spindle that spins in a fluid sample. For a given sampling event, the rheometer typically measures viscosity, shear rate and shear stress, temperature, spindle speed, and torque percent.

Three streams were identified for rheology testing to inform process design for this project. Combined thickened primary sludge (TPS) and septage, thickened waste activated sludge (TWAS), and digested sludge (DIG) samples were tested to determine rheological characteristics applicable to the required design criteria. Samples were tested in the summer to measure anticipated seasonal changes in sludge characteristics. Additional sampling and testing will be collected during the winter season in early 2024 for further data collection. This report summarizes and evaluates hydraulics and pump sizing based on the summer data alone. Further refinement of sizing will account for observed results from winter data.

2.3.2 Rheology Testing Results

Preliminary results of rheology testing are described below. Two sampling events occurred over summer 2023, when the following samples were collected and analyzed:

- **Sample Day 1 (August 31, 2023):**
  - TPS at 4.65 percent TS
  - CKTP TWAS at 5.43 percent TS
  - DIG at 2.14 percent TS
- **Sample Day 2 (September 7, 2023):**
  - TPS at 3.84 percent TS
  - Decanted thickened primary sludge (TPSD) at 4.67 percent TS
  - CKTP TWAS at 4.62 percent TS
  - HTWAS at 4.75 percent TS
  - DIG at 2.05 percent TS

Figure 2-10 shows the results of the summer 2023 samples.

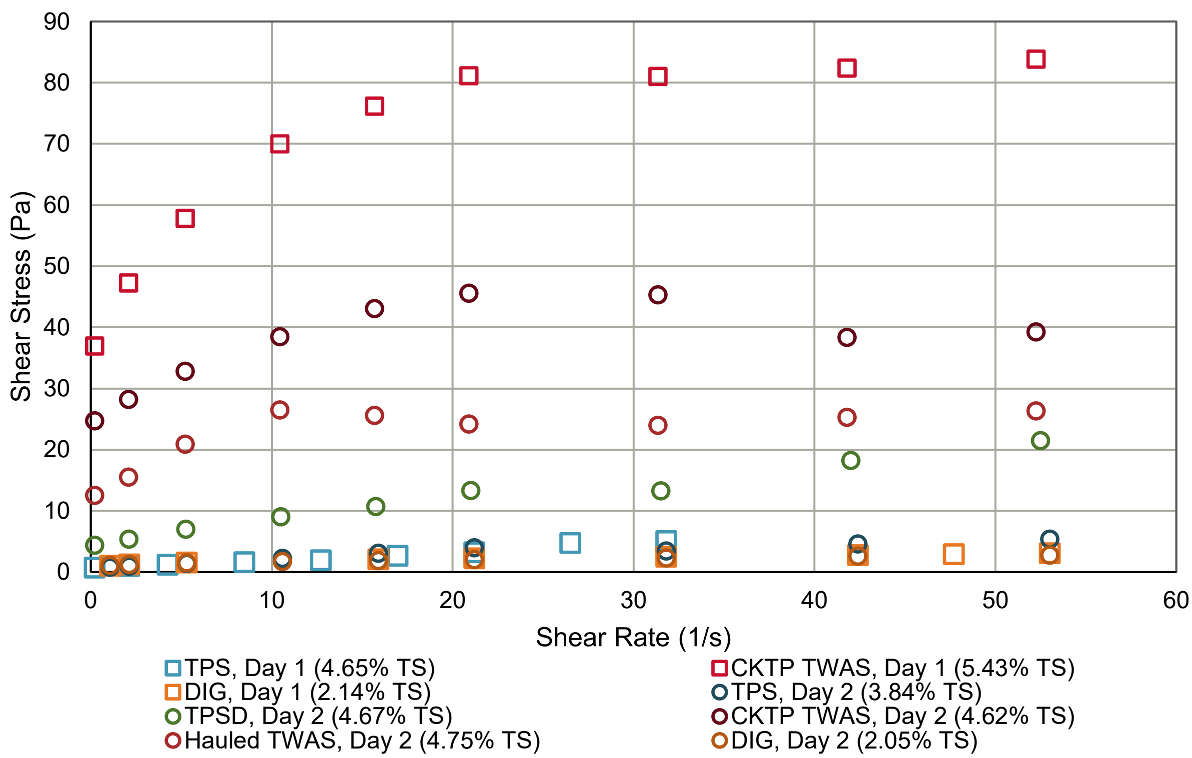

Figure 2-10. Rheological data results, shear stress versus shear rate

Key takeaways from this analysis include the following:

- CKTP TWAS versus CKTP + HTWAS: CKTP TWAS has more TS and is more viscous. Therefore, modeling only CKTP TWAS is more conservative for design.
- All TWAS samples were significantly more viscous than the DIG and TPS samples. Therefore, TWAS pumps will be the most affected relative to pump design.

- DIG has a much lower shear rate range. However, because of the low TS and shear stress values, this fluid is likely easier to pump compared to the TWAS and TPS.

The rheological data of non-Newtonian sludge at different solids concentrations are required for pump design for these fluids. CKTP-specific sampling and testing can be the most dependable reference for this analysis, especially when evaluating friction losses through piping and fittings. These results, various fit models, and normalization bases will be evaluated to establish preliminary design criteria for thickened sludge and sludge transfer pumps based on the summer 2023 data. Winter sampling will also be conducted as it is critical to more conservative pump sizing because it is typically more difficult, because of increased viscosity, to pump sludge at lower temperatures.

The standard operating procedure (SOP) and raw data tables for each stream sample are provided in Appendix I.

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3 Septage and FOG Receiving and Treatment

The following sections outline the BOD for the new septage- and FOG-receiving facilities proposed for CKTP.

3.1 Septage Overview

The existing septage-receiving station at CKTP, shown in Figure 3-1, currently experiences several operational-related issues including inefficient rock and large debris removal, lack of redundancy, and the inability to monitor septage parameters in real time during offloading (e.g., pH, flow metering, etc.). Additionally, the existing septage-receiving station does not include any form of equalization, which limits operational flexibility subsequent to the screening process. As part of the hauled-waste upgrades, and with the replacement of the existing GTs, septage will be conveyed to new mechanical thickening equipment through an interconnection with new PS piping in the PS and septage thickening building. Septage receiving and treatment improvements will include the following:

- Two new 6-inch-diameter truck connections
- A new septage influent box with manual bar screens and gravity bypass
- External rock traps and flow metering
- Two new screening systems with grit removal
- Residual grease removal
- Monitoring equipment and instrumentation
- Septage EQ tanks, wet well, and submersible pumps
- Wash water at applicable points throughout the receiving and treatment process including the influent box, manual bar screens, septage-screening equipment, and EQ tanks (hot water is currently not assumed for the design of septage receiving, but can be added as an extension from the FOG building if desired)

The improvements will also include two bypass configurations to allow septage receiving either under emergency conditions, or when the septage screening and degritting equipment is not operational. Brief descriptions of each bypass configuration are provided below.

3.1.1 Septage Gravity Bypass

Septage will be intercepted between the influent box and screening equipment, and gravity bypass around both screening and degritting systems to a new manhole (MH) located adjacent to the Decant Facility. A portable bypass pump will be required to pump from the new manhole into the Decant Facility. Due to the redundant screening and degritting systems, the likelihood of implementing this bypass configuration is low.

3.1.2 Septage Pumped Bypass

Screened and degritted septage will be intercepted in the EQ valve vault through a bypass piping and valve configuration, bypassing the new mechanical thickening equipment, and pumped to existing MH 11 located upstream of the headworks distribution channel.

3.1.3 Septage Workshop Material

Appendix C includes the workshop fact sheets, meeting minutes, and presentation as a record of the various septage receiving and treatment alternatives evaluation and selection. Final equipment selection and sizing is described in Section 3.4.

Figure 3-1. Existing septage-receiving station

3.2 FOG Overview

FOG, or trap grease, consists of grease collected from food service establishments (i.e., grease traps), or food processing businesses. FOG at CKTP is currently received and offloaded into the primary clarifier scum pit and pumped into the existing digesters through an existing scum pump and associated piping, which are nearing the end of their useful service life. FOG receiving will remain a separate process from septage receiving and will include a new FOG building dedicated to the receiving, screening, and feeding of FOG at temperatures that prevent congealing in transit and promote assimilation or blending before being introduced into the digestion process. The FOG process and instrumentation diagrams (P&IDs) (Appendix F) currently show direct injection of FOG into each digester, which will serve as the basis of design and is intended to minimize time in piping or contact with the heat exchanger. FOG receiving and treatment improvements will include the following:

- New 4-inch-diameter truck connection
- External rock trap and flow metering
- FOG screening system with monitoring equipment and instrumentation
- FOG screening system bypass and grinder
- FOG-receiving tank with submersible mixer
- FOG feed pumps to pump FOG at a controlled rate to the digesters
- Hot and cold spray/wash water for the rock trap, screening equipment, and FOG-receiving tank
- Hot water connection points located throughout the building to provide wash water for hose bibs and direct connections to FOG piping for manual flushing

3.2.1 FOG Workshop Material

Appendix C includes the workshop fact sheets, meeting minutes, and presentation as a record of the various FOG receiving and treatment alternatives evaluation and selection. Final equipment selection and sizing is described in Section 3.4.

3.3 Septage and FOG Flows and Loads

As summarized in Sections 2.2.3 and 2.2.4, current and projected flows and loads have been identified for both septage and FOG; however, the improvements planned for each system incorporate additional design criteria to accommodate operational flexibility, and most significantly, the variability in frequency and volume for septage and FOG delivery. The following additional criteria were used in the development of selected design criteria for the proposed improvements:

- **Septage:**
    - Two 100,000-gallon (gal) EQ basins will allow for operational flexibility, and controlled flow-metered feeding to the new mechanical thickening equipment.
    - Assumed water:septage dilution of 2:1 by volume to account for added water during the septage receiving and treatment processes. Submersible pumping equipment and associated variable-frequency drives (VFDs) designed to handle pumping rates up to 150,000 gpd (approximately 105 gpm).
    - Screening and degritting equipment hydraulic capacity of 576,000 gpd (400 gpm) at 3 percent TS, and 410,400 gpd (285 gpm) at 6 percent TS.
- **FOG:**
    - One 7,500-gallon FOG-receiving tank with submersible mixer.
    - FOG-screening equipment with a capacity of 950,400 gpd (660 gpm) at 3–4 percent TS.

- Progressive-cavity FOG feed pumping equipment and VFDs designed to handle pumping rates up to 72,000 gpd (approximately 50 gpm).

3.4 Septage and FOG Equipment Selection

The following sections detail the specific equipment selected to achieve the design criteria listed in the previous sections.

3.4.1 Septage Equipment

This section describes selection of septage equipment, including the septage-screening system.

Septage-Screening System

Septage equipment is typically manufactured as a packaged system to perform preliminary treatment of septage by removing floating, particulate, or fibrous material; aerated grit removal; and residual grease skimming. The selected packaged system for the septage receiving and treatment improvements is the Lakeside Raptor® Complete Septage Plant (model 31CPSAG). The pre-engineered Lakeside Raptor Complete Septage Plant will provide fine screening, grit removal in a designated grit chamber that includes aeration to keep organics suspended and allows grit to settle, regardless of flow, and residual grease removal through a motorized skimmer. Each Lakeside Raptor Complete Septage Plant includes a three-plane cylindrical bar screen complete with screen basket, rotating rake, cleaning comb, concentric screw conveyor, dewatering screw, grit aeration system with blowers, grease collection and removal system, automated grease skimming system, grease pump, spray wash system, and screenings press with drive unit. The pre-engineered housing includes gasketed covers with a tank vent for odor control connection and ultrasonic liquid level sensing system. Additionally, the packaged system includes weather protection; screenings and grit baggers; and a Raptor Acceptance Control System (RACS) control station with a security access and keycard system to record time, volume, pH, etc. of septage deliveries from authorized dischargers.

A section of the proposed Lakeside Raptor Complete Septage Plant is shown in Figure 3-2, an example of a complete plant installation is shown in Figure 3-3, a Lakeside RACS control panel is shown in Figure 3-4, and design criteria are listed in Table 3-1.

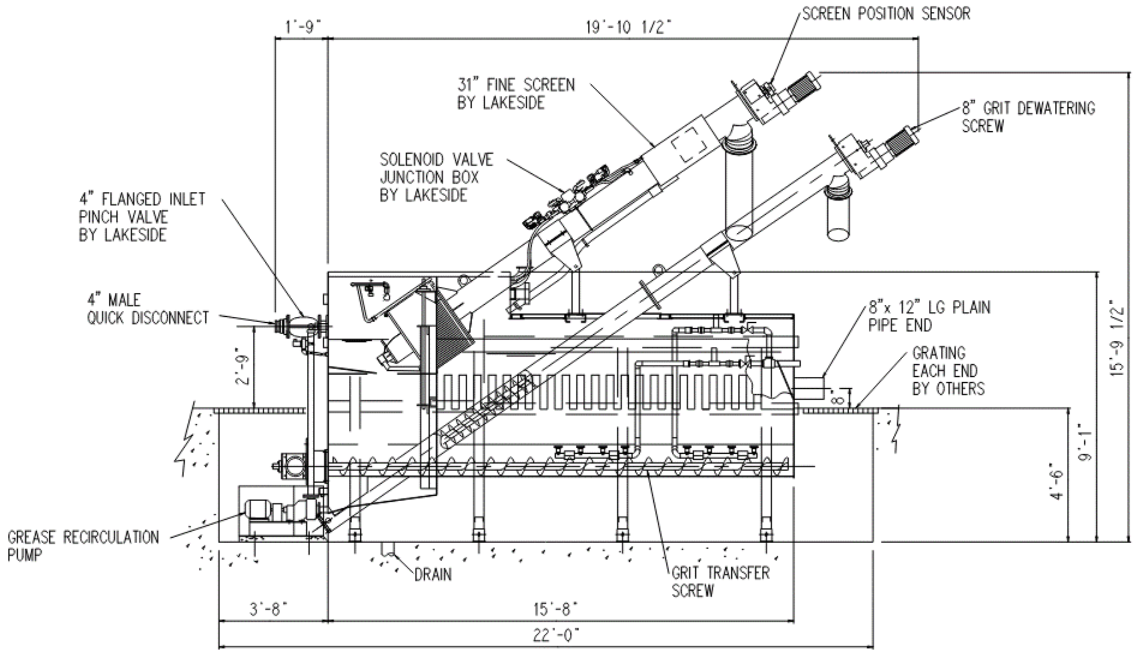


Figure 3-2. Lakeside Raptor Complete Septage Plant (model 31CPSAG)

Figure 3-3. Example Lakeside Raptor Complete Septage Plant

Figure 3-4. Lakeside RACS control station

Table 3-1. Lakeside Raptor Complete Septage Plant design summary

Parameter	Value
Septage system hydraulic capacity (gpm) (at 3% TS)	400
Septage system hydraulic capacity (gpm) (at 6% TS)	285
Electrical power characteristics (VAC/Hz/phase)	460/60/3
Motor and solenoid valve electrical classification	Non-hazardous
Electrical enclosure type	NEMA 4X AISI Type 304 stainless steel
Screen design summary	
Screen clean water hydraulic capacity (gpm)	2,061
Maximum upstream liquid level (in.)	13.75
Maximum clean water head loss (in.)	8
Bar spacing (in.)	0.25
Nominal screening basket diameter (in.)	31
Maximum allowable screen cleaning time (seconds)	5
Screen screw conveyor diameter (in.)	10
Screen speed reducer minimum service factor	1.56
Screen speed reducer minimum torque rating (in.-lb)	15,700
Screen speed reducer minimum thrust rating (lb_f)	5,800
Screen drive motor size (hp)	2
Grit auger drive motor size (hp)	2

Parameter	Value
Grease skimmer drive motor size (hp)	0.5
Maximum spray wash system flow rate (gpm)	25
Minimum spray wash system pressure (psig)	60
Screen lower wash system number of nozzles	7
Blower design summary	
Number of blowers (per unit)	1
Blower capacity (scfm)	9
Blower pressure (psig)	2.5
Blower motor size (hp)	2
Tank design summary	
Minimum tank width (ft)	5
Minimum tank length (ft)	15.67
Minimum tank height (ft)	9.08
Tank inlet pipe size (in.)	4
Outlet pipe size (in.)	8
Grease pump summary	
Minimum pumping capacity, gpm	20
Minimum discharge head, ft	30
Minimum drive motor size, hp	2

3.4.2 Associated Septage Equipment

Equipment used in support of the septage receiving and treatment improvements also includes the following:

- **Septage offloading/influent box:**
  - Control pinch valve
  - Ultrasonic level elements and float switch (overflow vault)
- **Septage piping:**
  - External rock trap
  - Inline pH sensor
  - Magnetic flow meter
  - Associated cement-mortar-lined ductile-iron piping and valves
- **Septage equalization tanks:**
  - Ultrasonic level elements
  - Motorized slide gates
  - Submersible mixers

- **Septage equalization wet well:**
  - Submersible pumps
  - Ultrasonic level elements and float switches
- **Septage equalization valve vault:**
  - Inline diaphragm seal with pressure element
  - pH sensor
  - Magnetic flow meter
  - Combination air release/vacuum valve
- **Septage interconnection to primary sludge:**
  - Pressure sustaining valve
  - Inline diaphragm seal with pressure element

3.4.3 FOG Equipment

This section describes selection of FOG equipment, including the FOG-screening system.

FOG-Screening System

FOG makes up a relatively small fraction of the overall wastewater flow in relation to the volume of screening and grit; however, FOG material typically requires a disproportionate amount of labor and resources when compared to other pretreatment processes. As a result, the selected FOG receiving and screening equipment is specially designed and intended for FOG and generally includes a screening system where FOG is gravity-fed or pressurized directly into a rotating screen basket and debris is captured on flights that carry it around the basket and deposit it into an auger trough, a washing zone, and then to a dewatering zone. The selected system for the FOG receiving and treatment improvements is the SAVECO VFA1200-DM SAVI BEAST. The BEAST system has a two-stage tank with radar liquid level sensing system, and a curved and sloped inlet section that directs flow into the screen cylinder. The hopper trough extends beyond the cylinder opening, which reduces screenings recycle. The screen uses a dual-drive system, which allows the screen basket and auger to operate independently, thus allowing the speed of the auger to be increased to provide faster debris removal while the speed of the screen basket can be decreased to improve capture efficiency. To mitigate the typical maintenance challenges associated with FOG equipment, the BEAST system does not use brushes inside the screen basket, which equates to the system catching fewer rags and debris. The screen is also supported at the drive end, which eliminates the need for support arms and further reduces ragging-related issues.

An isometric of the SAVECO VFA1200-DM SAVI BEAST system is shown below in Figure 3-5, screen features of the BEAST system are shown in Figure 3-6, and design criteria are listed in Table 3-2.

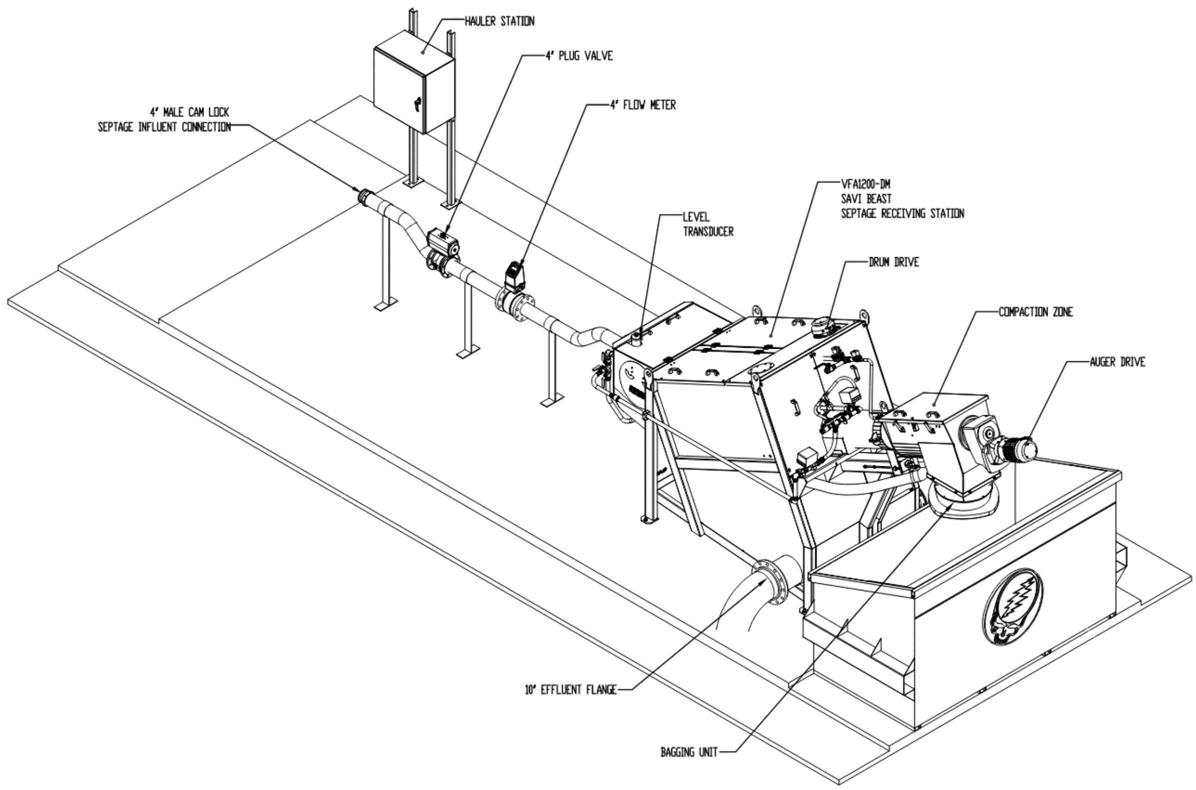


Figure 3-5. VFA1200-DM SAVI BEAST isometric

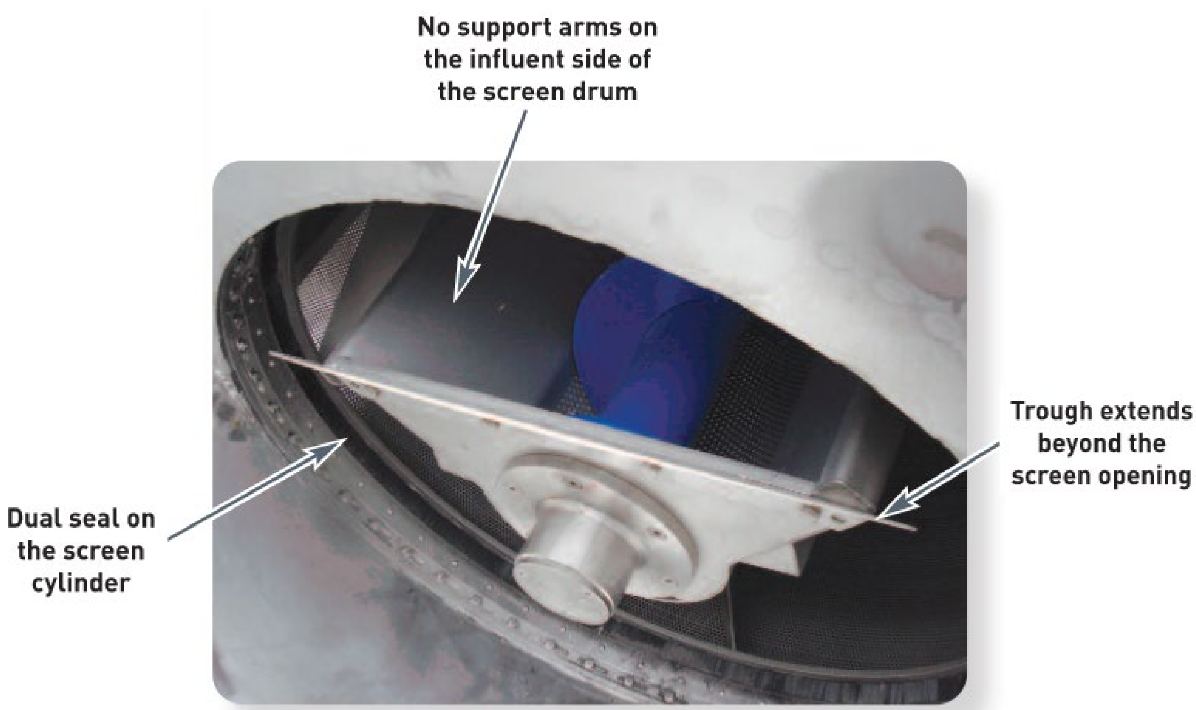


Figure 3-6. VFA1200-DM SAVI BEAST screen features

Table 3-2. FA1200-DM SAVI BEAST design summary

Parameter	Value
Septage system hydraulic capacity (gpm) (at 3%–4% TS)	660
Electrical power characteristics (VAC/Hz/phase)	460/60/3
Screen (type)	Perforated plate
Perforation size (mm)	6
Angle of inclination (degrees)	25
Cold water spray (gpm/psi)	45/40–60
Hot water spray (gpm/psi)	33/40 (min temp. of 125°F)
Drum screen drive motor (hp)	2
Auger drive motor (hp)	1.5
Controls	NEMA 4X

3.4.4 Associated FOG Equipment

Equipment used in support of the FOG receiving and treatment improvements also includes the following:

- **FOG offloading:**
  - Control pinch valve
- **FOG building:**
  - External rock trap
  - Magnetic flow meter
  - Inline grinder
  - Radar level element
  - FOG-receiving tank with ultrasonic level element and submersible mixer
  - Progressive-cavity FOG feed pumps
  - Inline diaphragm seal with pressure element
  - Associated glass-lined and heat-traced ductile-iron piping and valves

3.5 Septage and FOG Facility Layout

This section presents a septage and FOG facility layout, including a general layout; the septage influent box; septage screening, equalization, and pumping; and the FOG building.

3.5.1 General Layout

The new septage-receiving station and FOG building locations are proposed for the southeast corner of CKTP, as shown in Figure 3-7. A general layout of both facilities and conceptual site plan are provided in Section 12 and in Appendix H. The preliminary civil design incorporates additional facility layout details and provides general piping routing and appurtenant structures that may not generally be shown in this section. The proposed area for the new septage-receiving station is located to the east of the existing septage-receiving station. The existing grade of this location is a relatively steep slope that will be cut, as required, to allow the influent box, septage EQ tanks, wet well, and valve vault to be buried. Because of the existing grades, a retaining wall may be required between the influent box and EQ tanks, as shown in Figure 3-11. The proposed area for the new FOG building location is on the south end of the existing grass island, to the north of the existing vactor decant facility and east of the headworks building. The general area of the proposed FOG building is combined with space that will become available following demolition of the existing septage-receiving station. This available space allows for expansion of the FOG facility if additional capacity is needed in the future, or if additional FOG treatment or technology is desired, similar to the packaged treatment system evaluated during the septage and FOG workshop that processes raw FOG to a biofuel precursor.

Equipment and plumbing drains from the FOG and Septage facilities, for use during washdown, equipment draining, or other maintenance activities, will be routed to the headworks or the EQ tanks to collect drainage when needed.

Figure 3-7. General septage and FOG facility layout

3.5.2 Septage Influent Box

At the septage offloading point, and upstream of the septage screening and degritting systems, septage haulers will gravity-offload through a 6-inch-diameter truck connection into an influent box with a 1- to 2-inch manual bar screen (final size to be determined [TBD] during detailed design), intended to collect large rocks and debris and protect the packaged screening and degritting equipment. The septage offloading point at the influent box structure will be accessed by septage haulers through a new road located on the upper level of the property that was recently acquired by CKTP. The influent box structure will include three separate vaults: two exterior vaults will be used for active discharging of septage, and the middle vault will be dedicated to overflows in the event that a septage hauler overcomes or clogs the bar screen and backs up the vault being used. Wash water will be located at multiple points in and around the influent box. A washdown header will be located inside each vault to provide an automatic washdown for the interior walls, bar screen, and sump of each vault, and three hose bibs will be provided so that the bar screen can be washed from above grade, and a general washdown of the surrounding area can be provided. Septage haulers will be required to clean the offloading area, influent box, and manual bar screen following a septage delivery. Access hatches for each vault will allow septage haulers to use a CKTP-provided rake and dumpster to clean rocks and larger material from the manual bar screen. As noted in Section 6.3, foul air will be collected from the influent box and a negative pressure will be maintained in each vault when the access hatches are closed.

Conceptual influent box isometrics, plans, and sections are shown below in Figure 3-8, Figure 3-9, and Figure 3-10. A septage influent box P&ID is provided on Drawing P-510.

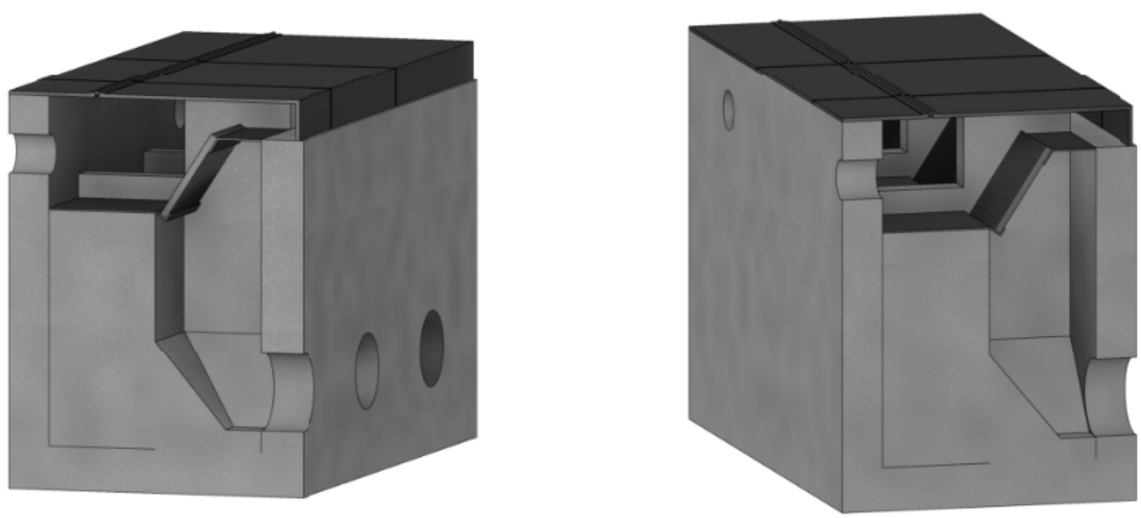


Figure 3-8. Septage influent box isometrics

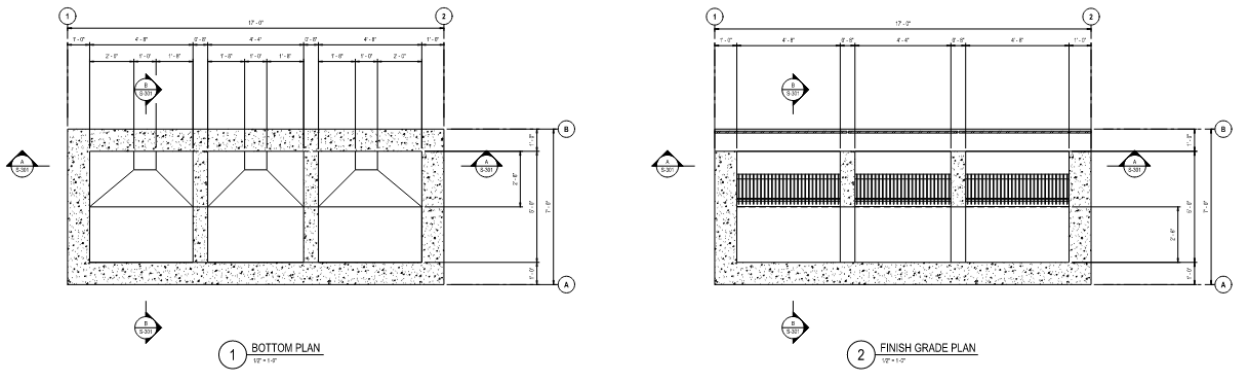


Figure 3-9. Septage influent box plans

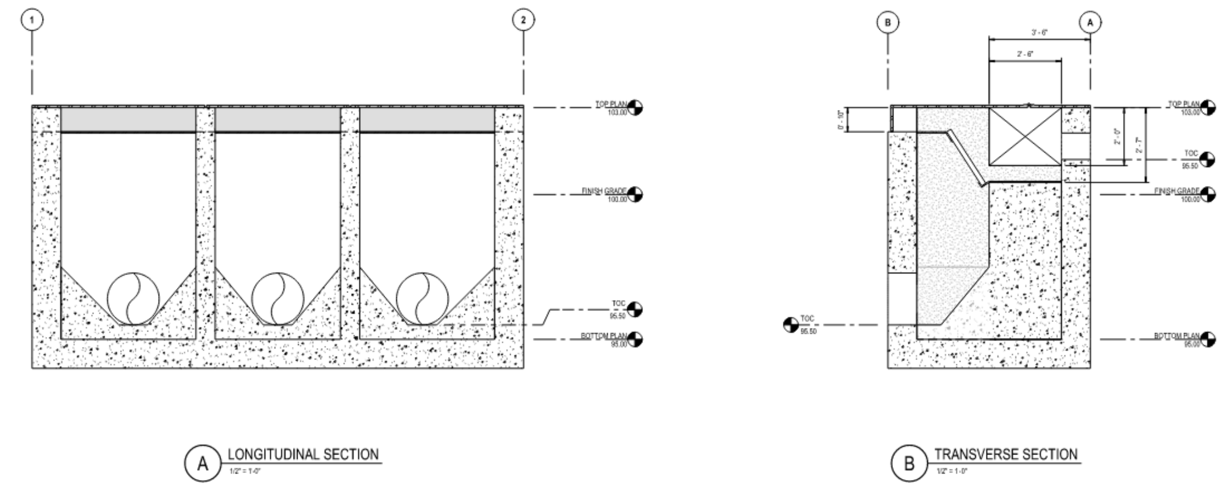


Figure 3-10. Septage influent box sections

3.5.3 Septage Screening, Equalization, and Pumping

As septage leaves the septage influent box, 6-inch-diameter cement-mortar-lined ductile-iron piping will convey flow from the two exterior vaults through a piping configuration that incorporates various plug valves that will allow septage to be routed to either of the screening systems and for flow to be metered from each septage hauler truck. Upstream of the screening system inlet, septage will flow through an external Type K rock trap and 4-inch magnetic flow meter and into the screening systems. A gravity bypass will allow for thickened septage and thickened biosolids to bypass the influent box and either go to the screening and degritting equipment, or directly into the septage EQ tanks.

Subsequent to screening and degritting, septage will be discharged into one of two 100,000-gallon septage EQ tanks. The proposed installation location for each screening system is on the roof of each septage EQ tank. Each tank will be equipped with washdown headers to clean the interior of the tank, and motorized mixers to ensure that a homogenous mixture is pumped to the new mechanical thickening equipment. Each septage EQ tank will include a motorized slide gate in the sump area of the tank that allows septage to flow into the septage EQ wet well. From the septage EQ wet well, septage will be pumped via submersible solids-handling pumps to the new mechanical thickening equipment, or the headworks building, through 4-inch cement-mortar-lined ductile-iron piping.

The submersible septage pump discharge piping will be routed through the EQ valve vault to an interconnection with the new PS piping to provide the flexibility of mixing septage with PS, or sending only septage, to the new mechanical thickeners. Because of the existing site grade and elevations of the proposed infrastructure, the discharge point of the septage piping is below the septage EQ wet well operating level, which creates the potential for column separation, or a break in the system hydraulic grade line, between each septage pumping cycle. At the current proposed infrastructure locations, this condition results in a ± negative 1 foot of static head on the septage pumping system and may also have the potential to allow the accumulation of air in the piping system, through air/vacuum valves or combination air valves, and subsequently allow that air to transfer to the new mechanical thickening equipment when PS is being pumped while the septage pumps are not in operation.

To mitigate this potential operational challenge, a pressure-sustaining valve is being proposed at the interconnection to the new PS piping. The pressure-sustaining valve would allow a specific minimum pressure for the septage pumps to be maintained and allow for efficient pump performance across all pumping scenarios. A specific type of pressure-sustaining valve that may be considered for this application is an electric-actuated control pinch valve with an elastomer sleeve. The elastomer sleeve would be the only part of the valve that is in contact with screened septage. During a septage pumping operation, and as pressure begins to build on the upstream side of the pressure-sustaining valve, the valve would open to reduce the upstream pressure down to a pr-determined pressure set point. As pressure continues to build, the valve would open further. At the end of a pumping operation, and as pressure decreases upstream of the valve, the valve would gradually close to maintain a predetermined minimum pressure set point. This type of pressure-sustaining valve does not require an air compressor to operate like a traditional plunger-type pressure-sustaining valve and has been used in sewer force main applications for several years.

Layout sections of the septage-receiving station and EQ tanks, including an isometric, are shown below in Figure 3-11, Figure 3-12, Figure 3-13, and Figure 3-14. Preliminary piping is shown on the Civil Plan sheets in Appendix H, and septage screening, EQ, and pumping P&IDs are provided on Drawings P-510 through P-513 in Appendix F.

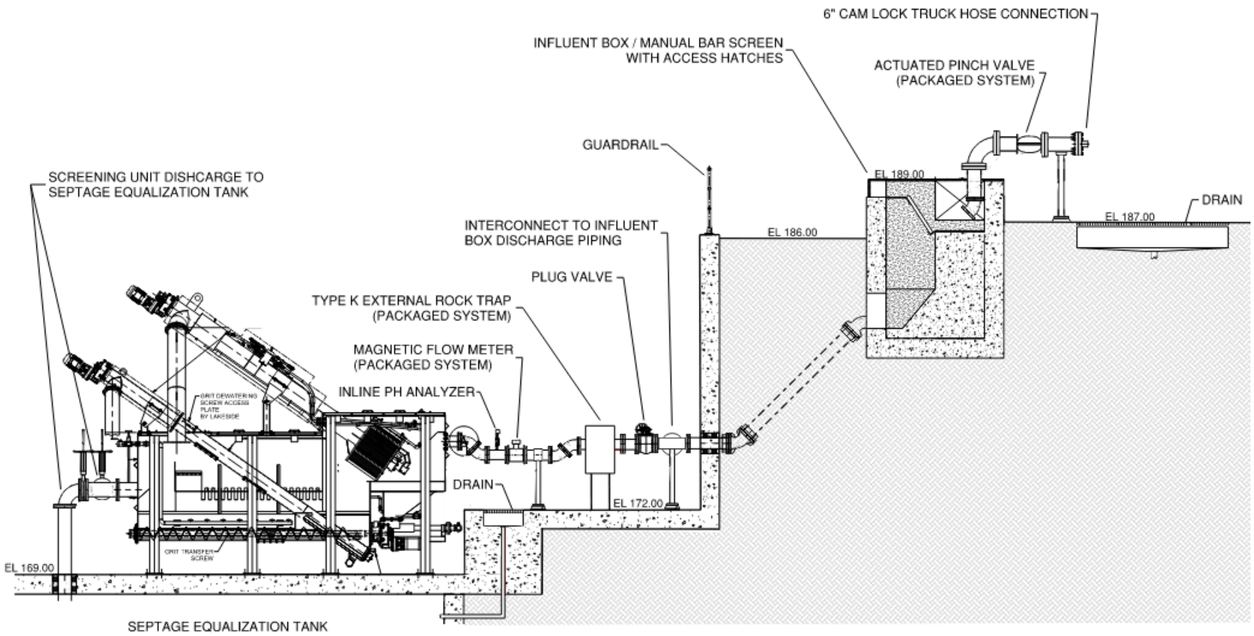


Figure 3-11. Septage-receiving station layout

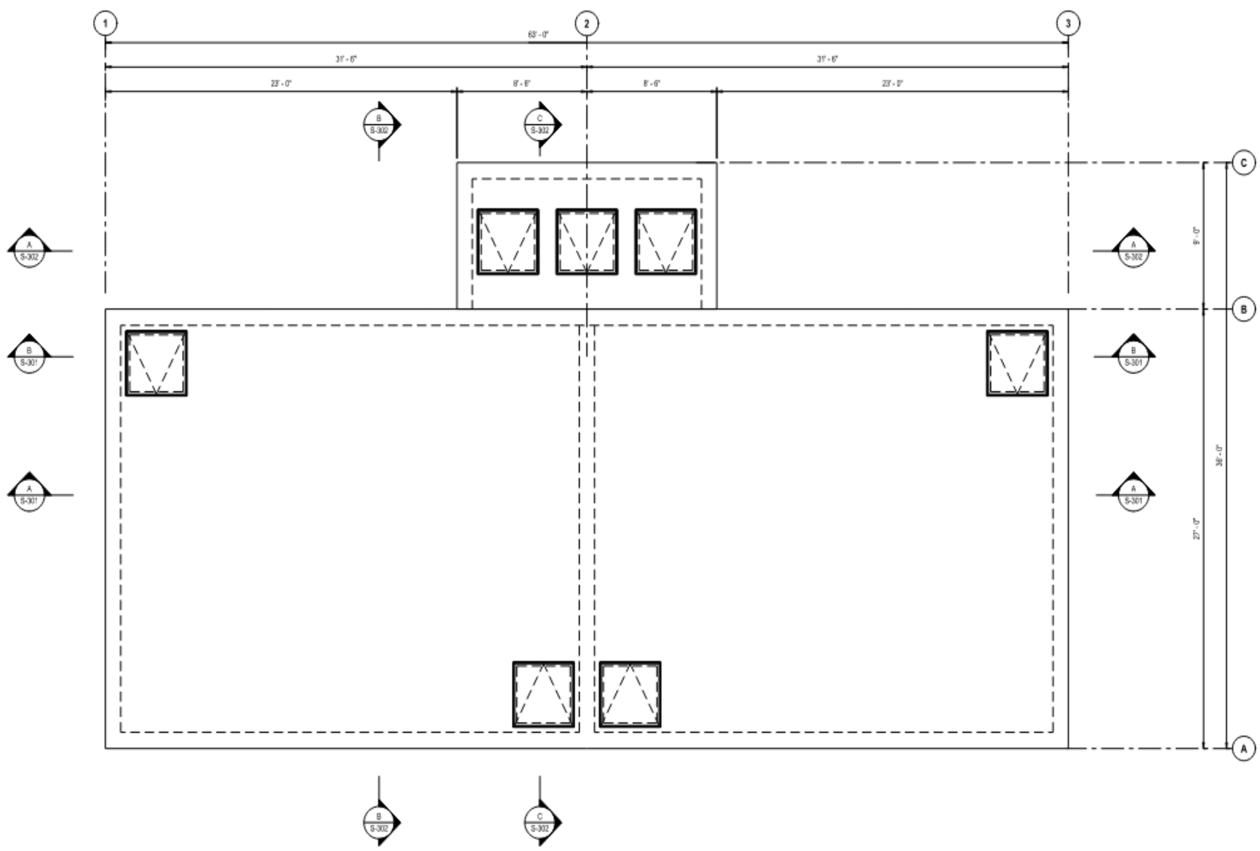


Figure 3-12. Septage EQ tank roof plan

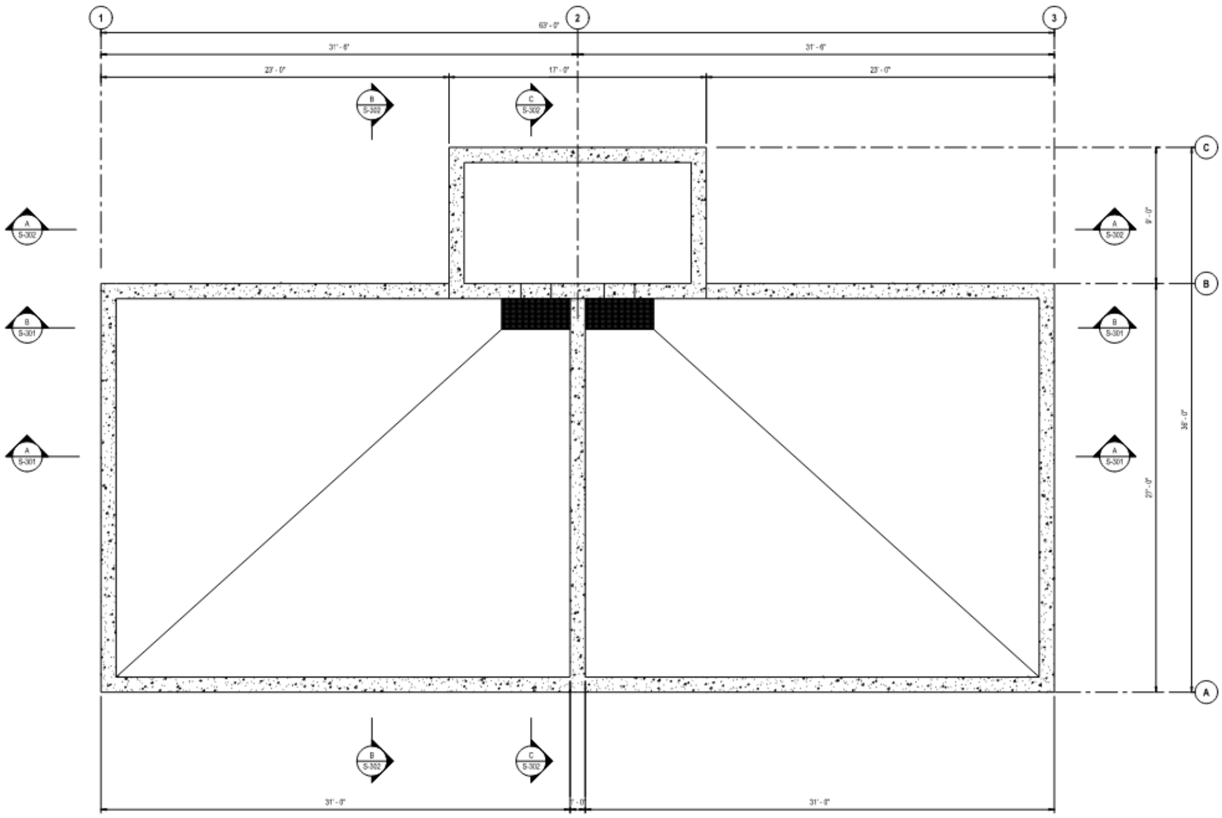


Figure 3-13. Septage EQ tank foundation plan

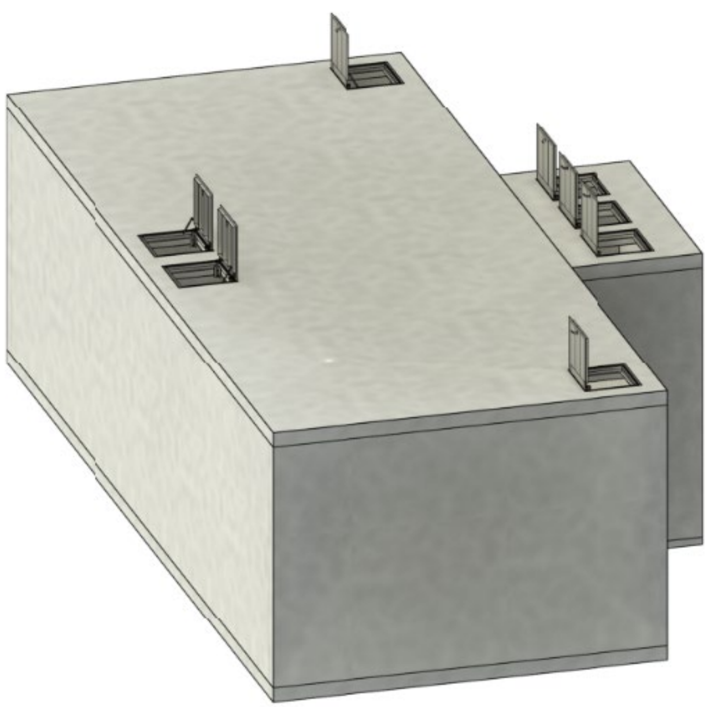


Figure 3-14. Septage EQ tank isometric

3.5.4 FOG Building

The new FOG building will house all FOG-related equipment and include an electrical room, utility room, and FOG-handling room. FOG haulers will access the new FOG building offloading location from the service road through CKTP, similar to how haulers currently access the existing septage-receiving station. Offloading will include gravity and pressurized discharging of FOG through a 4-inch truck connection with an exterior-mounted control station that will provide secure keycard access and record time, volume, pH, etc. FOG will be conveyed through glass-lined and heat-traced ductile-iron piping, an external rock trap with bypass, a magnetic flow meter, and into the FOG screening system. Screened FOG will discharge through a 10-inch-diameter gravity line from the FOG screening system into a 7,500-gallon FOG-receiving tank with submersible mixer. Progressive-cavity FOG feed pumps will convey FOG from the FOG-receiving tank to a specific digester(s), discussed in Section 3.7.

Bypass FOG piping will include a connection between the magnetic flow meter and inlet to the FOG screening equipment to allow FOG to gravity bypass to the FOG-receiving tank. As part of the gravity bypass, and in the absence of using the FOG screening equipment, FOG is conveyed through the FOG bypass piping and an inline grinder prior to discharging into the FOG-receiving tank.

The BOD for the sizing of the FOG-receiving tank is to provide adequate storage volume to completely offload two FOG hauler trucks, typically ranging between 2,500 and 3,500 gallons per truck, which provides CKTP staff the flexibility to not immediately feed FOG into the FOG-feed tank and digesters, if desired. A small amount of additional tank capacity is incorporated into the sizing of the FOG-receiving tank to ensure that the tank is allowed to operate as intended while maintaining sufficient freeboard to prevent overflows. This additional tank capacity will also allow the residual grease that is collected from the septage-screening equipment to be pumped to the FOG-receiving tank and combined with FOG that is offloaded from FOG haulers. Due to the heavy maintenance typically associated with FOG, hot water will be provided throughout the FOG building. Hot water will be routed to all hose bibs, the external rock trap, and to dedicated hot water flush connection points upstream of the flow meter and inlet to the screening equipment, downstream of the screening equipment discharge, a direct connection to the FOG-receiving tank, upstream of the FOG feed pumps, and to the FOG-feed pump recirculation piping. Hot spray water will also be routed to the screening equipment manufacturer’s connection points at the screen inlet, drum drive, and compaction zone. The electrical room will house all FOG-related electrical equipment and the utility room will house the hot water heaters for all hot water flushing and spray requirements.

Conceptual layouts, including plan and section views of the FOG building, are shown below in Figure 3-15, Figure 3-16, and Figure 3-17. FOG P&IDs are provided on Drawings P-520 through P-521 in Appendix F.

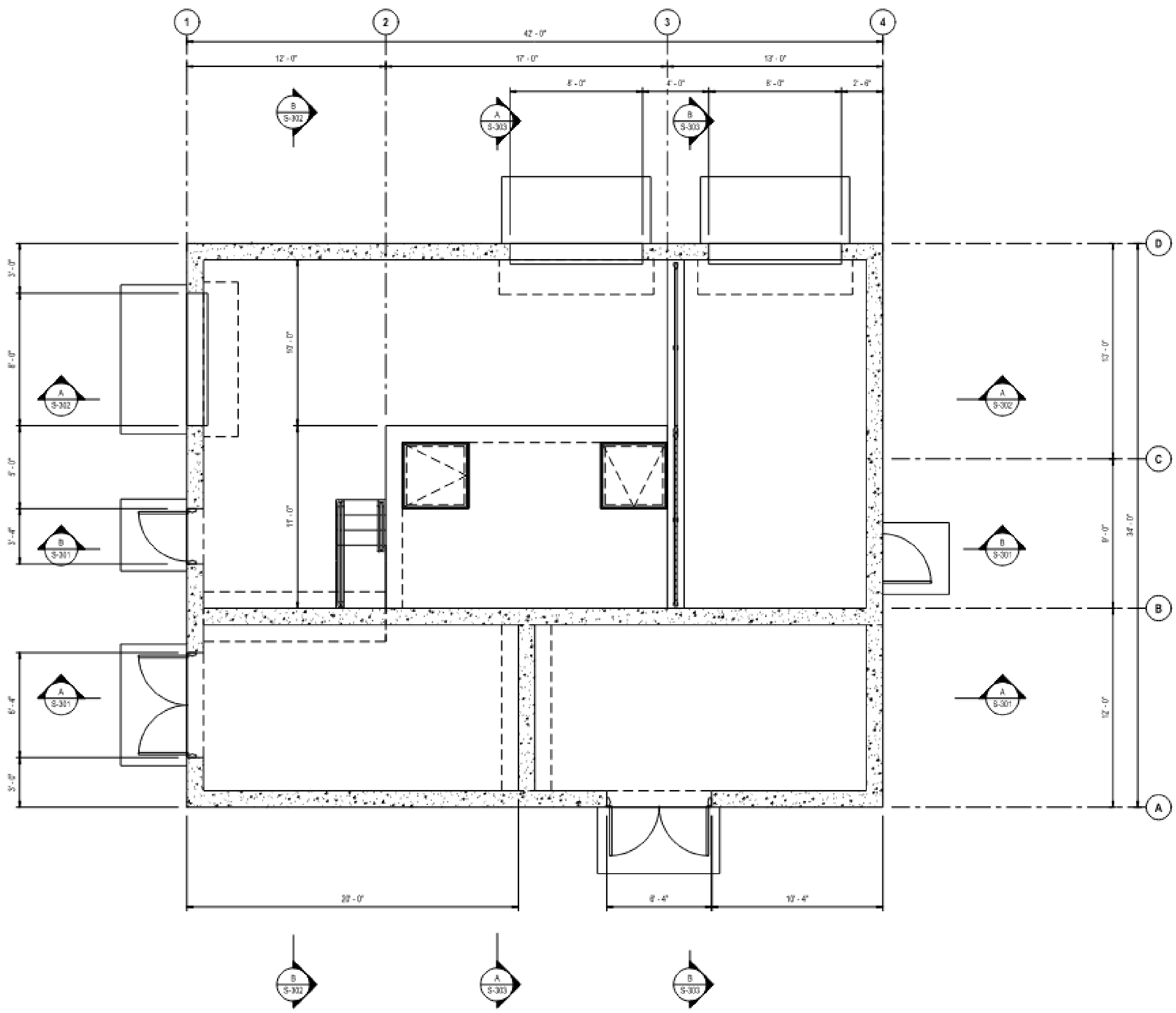


Figure 3-15. FOG building first-floor plan

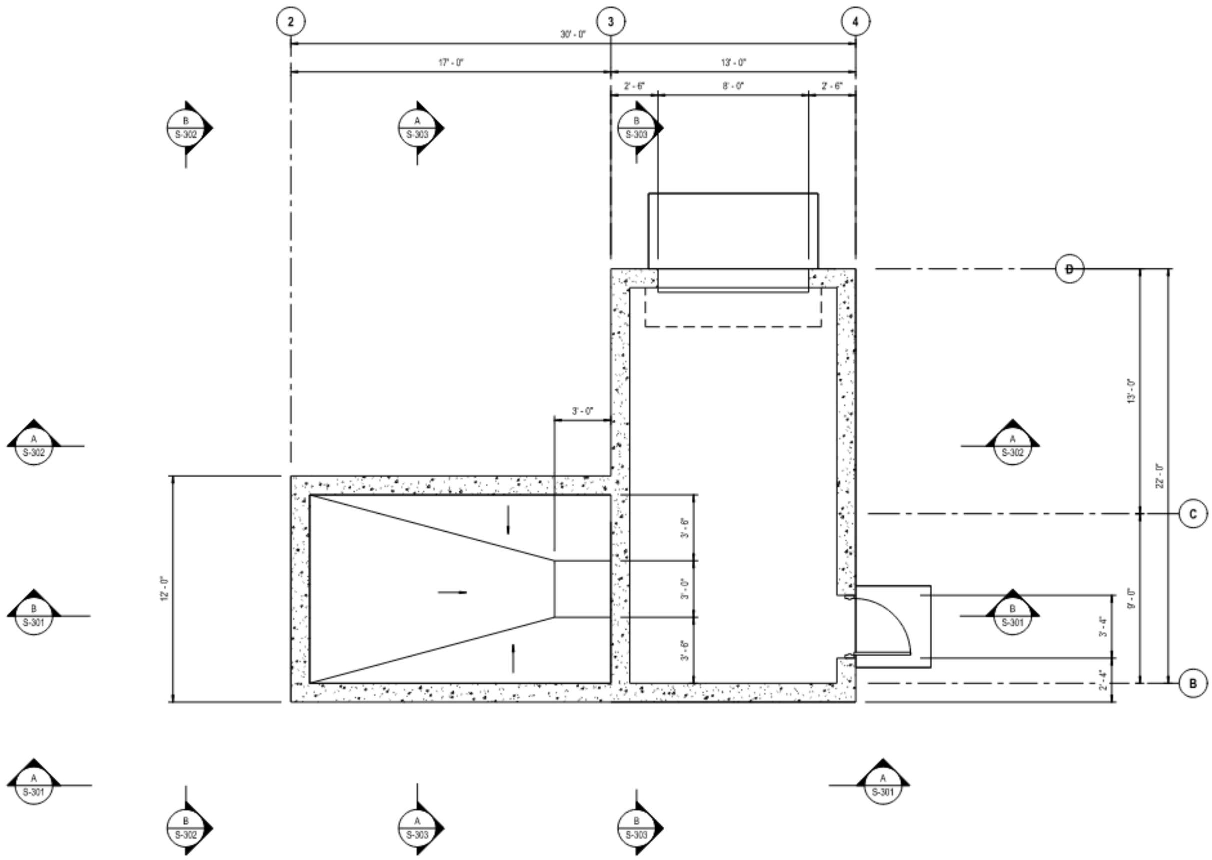


Figure 3-16. FOG building lower-floor plan

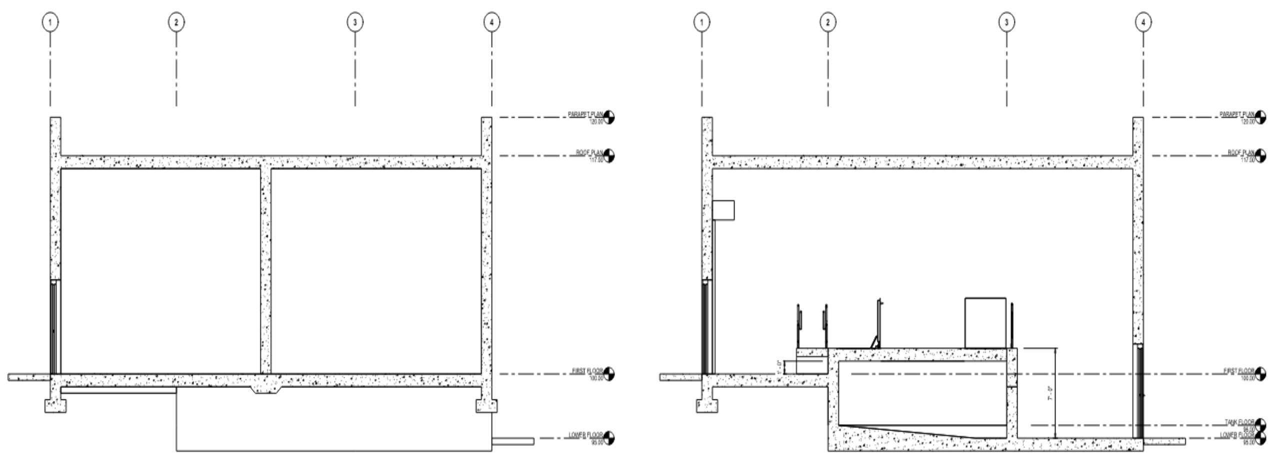


Figure 3-17. FOG building sections

3.6 Septage and FOG System Operation

The following sections describe the process operation recommendations for the septage and FOG systems. Further control information is summarized in Section 11.

3.6.1 Septage

Septage offloading will remain similar to how septage haulers currently discharge into the existing septage-receiving station; however, all septage offloading will be by gravity in lieu of pressurized offloading. Septage haulers will connect to a 6-inch-diameter truck connection and offload their septage delivery into the septage influent box. It is expected that the hauler will monitor septage during the offloading process and throttle the discharge accordingly to avoid clogging the manual bar screen. Subsequent to offloading, septage can be routed to one or both septage-screening systems for fine screening, grit removal, and residual grease removal, and can then be routed to one or both EQ tanks.

Septage Feeding

While the new mechanical thickening equipment is efficient, the desire is to minimize, as much as practicable, additional dilution water included with the septage receiving and treatment process that gets conveyed to the thickening equipment. It is anticipated that washdown water from the septage influent box, the screening system manufacturer's required wash water, and washdown water for the septage EQ tanks will be the only additional water incorporated into septage. In addition to minimizing wash water, it is desired to provide as consistent flow and solids concentration as practicable to the new mechanical thickening equipment. Although septage will mix with PS prior to thickening, consistent septage flow and solids concentration will reduce the potential for mechanical thickening upset and the need to make polymer adjustments.

Brief descriptions of basic approaches to the operational strategy for the EQ tanks are listed below.

Equalization Feed Option 1: Septage-Screening System/One Equalization Tank

This operational scenario anticipates that one of the screening systems will be used in conjunction with one of the two septage EQ tanks. As septage flow is received, it is routed to the screening system and discharged into the selected septage EQ tank.

Equalization Feed Option 2: Septage-Screening Systems/Two Equalization Tanks

This operational scenario anticipates that both screening systems will be used in parallel along with one or two of the septage EQ tanks. As septage flow is received, it is routed to both screening systems and discharged into one or both tanks. This scenario does not provide for redundancy, making it a less desirable operational scenario.

Septage Equalization Discharge Strategies

Under each operational scenario, septage can be pumped and conveyed to the new mechanical thickening equipment through the following methods:

- **EQ tank level hold**: Septage is received, screened, and discharged into an EQ tank up to a certain level set point, and pumping from the wet well is controlled by maintaining that predetermined level set point throughout an operational window or duration. This operating method does not take advantage of the EQ storage volume and results in intermittent slugs of septage being pumped to the new mechanical thickening equipment, creating the potential for polymer dosing variability and inconsistencies.

- **Fill and draw**: Septage is received, screened, and discharged into an EQ tank, and the submersible pumps operate based on various level set points (e.g., Pump ON, Pump OFF, etc.) within the tank. This operating method uses a predetermined operational volume within the tank and does not take advantage of the available EQ storage volume, resulting in inconsistent septage flows to the new mechanical thickening equipment.
- **Set volume discharge**: Septage is received, screened, and discharged into an EQ tank, and as it reaches a predetermined set point, CKTP staff calculate a set volume and/or pumping rate of septage to send to the new mechanical thickening equipment for that given operational window, day, or duration. While a steady rate of septage is being pumped from one EQ tank, the second EQ tank is being actively used to receive screened septage from septage haulers**.** This operating method allows for a consistent feed of septage over a given period, providing for more favorable operating parameters for the new mechanical thickening equipment.

Because of the desire to feed consistent septage flow and solids concentration to the new mechanical thickening equipment, it is recommended to use a set volume discharge operating method, when available.

3.6.2 FOG

FOG haulers will have the ability to either gravity or pressurize offload at the FOG building truck connection. Once FOG is metered and screened, it will flow by gravity into the FOG-receiving tank. The FOG-receiving tank will include a submersible mixer to allow screened FOG to be homogenized before it is pumped directly to the digesters.

As part of the FOG screening equipment, hot and cold spray/wash water is used. Hot and cold spray/wash water will operate on cycle timers, and when the FOG screening drum is in operation. It is important to note that the frequency and runtime for hot and cold water during the screening process is highly dependent upon truck size, offloading time, and subsequent throughput of FOG through the screening equipment, and will vary significantly depending on the type of FOG, solids concentration, and temperature. Optimization for the FOG screening equipment and hot- and cold-water timer settings will begin during startup and commissioning, and potentially continue for a period as the overall FOG screening and feeding operation is fine-tuned. As part of the preliminary digester design, projected FOG flows were increased by approximately 20 percent to account for hot and cold spray/wash water that is added through the FOG screening process. Estimated hot- and cold-water runtimes, which generally align with the FOG screening manufacturer's factory settings, and demands are listed below:

- **Hot water spray drum:** 8–10 minutes at 33 gpm
- **Hot water compaction spray:** 1–2 minutes at 33 gpm
- **Cold water main spray to drum wash:** 5–7 minutes at 45 gpm
- **Cold water tank flush:** 10–15 seconds at 45 gpm

As a result of the extremely variable nature of FOG and the lack of having no real “standard,” the design of the FOG screening system will acutely focus on minimizing, as much as practical, the addition of water to FOG during the screening process to reduce the potential adverse impacts to the digestion process and HRT.

3.6.3 Future FOG System Operation

The FOG receiving and treatment improvements described in the previous sections will implement a process to receive, screen, and feed FOG into the digesters at a controlled rate that meets the base design requirements for the FOG building. However, it is understood that over time and as the frequency of FOG deliveries and volume increases, there may be a need for additional infrastructure to provide a means of decanting FOG to remove excessive water prior to digestion or to provide additional FOG treatment to process raw FOG to a biofuel precursor. Therefore, the proposed FOG building is not only intended to meet the base design requirement, but also to serve as the pretreatment step of a future FOG and scum thickening facility.

A future FOG and scum thickening facility could include equipment to provide for FOG and scum co-thickening, heated tanks, and associated equipment designed to decant gravity-separated FOG water and settleable solids (food debris, heavier solids, etc. that make it through the screening equipment) prior to pumping thickened FOG to the digester(s), or it could include specialty vendor equipment or technology to process raw FOG to a biofuel precursor.

3.7 Septage and FOG Pumps and Mixers

The following sections provide a summary of the pump sizing and mixer selections for the septage and FOG systems.

3.7.1 Septage Pumps

The septage pumps will be Flygt Concertor submersible-type pumps with an adaptive N-impeller operated by a fully integrated VFD and control system, and located in the EQ wet well to convey septage from the EQ tanks to either the new thickening equipment or headworks building. Two septage submersible pumps, with space for a third future pump, will be sized to approximately 125 gpm at 35 feet total dynamic head (TDH) with 5.5 hp motors, similar to a Flygt Concertor XPC N100-4050. Discharge piping for the septage submersible pumps will be installed through the EQ wet well and EQ valve vault, and then routed northwest to the PS and septage thickening building, and west to MH 11, upstream of the headworks distribution channel. Septage pump design criteria are shown in Table 3-3 below.

3.7.2 Septage Mixers

The septage mixers will be Flygt submersible compact mixers operated by a VFD with one submersible mixer located in each EQ tank and installed with guide rails to facilitate future maintenance requirements. The submersible mixers will ensure that septage is homogenized prior to being pumped to the new mechanical thickening equipment, and to prevent sedimentation in each tank. Septage mixer design criteria are shown in Table 3-4 below.

Table 3-3. Septage submersible pump design criteria

Parameter	Value
Pump type	Submersible
Fluid	Septage
Design flow rate range (gpm)	125
TDH (ft)	35
Nominal horsepower	5.5
Max pump speed (rpm)	1756
Adjustable speed	Yes

Table 3-4. Septage submersible mixer design criteria

Parameter	Value
Mixer type	Submersible
Fluid	Septage
Motor size (hp)	10
Velocity gradient, G (sec -1)	5 (assumes TS of 2.10% as determined from recorded average from 2021–2022)
Propeller diameter (in.)	14.5
Propeller speed (rpm)	Variable (up to 800)

3.7.3 FOG Feed Pumps

The FOG feed pumps will be a progressive-cavity-type pump operated by a VFD and located in the lower level of the FOG building and will pull FOG from the FOG-feed tank and discharge to the digesters. The FOG feed pumps will be sized to provide approximately 50 gpm at 150 pounds per square inch differential (psid), with 15-horsepower (hp) motors. Discharge piping for the FOG feed pumps will be routed north to the existing and new digester control building. FOG feed pump design criteria are shown in Table 3-5 below.

3.7.4 FOG-Receiving Tank Mixer

The FOG-receiving tank mixer will be a Flygt submersible compact mixer operated by a VFD and installed with guide rails to facilitate future maintenance requirements. The submersible mixer will ensure that FOG is homogenized prior to being pumped to the FOG-feed tank, primarily when FOG decanting is not taking place. FOG mixer design criteria are shown in Table 3-6 below.

Table 3-5. FOG feed pump design criteria

Parameter	Value
Pump type	Progressive cavity, min 2-stage (TBD)
Fluid	FOG
Design flow rate (gpm)	50

Parameter	Value
TDH (psi, differential pressure)	150
Nominal horsepower	15

Table 3-6. FOG submersible mixer design criteria

Parameter	Value
Mixer type	Submersible
Fluid	FOG
Motor size (hp)	10
Velocity gradient, G (sec -1)	5 (assumes TS of 2.0%)
Propeller diameter (in.)	14.5
Propeller speed (rpm)	Variable (up to 800)

4 Solids Thickening

Solids-thickening improvements will be implemented for PS, septage, and WAS before digestion. Though there is an existing WAS rotary-drum thickener (RDT), a redundant unit was not installed as part of prior solids improvements, so CKTP staff requested that redundancy for WAS thickening be included as part of this project. After evaluating thickening streams as described in Section 2.2, various thickening technologies were evaluated to ultimately replace the existing GTs. A workshop with CKTP staff was conducted to confirm design flows and loads and elect a preferred thickening technology. Upon technology selection, final thickening equipment design criteria and performance requirements were determined. This section describes the thickening technology evaluation, workshop results, equipment selection, and thickening design criteria.

4.1 Thickening Technology Evaluation, Selection, and Performance Testing

Various thickening technologies were evaluated leading up to a workshop with CKTP on July 24, 2023, where evaluation findings were presented and, ultimately, a preferred technology was selected for the project. The following thickening technologies and manufacturers were considered to replace the existing GTs:

- **Centrifuge thickeners:** Centrysis
- **Disc thickeners:** Huber
- **Rotary-drum or screw thickeners:** FKC

4.1.1 Thickening Technology Evaluation

In discussion with various thickening equipment representatives and vendors, the following manufacturers, technologies, and models were evaluated. Huber recommended the use of the rotary screw thickener as compared to a disc thickener, so disc thickeners were no longer considered in the evaluation.

- **Centrisys centrifuge:**
  - THK 350
  - THK 600
- **Huber rotary screw thickener:**
  - S-Drum Size 3L
  - S-Drum Size 4L
- **FKC RDT:**
  - RST-S630x2000L
  - RST-S630x3000L
  - RST-S775x3600L

Vendors provided equipment sizing, operational metrics, budgetary cost estimates, and other information based on preliminary design flows and loads, and operational criteria provided by HDR. HDR evaluated vendor information to determine thickener performance, operational requirements, and estimated life-cycle cost for various operational approaches such as PS and septage co-thickening.

4.1.2 Thickening Technology Selection and Performance Testing

Evaluations for each technology were summarized in a set of fact sheets and a presentation delivered to CKTP staff. CKTP staff selected the FKC RDT technology for the following reasons:

- At a nearby WWTP, an FKC RDT technology has been co-thickening PS and septage successfully for a couple of years. Co-thickening is a priority for CKTP, so this capability was preferrable. Other technologies had little or no experience or local experience thickening septage or co-thickening PS and septage.
- FKC is headquartered relatively close to CKTP (about a 1.5-hour drive), allowing for prompt service in the form of preliminary equipment testing, ongoing maintenance, parts replacement, etc. Other technology manufacturers are not located as closely to CKTP.
- To complement the points above, preliminary life-cycle cost estimates for FKC equipment were less than other technologies.

Appendix B includes the workshop fact sheets, meeting minutes, and presentation as a record of the thickening equipment evaluation and selection. Final equipment selection and sizing is described in Section 4.3.

4.1.3 FKC Performance Testing

After the workshop where FKC thickening equipment was selected, FKC performed thickener performance testing to determine thickening potential of PS, septage, and WAS. Table 4-1 summarizes testing results while Appendix E includes data provided by FKC. Testing results indicate that co-thickening of PS and septage can accomplish a TS of 6 percent whereas WAS thickening can accomplish a TS of 3.5 to 4.5 percent.

Table 4-1. Performance testing results summary

Parameter	PS			Septage			Combined[a]			WAS		
	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
TS (%)	1.17	0.37	1.98	0.31	0.18	0.59	0.49	0.30	0.69	0.41	0.35	0.47
Ash (%)	12.8	11.1	14.8	32.1	25.4	36.2	22.6	16.6	33.9	24.6	22.1	27.3
Fiber content (150 mesh)	0.442	0.255	0.537	0.113	0.001	0.206	-	-	-	None	None	None
Polymer dosage (lb/dry ton active)	10	5	13	20	18	23	14	6	21	16	14	18
RST effluent TS (%)	6.56	6.05	7.42	6.95	6.39	7.62	7.39	6.70	7.98	4.05	3.53	4.57

a. 75% PS and 25% septage by volume.

4.2 Thickening Flows, Loads, and Operation

Thickener design flows and loads determined the required equipment sizing, recommended operational approach, and proposed equipment layout. Though Section 2.2 summarizes daily average and MM flows and loads for the thickening streams in question, additional operational and design criteria will determine thickening equipment flows and loads. To accommodate flexible operations and variations in flow and load variability, the following assumptions were made for each waste stream in development of thickening equipment design criteria:

- **PS:**
  - Preferred continuous operation of PS thickening equipment, e.g., 24 hours per day, 7 days per week.
  - Currently PS is pumped at 75 gpm continuously, which results in a flow of 108,000 gpd. A TS of 0.58 percent could be assumed to meet current estimated PS loads. If this TS is maintained for future conditions, thickening units are more hydraulically limited but if PS was thickened more in the clarifiers, it would provide more thickener capacity in the future.
  - During preliminary thickening equipment testing, HDR requested that primary clarifiers be operated with a larger blanket to promote thickening of the PS. From preliminary reports, this operational change was not a concern to CKTP staff. Test results indicate that the operational changes allowed for an increase in TS from 0.57 percent to 1.77 percent. Based on these successful operational changes, it is recommended that for future conditions the primary clarifiers be operated to promote a PS TS of at least 1.25 percent. This operational approach will likely improve thickening efficacy, decrease polymer consumption, and increase thickening equipment hydraulic throughput capacity for future conditions.
- **Septage:**
  - Preferred thickening of septage to occur in a shorter period during operating hours, e.g., 14 hours per day, 5 days per week.
  - An EQ basin for received septage will allow for operational flexibility for co-thickening of PS and septage.
  - Assumed water:septage dilution of 2:1 by volume to account for added water during septage-receiving processes.
  - Average daily flow and load increased as compared to values in Section 2.2.3 because of omission of zero values on weekends. New 5-day averages provide more representative estimates of daily maximums and thickening equipment performance requirements.
  - For typical thickening design and operation, the 2042 MM values were assumed to be the 2042 AA design values per discussion in Section 2.2.3. To evaluate maximum thickener performance for atypical operational requirements, the facility plan 2042 MM values were assumed.

- **WAS:**
  - Preferred to have an available unit for redundant WAS thickening on a continuous basis, e.g., one unit can thicken was for 24 hours per day, 7 days per week.
  - Secondary clarifiers can be operated with a thicker blanket to create a thicker WAS to promote lower hydraulic flows with higher solids loading, allowing for more efficient use of redundant thickening equipment. The TS discrepancy between current and future design values mentioned in Section 2.2.2 was included because previous work (HDR 2022) has recommended to thicken WAS via an increase in mixed liquor suspended solids (MLSS) concentration (aerobic solids retention time [SRT]) and improve BNR performance. This is expected to be the long-term operation of MLSS in the aeration basins.

All modeled flow and load scenarios assume that three RST-775X3600L units are available to thicken with two in operation and one available for redundancy. Section 4.3 describes thickener characteristics and layout in detail. Table 4-2 and Table 4-4 summarize evaluated flow and load scenarios and associated evaluation results for co-thickened septage and PS and WAS for current, future, minimum turndown, and maximum thickener capability conditions. Table 4-3 and Table 4-5 summarize design flows, loads, and operational parameters for all scenarios. Key takeaways for each condition are included to elaborate on qualitative characteristics of each condition and operational scheme. Footnotes highlight assumptions or intricacies of the analysis. Generally, the units are limited based on the hydraulic loading rate as compare to the solids loading rate.

Table 4-2. Thickener analysis scenarios and results for PS and septage

Scenario	Description
Turndown	Turndown conditions evaluate thickener minimum turndown requirements against proposed flows and loads as the thickener needs a minimum flow and load to work. This scenario considers “worst-case” conditions where no septage is being processed and PS is especially thick. Opposite to other evaluated scenarios, this scenario lists maximum required operating hours needed to maintain a flow and load above minimum turndown requirements. This scenario describes operational adjustments required for a unique “lowest flow and load” situation.
2023 average	2023 average conditions evaluate thickener performance under current septage and PS flows and loads. A key part of this assumption includes the dilute nature of the PS. If primary clarifiers are operated to promote a higher PS TS, flow and required operating hours decrease significantly as shown in 2028 average conditions. The higher PS flows in turn require more time to process septage flows and loads.
2028 average	2028 average conditions evaluate thickener performance under 2028 septage and PS flows and loads. A key part of this assumption includes the thicker nature of the PS. The thicker PS allows septage to be processed quicker than in 2023 despite increased flows and loads.
2042 adjusted MM	2042 MM conditions evaluate thickener performance under 2042 MM septage and PS flows and loads. This design condition is key to ensuring that thickeners can perform at a high level for an extended period (typically 1 month). A key part of this assumption includes use of 2042 AAFs for 2042 MM septage flow and load. This approach was selected per CKTP advisement as described in previous sections. Additionally, if septage is processed 22 hours per day, 7 days per week, and PS is processed 24 hours per day, 7 days per week, one unit can process all flows and loads for this design condition.
2042 peak design	2042 peak conditions evaluate maximum thickener performance under worst-case PS flows and loads. This design condition is meant to evaluate max thickener performance and compare those conditions to observed flow and load trends. PS is assumed to be thicker, but slightly more dilute than preferred to conservatively estimate PS hydraulic flows. Septage flows and loads are then increased to the maximum amounts allowed by the thickeners to understand what peaking factors would be seen under those conditions. Peak conditions are ultimately composed of a 2042 Peak:AA solids peaking factor of 6.3 and a liquid peaking factor of 1.6 at a TS of 4.8%. As expected, and as indicated in the peaking factor values, the thickening equipment is primarily hydraulically limited. In evaluating recorded data, the maximum solids peaking factor experienced was about 3.7 with an associated liquid peaking factor of 1.5 and TS of 5.4%. The maximum liquid peaking factor experienced was about 2.9 with an associated solids peaking factor of 2.28 and TS of 1.8%. Evaluation of these recorded events would suggest that a solids peaking factor of 6.3 would not be likely but a liquid peaking factor of 1.6 with an associated TS of ~5.0% is likely for peak day conditions. Though peak conditions are generally unlikely, the proposed equipment and layout would perform well for the estimated worse-case conditions.

Table 4-3. Thickener flow, load, operation, and other criteria for PS and septage thickening

Scenario	Turndown	2023 average			2028 average			2042 adjusted MM			2042 peak design		
Stream	Primary	Septage	Primary	Combined	Septage	Primary	Combined	Septage	Primary	Combined	Septage	Primary	Combined
Year	2023	2023	2023	2023	2028	2028	2028	2042	2042	2042	2042	2042	2042
Condition	AA	AA	AA	AA	Adjusted AA	AA	Adjusted AA	Adjusted MM	MM	Adjusted MM	Peak	Peak	Peak
Flow (gpd)	31,519	23,000	125,800	148,800	28,000	96,600	124,600	52,100	110,400	162,500	143,500	110,400	253,900
Load (lb/d)	5,310	4,100	5,300	9,400	5,000	6,100	11,100	9,300	9,300	18,600	58,700	9,300	68,000
S.G.	1.01	1.02	1.01	1.02	1.02	1.01	1.02	1.02	1.01	1.02	1.02	1.01	1.02
% TS	2.00%	2.10%	0.50%	0.75%	2.10%	0.75%	1.05%	2.10%	1.00%	1.35%	4.81%	1.00%	3.16%
Dilution (water:XX)	-	2:1	-	-	2:1	-	-	2:1	-	-	2:1	-	-
Diluted % TS	2.00%	0.70%	0.50%	0.57%	0.70%	0.75%	0.73%	0.70%	1.00%	0.83%	1.60%	1.00%	1.49%
Diluted flow (gpd)	31,519	69,000	125,800	194,800	84,000	96,600	180,600	156,300	110,400	266,700	430,500	110,400	540,900
Selected unit	RST-775X3600L												
Number of units	1	1			1			2			2		
Rated flow (gpm)	62	250			250			375			375		
Rated load (lb/hr)	470	1,895			1,895			3,791			3,791		
Safety factor	75%	75%			75%			75%			75%		
Design flow (gpm)	62	188			188			375			375		
Design load (lb/hr)	353	1,421			1,421			2,843			2,843		
Required minimum operating hours													
5 days per week	11	24	24	-	16	24	-	13	24	-	-	-	-
7 days per week	8	13	24	-	12	24	-	9	24	-	24	24	-
Recommended operational metrics													
Hours per day	**8**	**16**	**24**	**-**	**16**	**24**	**-**	**14**	**24**	**-**	**24**	**24**	**-**
Days per week	**7**	**5**	**7**	**-**	**5**	**7**	**-**	**5**	**7**	**-**	**7**	**7**	**-**
Flow (gpm)	**66**	**101**	**87**	**187**	**140**	**40**	**188**	**203**	**61**	**263**	**299**	**77**	**375**
Load (lb/hr)	**664**	**544**			**849**			**1,206**			**2,843**		

Table 4-4. Thickener analysis scenarios and results for WAS

Scenario	Description
Turndown	This scenario considers “worst-case” conditions where WAS flow and load are the lowest and thickest. Opposite to other evaluated scenarios, this scenario lists maximum required operating hours needed to maintain a flow and load above minimum turndown requirements.
2023 average	2023 AA flows and loads. A key part of this assumption includes the dilute nature of the WAS. Despite the dilute assumption, WAS can be processed through one unit without issue.
2028 average	2028 MM conditions evaluate thickener performance under 2028 WAS MM flows and loads. A key part of this assumption includes the thicker nature of the WAS.
2042 MM	2042 MM conditions evaluate thickener performance under 2042 WAS MM flows and loads. Because thicker WAS is assumed, the unit can handle the proposed flows and loads without issue.
2042 peak design	A more dilute WAS for 2042 MM load is assumed, therefore increasing flow and requiring 24/7 operation to process. WAS TS cannot decrease below 0.375% under this condition or else peak conditions cannot be met from a hydraulic standpoint. A Peak:MM solids peaking factor of 4.0 would require a WAS TS of 3.0% for the same WAS flow to exceed thickener solids capacity so a WAS TS between 0.4 and 3.0 is required under peak conditions. It is expected that the thickener would be hydraulically limited under peak conditions.

Table 4-5. Thickener flow, load, operation, and other criteria for WAS redundancy

Scenario	Turndown	2023 average	2028 average	2042 MMF	2042 peak
Stream	WAS				
Year	2023	2023	2028	2042	2042
Condition	AA	MM	MM	MM	Peak
Flow (gpd)	70,900	200,100	156,700	201,800	269,100
Load (lb/d)	2,986	5,900	6,600	8,500	8,500
S.G.	1.01	1.01	1.01	1.01	1.01
% TS	0.50%	0.35%	0.50%	0.50%	0.375%
Selected unit	RST-775X3600L				
Number of units	1	1	1	1	1
Rated flow (gpm)	62.5	250	250	250	250
Safety factor	100%	75%	75%	75%	75%
Design flow (gpm)	63	188	188	188	188
Required minimum operating hours					
5 days per week	24	21	16	21	Not Viable
7 days per week	18	15	12	15	24
Recommended operational metrics					
Hours per day	**18**	**24**	**24**	**24**	**24**
Days per week	**7**	**7**	**7**	**7**	**7**
Flow (gpm)	**66**	**139**	**109**	**140**	**187**
Solids load (lb/hr)	**166**	**246**	**275**	**354**	**354**

4.3 Thickening Equipment Characteristics and Layout

Based on selected flow and load scenarios, three FKC RST-775X3600L RDTs have been selected to thicken the proposed solids streams: PS, septage, and WAS.

4.3.1 Thickening Equipment Characteristics

This unit is the same size and model and is currently used in the WAS-thickening building. The RDT technology consists of a set of rotating stainless-steel drum screens that allow liquids to drain freely from polymer-dosed sludge. The unit includes a flocculation tank ahead of the RDT, with a polymer injection ring on the influent piping. As flow enters the flocculation tank, it is mixed with polymer, develops a stable floc structure within the tank, then overflows in the rotary drum, where water can freely drain as the solids are slowly rotated toward the discharge. Spray bars clean the screen during operation. Filtrate (through appropriately sized gravity lines) will be drained back to the IPS (see Section 6.1). Discharged solids enter a hopper for the thickened sludge pumps that will take the material to the digesters. Table 4-6 summarizes proposed equipment characterization. Figure 4-1 and Figure 4-2 depict a summary of technology components and a picture of the RDT pre- and post-installation, respectively.

Table 4-6. FKC RST-775X3600L characteristics

Parameter	Value
Rated flow (gpm)	250
Rated solids throughput (dry lb/hr)	1,870
Solids capture	95%
Effluent solids concentration	6%
Polymer dose (active lb/dry ton)	7.5
Length (in.)	254.9
Width (in.)	75.4
Height (in.)	111.8
Empty weight (lb)	2,500
Operating weight (lb)	2,800
Minimum maintenance clearance (ft)	3
Largest component dimension (lb”)	8" dia., 156" L
Heaviest component (lb)	600
Special tools	Provided with equip.
Operating speed (rpm)	2–15
Noise level (dBA – 1 m)	< 70
Unit power consumption (hp)	3
Ancillary power consumption (hp)	1
Total connected power (hp)	4
Average wash water consumption (gph)	18.87
Water supply pressure (psi)	40
Minimum ventilation rate (cfm)	50–75

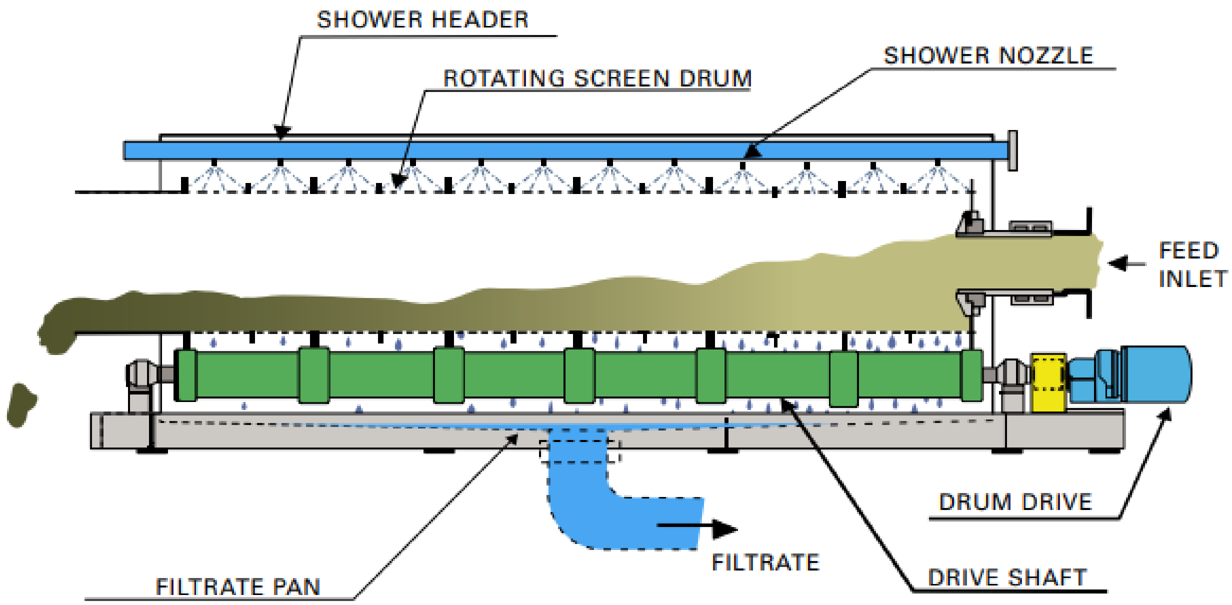


Figure 4-1. Summary of RDT components

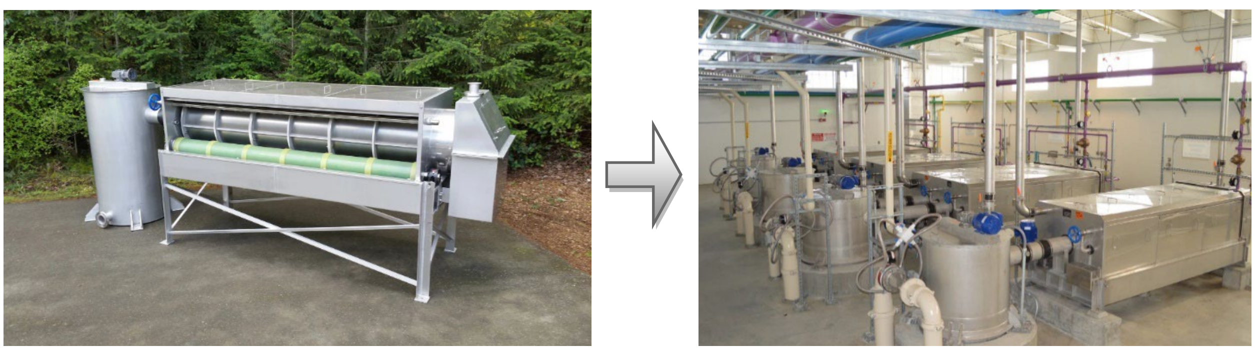


Figure 4-2. Example RDT pre- and post-installation

For recommended operational approaches for current and future conditions, it is likely that one unit will have the capacity to co-thicken PS and septage streams, but 2042 MM conditions will require two units to thicken the proposed flows and loads. The third and final unit should serve as redundancy for both WAS and PS/septage. Figure 4-3 and Figure 4-4 depict the proposed RDT layout and associated equipment within the thickening building in plan and profile view.

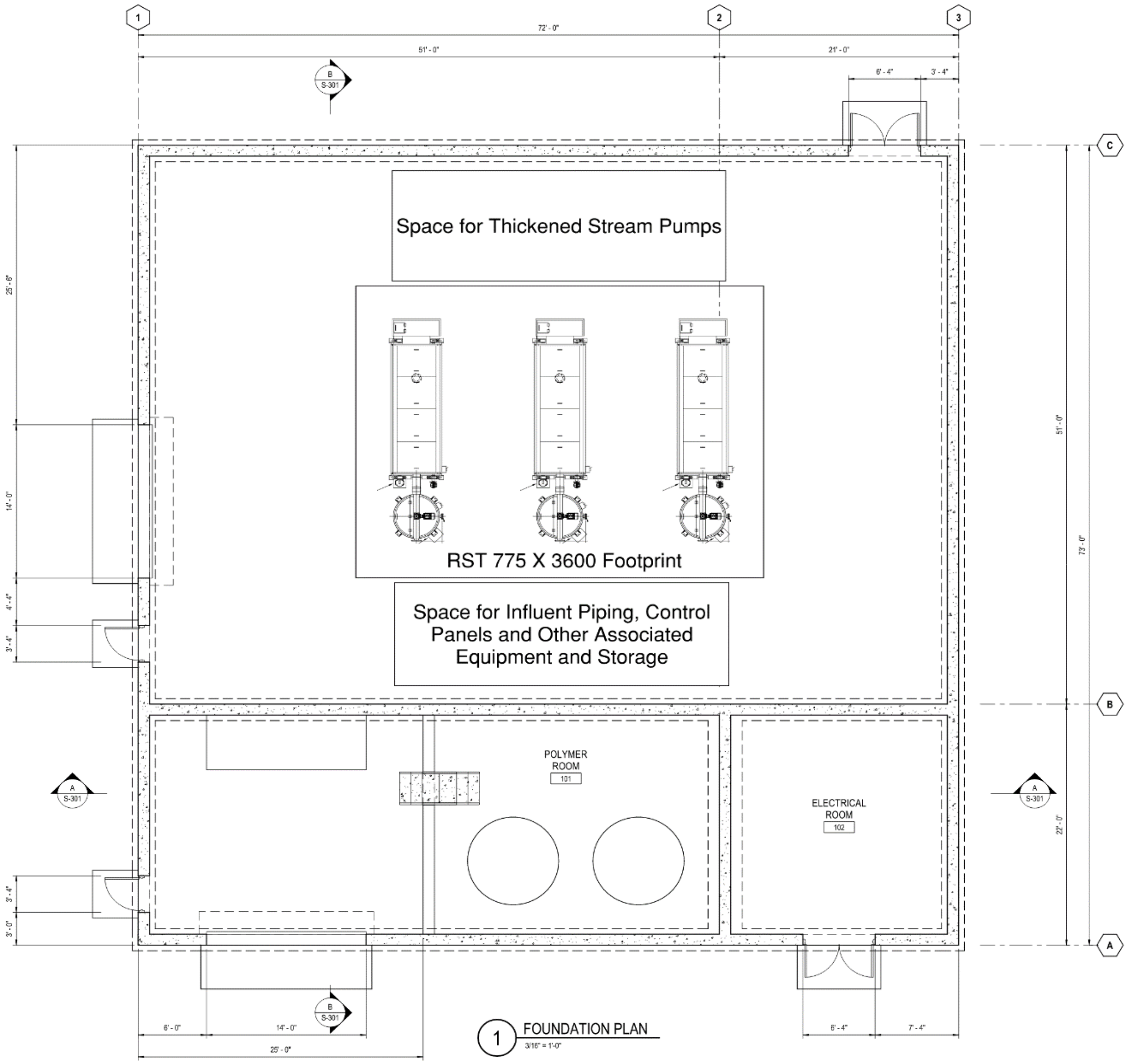


Figure 4-3. Proposed thickener layout plan view

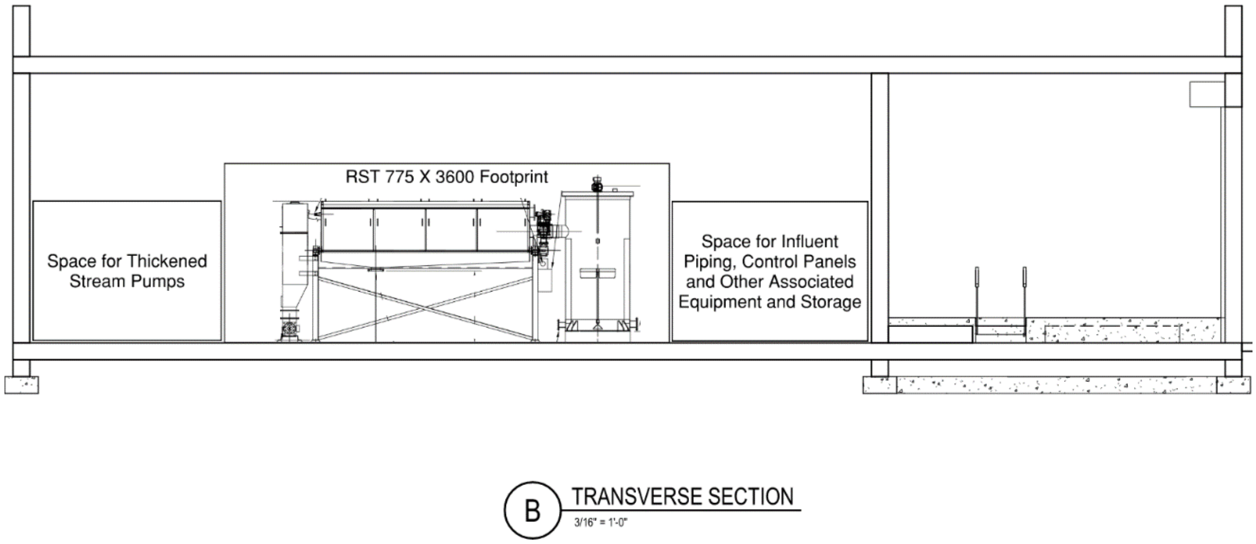


Figure 4-4. Proposed thickener layout profile view

4.4 Thickened Sludge Pump Design

Pump design for new thickened sludge pumps is based on a comparison between the summer 2023 site-specific rheology data acquired from CKTP and more standardized rheology coefficient (typical industry values based on experience with similar sludges) values through various fits for each data set. Preliminary pipe routes and fittings were also assumed at this stage of design to assess pumping sludge from the RDTs in the PS and septage thickening building to each pair of digesters.

The maximum flow through these pumps was based on the highest effluent flow, which was found to be the co-thickened PS and septage at a solids concentration of 6.0 percent, based on the FKC thickener performance for 2042 peak flows. Therefore, the thickened sludge pumps will be designed to support 50 gpm from the RDTs.

AFT Fathom software was used to determine the TDH for these pumps based on the observed rheology data from summer 2023 and various modeling curves. The results from this analysis are shown in Table 4-7. Effluent from the existing GTs, which co-thicken PS and septage, was collected and tested, as well as CKTP TWAS and HTWAS from Kingston WWTP. These streams were all evaluated to determine the loads for the new pumps. Rheology data are provided in Appendix I.

TDH values were assessed based on three fit models to find a typical range and determine a worst-case condition. AFT Fathom has a function to enter the raw rheology data to determine the model coefficients for the Power Law, Bingham Plastic, and Herschel-Buckley fits. In addition, typical industry rheology coefficients based on experience for similar sludge using the Bingham Plastic model were used in this evaluation. Estimated pipe lengths and fittings, along with the fit models, were used to evaluate the TDH for each condition. In addition, the observed rheology data were extrapolated to represent 6 percent solids, which is the expected RDT performance, and 8 percent solids, which represents an additional safety component.

Table 4-7. Thickened sludge pump evaluation at 50 gpm

Model		Observed data, Power Law fit	Observed data, Bingham Plastic	Typical industry rheology coefficients, Bingham Plastic	Observed data, Herschel-Buckley
Value	TS (%)	Total dynamic head (ft)			
All summer TPS data					
Observed	4.39	23.9	24.1	46.7	N/A
Typical	6.0	23.8	24.1	53.5	N/A
Maximum	8.0	23.7	24.0	60.6	N/A
Summer decanted TPS data only					
Observed	4.67	35.0	32.6	48.3	32.9
Typical	6.0	34.9	32.5	60.6	32.8
Maximum	8.0	34.8	32.4	60.6	32.7
All summer TWAS data					
Observed	4.93	106	111	87.9	N/A
Typical	6.0	105	111	56.2	N/A
Maximum	8.0	105	110	481	N/A
Summer CKTP TWAS data only					
Observed	5.03	139	136	92.1	N/A
Typical	6.0	138	135	91.8	N/A
Maximum	8.0	139	134	481	N/A

Preliminary design criteria were based off the highest expected TDH. In this case, the highest TDH occurs with CKTP TWAS at 8 percent TS. The typical values are based on extrapolated data, similar to those based on HDR's observed data. Therefore, pump design does not always have to accommodate these values if they are deemed unreasonable. In this case, the typical industry rheology coefficients for the Bingham Plastic model see values up to 481 feet. These values are extrapolated based on data with lower solids content. In addition, comparing other models at the same condition do not see values above 140 feet. Therefore, the outlier was not considered for BOD criteria.

Preliminary design criteria are shown in Table 4-8, which is based on the expected flows and loads from the RDT, the modeling exercise for TDH values, and an added safety factor. Two more instances of rheology testing will be conducted in early 2024 to collect winter data on this sludge. Therefore, final design criteria will be adjusted as needed to accommodate this additional information.

Table 4-8. Thickened sludge pump preliminary design criteria

Design criterion	Value	Unit	Notes
Pump type	Progressive-cavity, 2-stage	-	Minimum of a 2-stage pump for those with a TDH of > 50 psi
Design flow	50	gpm	Based on minimum solids concentration
Design TDH	150	psi	Does not account for “typical values” outliers because of the nature of extrapolation
Approximate motor size	15	hp	Based on vendor feedback

These new thickened sludge pumps are conservative in comparison to the existing TWAS pumps in the WAS-thickening building. The existing pumps are rated for 30 gpm at 100 psi. In addition, the existing pumps were evaluated to require 29.7 feet using the Bingham Plastic model for viscosity of the TWAS using AFT Fathom.

4.4.1 Polymer System Design Criteria

The polymer system will have the capability to feed polymer to either of the two solids streams (blended PS and septage and redundant WAS) upstream of the three RDTs. Each of the streams may require a different type of polymer; therefore, the system will be able to produce whichever type is needed, be it cationic or anionic emulsions. Additionally, the polymer system will allow operators to have different types of polymers in each tote without them mixing. In operation, it is expected that the RDTs will service primarily PS and septage flows, with WAS flows only serviced in rare instances for redundancy.

Initially, the design criteria used to size the system were established as the neat polymer flow rate and dilution water flow rate, which were calculated for each of the two solids streams considering each combination of the following operational parameters for 2028 AA, 2028 MM, 2042 AA, and 2042 MM flows and loads (Table 4-9).

Table 4-9. Polymer system sizing operational parameters

Operational parameters	PS and septage	WAS
Polymer		
Active polymer (%)	40	41
Dosing (lb active polymer/dry ton of solids)		
Low	12	25
High	30	30
Skid concentration (%)		
Diluted	0.25	0.50
Concentrated	0.50	1.0

Operational parameters of active polymer dosing for blended PS and septage were based on four dates of laboratory testing conducted by the RDT vendor, FKC Co., in August 2023. A detailed summary of results is provided in Appendix E. For WAS, active polymer type currently in use is known and its operational parameters were based on operational data provided by CKTP staff.

The design criteria selected were:

- **Minimum:** 2028 AAF for low dosing and diluted skid concentration
- **Maximum:** 2042 MMF for high dosing and diluted skid concentration

Table 4-10 summarizes the initial design criteria for sizing the polymer system.

Table 4-10. Polymer system sizing initial design criteria

Design criterion	Neat polymer feed rate (gph)	Dilution water flow (gph)
PS and septage		
Minimum	0.19	75.0
Maximum	1.64	654.2
WAS		
Minimum	0.10	38.6
Maximum	0.95	379.8

After sharing these initial criteria with vendors, it became evident that the range of flows was too wide for standard manufactured polymer systems to meet CKTP's instantaneous demand. It was then investigated what these design criteria would be considering operation time (24-hour, 16-hour, 12-hour, and 8-hour).

For resilience, a system with polymer storage tanks was considered. A system such as this would not only be able to provide higher polymer aging than an instantaneous system but could also be configured to service three RDTs with only two polymer systems, thus reducing capital costs. Therefore, a new design approach was selected to size a polymer system that can outpace the instantaneous 16-hour demand by 1.5 times and fill a polymer storage tank upstream of a flocculation chamber and subsequently, service the RDT at any rate within the range of anticipated polymer dosing.

4.4.2 Polymer System Equipment Selection

Design criteria shown in Table 4-11 were provided to two prominent polymer system vendors, VeloDyne and cleanwater1 (formerly UGSI), to estimate equipment sizing and cost.

Table 4-11. Polymer system sizing revised design criteria

Design criterion	Value	Unit	Description
Polymer skid			
Neat polymer	5.2	gph	1.5× maximum criterion, WAS
Dilution water	1,472	gph	1.5× maximum criterion, PS and septage
Polymer tank metering			
Polymer storage tank	3,000	gal	High-density polyethylene (HDPE) tank
Minimum metering feed flow	75	gph	Minimum criterion, PS and septage, 24 hr operation
Maximum metering feed flow	981	gph	Maximum criterion, PS and septage, 16 hr operation

Drawings P-560, P-562 and P-563 (Appendix F) show the proposed design layout of the polymer feed system. Two emulsion polymer totes will serve their respective polymer mixing chambers and solution tanks through their neat polymer feed pumps. On the floor of the polymer room, polymer totes will be stored on scales instrumented to measure and track polymer usage. Considering 2028 and 2042 AAF projections of primary and septage flows and loads, it is anticipated that one to two polymer totes will be used per week by CKTP staff.

From the totes, the neat polymer feed pumps will send neat polymer to the polymer mixing chambers. The neat polymer will be activated in the polymer mixing chambers with the addition of 2W water, and this solution will then be fed into 3,000-gallon high-density polyethylene (HDPE) storage tanks.

Figure 4-5 shows a diagram of a typical polymer activation system, provided by cleanwater1. These systems are designed to combine high shear/low shear mixing to break the oil beads within the emulsion and elongate the high molecular weight polymer molecules. Such systems provide efficient activation for polymers and allow the make down solution to be immediately available for use (aging is not necessary).

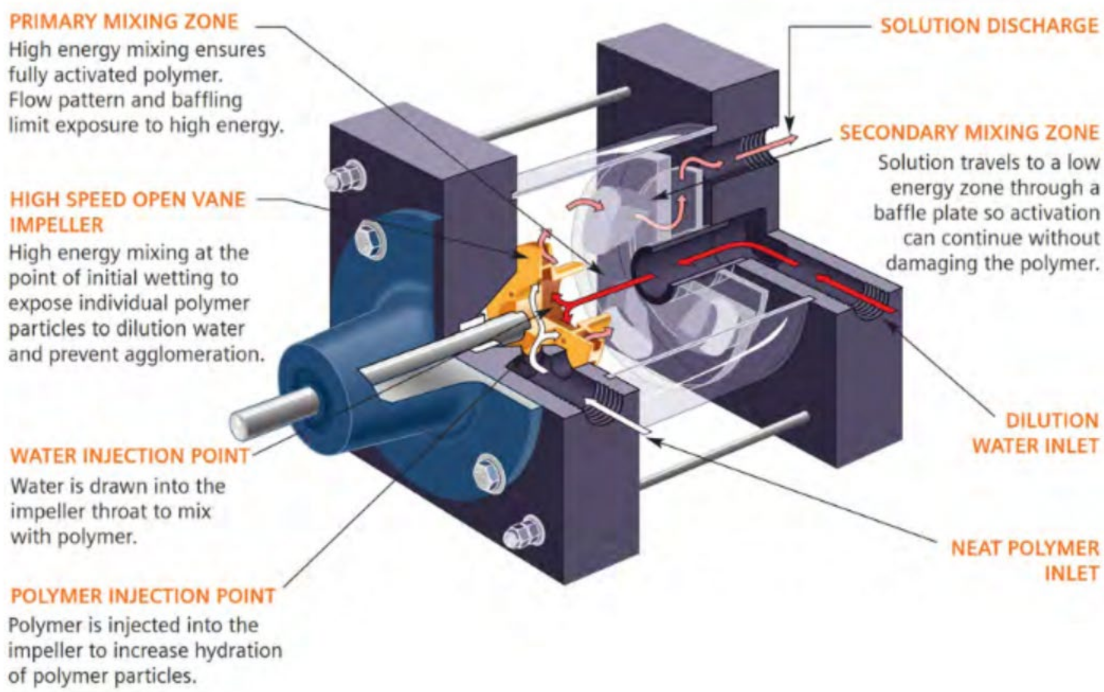
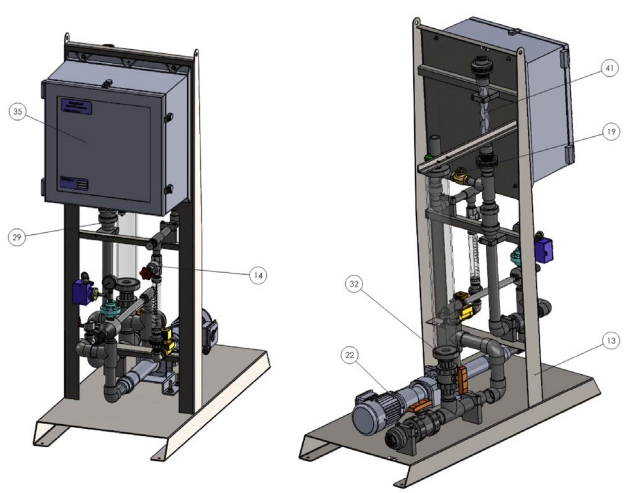


Figure 4-5. cleanwater1 Polyblend polymer feed system

A typical polymer feed pump skid assembly is shown in Figure 4-6. These skids include control panels, neat polymer pumps, and water/dilution control.



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	9740315	LOCK WASHER, 1/4", 316SS	14
2	9740300	1/4" SMALL OD FLAT WASHER, 316SS	14
3	1600340	BOLT, H.H., 316SS, 1/4-20 x 4-1/2	2
4	1601316	SCREW, CAP, HH, 5/16"-18 UNC-2A X 1.00 LG	4
5	5551006	LABEL, VINYL, 2" x 1", WATER INLET	1
6	5551007	LABEL, "SOLUTION OUTLET"	1
7	5551008	LABEL, VINYL, 2" x 1", POLYMER INLET	1
8	5551210	LABEL, "POLYBLEND"	1
9	5554000	LABEL, POLYBLEND SERIAL. 26ga	1
10	9741300	WASHER, FLAT, .313, 316SS	8
11	5551209	LABEL, WATER FLOW	1
12	2727590	1/2" FLEX CONDUIT CONNECTOR, HUBBELL	6
13	556030-S2	FINAL FEED SKID ASSEMBLY, WELDMENT	1
14	556030-SA8	WATER INLET ASSEMBLY, 600 GPH, 1" PIPING	1
15	1931024	BUSHING PIPE REDUCER, PVC, 1.5" X 1", SXS, SCH 80	1
16	1692001	BLOCK, PIPE, PVC, BOTTOM, 1" SCH 80	1
17	3571006	PVC PIPE ELBOW, 90, 1", SxS, SCH.80	2
18	RM6600101	PVC PIPE, SCH 80, 1"	3'
19	9572241	VALVE, CHECK, 1" SPRING BRONZE	1
20	9501006	PVC PIPE UNION, SCH. 80, 1" SxS, VITON	1
21	1692000	BLOCK, PIPE, PVC, TOP, 1", SCH 80	1
22	556030-SA7	PROGRESSIVE CAVITY PUMP ASSEMBLY, 180 GPH	1
23	1690537	BRACKET, PIPE CLAMP, 1.50 DIA	3
24	3571008	ELBOW, 90, PVC, SCH 80, SxS, 1.5"	1
25	1692013	BLOCK, BOTTOM, SPECIAL, 2" DIA. PVC	2
26	1692014	BLOCK, TOP, SPECIAL, 2" DIA. PVC	2
27	RM6600401	PVC PIPE, 2", SCH. 80	2'
28	3571009	PVC ELBOW 90, 2" SXS, SCH. 80	2
29	9572061	VALVE, BALL CHECK, 1.5" PVC T-U	1
30	RM6600301	PVC PIPE, SCH. 80, 1.5"	4'
31	8851008	TEE, PVC, SCH 80, SLIP, 1-1/2"	1
32	556030-SA9	CALIBRATION COLUMN ASSEMBLY, 7,000mL	1
33	5960815	PVC PIPE TOE NIPPLE, SCH. 80, SxT, 1.5" x 3"	2
34	RM2701081	1/2" ELECTRICAL CONDUIT	15'
35	556030-S53	FINAL FEED CONTROL PANEL	1
36	5960114	PVC PIPE NIPPLE, TOE, 1" MPT x 6", SCH. 80, CUT	2
37	FD0218014	ANGLE IRON, 1.5" x 1.5" x 3/16", 316SS	3'
38	1600343	BOLT, HEX, 316SS, 1/4-20 x 6"	4
39	6022231	5/16"-18 NE 316SS NYLON LOCK NUT	4
40	1600341	1/4"-20 x 5" 316 SS HEX CAP BOLT	6
41	556030-S3	KOFLO STATIC MIXER, 1-1/2" x 15", 6 ELEMENTS	1
42	9500008	PVC PIPE UNION, SCH 80, 1.5" TxT	2
43	FD0150103	CLAMP 1-1/2" PIPE	1
44	1600338	HEX BOLT, 1/4"-20 X 3.5" , 316SS	2
45	2726564	CONNECTOR, CORD GRIP, 1/2" MPT	1
46	P12655	CONDUIT LOCK NUT, 1/2"	1
47	U22760	SEAL RING, CONDUIT, 1/2"	1
48	FD0090187	STUD, 1/2"-13 X 2 1/2" 304SS	4
49	9744300	WASHER, FLAT, 1/2", 316SS	4
50	6022431	1/2"-13 NE 316SS NYLON LOCK NUT	4

Figure 4-6. cleanwater1 polymer feed pump skid assembly

From the storage tank, polymer will be metered to feed the demand of the solid streams. Controls allow for the operation of three RDTs to be serviced by two polymer systems. This design will allow the polymer system to meet the full range of dosing needs for the anticipated solids streams. Preliminary design criteria are shown in Table 4-12, which is based on the design criteria discussed in Table 4-11.

Table 4-12. Polymer feed pump preliminary design criteria

Design criterion	Value	Unit	Notes
Pump type	Progressive-cavity	-	Viton stator, 316 stainless-steel rotor, single mechanical seal
Design flow minimum	75	gph	Based on thickening PS and septage at instantaneous demand with 5 lb active polymer/dry ton of solids; 0.25% neat; 0.1% active polymer
Design flow maximum	981	gph	Based on thickening PS and septage for max month flow and polymer dosing at 12 lb active polymer/dry ton of solids
Design TDH	60	psi	-
Approximate motor size	2	hp	May need to operate at higher frequency to meet 13:1 solution pump feed rate requirement; cleanwater1 recommends operating at 77 Hz

The polymer selected for use in the system will require field testing and confirmation with both polymer vendors and the thickening equipment supplier (FKC) to optimize; however, initial jar testing by FKC (Appendix E) can be used as a basis for an initial selection during startup of the equipment.

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5 Anaerobic Digestion

The following section outlines the current baseline and expansion of the CKTP mesophilic anaerobic digestion system, including current flow and loads, with associated hydraulic retention time (HRT), as well as the proposed improvements and future system capacity.

5.1 Digester Process Improvements

Kitsap County has been evaluating improvements for the solids-handling facilities at CKTP because of the approaching end of service life of the existing digesters, increase in WWTP solids and LHW, and lack of digestion redundancy. The facility has also experienced performance issues with its anaerobic digesters relative to apparent volatile solids reduction (VSR). Previous facility plan analysis has also observed the need for increased flexibility for digester feeding, improved monitoring and control for feeding of the different solids streams, and additional capacity for digester gas.

CKTP currently has two 0.65 MG anaerobic digesters that were constructed in 1977 and have fixed steel covers that were replaced in 1992. Both digesters are typically operated continuously, and removing one digester from service significantly compromises CKTP’s solids-handling operations and its ability to receive LHW, in particular, hauled septage.

5.1.1 Historical Digester Flows and Loads and Digester Performance

Current influent flows to each digester are monitored from the following three sources:

- **GT** (co-thickened PS and septage)
- **TSBT** (includes CKTP TWAS and TWAS hauled from other Kitsap County WWTPs)
- **Grease** (hauled, which also accounts for negligible amounts of scum as FOG hauls are currently discharged to the primary clarifier scum pits)

CKTP operations staff analyzes weekly samples of the two largest streams (from GTs and TSBT) for TS and VS. Digester feed and withdrawal rates to the centrifuge are managed to maintain, on average, a relatively constant digester level.

To better understand the current digester operation and performance, in addition to the previous facility planning efforts, digester feed data from 2021 to the first quarter of 2023 were analyzed.

Figure 5-1 presents monthly averages for digester influent flows from each source, as well as the total digester influent flows. Table 5-1 summarizes the AAF per source, total digester influent flows, and calculated HRT. When digesters are not designed to withdrawal supernatant and there is only one effluent stream, the HRT can be used interchangeably with the SRT to estimate digester performance. HRT was determined by dividing the nominal digester volume by the influent flow; the nominal digester volume of 642,830 gallons was used for calculations to match the value used by CKTP. Table 5-2 summarizes the AA solids loading per source and total digester influent solids loading.

Figure 5-2 shows charts for the composition of digester influent flows and influent solids loading per sludge source for the period of 2021 to first quarter (Q1) 2023. Table 5-3 summarizes the annual percentages of each influent source in the composition of digester influent flow and solids loading.

Figure 5-3 shows a chart for monthly average digester HRT and VAR for the period of 2021–Q1 2023; the VAR factor is determined by the VSR, which can be determined by various methods. Since 2022, with approval from Ecology, CKTP has used the direct mass balance method in lieu of the Van Kleeck method, as the latter could be overly conservative depending on the digester operating conditions and inert material (HDR 2021). HRT values for August and September 2022 were impacted by having one of the digesters offline to complete an emergency repair of the existing cover seals.

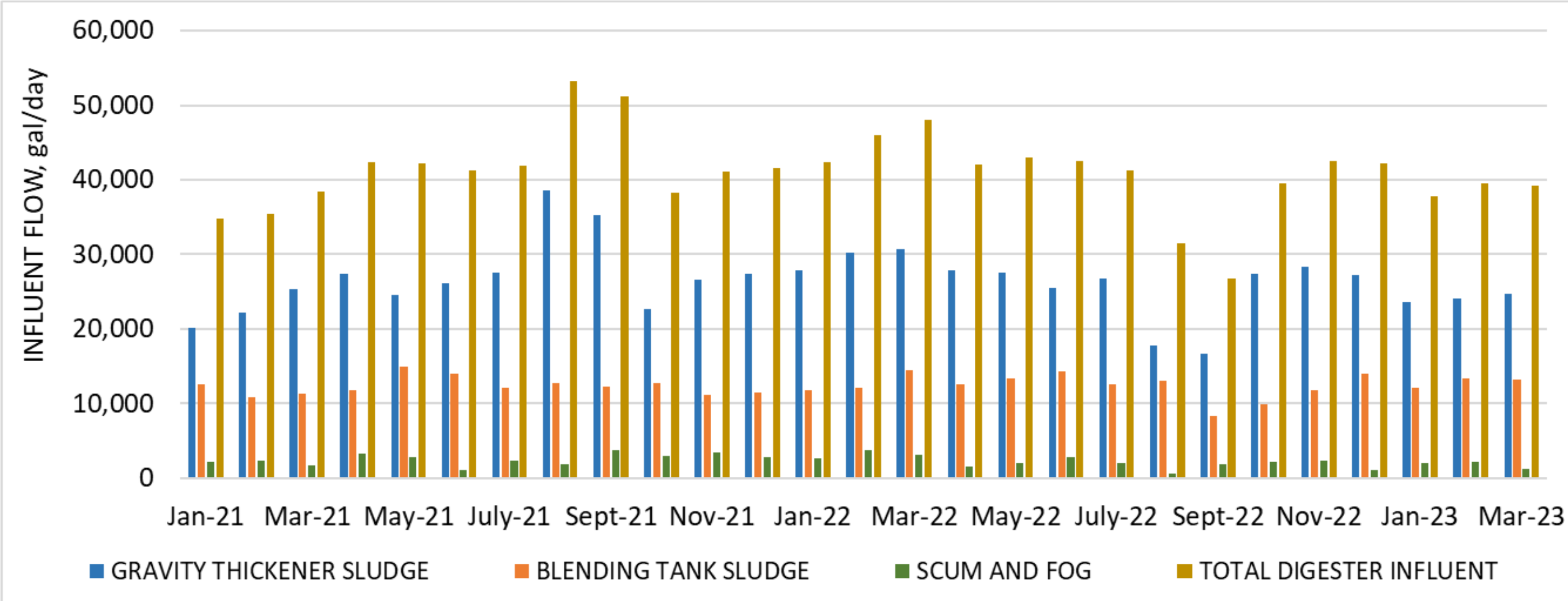

Figure 5-1. 2021–Q1 2023 total digester influent flows and flows per feed source

Table 5-1. 2021–Q1 2023 total digester influent flows, average HRT, and flows per feed source

Date range	Gravity thickener (gpd)	Blending tank (gpd)	Scum and FOG (gpd)	Total digester influent (gpd)	Average digester HRT (days)
2021	26,975	12,311	2,526	41,812	31.20
2022	26,146	12,344	2,138	40,627	32.43
Q1 2023	24,112	12,883	1,838	38,833	33.12
2021–Q1 2023 avg.	**26,288**	**12,389**	**2,277**	**40,955**	**31.39**

Table 5-2. 2021: total digester influent solids loading and solids loading per feed source (lb/d)

Date range	Gravity thickener	Blending tank	Scum and FOG	Total digester influent
2021	11,394	5,752	351	17,497
2022	12,186	6,100	357	18,643
Q1 2023	9,946	5,941	297	16,184
2021–Q1 2023 avg.	**11,605**	**5,916**	**346**	**17,867**

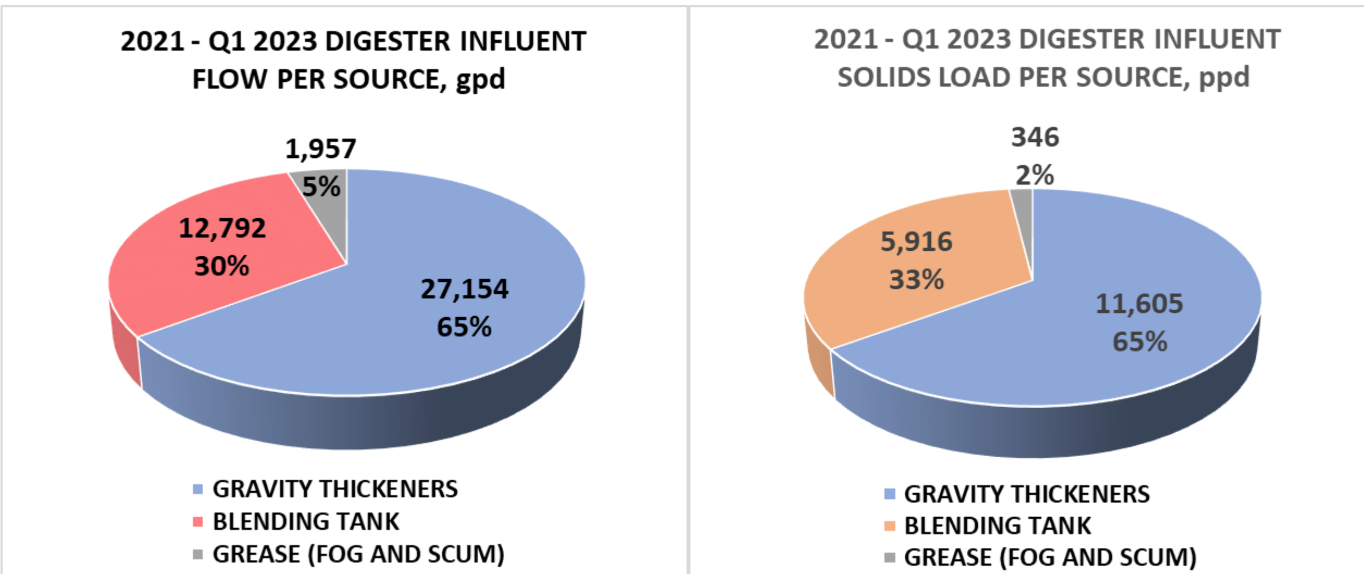

Figure 5-2. 2021–Q1 2023 digester influent flows and solids load composition per solids source

Table 5-3. 2021–Q1 2023 digester influent flows and solids load composition per solids source

	Gravity thickener	Blending tank	Scum and FOG
Percent influent flow per sludge source			
2021	65%	30%	5%
2022	65%	31%	5%
Q1 2023	62%	33%	4%
2021–Q1 2023 avg.	**65%**	**31%**	**5%**
Percent influent solids loading per sludge source			
2021	65%	33%	2%
2022	65%	33%	2%
Q1 2023	61%	37%	2%
2021–Q1 2023 avg.	**65%**	**33%**	**2%**

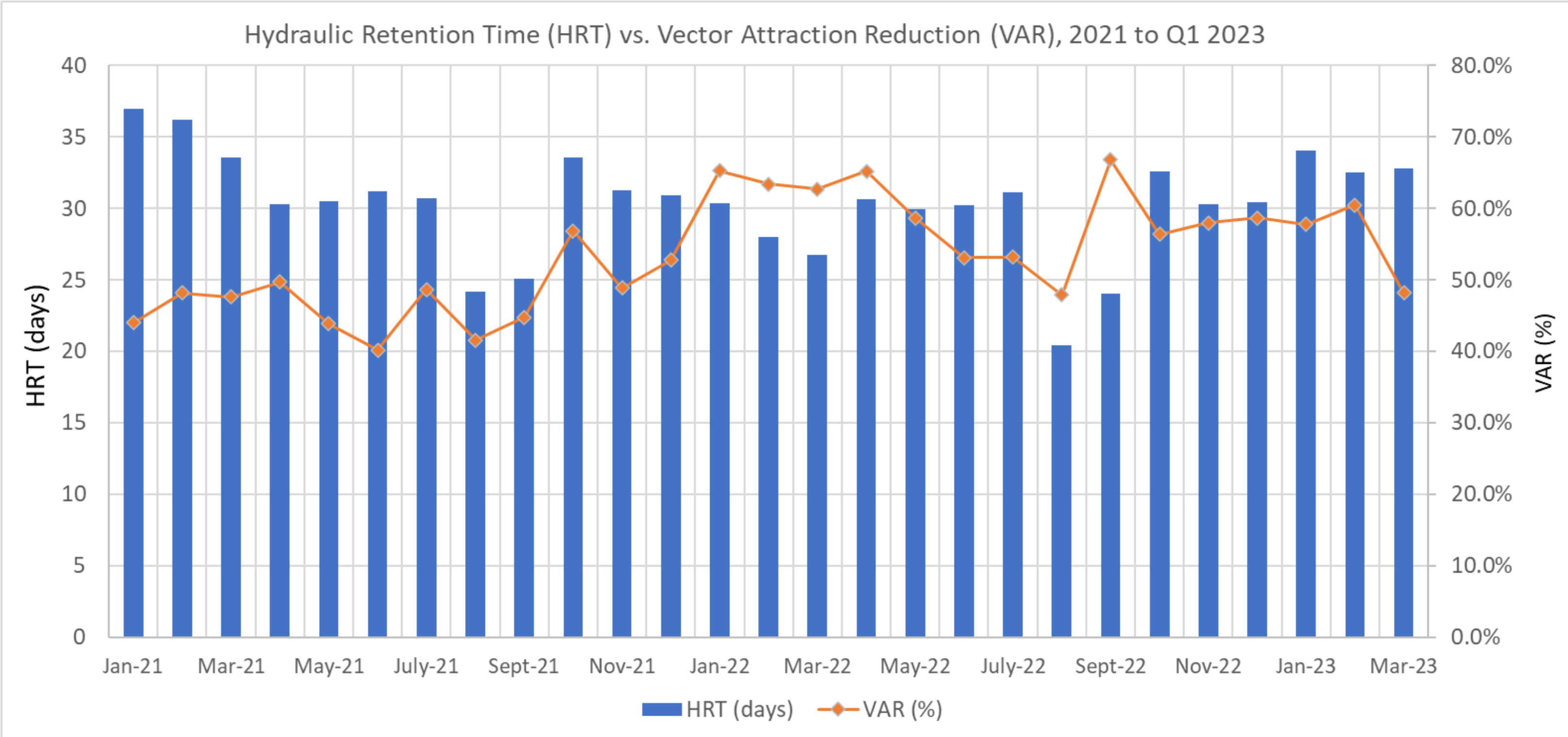

Figure 5-3. HRT vs. VAR, 2021–Q1 2023

Based on current flows, the existing digesters still allow for an adequate retention time that is conservative relative to the required minimum for Class B solids (15 days). Despite this HRT, prior to modification of the mass-balance calculation it appeared more difficult to maintain VSR percentages well above the minimum of 38 percent to meet the biosolids treatment goal of Class B, per EPA biosolids regulations. The alternative mass-balance calculation shows generally higher VSRs (above 50 percent) that are more in line with what would be typically expected for the extended digester HRT at CKTP. It was also observed that an increase in HRT did not always result in an improvement in VSR. That can be observed in Figure 5-3 between April and July 2022, when the HRT was maintained somewhat constant at approximately 31 days, while VAR decreased from 65.2 percent in April to 53.2 percent in July. In general, a strong correlation between the HRT and VAR was not readily apparent. The variability in the response is likely related to two other factors:

1. Longer retention times (well above 20 days) create diminishing returns relative to the effect of slight variations in HRT on VSR (effectively the great majority of the available VSR has taken place).
2. The type of feed to each digester can vary from month to month, depending on the length of time when loads of FOG or septage have been devoted to one tank over another. The changes in VSR may be more closely related to feed type than HRT.

One example of factor 2 above is the septage feeding to the digesters, which presents highly variable conditions (pH, VSS, and presence of specific components) per each septage haul and that CKTP has limited conditions to monitor and address prior to routing through the thickening system. The frequency and flow rates of hauled septage are also variable, and CKTP currently lacks the ability to equalize those flows prior to sending septage to the GTs. That can create a thickened blended sludge (septage and PS) that is inconsistent in quality and proportions of the different sludges, which creates less consistent feeding to the associated digesters. Another example is the FOG feeding to the digesters. Similarly to septage, CKTP has limited ability to control the flow and frequency of FOG loads. Although a smaller source of digester influent, the variability in FOG feed (high VS content) can affect the digesters' VSR performance.

The improvements provided in this report will provide improved flexibility for receiving, equalizing, and monitoring for septage flows, allowing a more consistent blend with PS prior to feeding to the digesters. The proposed improvements will also expand on monitoring and feed control for FOG feeding, allowing a more consistent feed to each digester.

In addition, the current digester operations lack redundancy for the digester tanks, which does not allow one tank to be taken out of service without significantly impacting operation and HRT. In the event that all digester influent flows needed to be sent to one tank only, retention times would be approximately 15 days, assuming total average daily flow to digesters from 2021–Q1 2023, which is the minimum recommended retention time to achieve the Class B biosolids and would likely have a significant impact on operations of the CKTP digesters. Once again, the improvements in this report are designed to increase the overall HRT and allow for redundancy within retention times that have a greater safety factor relative to Class B biosolids minimum VAR requirements.

5.1.2 Design Digester Influent Flows and Loads

The proposed digester improvements considered the 2028 and 2042 flows and loads projections were retrieved from the Central Kitsap WWTP LHWS (Murraysmith 2022), as discussed in Section 2. The thickened flows and loads for septage and PS were calculated based on the predicted performance of the RDTs, planned to replace the existing GTs, assuming a thickened sludge concentration of 6 percent. For the digester influent flows and loads evaluation, capture rate for the RDTs was assumed at 100%, which is higher than the anticipated performance of the RDTs, as discussed in Section 4.3. That assumption on capture rate was also applied to the existing RDT for WAS. Assuming 100% capture rate add conservativeness to the solids load rates associated with the thickened septage, TWAS, and PS streams, and accounts for solids not initially captured at the RDTs (present in the filtrate stream) that will be sent back to the Headworks and will likely be captured downstream.

The LHWS also provided projections for flows and loads of the HTWAS from satellite WWTPs, where it is currently blended with TWAS produced at CKTP (Murraysmith 2022). Projected CKTP TWAS was estimated during the facility planning effort and could also be determined by subtracting flows and loads of each solids stream from the total projected flows and loads in the LHWS (Murraysmith 2022). However, when comparing current flows and loads from the TSBT to the digesters (CKTP TWAS and HTWAS combined) with the projected values, it was noted that average current flows were larger than 2028 AAF projections and therefore projected values could potentially be underestimating future flows. TWAS flows generated at CKTP are substantially greater than HTWAS from other facilities, and CKTP TWAS is proportional to WAS yield at CKTP, assuming constant performance of the existing WAS RDT. The WAS yield at CKTP has generally decreased since 2019 (which is the beginning of WAS data made available to HDR) because BNR operations were implemented over the last several years. However, BNR operation has not been constant. The TWAS flows projections generally tend to assume BNR operation. However, to provide a conservative and robust design for the new digester facilities, HTWAS and CKTP TWAS flows and loads were reevaluated and adjusted to better align with the most current flows and loads from TSBT to the digesters and provide a more robust safety factor.

Scum from clarifiers will continue being routed to digesters, but based on current operations scum flows are negligible and infrequent. Per discussions with CKTP staff, an assumed flow of 3,000 gallons per week was considered for all projections. Scum solids load was determined using the average %TS based on CKTP operation records.

The projected digester influent flows, TS and VS loadings, and approximate TS percent per solids stream are presented in Table 5-4. These values served as design criteria for the new digester facilities. Scum from clarifiers will continue being routed to digesters, but based on current operations scum flows are negligible and infrequent and were not considered for projections.

Table 5-4. Design digester influent flows and loads, 2028 and 2042 projections

Digester influent source	Parameter	2028		2042	
		AAF	MMF	AAF	MMF
Thickened septage [a]	Influent flow (gpd)	9,700	13,900	17,700	25,500
	Influent solids (lb/d)	5,100	7,300	9,300	13,400
	TVS influent (lb/d)	4,340	6,210	7,910	11,390
	% solids	6%	6%	6%	6%
FOG [b,c]	Influent flow (gpd)	2,800	7,800	4,200	13,400
	Influent solids (lb/d)	400	1,100	600	1,900
	TVS influent (lb/d)	360	1,000	550	1,730
	% solids	1.7%	1.7%	1.7%	1.7%
Scum [a]	Influent flow (gpd)	107	107	107	107
	Influent solids (lb/d)	3.2	3.2	3.2	3.2
	TVS influent (lb/d)	2.8	2.8	2.8	2.8
	% solids	0.36%	0.36%	0.36%	0.36%
Thickened primary sludge (TPS) [a]	Influent flow (gpd)	11,600	13,300	15,800	17,700
	Influent solids (lb/d)	6,100	7,000	8,300	9,300
	TVS influent (lb/d)	5,190	5,950	7,060	7,910
	% solids	6%	6%	6%	6%
Thickened TWAS from other WWTPs [a]	Influent flow (gpd)	5,300	8,400	6,300	9,900
	Influent solids (lb/d)	2,100	3,300	2,500	3,900
	TVS influent (lb/d)	1,790	2,810	2,130	3,320
	% solids	4.5%	4.5%	4.5%	4.5%
Thickened CKTP TWAS [a]	Influent flow (gpd)	10,100	13,100	13,100	16,900
	Influent solids (lb/d)	5,100	6,600	6,600	8,500
	TVS influent (lb/d)	4,340	5,610	5,610	7,230
	% solids	5.75%	5.75%	5.75%	5.75%
Total digester influent	**Influent flow (gpd)**	**39,610**	**56,610**	**57,210**	**83,510**
	Influent solids (lb/d)	**18,800**	**25,300**	**27,300**	**37,000**
	TVS influent (lb/d)	**16,020**	**21,580**	**23,260**	**31,580**
	% solids	**5.4%**	**5.1%**	**5.4%**	**5.1%**

a. Estimated %TVS for septage, scum, primary sludge and TWAS = 85%..
b. Estimated %TVS for FOG = 91%.
c. A dilution factor of 20% was added to FOG flows to account for wash water at the receiving station. %TS accounts for dilution.

Although Table 5-4 presented each solid stream that is ultimately fed to the digesters, digester feeding will occur from three main sources, similar to the existing sources described in Section 5.1.1:

- **Blended sludge** (PS and septage), thickened at the new PS and septage thickening building, replacing the existing GTs (see Section 4)
- **TWAS** (CKTP TWAS and HTWAS), pumped from the existing WAS-thickening building with provisions for redundancy at the PS and septage thickening building
- **FOG**, from new FOG building

Figure 5-4 and Figure 5-5 detail the proportion of each sludge source in the composition of the overall digester influent feed flows and solids loading, for the 2028 AAF and 2042 AAF projections, respectively. The sludge composition based on flow projections is substantially similar to the current digester influent composition, as shown in Figure 5-2. Combined septage and PS still represents the majority of the digester influent, at approximately 60 percent for both flows and solids loading. Combined TWAS is the second largest source of digester feed, at approximately 35 percent of the flows and loads, while FOG represents approximately 5 percent or less of the digester influent flows and solids loads.

In absolute numbers, the 2028 AAF projections estimate a digester influent flow rate of 39,610 gpd, which is slightly smaller than the 2021–Q1 2023 average flow rate of 40,955 gpd. That decrease is mostly due to an increase in TS concentration (percent TS) of the PS and septage stream, which is the largest contributor of digester influent. Concentration of the thickened and blended septage and PS is anticipated to increase from 4.9 percent of current operations (2021–Q1 2023 average) to 6.0 percent with the adoption of RDTs in lieu of the existing GTs. For influent solids, the 2028 AAF projections estimate approximately 18,800 lb/d, which is an increase from the 2021–Q1 2023 average influent solids rate of 17,867 lb/d.

The proposed improvements for the digester facilities use the 2042 MM flows and loads projections as design criteria. This will allow CKTP to accommodate nearly double the current average flow rate and solids loading, with a design, as outlined in Section 4 and following sections, that provides improved thickening, feed controls, monitoring, and redundancy for the different solids sources.

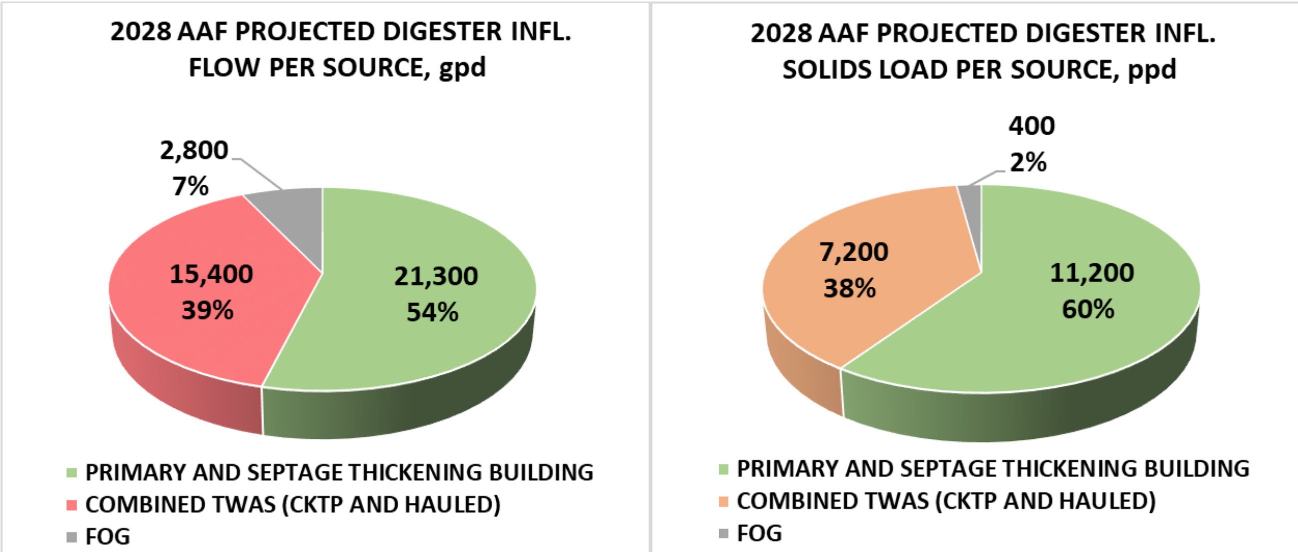

Figure 5-4. 2028 AAF digester influent flows and solids load composition per solids source

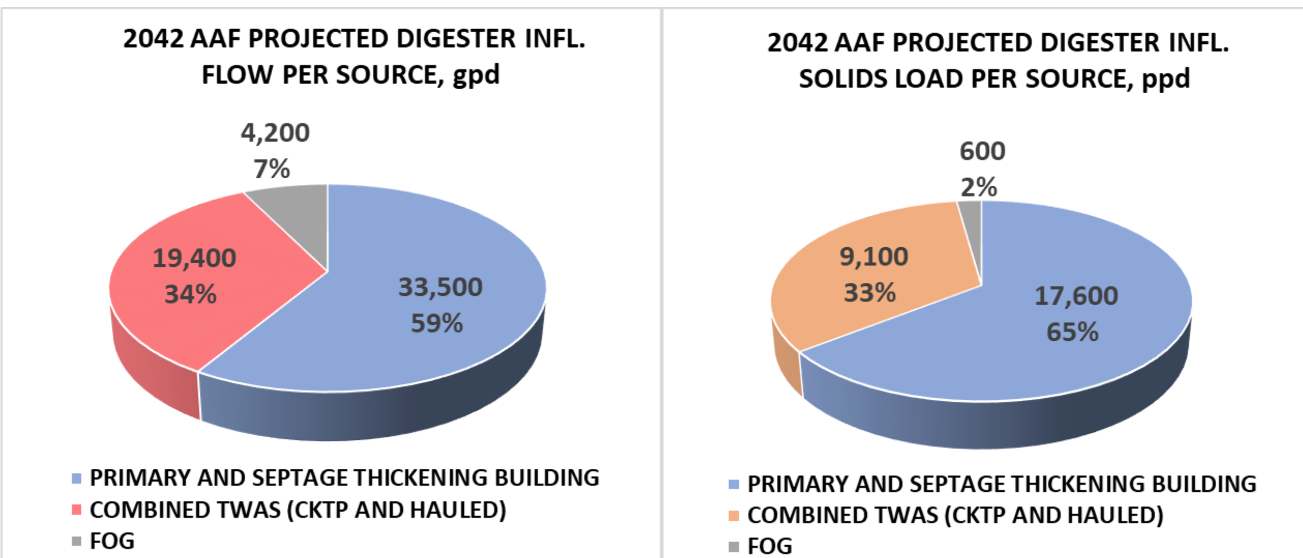

Figure 5-5. 2042 AAF digester influent flows and solids load composition per solids source

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5.1.3 Digester Improvement Alternatives

HDR evaluated alternatives to increase CKTP's digestion capacity and allow for robust retention times for the projected digester influent flows and loads. In addition to rehabilitating the two existing digesters, two main options were considered for digester expansion: construction of one 1.3 MG digester or construction of two 0.65 MG digesters. The alternatives were presented and discussed with CKTP staff during a workshop in June 2023 (Appendix A).

Both alternatives would double current digester capacity and would allow for much greater HRT with all digesters in operation. However, the alternative of constructing two additional digesters for a total of four 0.65 MG digesters would provide additional flexibility and redundancy, as one of the digesters could be taken offline without significantly compromising retention time for most of the anticipated flows. The alternative of constructing one additional 1.3 MG digester would require a smaller footprint and would be less expensive to construct and maintain but could significantly impact HRTs if the larger digester is taken out of service in the future. Additionally, having four 0.65 MG digesters would facilitate maintenance and operations as auxiliary systems (mixing system, recirculation, HEXs) would be of similar size and type among all digesters.

Therefore, CKTP staff selected the approach of having two new 0.65 MG digesters because of its improved redundancy and lower long-term risk in meeting HRTs and pathogen reduction. A summary of the workshop discussions is presented in Appendix A.

In addition to the strict doubling of the digester volume, it is anticipated that the vertical walls of the existing digesters will be increased in height (to raise and upsize the overflow pipe). This will provide roughly 2 feet of additional active volume (roughly 50,000 gallons) to each tank for a total of approximately 0.7 MG of volume per tank, which is an additional improvement over the current system. The new digesters will also be 0.7 MG to match the rehabilitated existing digesters.

5.1.4 Digester Operating Modes

As part of the evaluation of digester improvement alternatives and analysis of flows and loads, a mass-balance evaluation was conducted to determine parameters such as digester loading, estimated HRTs, volatile solids destruction (Vd), VSR, and VS loading rate for the proposed system of new and rehabilitated digesters. This mass-balance evaluation considered four 0.7 MG digesters in various operating modes:

- Four digesters online, operating in parallel
- Three digesters online, operating in parallel (redundant unit out of service)
- Digesters operating in series (two-stage): two primary and two secondary digesters

Table 5-5 summarizes the mass-balance parameters for the various operating modes. For mass-balance calculations, HRT is considered equivalent to SRT. The Vd parameter (which is equivalent to VSR) was determined using Equation 1 (Metcalf & Eddy/AECOM 2014) as an empirical reference for VSR.

$$Vd = 13.7\ln(SRT) + 18.9$$

(Equation 1)

The Vd parameter presented on Table 5-5 was calculated for comparative purposes only, as it likely overestimates the Vd by accounting for the large HRTs that the upgraded digester facilities will allow for. This parameter is intended for high-rate digestion systems (15–20 days), while the system under design for CKTP operates more similarly to low-rate digesters (30–60 days). Therefore, the calculated Vd is not an anticipated or design performance criterion for the digester system.

To estimate effluent TS and VS loading out of the digesters, a mass balance–based solids destruction parameter (U%) was assumed for the different digester operations (in parallel and in series). For in-parallel digester operations, an average VSR of 50 percent was assumed, while combined VSR (at primary + secondary digester) for in-series operations was assumed at 55 percent (the sum of removal rates for each digester in-series operation, shown in Table 5-5). These assumptions are conservative and consistent with average VSR values shown on Figure 5-3 above, although the proposed upgrades will likely improve the average VSR. The slightly larger VSR anticipated when digesters are operated in series is supported by Zahller et al. (2005), which reported that for a similar SRT, a two-stage digester provided better VSR and more methane production. For the overall VSR when digesters are operated in series, approximately 75 percent of the destruction is anticipated to occur at the primary digesters.

Table 5-5. Mass balance for proposed digesters per 2028 and 2042 projected flows and solids loads

Digester operation	Parameter	2028		2042	
		AAF	MMF	AAF	MMF
Parallel operation (normative)					
4 digesters in operation	Influent flow per digester (gpd)	9,903	14,153	14,303	20,878
	Influent solids loading per digester (lb/d)	4,700	6,325	6,825	9,250
	Influent VS per digester (lb/d)	4,005	5,395	5,815	7,895
	HRT (days)	**70.69**	**49.46**	**48.94**	**33.53**
	VS loading rate (lb/ft^3/d)	**0.043**	**0.058**	**0.062**	**0.084**
	Vd from HRT (%)	77.2%	72.3%	72.2%	67.0%
	VSR (%)	50%	50%	50%	50%
	Effluent solids loading per digester (lb/d)	2,698	3,628	3,918	5,303
	Effluent VS per digester (lb/d)	2,003	2,698	2,908	3,948
3 digesters in operation, 1 offline	Influent flow per digester (gpd)	13,203	18,870	19,070	27,837
	Influent solids loading per digester (lb/d)	6,267	8,433	9,100	12,333
	Influent VS per digester (lb/d)	5,340	7,193	7,753	10,527
	HRT (days)	**53.02**	**37.10**	**36.71**	**25.15**
	VS loading rate (lb/ft^3/d)	**0.057**	**0.077**	**0.083**	**0.112**
	Vd from HRT (%)	73.3%	68.4%	68.3%	63.1%
	VSR (%)	50%	50%	50%	50%
	Effluent solids loading per digester (lb/d)	3,597	4,837	5,223	7,070
	Effluent VS per digester (lb/d)	2,670	3,597	3,877	5,263
In-series operation					
2 primary digesters	Influent flow per digester (gpd)	19,805	28,305	28,605	41,755
	Influent solids loading per digester (lb/d)	9,400	12,650	13,650	18,500
	Influent VS per digester (lb/d)	8,010	10,790	11,630	15,790
	HRT (days)	**35.34**	**24.73**	**24.47**	**16.76**
	VS loading rate (lb/ft^3/d)	**0.084**	**0.114**	**0.122**	**0.166**
	Vd from HRT (%)	67.7%	62.9%	62.7%	57.5%
	VSR (% of Influent Load)	41.3%	41.3%	41.3%	41.3%
	Effluent solids loading per digester (lb/d)	5,635	7,579	8,184	11,079
	Effluent VS per digester (lb/d)	4,245	5,719	6,164	8,369
2 secondary digesters	Influent flow per digester (gpd)	19,805	28,305	28,605	41,755
	Influent solids loading per digester (lb/d)	5,635	7,579	8,184	11,079
	Influent VS per digester (lb/d)	4,245	5,719	6,164	8,369
	HRT (days)	**35.34**	**24.73**	**24.47**	**16.76**

Digester operation	Parameter	2028		2042	
		AAF	MMF	AAF	MMF
	VS loading rate (lb/ft^3/d)	**0.045**	**0.061**	**0.066**	**0.089**
	Vd from HRT (%)	67.7%	62.9%	62.7%	57.5%
	VSR (% of Influent Load)	13.7%	13.7%	13.7%	13.7%
	Effluent solids loading per digester (lb/d)	4,999	6,721	7,259	9,823
	Effluent VS per digester (lb/d)	3,609	4,861	5,239	7,113

Mass-balance results show that proposed digester improvements will allow for generous retention times in any of the considered flows and loads projections. For the 2028 MMF projection, when flows and loads are anticipated to be more than 35 percent larger than current flows and loads, HRTs were approximately 50 days with all four digesters in operation and over 37 days with just three digesters in operation. For the 2042 MMF projection, flows and solids loading are double the current flows and loading, and calculated HRTs were nearly 34 days with four digesters in operation and 25 days with three digesters in operation. With digesters operating in series, HRT at each tank will be approximately 17 days, summing up to 34 days when considering primary and secondary retention times. Typically, a combined retention time between primary and secondary digester results into improved VSR when compared to a single-phase digester with similar retention time by approximately 5 percent (Zahller et al. 2005).

The calculated HRTs for the 2028 and 2042 projections, for three and four digesters in operation, resulted in retention times that are much greater than existing HRTs for most operating conditions. The only exception is the worst-case scenario considered, at 2042 MMFs with three digesters in operation, when the calculated HRT of approximately 26 days was slightly lower than the 2021–Q1 2023 average of 31.4 days. However, the improved digester feed control, screening, thickening, and monitoring of the different influent solid streams, as proposed by this upgrade project, should support a satisfactory digester performance even at this extreme edge of potential high loads in the future.

Another parameter used to evaluate digester sizing is the VS loading rate, which is the amount of VS added per day per unit volume of digester capacity. Typical solids loading rate criteria for a mesophilic high-rate complete-mix anaerobic digester vary between 0.1 and 0.3 pound (lb) volatile suspended solids (VSS)/(cubic foot-day [ft^3-d]). Considering parallel digester operations, loading rates were lower than 0.1 lb VSS/(ft^3-day) for all projected solids loading, with three or four digesters in operation, except for the scenario where 2042 MMF is fed to three digesters only, which resulted in a solids loading of 0.110 lb VSS/(ft^3-d). In all cases, the CKTP digesters are effectively low-rate mesophilic digesters (loaded well below their capabilities) with retention times in the 30- to 60-day range.

Considering the larger HRT for most digester operations, similar composition of digester influent feed to existing, and improved feed controls, monitoring and thickening process, it is reasonable to assume that the proposed digesters will provide a VSR (and therefore, VAR) performance that is similar to or better than the existing digesters at current loads, even at projected 2042 conditions. As shown in Figure 5-3 above and discussed previously, an HRT larger than 25 to 30 days does not necessarily result in additional VSR, but it does provide flexibility and resilience for larger flows and loads that may occur in the future. The proposed digester improvements provide even greater HRTs for the flows considered, to allow CKTP to have redundancy of digester facilities and take one digester offline without significant compromises in digester operation or performance. A stable VAR will be supported by enhanced septage- and FOG-receiving facilities, in particular the addition of equalization for septage flows, improved thickening for PS and septage, and improved digester feed controls that promote a more equal distribution of flows to each digester.

5.2 Digester Design

Given the mass balance and process analysis of the previous section, the new digester design will incorporate sizing and operational features to allow for improved HRT and enhanced operation. The two new proposed digesters (Digesters 3 and 4) will be designed to match the existing digesters (Digesters 1 and 2) in shape, diameter, and elevations as much as possible. That consistency among all four digesters will facilitate a homogenous flow distribution, promote similar performance between the digesters, and make for similar operations between the digesters.

The existing digesters will be rehabilitated, including the replacement of all auxiliary systems (mixing, HEXs, feed and withdrawal pumps, etc.), covers, interior coating, and reconditioning of the structure as needed. The existing digesters side walls will be increased by 5 feet, increasing height from 31 feet to 36 feet, so that the overflow pipe can be raised and upsized. That will also allow for a higher digester operating level and will increase digester capacity from 0.65 MG to 0.70 MG. This feature is proposed and will be fully evaluated structurally as part of the final design effort.

The new digesters will be constructed of cast-in-place or prestressed concrete and will have an internal diameter (ID) of 65 feet and side wall height of approximately 36 feet, to match the rehabilitated existing digesters.

5.2.1 Digester Area Layout

Digesters 3 and 4 are proposed for an area southeast of the existing Digesters 1 and 2, as shown on Figure 5-6 and Appendix H. The proposed area for the new digesters is at a slope, nearby the existing access road that connects the entrance of CKTP to the existing septage-receiving station and headworks building. The grade of the proposed location will allow for a partially buried digester structure at similar elevations to the existing digesters, which will support consistent operations between the digesters. Both pairs of digesters will have process buildings between the digester structures; the existing building between Digesters 1 and 2 will be rehabilitated to meet current building codes and to house all digester-related pumps and HEXs.

In addition to the process buildings between each digester, a separate digester control building will be located between the pairs of digesters. This building will house the primary electrical room for the digesters, as well as the new boilers and hot water pumps that will replace the existing units in the current Digesters 1 and 2 complex. These boilers are at the end of their useful life and are located in a room that is no longer code compliant with current NFPA 820 standards. A separate control building will allow for electrical and boiler infrastructure separated from the digester tanks (see Section 7).

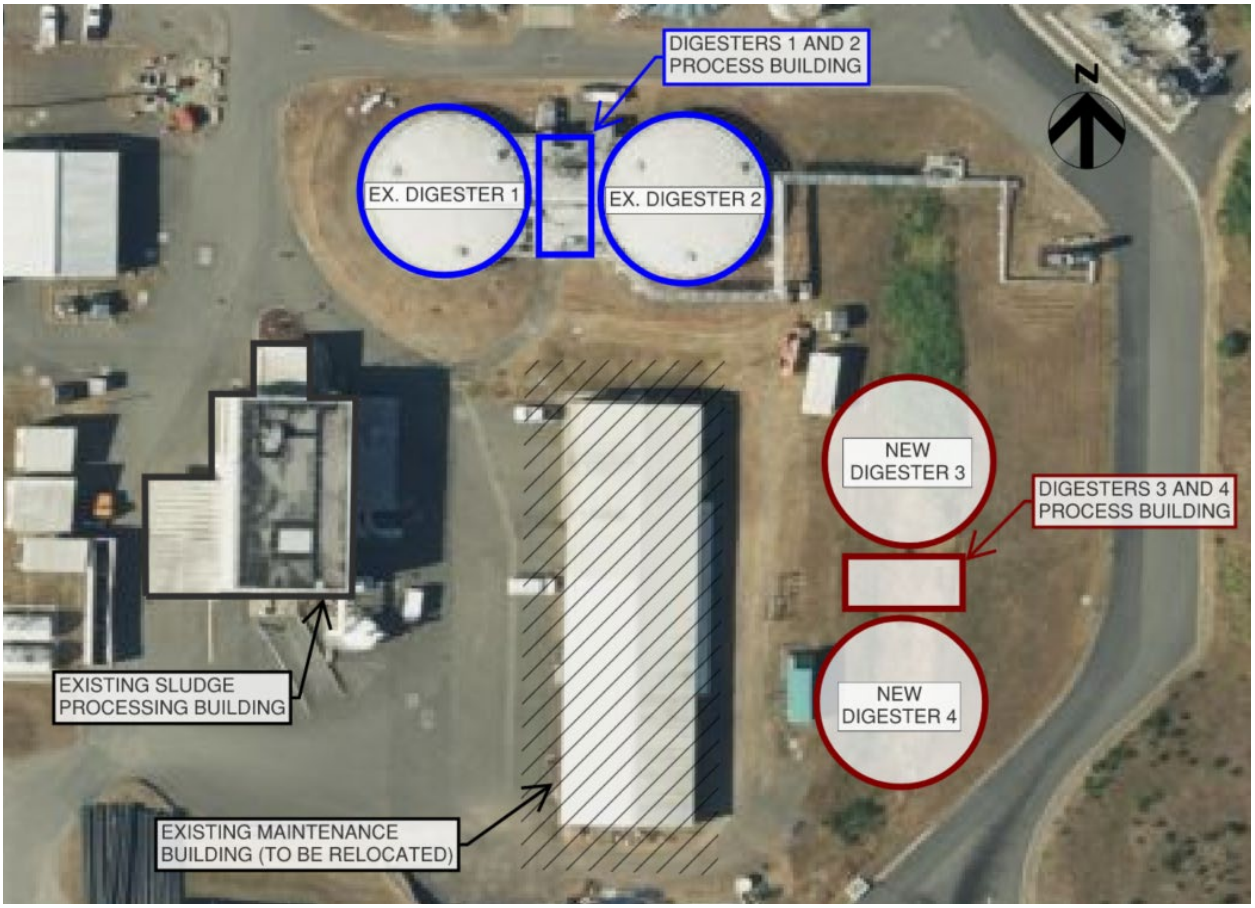

Figure 5-6. Proposed digester area layout

5.2.2 Digester Covers

The two existing digesters at CKTP have fixed steel covers, last replaced in 1992. CKTP staff have identified the lack of digester gas storage as a challenge for digester gas management. The ability to store gas and control gas withdrawal flow rates could also allow CKTP to resume operation of beneficial uses for biogas (see Section 5.4), which requires a more constant influx of gas for optimal operations.

Considering those goals for improved digester gas management, three digester cover technologies were evaluated for the replacement of the existing digester covers and for installation on the new digesters:

- Fixed covers (steel or stainless steel)
- Floating covers (steel or stainless steel)
- Gas-holding membrane, as shown on Figure 5-7.

Table 5-6 summarizes the pros and cons of each proposed cover type. Additional information for each digester cover technology is provided in Appendix B.

Figure 5-7. Example of gas-holding membrane cover

Table 5-6. Pros and cons of digester cover alternatives

Digester cover option	Pros	Cons
Fixed	Simple design and maintenance	No real gas storage (if needed)
	Maximum options for mixing technologies	Need to maintain slow/minimal volume changes to better control biogas
	Access and protective valving mounted on top	
Floating	Modest gas storage flexibility	Odor control issues at seal
	Accommodates more rapid volume changes	More complicated and expensive design (moving parts)
	Access and protective valving mounted on top	Some limitations (or added complexity) for mixing options
Membrane	Larger gas storage properties	Most limited mixing technology options
	Simple design	More regular cover replacement and equipment maintenance
	Flexible with liquid level	Limits access and piping to sidewalls

During workshops with CKTP staff, it was decided to proceed on the design considering fixed steel covers for replacement of the Digesters 1 and 2 covers and membrane covers for installation on Digesters 3 and 4. The reason for that decision is the improved gas storage flexibility that two membrane covers would allow for, while maintaining the simpler operation and maintenance of two fixed covers on the existing digesters. The option for the membrane covers installed on the new digesters is tentative and will be evaluated further as part of the detailed structural analysis of the existing digesters. It is possible that the gas-holding membranes may be located on Digesters 1 and 2, with fixed covers on Digesters 3 and 4, if this better suits the final design. This does not affect the overall selection or operation of the system, and for the purposes of this report, the BOD proposes the following:

- **Digesters 1 and 2 (rehabilitated):** fixed steel covers
- **Digesters 3 and 4 (new):** gas-holding membrane

Although each digester pair will feature different cover types, they will work in conjunction for gas storage purposes. The headspace of all digesters will be connected via a common header that will allow for gas produced in Digesters 1 and 2 to flow to the headspace of Digesters 3 and 4, where increased storage capacity will be available with the membrane covers. Additional discussion on how each cover type is intended for the proposed digesters at CKTP follows.

Fixed Steel Covers

CKTP staff are familiar with fixed digester gas covers as the existing digesters at CKTP are installed with this cover type. Operation and maintenance required for these covers are minimal and simple, and the only major repair is for recoating every 10 to 20 years.

Gas-Holding Membrane Covers

Gas-holding membrane covers consist of a double-layered polyvinyl chloride (PVC)-coated polyester cover that can provide storage for a large volume of gas and accommodate gas volume variations. The inner layer holds digester gas above the sludge level and expands as digester gas is produced, while the outer layer maintains the cover shape and withstands environmental conditions. The annulus space between the membrane layers is maintained by a fan system (duty and standby units for each cover) that blows ambient air to maintain a threshold pressure on the outer layer; fans also blow air to fill space when the inner layer deflates because of sludge or digester gas withdrawal. When digester gas is produced and the inner layer compresses the annulus volume beyond the pressure threshold, an air purge line connected to the annulus space allows for excess air to be released. Preliminary P&IDs included in Appendix F show in more detail the auxiliary components that are part of the gas membrane cover system. Figure 5-8 illustrates the auxiliary components for the gas-holding membrane cover located on the roof of a building adjacent to the digester tank, in a similar layout planned for CKTP.

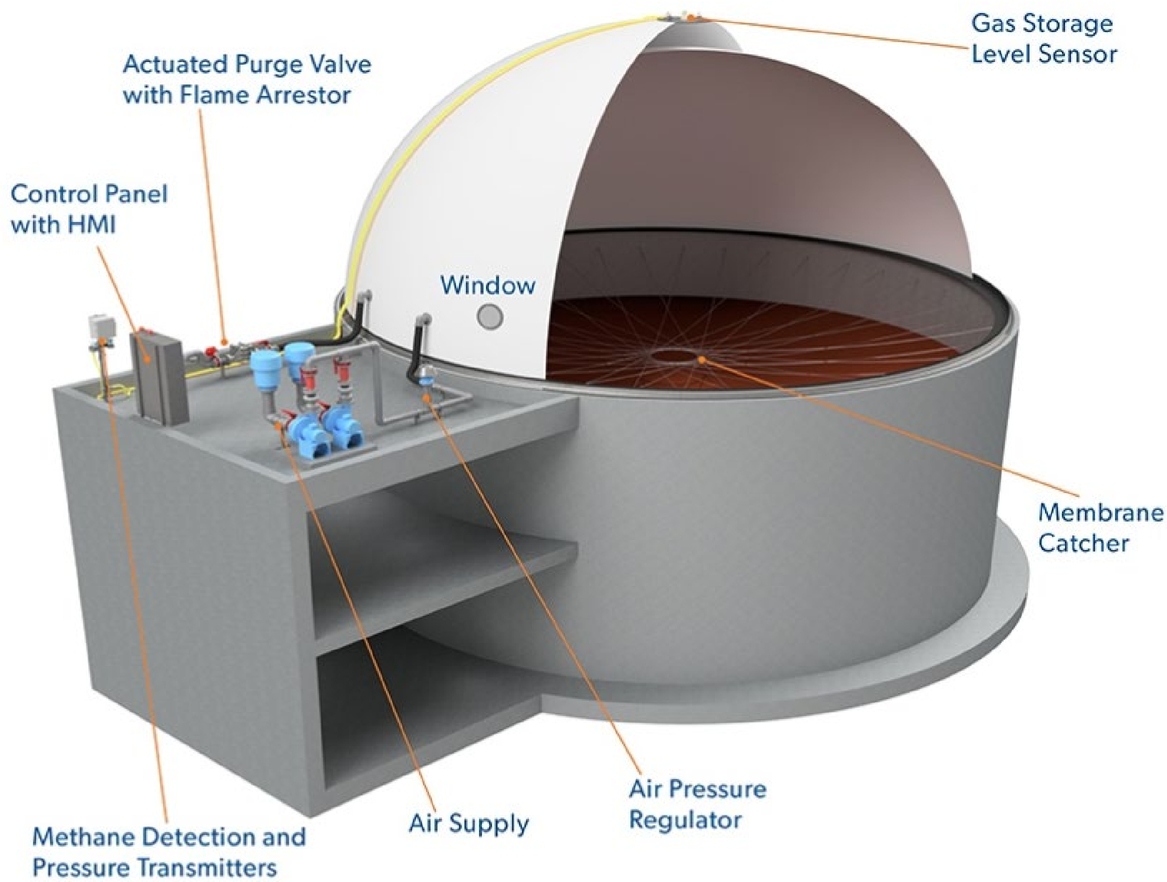

Figure 5-8. Example of gas-holding digester covers and auxiliary systems

The installation of membrane covers on Digesters 3 and 4 will allow for increased gas storage. Considering the 65-foot-diameter digesters, each membrane cover is estimated to hold approximately 60,000 ft^3 of gas storage, and a higher capacity could be achieved if the membrane is designed for a higher operating pressure. Based on CKTP gas production data from 2018 to 2020, the daily average total gas production was approximately 94,000 ft^3. Considering those gas production rates, the membrane covers on Digesters 3 and 4 will hold approximately more than 1 full day of digester gas production. Additional gas storage information is summarized on Table 5-7.

Table 5-7. Gas storage capacity from Digesters 3 and 4

Parameter	Value	Comments
Gas production data		
Average monthly gas yield	2,842,000 ft^3	Monthly averages from 1/2018 to 12/2020
Average daily gas yield	94,730 ft^3	Calculated from monthly averages
Gas storage capacity on Digesters 3 and 4		
Total gas storage volume (Digesters 3 and 4)	120,000 ft^3	Approximate value[a]; higher capacity available
Storage in hours of gas yield	30 hr	

a. Storage volume based on a cover operating pressure of 15 in. w.c. Specific storage volume varies for different cover manufacturers.

5.2.3 Digester Feed Strategy

Existing Digesters 1 and 2 receive solids via three separate streams: TPS and septage pumped from the existing GTs, blended TWAS from CKTP and other satellite facilities via the WAS-thickening building, and scum and FOG conveyed from the primary clarifier scum boxes.

Current operations alternate the feeding of these influent streams between the digesters for a somewhat consistent feed rate and composition of DIG. However, some of those streams, such as scum/FOG, are fed to a single digester for a prolonged period before being routed to another digester, which can cause inconsistency in the loading of a digester from month to month. The LHW upgrades are designed to improve this feature by allowing consistent, slow, steady feeding of each digester on a daily basis, allowing for as smooth an operation as possible given the variables that can be controlled by CKTP staff.

During workshop discussions a few digester feed strategies were discussed. CKTP staff have identified septage as potentially problematic for co-digestion, and a septage-only digester was evaluated. However, that approach was discarded because of the operational complications, such as maintaining two different digester operations, and because septage hauls are an unpredictable flow stream, and therefore CKTP would lack the ability to control and maintain a consistent influent feed rate. Although CKTP staff did not select a septage-only digester to move forward into design, the current project improvements anticipate other provisions to mitigate the issues with co-digesting septage; those improvements, discussed in Section 3, include EQ tanks where septage loads can be blended and monitored before being sent for thickening and digestion.

Two digester feed strategies, described below, were evaluated.

Centralized Feed

All solid streams would be sent to a common holding tank prior to pumping to digesters. Sludges would be mixed inside the tank for homogeneity, and a set of pumps would route the mixed sludges to each digester.

Individual Feed Control

Sludge feeding into each digester would be controlled by the totalized flow measured by flow meters and motorized valves at each digester connection. For instance, TWAS flows pumped from the TSBT would be routed to Digester 1 until a defined set point volume is achieved. Once that predetermined sludge volume is met, the motorized valve at the TWAS connection to Digester 1 closes and the valve at the TWAS line to Digester 2 opens, then routing the same volume of TWAS to Digester 2. The same process occurs until equal volumes of TWAS are routed to all digesters before feeding TWAS again to Digester 1. This process would be similarly done to all solid streams being fed to the digesters (PS/septage, scum, FOG).

During workshop discussions (Appendix A) the alternative for individual feed control was selected to move forward into design, as this provides both redundancy and a high degree of flexibility in flow and loading control. Preliminary P&IDs provided in Appendix F show the flow meters and control valves for each solids stream routed to the digesters. Those valves will open and close based on flow meter signals so that flows are equally distributed between the digesters.

5.2.4 Digester Mixing System

Digestion mixing is an essential process for optimal digester operation as it prevents septicity and promotes uniformity of the sludge, as well as minimizes gas entrainment to allow for steady and consistent gas production rates while reducing the risk of gas entrainment and rapid level rise. The current digesters use a form of pumped mixing technology with a dedicated pump per digester and recirculates flow within the tank. Along with an updated (more efficient) version of this type of mixing for the new and rehabilitated tanks, other mixing technologies were considered for the digester retrofits and upgrades:

- Linear motion (LM) mixer
- Pumped (Vaughn Rotomix)
- Submersible turbine

Table 5-8 summarizes the pros and cons of the evaluated alternatives for digester mixing technologies. Appendix B includes the fact sheets with additional information on each technology, including primary vendors and equipment.

Table 5-8. Pros and cons of digester mixing alternatives

Digester mixing options	Pros	Cons
Linear motion	Simple system with easy repair. Low risk of failure.	Single point of failure for mixing
	Workable with fixed and floating covers	Crane for full removal
	Moderate mixing for standard mesophilic digester	Sole source
	Can be specified with combined cover/mixer unit responsibility	Minimal adjustment once installed
Pumped	Equipment located at "ground" level. Relatively easy to maintain with typical pump/valve O&M.	Nozzles can clog and/or create low pressure zones that promote struvite formation
	Options for redundancy	High horsepower (energy load) requirements
	No moving parts in digester	More regular maintenance
	Moderate mixing for standard mesophilic digestion	Added footprint to digester pump building
Submersible	High mixing rate (best velocity and tank coverage)	Single point of failure for mixing
	Flexible positioning of mixer for adjustment at different operating levels	Sole source
	Full removal of system relatively easy. Built-in access to tank components.	More complex cover design coordination
	Workable with fixed or gas-holding cover	Motor and cables go in the liquid

During workshop discussions with CKTP staff, an upgrade pumped mixing system was selected. The reasoning for this decision includes the flexibility of using this technology with both digester cover types (fixed and membrane covers), familiarity of staff with the equipment, and ability to have a swing pump in place, for redundancy or easier maintenance of duty pumps.

The proposed pump mixing design for the rehabilitated Digesters 1 and 2 and new Digesters 3 and 4 uses three chopper pumps per pair of digesters in a 2+1 configuration to recirculate sludge via four nozzle assemblies installed around the digester walls. A foam buster nozzle will be installed slightly above the digester maximum operating level with a dedicated feed line and motorized valve, so that it can be used as needed to prevent and mitigate foam formation inside the digesters. An ultrasonic level sensor will be provided for the fixed-cover digesters to help identify the formation of foam and indicate when the foam buster nozzles may need to be used. Additional information on the proposed pump mixing design is provided in Table 5-9. The mixing pumps and related instruments are shown in more detail on the P&IDs, provided in Appendix F. Figure 5-9 shows an example of the chopper pump intended for the mixing systems, and

Figure 5-10 depicts the preliminary layout for the mixing nozzle configuration at the CKTP digesters.

Table 5-9. Digester mixing system design parameters

Parameter	Value	Comments
Pump type	Chopper pump	
Number of units per digester pair	2 duty + 1 standby	
Motor hp	60 hp	
Rated flow rate	3,600 gpm	
Number of nozzles per digester	6 standard + 1 foam buster	

Figure 5-9. Example of chopper pump intended for digester mixing system

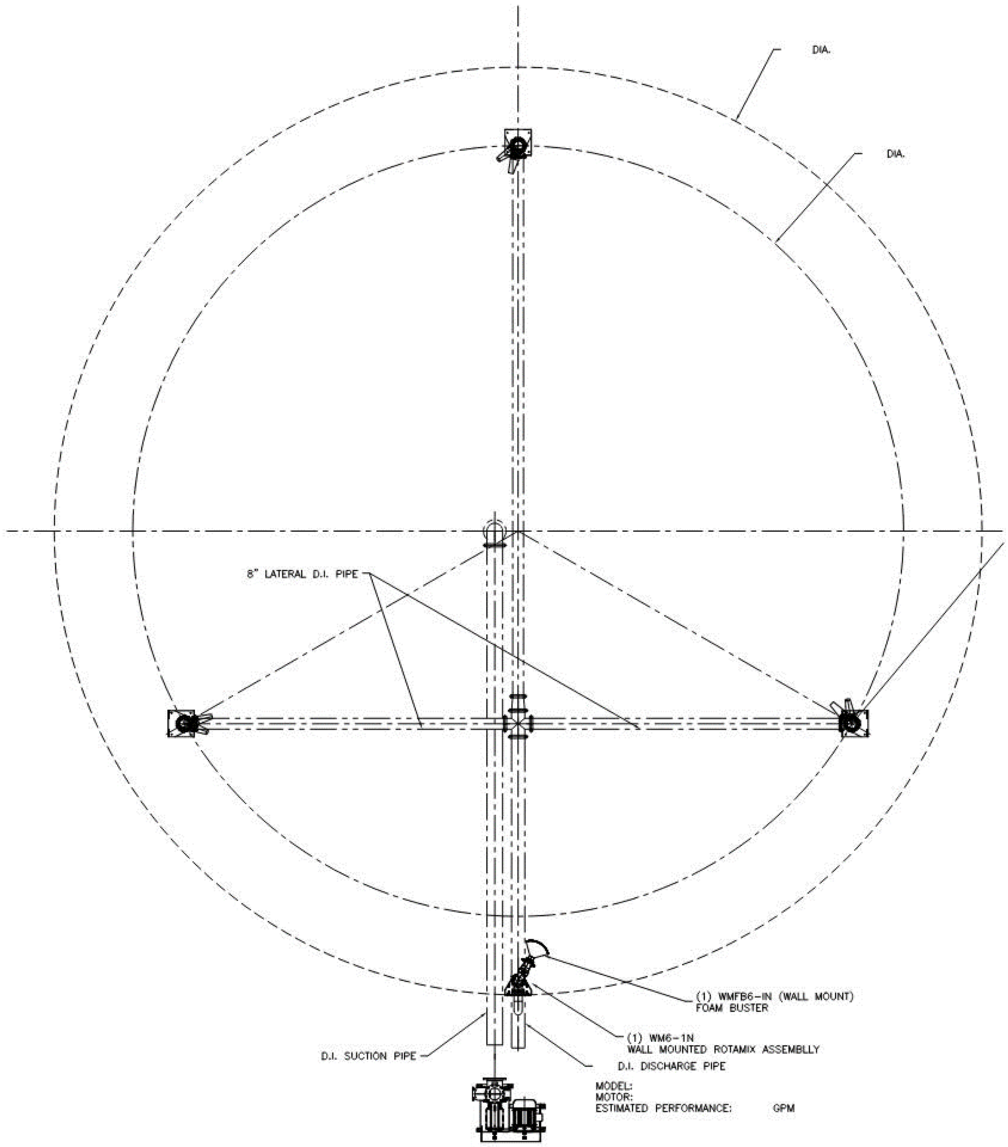

Figure 5-10. Preliminary mixing piping and nozzle layout

5.2.5 Digester Heat Demand

The primary demand for the new boilers that will be located in the digester control building will be the load required to maintain temperature in each of the four digesters. The heat input required (in million British thermal units per hour [MMBtu/hr]) to operate the digesters at the optimal operating design temperature of 98 degrees Fahrenheit (°F) is the target BOD. The digester heat input requirement considered two major sources:

1. The heat input required to raise the digester feed temperature to the design operating temperature.

   Heat input (MMBtu/hr) was calculated using the heat capacity equation, $Q = mc\Delta T$, where:

a. m = maximum month digester feed mass flow rate, lb/d

b. c = specific heat, 1 BTU/lb-°F (assumed equal to water)

c. ΔT = temperature differential between digester feed and operating digester temperature, °F

2. The heat losses from the digesters to the environment.

Heat loss (MMBtu/hr) was calculated using the heat transfer equation, $q = UA\Delta T$, where:

a. U = coefficient of heat transfer, Btu/h-ft^2-°F

b. A = cross sectional area of heat loss, ft^2

c. ΔT = temperature differential across surface, °F

Distinct areas of coefficients of heat transfer (U), cross-sectional area of heat loss (A), and temperature differential across the surface (ΔT) are shaded and labeled on digester diagrams in Figure 5-11 and Figure 5-12 for the existing and new digester designs. Heat loss was calculated for each unique combination of U, A, and ΔT on the digesters and then totaled.

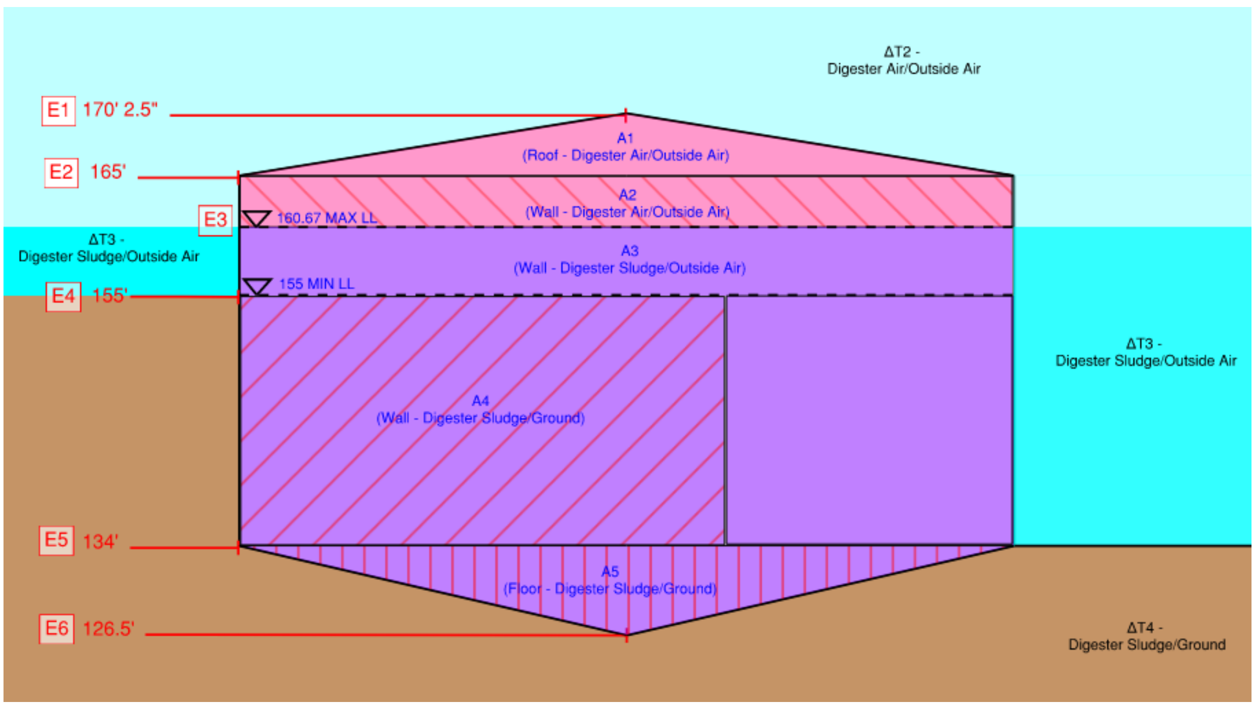

Figure 5-11. Existing digester heat loss calculations supporting diagram

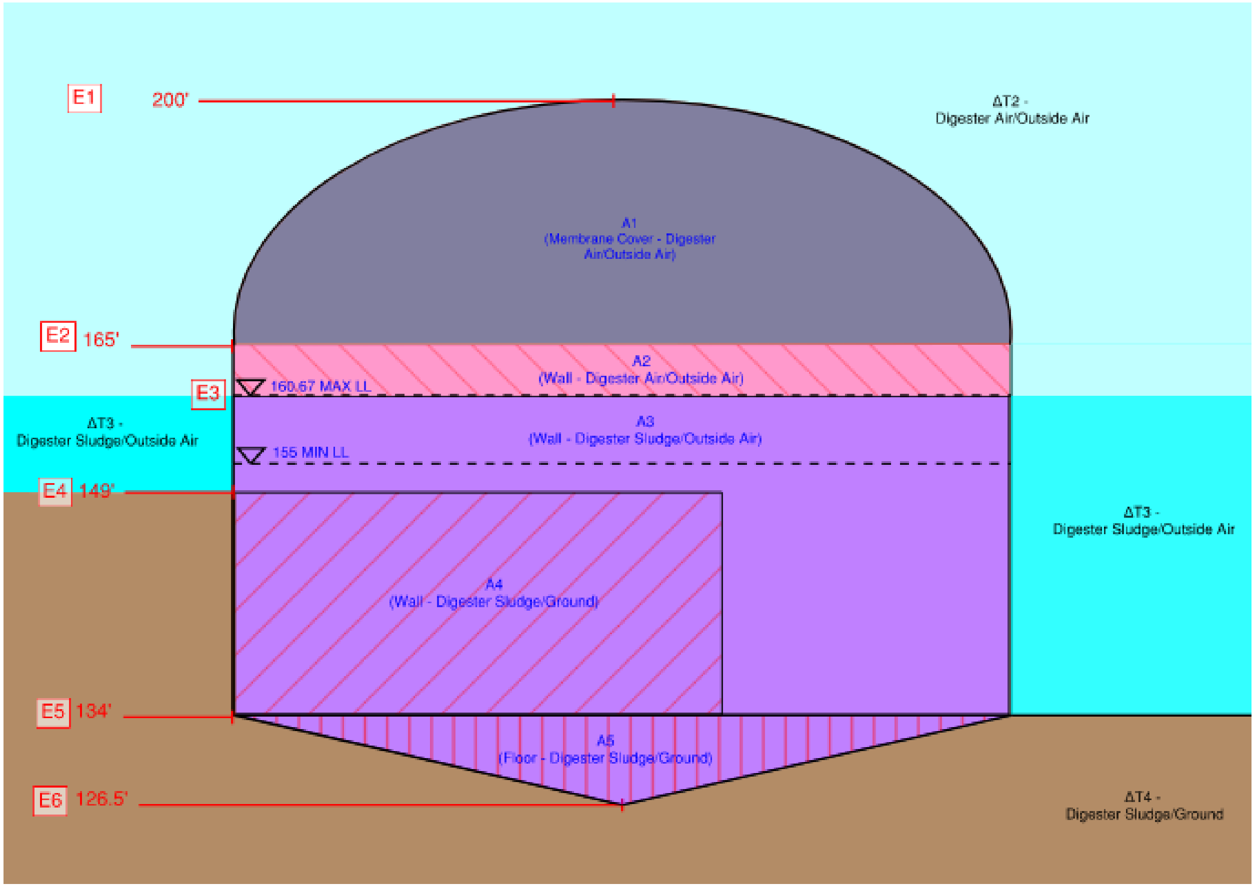

Figure 5-12. New digester heat loss calculations supporting diagram

The heat input requirement was calculated on a per-digester basis for different temperature conditions (winter and summer) and different projected flows and loads (2028 and 2042 projections). The minimum condition was considered to be all four digesters operating in summer conditions at 2028 AAF; the maximum condition was considered to be Digesters 3 and 4 operating in winter conditions at 2042 MMF. Table 5-10 and Table 5-11 present a detailed summary of the calculated heat input requirement for the minimum and maximum condition, respectively.

Table 5-10. Minimum heat input requirement

Heat input requirement	Value	Unit
(1) Heat input required to raise the digester feed temperature to the design operating temperature		
Heat transfer, per digester (MMFs)	2,684,100	Btu/d
Heat transfer, per digester w/ heat transfer efficiency	2,982,400	Btu/d
	0.124	MMBtu/hr
(2) Heat losses from the digesters to the environment		
Existing Digesters 1 and 2		
1. U1*A1*ΔT2 (roof area: digester air/ outside air)	308,000	Btu/d

Heat input requirement	Value	Unit
2. U2*A2*ΔT2 (wall: digester air/outside air)	108,000	Btu/d
3. U2*A3*ΔT3 (wall: digester sludge/ outside air)	270,500	Btu/d
4. U3*A4*ΔT4 (wall: digester sludge/ground)	979,100	Btu/d
5. U4*A5*ΔT4 (floor area)	475,800	Btu/d
Total heat losses per digester	2,141,400	Btu/d
	0.089	MMBtu/hr
New Digesters 3 and 4		
1. U5*A1*ΔT2 (roof area: digester air/ outside air)	1,534,900	Btu/d
2. U2*A2*ΔT2 (wall: digester air/outside air)	108,100	Btu/d
3. U2*A3*ΔT3 (wall: digester sludge/ outside air)	343,300	Btu/d
4. U3*A4*ΔT4 (wall: digester sludge/ ground)	798,600	Btu/d
5. U4*A5*ΔT4 (floor area: digester sludge/ground)	475,800	Btu/d
Total heat losses per digester	3,260,700	Btu/d
	0.136	MMBtu/hr
Total heat losses		
Total heat losses (all digesters)	10,804,000	Btu/d
	0.450	MMBtu/hr
(1) + (2) total heat demand		
Minimum total heat demand for one digester	5,123,700	Btu/d
	0.213	MMBtu/hr
Total heat demand (annual average); for all 4 digesters in operation	22,733,200	Btu/d
	0.947	MMBtu/hr

Table 5-11 Maximum heat input requirement

Heat input requirement	Value	Unit
(1) Heat input required to raise the digester feed temperature to the design operating temperature		
Heat transfer, per digester (MMFs)	14,741,100	Btu/d
Heat transfer, per digester w/ heat transfer efficiency	16,379,000	Btu/d
	0.682	MMBtu/hr
(2) Heat losses from the digesters to the environment		
New Digesters 3 and 4		

Heat input requirement	Value	Unit
1. U5*A1*ΔT2 (roof area: digester air/ outside air)	2,728,300	Btu/d
2. U2*A2*ΔT2 (wall: digester air/outside air)	192,100	Btu/d
3. U2*A3*ΔT3 (wall: digester sludge/ outside air)	610,100	Btu/d
4. U3*A4*ΔT4 (wall: digester sludge/ ground)	798,600	Btu/d
5. U4*A5*ΔT4 (floor area: digester sludge/ground)	475,800	Btu/d
Total heat losses per digester	4,804,900	Btu/d
	0.200	MMBtu/hr
<u>Total heat losses</u>		
Total heat losses; for digesters 3 and 4 in operation	9,609,700	Btu/d
	0.400	MMBtu/hr
(1) + (2) total heat demand		
Minimum total heat demand for one digester	21,183,800	Btu/d
	0.883	MMBtu/hr
Total heat demand (max month); for digesters 3 and 4 in operation	42,367,600	Btu/d
	1.765	MMBtu/hr
Total heat demand (max month); for all 4 digesters in operation	47,717,800	Btu/d
	1.99	MMBtu/hr

The minimum and maximum heat demand per digester (0.213 to 0.883 MMBtu/hr) provide a basis for the digester HEX sizing as outlined in the following section. The maximum heat loads (max month winter 2042, all four digesters in operation) for digester feed (1.365 MMBtu/hr) and environmental losses for all four digesters (0.623 MMBtu/hr) were used to size the boilers (total load of 1.99 MMBtu/hr) (see Section 7).

5.2.6 Heat Exchanger and Recirculation Pumps

CKTP currently uses spiral HEXs to maintain proper digester sludge temperature and rotary-lobe pumps to recirculate sludge in the digesters.

To date, the HEXs at CKTP have worked well and have not experienced issues with clogging, which can occur with this HEX design. Therefore, a spiral HEX will be used for the upgrade (Figure 5-13), as it allows for an efficient footprint and ease of access. Typical vendors include Gooch and Alfa Laval.

Figure 5-13. Gooch thermal GTS Type 1-DO sludge spiral heat exchanger

The proposed HEX design is presented in Appendix F, Drawings P-623 and P-643, and in a schematic in Figure 5-14. Sludge is pumped from the digester, through a recirculation pump, followed by the spiral HEX. The sludge pump maintains a constant flow from the digester. The hot water is managed by a primary and secondary hot water loop, via the boiler, controlled by three-way valves. The primary boiler loop is maintained at a return temperature of 150°F, while the secondary loop for the digester HEX is controlled to a maximum 135°F inlet temperature via the three-way valve and the local loop pump. A temperature gauge on the discharge of the HEX recirculated-sludge line signals to adjust the control of a three-way valve, which operates the flow of hot water into the HEX to achieve an operating sludge temperature of 104°F.

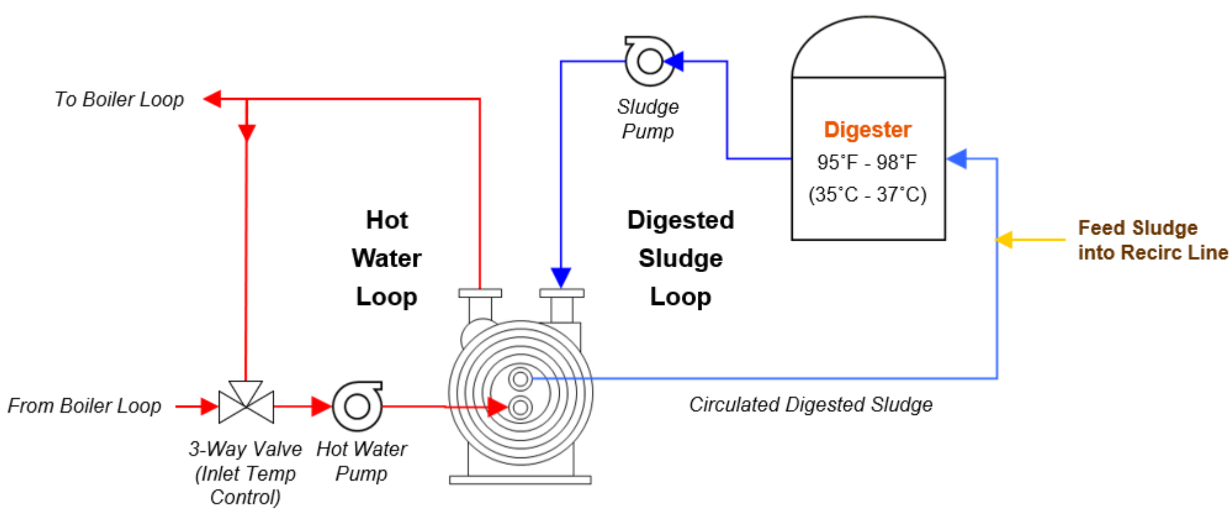

Figure 5-14. HEX process flow diagram

The proposed design uses rotary-lobe pumps to recirculate sludge from each digester through its respective HEX. These pumps are preferable over alternative types because they have a small footprint, are easy to service, and are reliable for maintenance and longevity at lower pressures (less than 50 pounds per square inch gauge [psig]). Figure 5-15 displays rotary lobe pumps of three typical vendors in the industry: Boerger, Netzsch, and Vogelsang. These pumps would use flush-less seals for simplicity and to minimize water use.

Figure 5-15. Typical rotary-lobe pump (left to right: Boerger, Netzsch, Vogelsang)

The calculated minimum and maximum heat input requirements were used to size the minimum and maximum mass flow rates (in gpm) for hot water and sludge recirculation. These were calculated using the thermodynamic equation, $Q = mC\Delta T$, and solving for m, where:

- Q = heat requirement, MMBtu/hr
- m = mass flow rate, gpm
- C = specific heat, 1 Btu/lb-°F (assumed equal to water for both water and sludge)
- ΔT = temperature differential, °F

The design criteria presented in Table 5-12 were used to size equipment.

Table 5-12. Summary of digester sludge heating design criteria

Design criterion	Maximum winter 2042	Unit
Digester heat input	0.883	MMBtu/hr
Hot water flow rate	160	gpm
Sludge recirculation flow rate	200	gpm
Hot water inlet design temperature	135	°F
Hot water return design temperature	123	°F
Input sludge temperature	95	°F
Sludge operating temperature	104	°F

For the hot water loop, a HEX efficiency of 90 percent was assumed; it was assumed that 10 percent of the heat provided by the hot water loop will be lost to the environment. The temperature differential for the hot water loop was assumed to be 12°F, and for the sludge recirculation it was assumed to be 9°F.

From these calculations, the hot water flow rate to the HEX and the sludge recirculation flow rate were determined. Preliminary design criteria for the HEX and sludge recirculation pumps are presented in Table 5-13. The sludge recirculation pump would operate at a single flow; however, the available range of the pump is shown for reference.

Table 5-13. HEX and sludge recirculation pumps preliminary design criteria

Design criterion	Value	Unit
HEX		
Hot water flow rate	160	gpm
Sludge recirculation pumps		
Pump type	Rotary lobe	-
Sludge recirculation flow rate	200	gpm
Design TDH	30	psi
DIG % solids	3	%
Approximate motor size	10	hp

5.2.7 Sludge Transfer Pumps

The design criteria of the digester transfer pumps, which serve to both transfer digester contents between tanks and send DIG to the existing centrifuge dewatering systems, are based on a comparison between the summer 2023 rheology data acquired from CKTP and typical assumption values through various fits for each data set. The most conservative values were chosen for the design criteria. Preliminary pipe routes and fittings were also assumed at this stage of design, and various models were used for evaluation. Each scenario was assessed at the observed solids concentration (2.1 percent), max design concentration (4.0 percent), and an additional safety factor solids concentration (6.0 percent). The modeled scenarios are summarized in Table 5-14.

Each pair of digesters will have two transfer pumps in their associated control building with redundant piping to connect both digesters to each pump. These pumps will pull from the digesters and pump to the centrifuges in the SPB. In addition, these pumps will have connections to the other set of digesters for the option to run sequenced digestion.

Table 5-14. Digester transfer pump evaluation at 250 gpm

Model		Observed data, Power Law fit	Observed data, Bingham Plastic	Typical industry rheology coefficients, Bingham Plastic	Observed data, Herschel-Buckley
Value	**TS (%)**	**Total dynamic head (ft)**			
Observed	2.10	42.9	41.4	41.0	43.0
Typical	4.0	42.9	41.3	48.1	42.9
Maximum	6.0	42.8	41.3	57.0	42.8

Preliminary design criteria were based off the highest expected TDH. The typical values are based on extrapolated data, similar to those based on our observed data. Therefore, pump design does not always have to accommodate these values if they are deemed unreasonable. In this case, no major outliers are present.

Preliminary design criteria are shown in Table 5-15, which are based on the expected flows to the centrifuge, the modeling exercise for TDH values, and an added safety factor. Two more instances of rheology testing will be conducted in early 2024 to collect winter data on this sludge. Therefore, final design criteria will be adjusted as needed to accommodate this additional information.

Table 5-15. Sludge transfer pump preliminary design criteria

Design Criterion	Value	Unit	Notes
Pump type	Progressive-cavity, 2-stage	-	Minimum of a 2-stage pump for those with a TDH of > 50 psi
Design flow	250	gpm	Based on minimum solids concentration
Design TDH	100	psi	Based on modeled TDH plus safety factor
Approximate motor size	40	hp	Based on vendor feedback

These new sludge transfer pumps are conservative in comparison to the existing sludge transfer pumps. The existing pumps are rated for 150 gpm at 50 psi.

5.3 Digester Facility Layout

The proposed digester facilities will comprise of two pairs of digesters with a process building between each pair, and a separate digester control building, which will serve all four digesters. The two existing digesters will be maintained at the same location and extensively rehabilitated, including replacement of digester covers, all process equipment (mixing system, recirculation and HEXs, withdrawal pumps), and structural repairs, as needed. Figure 5-16 shows the proposed digester facility layout; digesters, process buildings, and digester control building are outlined in blue for clarity.

The existing building between the digesters will be demolished and reconstructed without sharing walls with the digester tanks, allowing the new building to be unclassified per NFPA 820. The process building for the new digester pair will be constructed similarly and match dimensions of the reconstructed process building. Both process buildings will house most of the digester-related pumps and auxiliary equipment for each digester pair. Each building will include three mixing pumps, two transfer and centrifuge feed pumps, two recirculation pumps at the lower level, and two HEXs and digester feed control valves at the upper level. The blower system for the gas-holding membrane covers will be installed at the roof of the process building between the new digester pair. At the roof of both process buildings a walkway will connect to the digester covers. Similarly to the building between the existing digesters (current digester control building), both new process buildings will have direct access at the lower and upper levels, on opposite sides of the building, because of the site grade. Two staircases inside the process building will connect the lower and upper levels, and one of the staircases will continue to the roof. Figure 5-17 shows a section of the three-dimensional (3D) model for a pair of digesters and process building, showing the different levels of the building, staircases, and walkways to digester covers.

The new digester control building will be constructed south of the existing digesters and west of the new digester pair. The building will include a boiler room, which will house boilers and hot water recirculation pumps besides other mechanical equipment as discussed in Section 7, and an electrical room.

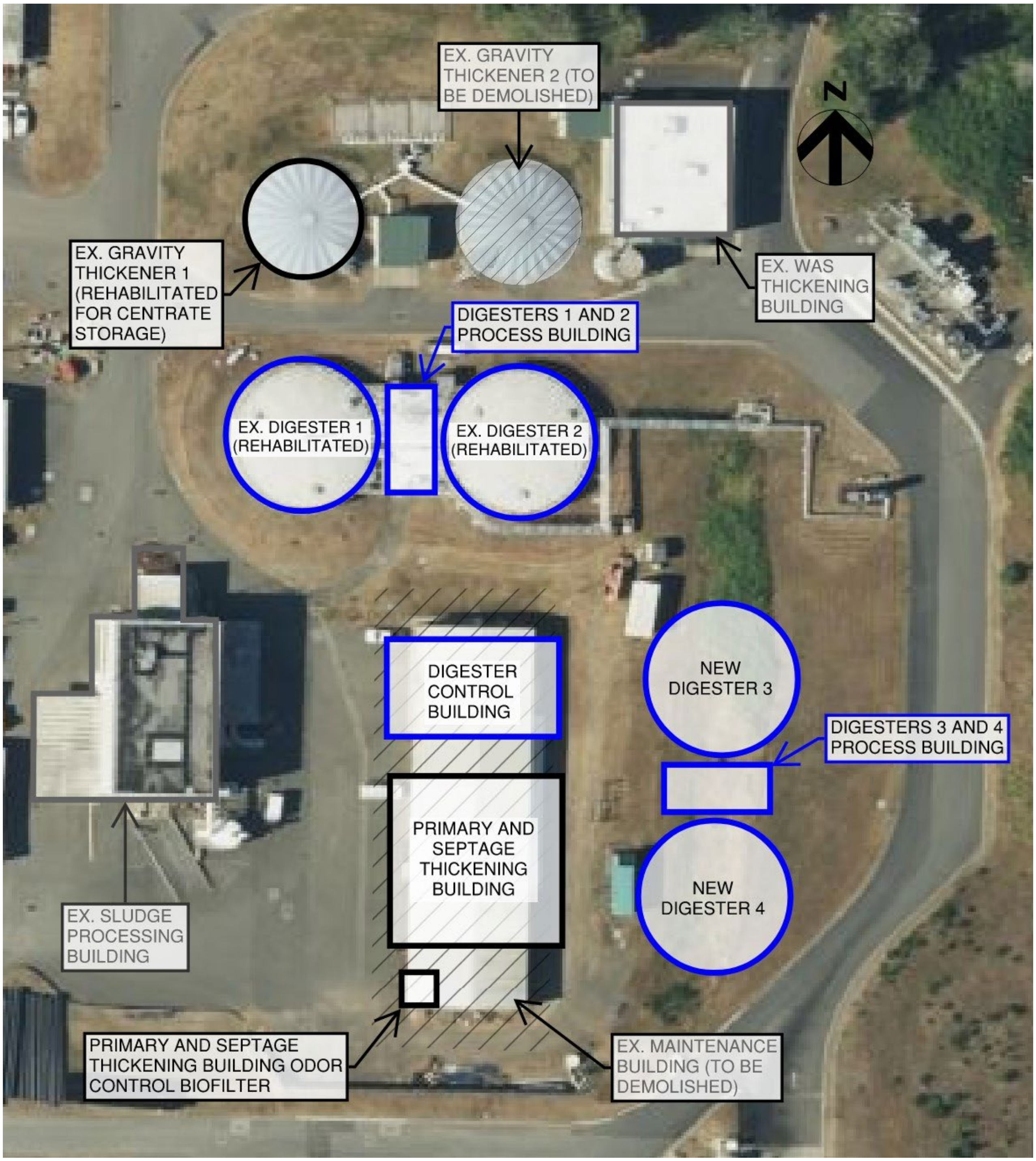

Figure 5-16. Digester facility area

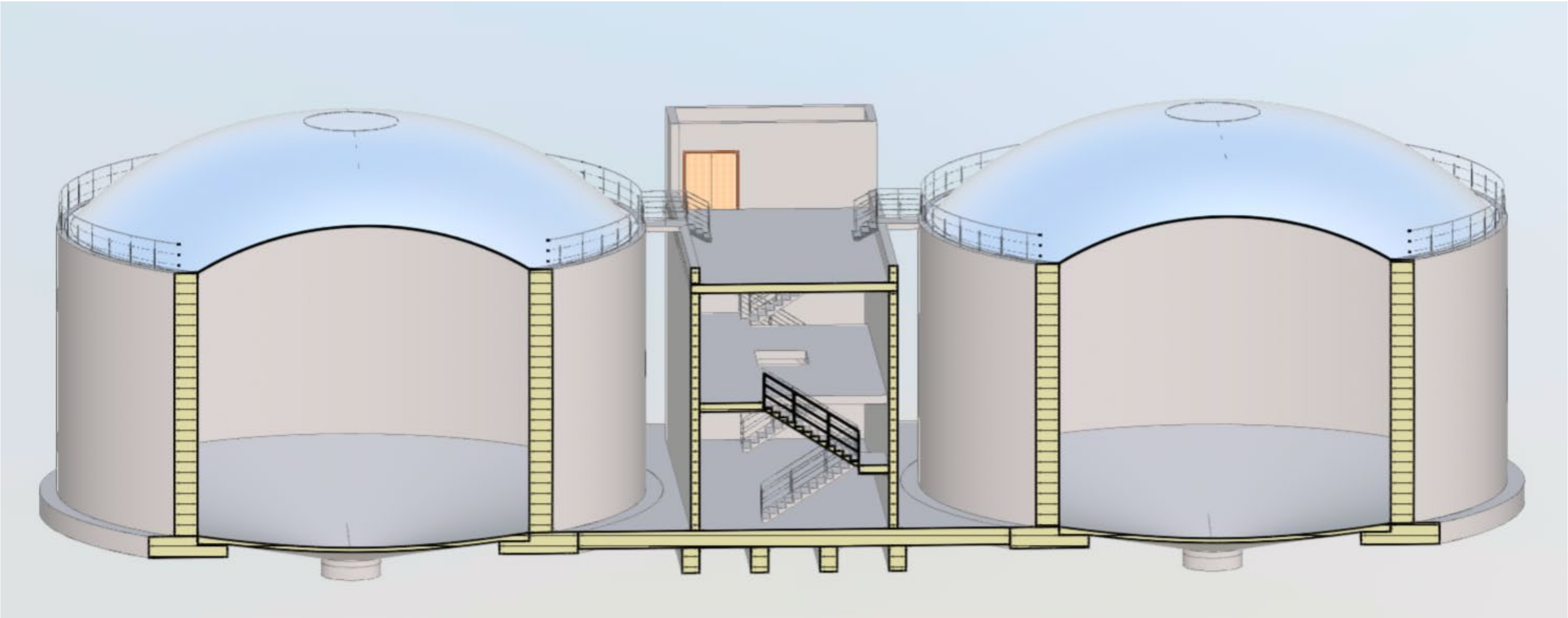

Figure 5-17. Section view of digester pair and process building

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5.4 Biogas Handling and Treatment

Currently, biogas from the existing digesters has two potential pathways for use/disposal: waste gas burner (WGB) flare system, or a cogeneration treatment process that includes combined heat and power (CHP) equipment. Both systems were upgraded/installed as part of the larger expansion of the biological treatment facilities in 2012–2016, which included construction of the existing WAS-thickening building.

The CHP system includes pressurization blowers, gas treatment (hydrogen sulfide [H_2S] and siloxane removal scrubbers), as well as the engine-generator and various pieces of heat recovery equipment. See Figure 5-18. Because of operations and maintenance (O&M) difficulties, the system has been offline for several years and is currently not in use.

Figure 5-18. Existing CHP system with engine-generator and pretreatment H_2S and siloxane scrubbers

The WGB currently processes all of the CKTP biogas through a common sediment/moisture trap and into an enclosed flare (Varec model 244E) (see Figure 5-19). The flare pilot light is supplied via an aboveground propane tank because of the lack of natural gas (NG) within the CKTP boundary.

Figure 5-19. Existing waste gas burner with propane pilot (yellow piping in foreground) that will be updated to natural gas

The existing WGB with propane pilot (yellow piping in foreground in Figure 5-19) will be updated to NG.

Modifications to the biogas use/disposal system, as part of the current project, are anticipated to be as follows:

1. The WGB itself is relatively new and is a modern enclosed flare design that represents the current standard approach for the industry. It is not expected that any immediate changes will need to be made to the WGB, with the one exception of connecting the pilot flare to NG. As part of this project, a new NG utility service will be brought to CKTP and this will provide an opportunity to install a less expensive and more reliable gas service for the WGB pilot. Both the new and existing digesters will be tied into the existing flare system with a new sediment/moisture trap for the Digesters 3 and 4 complex.
2. The WGB support frame has a series of support welds at the base that appear to be failing and will be reviewed as part of the detailed design to determine potential methods of repair.

3. The CHP equipment is currently under review to determine if the system can be salvaged or modified to place it back into service. If the unit can be salvaged, the necessary modifications will be included in the final design of the project. If the system cannot be reused, it will be demolished and CKTP will begin a process of looking for alternative beneficial-reuse options to be designed as part of a future project.

6 Miscellaneous Support Systems

This section describes miscellaneous support systems that are being designed as part of this project. This includes the IPS, centrate equalization and storage, odor control, and miscellaneous pumping systems.

6.1 In-Plant Pump Station

The IPS at CKTP has experienced capacity issues with both the volume of the wet well and the existing submersible pumps. This section of the report analyzes the current inflows to the IPS and changes to those inflows. The projected inflows to the IPS (Table 6-1) consist of the following with approximated flow rates.

The flows listed below where developed based on review with plant staff as well as estimates of potential overflow rates from tanks (such as digesters or centrate tanks). It should be noted that these flows are not a significant change from the current IPS. The IPS continues to serve all the same flows as it currently does, with minor exceptions as follows:

- The underflow from the existing GTs and septage grit treatment systems (thickening primary sludge and septage) is now replaced with the filtrate flow from the RDTs in the new thickening building (also thickening primary sludge and septage).
- The IPS will be able to slowly meter centrate back to the influent drain manhole at the front of the headworks building.
- The IPS will continue to feed the drain flows back to the maintenance hole in front of the headworks, where it can discharge through a 12-inch / 14-inch diameter gravity line to the grit tank effluent channel. This is the same location as the current IPS discharges, and the flows do not affect the screen or grit treatment systems. The forcemain from the IPS is a combination of 4-inch and 6-inch piping, and will be upgraded to a continuous 6-inch to reduce headloss on the new IPS pumps (discussed below). It is not anticipated that the changes to the IPS will affect the overall hydraulics of the headworks, as the flow capabilities remain the same order of magnitude as the existing station, but with a more robust installation.

Table 6-1. In-plant pump station influent flow summary

Input source	Assumed flows (gpm)
Aeration basins 1 and 2 drains, building drains/toilets, reclaimed-water filter reject backwash water	100
Digester overflow and centrate tanks overflow/metering	0–150
Thickened septage and primary sludge filtrate (replaces gravity thickener underdrain)	100–300
WAS building filtrate flow (RDT)	100–150

Because of the low elevation of the new primary and septage thickening building, the filtrate flows from that building will likely need to drain back to the IPS to be pumped to the front of CKTP. Consequently, the thickened septage and PS underflows from the existing GTs will be replaced with flows from the new thickening building. To provide both added capacity, as well as flexibility for turndown (to allow for steady flows and more consistent metering for centrate to the headworks, per Section 6.2), it is recommended that the new IPS be a triplex pump station (two pumps to handle max flow, with a backup, with a single pump for lower flow periods). Each of the three new IPS pumps will be initially sized for 500 gpm, for 1,000 gpm firm capacity.

The County has standardized on Flygt pumps for sewage wet well applications due to reliability, familiarity, and consistency with existing equipment. The local distributor for the Flygt pumps is Whitney Equipment Company, Inc. (WECI). HDR submitted a system curve to WECI for a pump selection that reflects the changing of the piping system from 4-inch to 6-inch diameter. This design decision was made because of the high flow velocities estimated with a system curve using 4-inch-diameter piping. Velocities calculated using the 4- and 6-inch-diameter piping system were approximately 14 and 5 feet per second (ft/s), respectively. Generally, velocities in piping systems should not exceed 10 ft/s, which resulted in replacing the 4-inch-diameter piping with 6-inch-diameter piping from the IPS wet well to the manhole adjacent to the headworks. Figure 6-1 below shows the pump and system curve with 6-inch-diameter piping. Table 6-2 below shows the selected pump specifications.

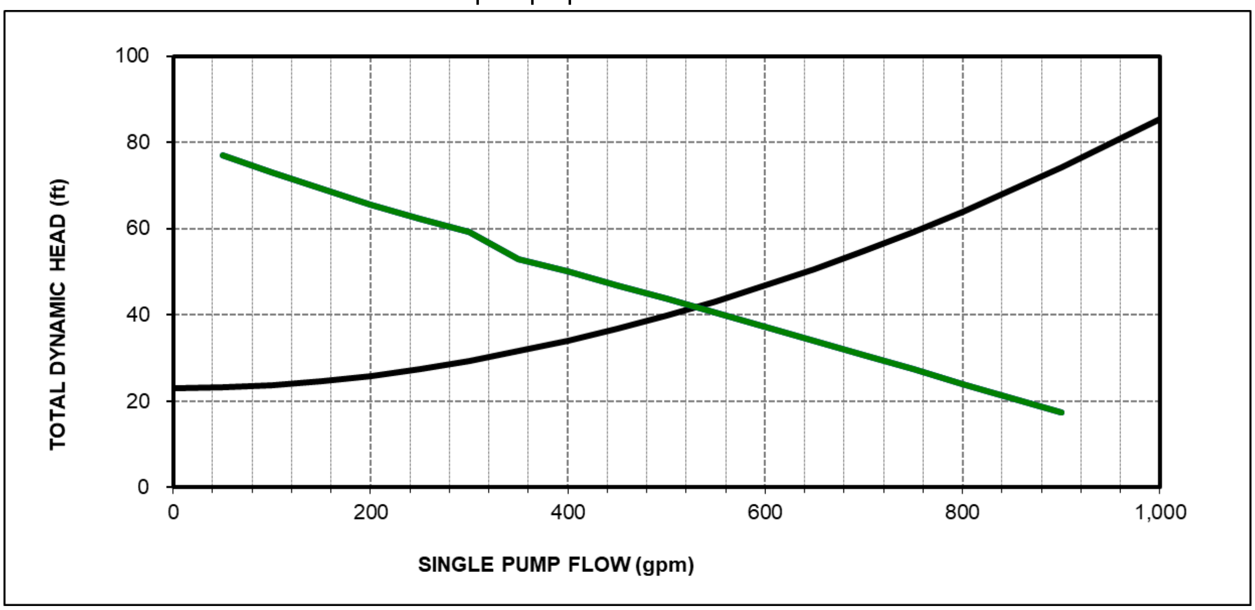

Figure 6-1. Pump and system curve

Table 6-2. Selected pump specifications (typical of 3)

Manufacturer	Xylem Flygt
Model	NP 3127 HT 3
Type	Submersible
Design flow rate (gpm)	500
Total dynamic head (ft)	39.6

Rated power (hp)	10
Rated speed (rpm)	1750
Rated current (amps)	13
Voltage (V)/phase/frequency (Hz)	460/3/60

The existing condition of the IPS wet well was reported to be very poor with eroded concrete in various locations inside the wet well. Therefore, a new wet well will be designed and constructed adjacent to the existing wet well. The current dimensions of the IPS wet well are approximately 6 feet in diameter and 14 feet in depth. The new IPS wet well will be designed with an increased diameter of 10 feet and maintain the 14 feet in depth. This will increase the volume of the wet well by approximately 175 percent and resolve the volume capacity issue. The conditions of the current valve vault were not reported, but because of the change in location of the new wet well, the valve vault and electrical panel will also be relocated. Figure 6-2 below shows an example placement of the new wet well and valve vault with associated rerouted piping for inflows and discharge. This example arrangement is for a duplex system to show the general approach; however, the IPS will be a triplex as shown on Drawing P-180 in Appendix F. The new wet well and valve vault will be coated for corrosion resistance and have an air outflow line from the top of the wet well for odor control.

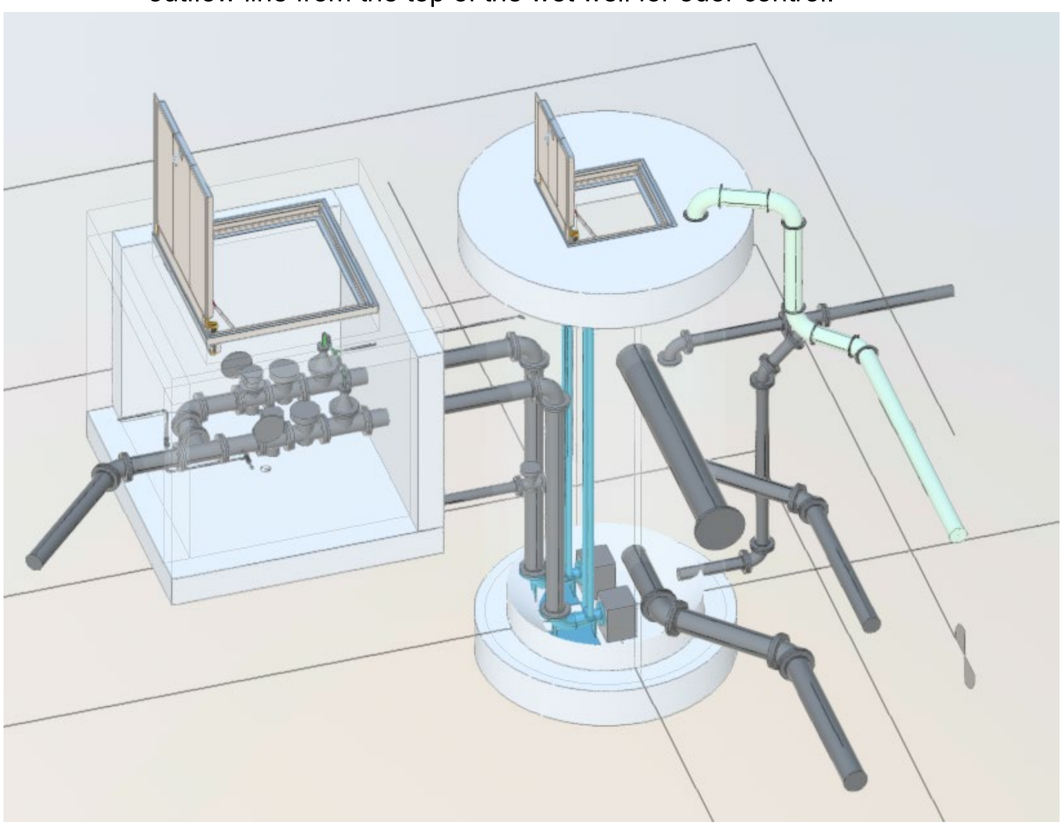

Figure 6-2. IPS general layout (duplex pump example)

6.2 Centrate Equalization and Storage

Centrate refers to the nutrient-rich liquid sidestream after dewatering digested solids. At CKTP, this centrate is produced by the centrifuges located in the SPB. During current operation of a centrifuge cycle, the centrate is directed to a sump with approximately 20,000 gallons of capacity. A typical centrifuge run cycle produces approximately 75,000 gallons of centrate over a 10-hour period. Therefore, when dewatering, centrate must be discharged to preliminary or primary treatment, with little opportunity to equalize the flow and better manage nutrient loading (ammonia) to the secondary treatment system.

As the existing GTs will be taken out of service and replaced with RDTs, it is proposed to use the existing tankage of one GT to provide a location to equalize centrate flows and better manage nitrogen loading to the secondary treatment system. Under the assumption that all major equipment and functions, including the scum pit, will be demolished, the current capacity of one GT is roughly 270,000 gallons. This storage allows multiple cycles of centrate to be stored while metering of flows can occur independently over 24 hours or even multiple days.

The existing centrate sump, with new discharge pumps, will be used to direct flow from the centrifuges to the repurposed GT, now referred to as the centrate storage tank (CST). A new 6-inch-diameter line will be routed from the pumps out the north side of the SPB to the CST, as shown in Figure 6-3. Additionally, a new effluent port will be constructed at the base of the CST for discharge to the IPS, including an actuated plug valve and flow meter to allow for flow-paced metering of centrate. The existing GT overflow connection, which is also routed to the IPS, will remain in place. This effluent line is also depicted in Figure 6-3. The CST and flow control vault are shown in Figure 6-4.

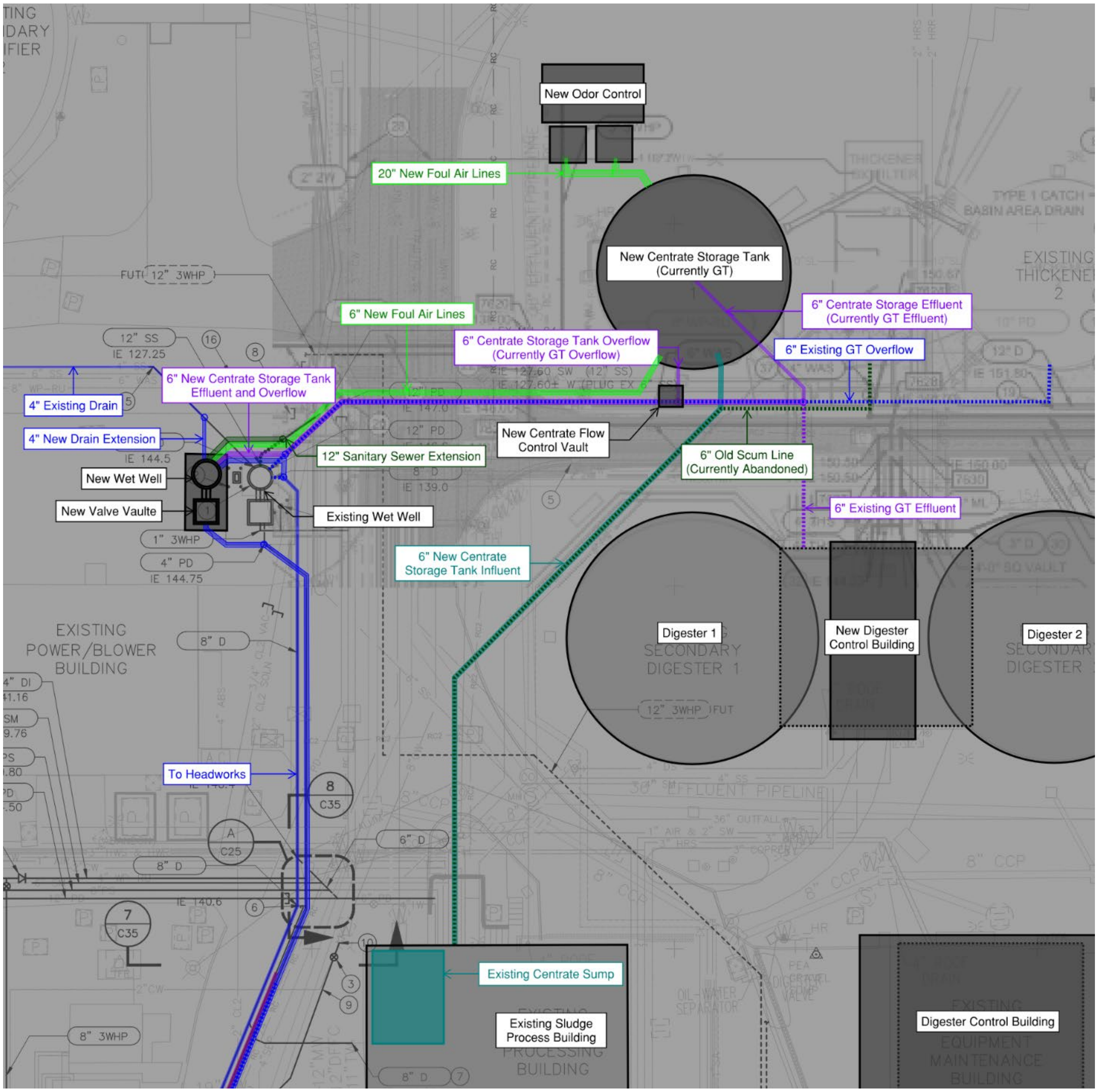

Figure 6-3. Centrate storage site piping

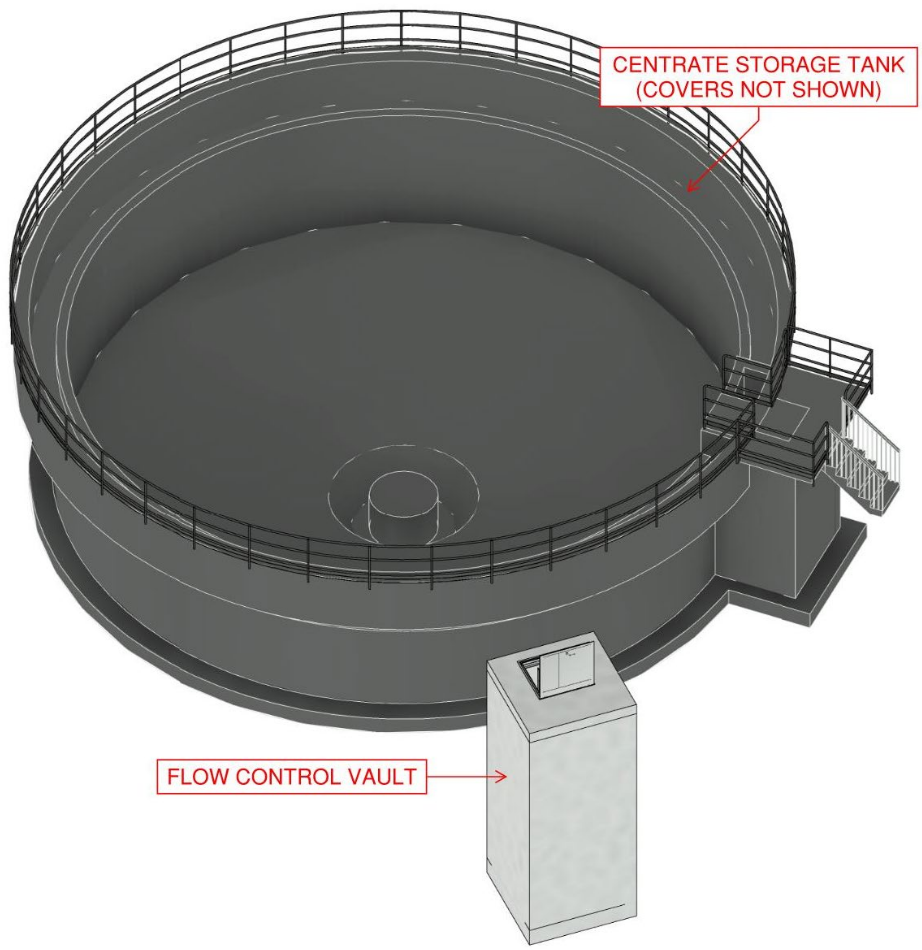

Figure 6-4. Centrate storage tank and flow control vault configuration

Overflow in the centrate sump connects to the existing septage sump in the SPB. This overflow sump has routing capabilities to connect to the existing centrate discharge at the headworks building. Therefore, the centrate will have two options for routing.

- The first option will be the existing route, in which the existing centrate pumps send flow directly to the headworks per the current routing from the PSB. The flow is discharged to the effluent channel of the grit treatment system. The existing septage pumps are no longer needed as part of the upgraded septage design and will be removed to allow for relocation of the existing centrate pumps within the same room in the PSB and to accommodate the new centrate pumps (second option noted below). This first option flow route represents the status quo and would not allow for equalization.
- The second option would be to use the new centrate pumps to pump flow to the new CST. The existing centrate pumps will be relocated to allow for placement of the new centrate pumps that accommodate a new flow route. These pumps will transfer centrate to the new CST, where it will be metered back to the headworks through the IPS (Section 6.1) and ultimately discharged into the same effluent grit channel as noted in the first option above. Consequently, the ultimate feed point of the centrate does not change with this project, but simply the route it

takes to that location. The preliminary equipment and piping reconfiguration for this second option are shown in Figure 6-5. The P&ID for this system is provided on Drawing P-700 in Appendix F. In addition, the CST piping and instrumentation is on Drawing P-701.

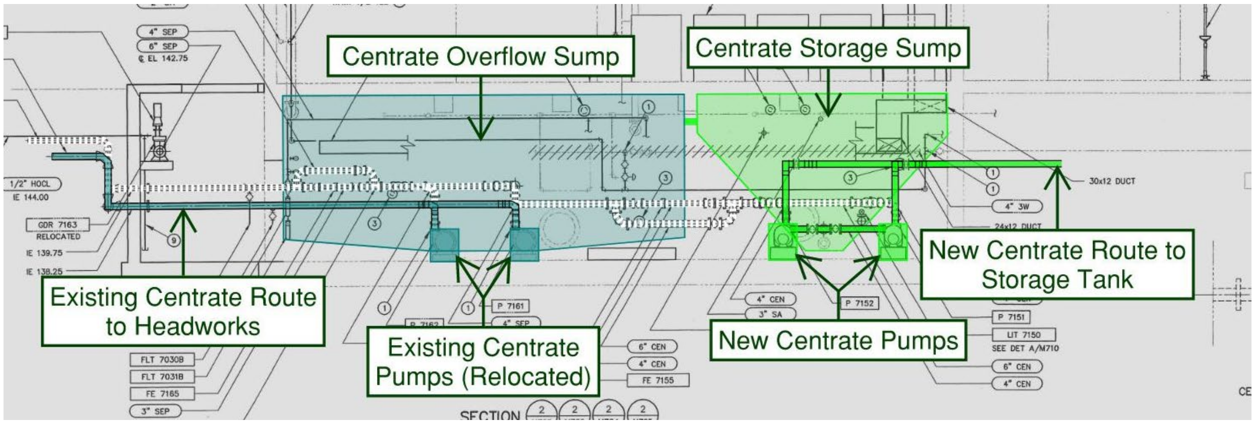

Figure 6-5. Equipment and piping reconfiguration for centrate storage and discharge

6.2.1 Centrate Pump Design

Preliminary pump design criteria for the new centrate pumps were based on an AFT Fathom model using anticipated pipe lengths and fittings and flows from the centrifuges. Because the centrifuges are fed by 250 gpm sludge transfer pumps, the most conservative flow estimation would match the maximum speed of the pump. Therefore, the maximum flow for these pumps would be 250 gpm. The remaining design criteria were determined by assessing the hydraulic model and receiving vendor sizing, shown in Table 6-3. For comparison, the existing centrate pumps (P-7151 and P-7152) are rated for 220 gpm with a 38.7-ft TDH with a 7.5 hp motor. This increase in size is consistent with the new routing associated with the CST.

Table 6-3. Centrate storage pump preliminary design criteria

Design criterion	Value	Unit	Notes
Pump type	End-suction centrifugal	-	-
Design flow	250	gpm	Based on centrifuge feed rate
Design TDH	35	psi	Based on preliminary site piping
Approximate motor size	15	hp	Based on vendor feedback

6.3 Odor Control

Three distinct areas have been identified as requiring odor control as part of this project, including the existing gravity thickening tank that will be repurposed as a CST, the new solids-thickening equipment, and the new septage- and FOG-handling stations and equipment. The selected technology for treatment at each of these locations is an in-ground inorganic biofilter (the basis for this technology selection is outlined in Appendix C). County staff are familiar with odor control and biofilter technology, including the operation of two organic biofilters currently on site.

6.3.1 Site Conditions

CKTP is in a moderately remote location off Brownsville Highway NE, with few neighbors within proximity. A common setback distance of 500 feet from the CKTP boundary is shown in Figure 6-6 below. The east property (formerly Jopp Energy) has been purchased by the County. Aside from two residences (12530 Brownsville Highway NE and 12108 Brownsville Highway NE) that appear to be within 500 feet CKTP, the land within 500 feet of CKTP is primarily forested or open grassy areas. The topography of the area is hilly shoreline typical of Puget Sound. Beyond the 500-foot zone are numerous homes with acreage and neighborhoods. The overall risk for odors traveling off site and receiving complaints from neighbors is currently low and shall remain low after completion of this project.

Figure 6-6. Off-site receptor boundary for CKTP

Source: Google Maps 2023.

Figure 6-7 shows the wind patterns of the nearest Ecology air monitoring station, which is located approximately 5.5 miles south of CKTP and identified as the Bremerton-Spruce Avenue station. The data, which are based on the previous 5 years of monitoring, show that the strongest and most frequent winds blow in the southerly direction and the second-most frequent wind pattern blowing northerly with a milder wind speed. This is a positive based on the surrounding areas as there are fewer receptors at greater distances to the north and south of CKTP.

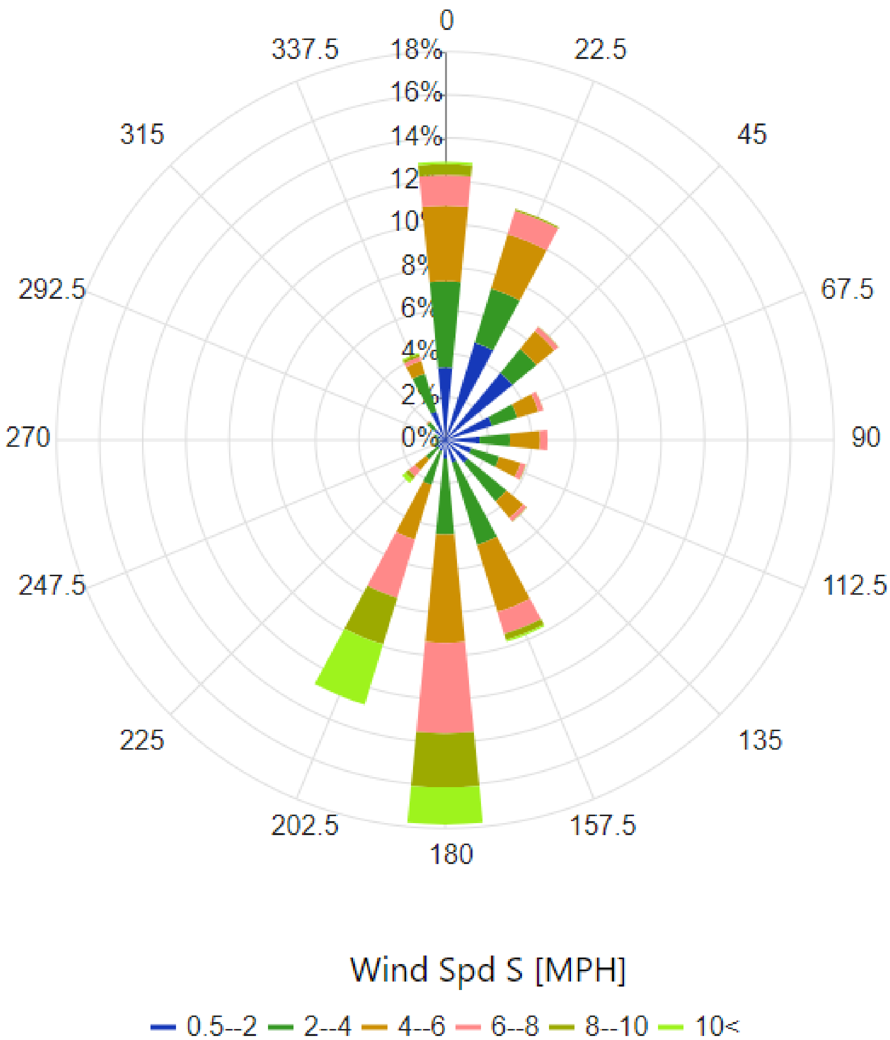

Figure 6-7. Bremerton-Spruce wind patterns

Source: Ecology 2023b.

6.3.2 Regulations

The Puget Sound Clean Air Agency (PSCAA) will oversee odor control design for CKTP. Each process system will require a Notice of Construction (NOC) and a permit through PSCAA prior to being placed in operation. The permit may require dispersion modeling, and at a minimum loading calculations to determine exhaust rates and constituent mass. It is recommended to submit this permitting well in advance (at least 1 year) of construction of the system, as the lead time for PSCAA has been problematic on recent projects.

6.3.3 Design Criteria

No site-specific odor control sampling has been completed to date to identify odor constituents for each of the areas. However, based on extensive experience with odor control in the Northwest, Table 6-4 summarizes preliminary design concentrations that will be used for each area. As described previously, CKTP is at low risk of odor control complaints because of the proactive existing odor control, large buffer zone with neighbors, and typical wind patterns.

Ventilation rates are typically determined by the following criteria:

- Worker safety and comfort
- NFPA 820, *Standard for Fire Protection in Wastewater Treatment and Collection Facilities*
- American Conference of Governmental Industrial Hygienists *Industrial Ventilation Manual*
- Ventilation rates required to effectively capture odorous air emissions from industrial guidance manuals and field experience
- Ventilation rates required to prevent buildup of highly corrosive conditions that will result in unwanted degradation of equipment and infrastructure

Development of the foul-air volumes for final design will be based on the following assumptions/criteria:

- Ventilation systems shall be designed to pull air from odorous spaces from the odor generation source. Foul air will not be pulled across clean air areas. Ventilation systems will be designed to pull air from the focused sources of odor to minimize flows and focus critical areas under negative pressure.
- Foul air will be collected at the odor sources using low-level covers and other isolation measures to limit the amount of air to be handled. Covers will be provided at the new grit facilities to the extent possible.
- For areas susceptible to grease aerosols, cleanable/washable filters will be provided.
- The new CSTs will be enclosed and the tank will be covered. Foul-air ventilation currently provided for the existing GT will be replaced by a new inorganic media filter. Additionally, foul air will be pulled from the IPS and treated at this location. See Appendix F Sheet P-790 for P&IDs showing this system.
- The PS and septage thickening odor control system will pull foul air from both the covers of the flocculation tank and RDT for each of the three new thickening systems. See Appendix F Sheet P-563 for the P&ID showing this system.
- The septage/FOG odor control system will pull from the covers of the new tanks and equipment. See Appendix F Sheet P-590 for P&IDs showing specific equipment and general locations.
- The remaining odor source airflows will be sufficient to maintain the space below the covers in a negative static condition.
- A push-pull (or pull-push) ventilation system will be used (as needed but not anticipated) in which the odor source areas are exhausted by local fans that discharge to the foul-air collection system. Foul air will then be forced through the treatment system by large, centralized blowers. The push-pull arrangement ensures

positive ventilation for source areas, and provides greater reliability in the event of a system fan outage or potential future facility modifications.

- Duct design will be fiberglass-reinforced plastic (FRP) duct for all above-grade applications. These applications will include surfacing veil with ultraviolet (UV)-resistant coating, without insulation.
- Duct design will be FRP or plastic HDPE for all below-grade applications. Smooth diameter, dimension ratio (DR) 7 under roadways and DR 11 minimum will be used for all biofilter applications and corrugated will be considered for larger diameters. Both FRP and HDPE applications will be designed to meet all applicable codes, standards, and manufacturer's recommendations.

Table 6-4 provides other general design criteria for estimating foul-air collection/ventilation rates. If the major odor and corrosion sources are effectively contained and ventilated, the foul-air quantities listed in Table 6-5 summarize the preliminary loading for each application.

Table 6-4. Foul-air collection/ventilation design criteria

Area/source	Rate
Occupied areas, such as rooms with open conveyors or truck loading bays for loading screenings and grit	6–12 air changes per hour (ACH)
Covered basins not occupied	2–4 ACH, depending upon openings needed
Sweep velocities along channels being ventilated	50 feet per minute (fpm) minimum
Capture face velocities at makeup air openings or at access hatches (including cracks)	100 to 200 fpm
Tightly closed conveyance or materials handling systems (e.g., overflow covers)	10 to 40 cfm minimum per unit
Air from process air source such as aerated tanks or channel	10% higher than inlet air volume and supply air
Areas requiring reduction of adjacent area classifications per NFPA 820	12 ACH minimum

Table 6-5 presents estimated air volumes for the three systems based upon the above design criteria and below assumptions:

- Point source control of odors used at covered facilities and enclosed equipment to the greatest extent possible to minimize air collection volumes
- Placing all covered areas in a slight negative static condition to ensure that foul air is not allowed to escape to atmosphere, and regular maintenance openings ventilated with a minimum face velocity during open conditions

No occupied spaces are planned for odor control. Providing minimum room air exchanges to meet requirements of NFPA 820 and the National Electrical Code (NEC) will be coordinated with the room ventilation design (see Section 7) to provide an overall air exchange rate as required per code. The point source odor control will be balanced with the room are for the FOG building and the PS and septage thickening building.

Table 6-5. Odor control: preliminary design concentrations

Odor control system	H_2S concentration (ppmv)	NH_3 concentration (ppmv)	Odorous air (cfm)	Connection points (#)	Notes
CSTs	2 avg.; 5 peak	20 avg.; 40 peak	2,000	2	Unoccupied, point source
Solids-thickening equipment	10 avg.; 30 peak	1 avg.; 3 peak	1,500	6	Point source (pull from connections at each RDT)
Septage- and FOG-handling equipment	10 avg.; 30 peak	1 avg.; 3 peak	1,900	14	Point source (pull from screening equipment, over dumpsters, from vaults and from tanks)

Each of the areas noted in Table 6-5 will have a dedicated biofilter system with the intent of reducing the amount of ductwork required. Each system will consist of the following components:

- Duty/standby fans
- Ductwork and appurtenances
- Inorganic biofilter with lateral/diffuser system, biofilter media, pre-wetting system, surface irrigation and bed drainage system

The biofilters will be designed based on the standards outlined in Table 6-6.

Biofilter Media

Biofilters consist of various types of solid media that provide a surface for microorganisms to live on. A foul-air distribution system is installed and the biofilter media is typically placed on top for an upflow system, similar to what is proposed for this project. The microorganisms can remove a wide range of compounds including H_2S, methyl mercaptan, and other reduced-sulfur compounds typical of wastewater applications. Continuous operation is important for these systems as the odorous compounds in the air are the food keeping the microorganisms alive; depriving them of food for extended periods will kill them off and require a longer seeding and startup time to get the biofilter back online and functioning as designed. Two types of media are being considered for this project: a typical inorganic media that will be supplied by Biorem, Environmental Composite Systems (ECS), Daniel Mechanical, and others will be considered. See Figure 6-8 for an example of this type of media.

Figure 6-8. Inorganic biofilter media, Biorem Biosorbens

The second type of media, which is also inorganic, is supplied by Bohn, which uses sands, soils, topsoils, and amendments as the media. Bohn is being recommended as it can provide higher levels of treatment for ammonia, which is expected at the CST. A benefit to this type of filter is that it can be placed at grade and topped with rock/gravel, grass, or other decorative surfaces that may be more aesthetically pleasing. Figure 6-9 shows an installation in Wenatchee, Washington, where a Bohn media odor control system was installed.

Figure 6-9. Bohn media biofilter, Wenatchee, Washington

Typical maintenance for biofilters includes cleaning, maintaining, and winterizing (as applicable) the pre-wetting and surface irrigation systems; weeding the biofilter media; and hydrojetting of the foul-air distribution system within the biofilter bed on a 5- to 10-year interval as distribution orifices can become plugged overtime. Fan maintenance includes greasing bearings and conducting visual inspections. Grease filter cleaning with water and solvent mixture is required, with the frequency dependent on service type but expected to be every 6 months initially. Both media types are under warranty for 10 years, with both types having numerous installations that have lasted upwards of 20 years.

Table 6-6. Typical biofilter bed sizing criteria

Process parameter	Unit	Recommended range	Design
Empty-bed residence time	min	0.5–1.5	>0.9
Bed surface loading	cfm/ft^2	2.5–4.5	<4.5
Bed media depth	ft	3.0–5.0	4.0
H_2S removal efficiency	%	99% removal with max input of 50 ppmv	
Ammonia removal efficiency[a]	%	90% removal with max input of 100 ppmv	

a. Applicable for Bohn biofilter media only.

Biofilter Bed Containment

There are a few options to contain the biofilter media and lateral diffuser piping including above-grade steel tanks, partially buried concrete containment walls with a membrane liner system, and earthen basin with a membrane liner system. Each system requires slightly different footprint space for construction with steel tanks requiring the smallest and earthen basin the largest. The structures will hold the foul-air distribution system piping, biofilter drain system, surface irrigation system, and various fill/medias as shown in Figure 6-10. An example section of the earthen basin containment wall is shown in Figure 6-11.

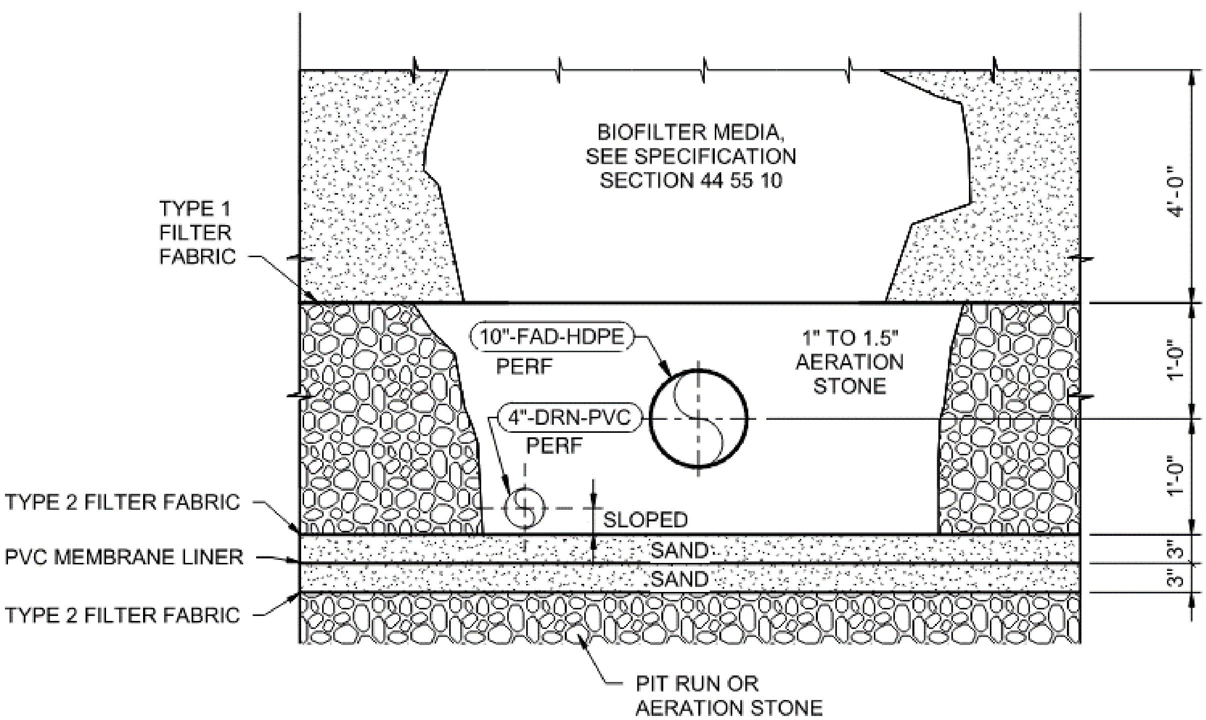

Figure 6-10. Biofilter media and piping section

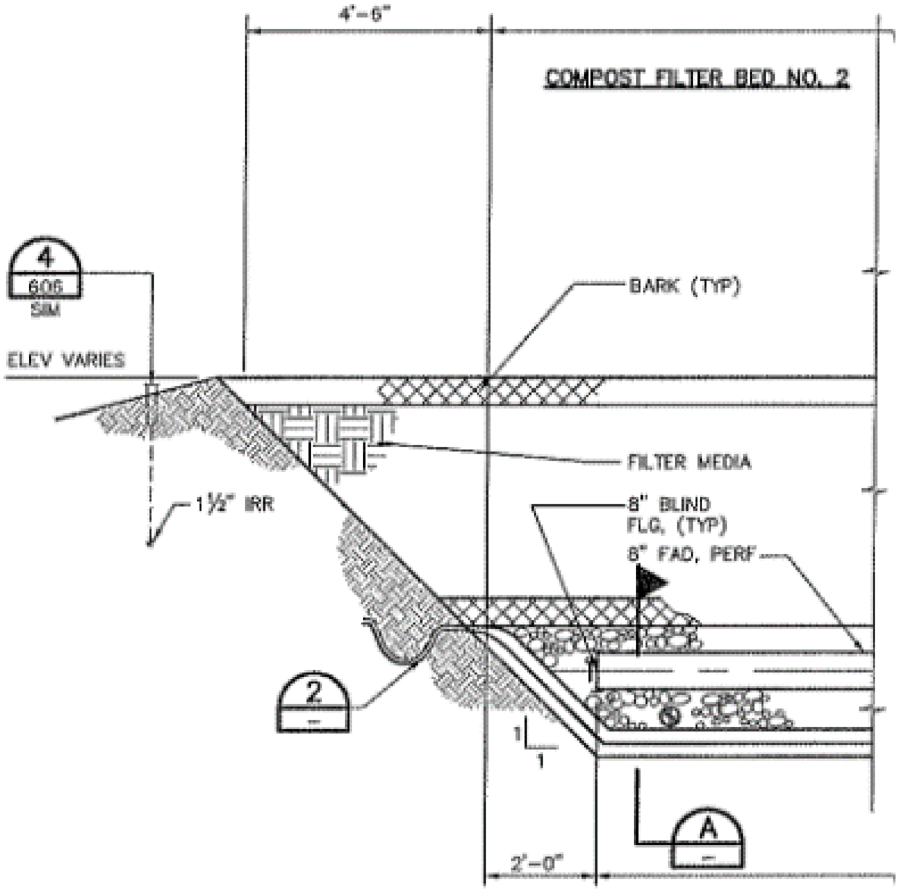

Figure 6-11. Biofilter: earthen basin with membrane liner

The partially buried concrete wall with membrane liner will be the BOD, as this provides a simple, robust system that can be easily cleaned for media replacement and provides simple construction with extended life. Figure 6-12 shows an example of the concrete wall with membrane liner.

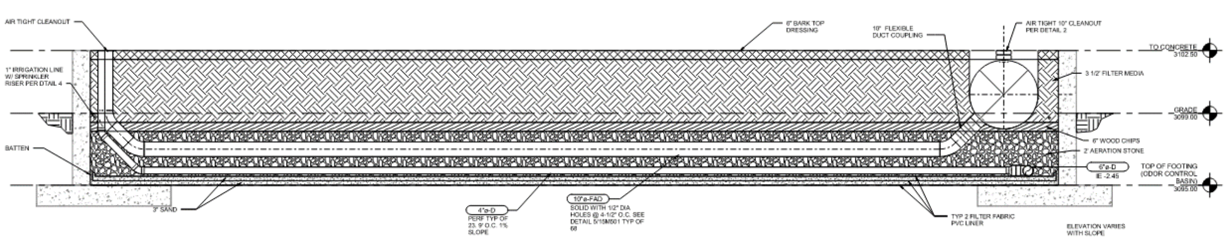

Figure 6-12. Biofilter: concrete wall with membrane liner

Odor Control Blowers

The odor control blowers will be factory-assembled and tested units consisting of a housing, a wheel, a fan shaft, bearings, and a side support structure. Design criteria and key specifications for the odor control blowers are provided in Table 6-7.

Table 6-7. Preliminary odor control blower design criteria and specifications

Description	Unit	Centrate tank fans	Solids-thickening fans	FOG/septage-receiving fans
Type of biofilter bed media	Type	Inorganic filter bed (Bohn)	Inorganic filter bed	Inorganic filter bed
Location	—	Outside, exposed		
Number of blowers	No.	2 (1 duty + 1 standby)	2 (1 duty + 1 standby)	2 (1 duty + 1 standby)
Type of odor control blower	Type	Centrifugal, radial fume exhauster		
Configuration	Type	Horizontal		
Sound enclosure	-	No		
Impeller material	Type	Fiberglass-reinforced plastic		
Temperature range	ºF	30°F–90°F		
Drive type	Type	VFD; V-belt drive with belt guard		
Design airflow rate	scfm	2,000	1,500	1,900
Design static pressure	in.	12	10	10
Maximum speed	rpm	2,200	3,800	2,000
Operating	hp	7.45	4.8	5.8
Motor horsepower	hp	15	7.5	10
Operating temperature	ºF	50		
Motor type	Type	460 V, 3 Ph, 60 Hz		
Static efficiency	%	48.9	46.7	49.5
Motor efficiency	—	Premium		
Motor rating	—	TEFC		
Blower body material	Type	Fiberglass-reinforced plastic		
Flange suction, size	in.	20	12	20
Flange discharge, size	in.	20	12	20
Base	—	Self-contained motor platform		
Exterior metal assembly coating	—	Coated with high solids vinyl coating 4 to 5 mils thickness		
Inlet and drive side plates	—	Fastened to housing with imbedded, FRP-encapsulated Type 316 stainless-steel bolts		
Outlet flange and Inlet collar	—	Solid FRP		
Enclosure	—	FX – TEFC, explosion proof, Class I, Group D, Class II Groups F and D		

Odor control blowers are readily available from multiple manufacturers, including Aerovent, Hartzell, and New York Blowers. Figure 6-13 and Figure 6-14 provide two examples of typical fan arrangements. All fans will include VFDs for ease of balancing and operation.

Figure 6-13. Hartzell FRP radial blower

Figure 6-14. New York Blowers FRP radial flume exhauster

Foul-Air Duct

All exposed foul-air duct piping will be constructed out of FRP for corrosion resistance. All buried foul-air duct piping will be HDPE with DR 7 rating below roadways and DR 11 within the biofilter. All exposed piping will be coated with a UV-protective coating and no insulation will be provided on the duct. The foul-air duct sizes are expected to be between 4-inch diameter for some of the small equipment connections and up to 20-inch diameter at the largest segments. Preliminary duct sizing is based on keeping each segment friction loss to less than 0.1 inch of water per 100 feet of duct length. This minimizes overall pressure loss and noise in the system. The P&IDs in Appendix F show expected duct sizes and components; see Sheets P-563, P-590, and P-790 for the biofilters and connections to other sheets for the duct collection system. Components of the odor control system are described in detail in the following sections. Figure 6-15 shows an example of the type of foul-air duct described and a transition between buried HDPE and exposed FRP duct.

Figure 6-15. Foul-air duct (FRP and HDPE)

Atomizing Nozzle

Pre-wetting of the foul-airflow and surface irrigation will be provided for each biofilter to maintain moist conditions in the filter bed that are conducive to sustaining biological growth. Moisture can be added through either a pre-wetting system that injects moisture into the inlet foul air (which then filters through the media from below) or a surface irrigation system that sprinklers the top of the media bed directly (soaking down through to the bottom). A pre-wetting system (as shown in Figure 6-16) consisting of atomization nozzles installed within the foul-air drop legs immediately upstream from the biofilter is recommended. The pre-wetting systems would be located on each biofilter bed supply duct to enable pre-wetting to be controlled to each bed. The pre-wetting system spray nozzle specifications are provided in Table 6-8.

Table 6-8 Pre-wetting system spray nozzle specifications

Description	Unit	Value
Spray nozzle size	in.	¼
Design condition	gpm	3.33
Design pressure	psi	40
Maximum temperature	ºF	180
Screen size	Type	80 mesh, manel screen
Material	Type	416 stainless steel
Spray pattern	Type	Full-cone
Spray direction	—	Straight
Spray angle	Degrees	80

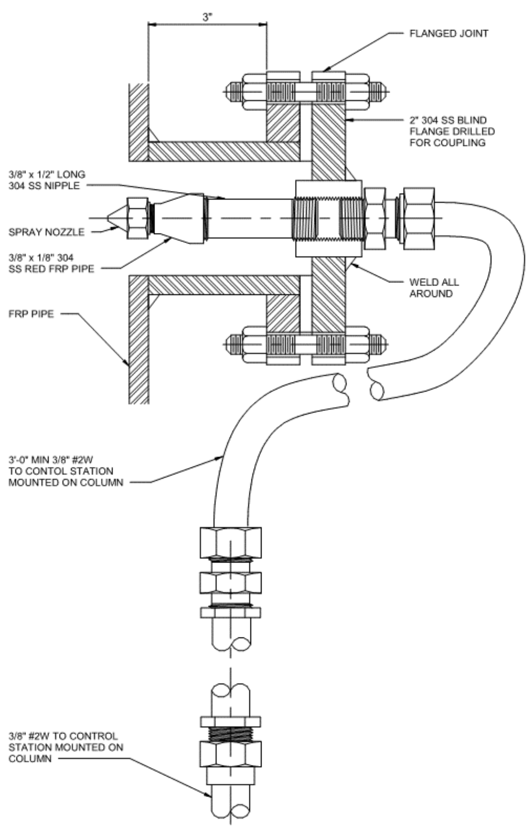

Figure 6-16. Typical spray nozzles (injecting into inlet ductwork for biofilter)

McMaster Carr Supply and Grainger (EXAIR) atomization nozzles for pre-wetting are shown on Figure 6-17 and Figure 6-18, respectively.

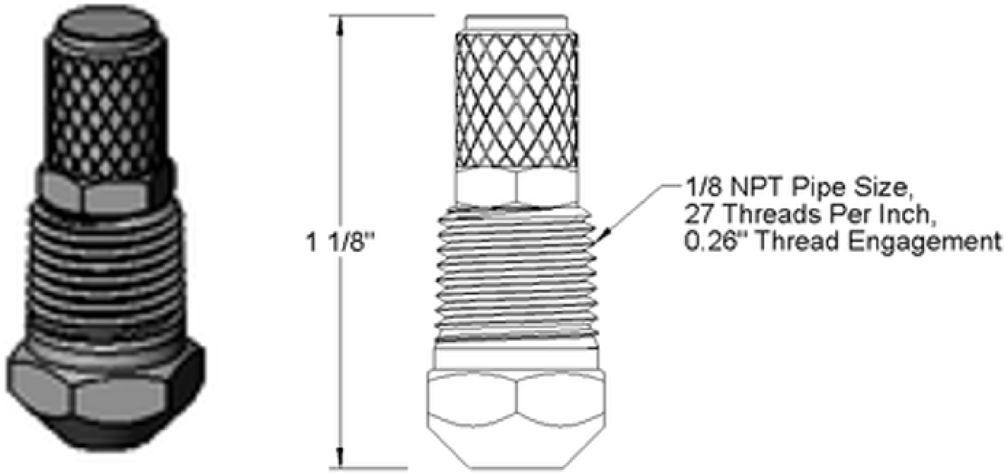

Figure 6-17. McMaster Carr Supply Co., atomizing spray nozzle

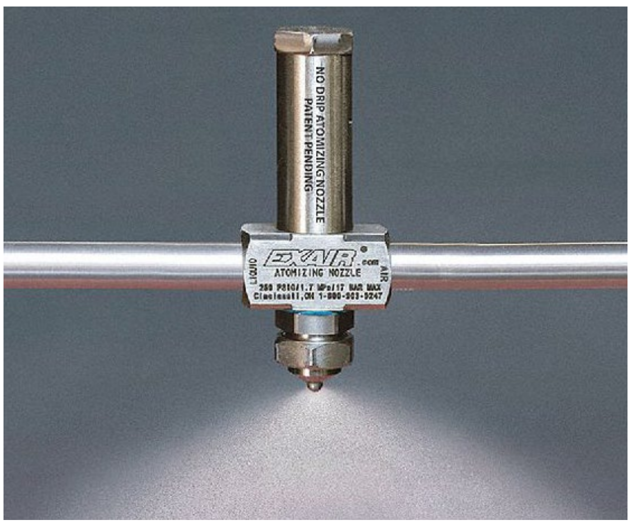

Figure 6-18. Grainger (EXAIR) atomizing spray nozzles

Surface Irrigation

An irrigation system controller will be required to control both pre-wetting humidification and biofilter bed surface irrigation. The surface irrigation system will consist of HDPE piping, timer/controller, solenoid valves, isolation valves, flow indicators, sprinkler heads, and pressure-reducing valves and strainers as required. Rain Bird or equal equipment will be used (see Figure 6-19). The system shall be capable of controlling a minimum of four zones and handling non-potable water. See Sheets P-563, P-590, and P-790 in Appendix F for diagrams of this system. Each biofilter will have three branch lines, one for the pre-wetting system, two zones for surface irrigation, and the fourth zone of the controller will not be used. The sprinkler control system and associated control valves and piping will be installed above grade on a weather-resistant board for easy access and maintenance.

Figure 6-19. Rain Bird sprinkler control system and surface irrigation nozzle

Source: Rain Bird 2023.

Damper

Dampers will be installed at each foul-air supply leg for blower and biofilter bed cell isolation, including backdraft dampers, and air balancing between the beds. The damper specifications and design standards are summarized in Table 6-9.

Table 6-9. Damper specifications

Description	Unit	Value	
Damper type	—	Isolation (control)	Balancing
Leakage rate	cfm/ft^2	0.00 at 10 in. w.g.	—
Material	Type	FRP	FRP
Body construction	Type	Molded fiberglass, vinyl ester resin	Fiberglass, vinyl ester resin
Blade construction	Type	Fiberglass/vinyl ester with blade seals	Fiberglass/vinyl ester resin
O-ring material	Type	Viton	None
Body configuration	Type	Unitary blade to body construction with no circumferential seal	Fiberglass channel
Shaft material	Type	316 stainless steel (FRP encapsulated)	Pultruded fiberglass
Liner thickness	mil	20 (100 on blades)	20
Operators	Type	Handwheel, locking	Hand quadrant lever, fixed

Spunstrand, Ruskin, and Daniel Mechanical are accepted damper manufacturers. Dampers from each manufacturer are shown in Figure 6-20, Figure 6-21, and Figure 6-22, respectively. The two main types of dampers in this project will be butterfly for isolation and balancing of the system and backdraft, which will function similar to a check valve on the discharge of the duty/standby fans.

Figure 6-20. Spunstrand dampers

Figure 6-21. Ruskin dampers

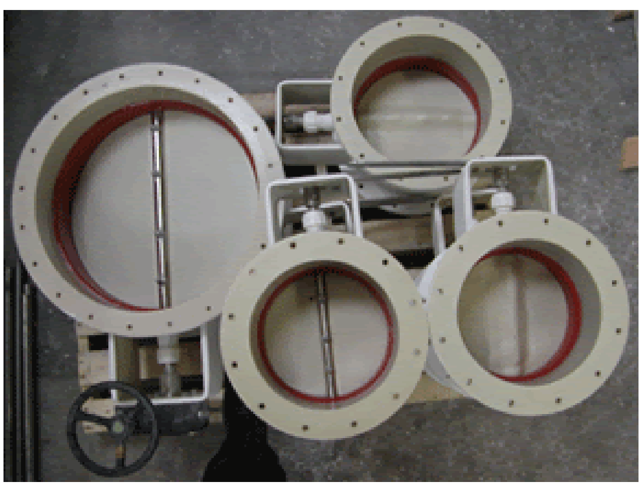

Figure 6-22. Daniel mechanical dampers

Grease Filter

A combination grease filter/inlet box will be provided to collect and remove grease and particulates from the foul airflow. Providing a filter helps reduce wear and the accumulation of grease on the blower components. The specification and selection of grease filters will be coordinated with odor control blower manufacturers so that the grease filter/inlet box does not impede the performance of the fan. Spunstrand and Ruskin are accepted grease filter manufacturers. The body of each filter will be FRP matching the ductwork, with easily accessible quick-bolt housing doors for access to the internal filter for removal. Each unit will include drains and differential pressure gauges for monitoring. An image of a similar grease filter is shown in Figure 6-23. The grease filter specifications and general design criteria are provided in Table 6-10.

Figure 6-23. Grease filter with differential pressure gauge

Table 6-10. Grease filter specifications

Description	Unit	Value
Material	-	FRP, Class 1 flame rating
FRP resin type	Type	Hetron 992SB vinylester
Hardware	-	Stainless steel
Grease filter material	-	Aluminum, washable
Grease filter differential pressure	in./w.g.	0.09 at 500 fpm
Diameter	in.	Varies
Minimum wall thickness	in.	0.187 (12–24)
		0.260 (26–48)
		0.375 (54–72)
Maximum temperature	ºF	180
Differential pressure gauge	-	Magnehelic, Ametek/USGauge, or Ashcroft
Differential pressure gauge range	in./w.g.	0–5

6.4 Existing Pumps Evaluation

The following pumps (existing pumps that are not currently in the scope of the upgrades) were evaluated to confirm that the changes to the site layout (pumping distances) and operational adjustments for the proposed upgrades would not affect the ability of each pump to continue to operate as designed. Such facility changes include the new PS and septage thickening building, the addition of Digesters 3 and 4, WAS-thickening redundancy, centrate storage, and new thickening equipment. Table 6-11 shows a summary of the applicable pumps that were modeled for due diligence.

Table 6-11. Summary of existing pump evaluation

Pump	Type	Rated TDH	Modeled TDH	Needs replacement?
PS pumps (P-1001, P-1002)	Double disc	200 gpm at 30 ft	3.0 ft	No
Scum pumps (P-1003, P-1004)	PD plunger	140 gpm at 70 ft	50.9 ft	No
WAS pumps (P-2201, P-2202)	PD rotary lobe	350 gpm at 46 ft	18.0 ft	No
Centrate sump pumps (P-7151, P-7152)	Centrifugal	220 gpm at 39 ft	21.6 ft	No
TWAS to digester feed pumps (P-4510, P-4520, P-4530)	Progressive cavity	30 gpm at 231 ft	29.7 ft	No

6.4.1 Primary Sludge Pumps (P-1001, P-1002)

PS pumps P-1001 and P-1002 are installed in the Aeration Basins 1 and 2 utilidor. They are double-disc pumps rated for 200 gpm with a 30-foot TDH and 10 hp motor. They were installed during the 2009 upgrade project to pump PS from the clarifiers to the GT splitter box, replacing the 10.0 hp torque-flow pumps that were installed previously.

New pipe routing on the discharge of these pumps is needed so that they feed into the new PS and septage thickening building. The existing lines will need replacement, but the new line will also be 6 inches and follow the same path to the east until it reaches the northwest corner of the existing SPB. At this point, it will be routed south, then west, then north, replacing and following existing PS or scum lines. Finally, it will head west to enter the new PS and septage thickening building.

The TDH assessed for this routing was found to be roughly 3.0 feet. The existing pumps are rated to accommodate a 30-foot TDH, so based on capacity, these pumps do not require replacement at this time. This extremely low TDH required comparative to the rated TDH is due to the lower elevation at the new PS and septage thickening building, compared to the existing outlet at the gravity thickening splitter box structure.

6.4.2 Scum/FOG Pumps (P-1003, P-1004)

Scum/FOG pumps P-1003 and P-1004 are installed in the Aeration Basins 1 and 2 utilidor. They are duplex plunger pumps that were installed during the original construction of CKTP in 1978. The pumps are considered by plant staff to be in good condition and will continue to be used for the foreseeable future (as needed). They are rated for 140 gpm with a TDH of 70 feet and 7.5 hp motor. Before the new PS pumps (P-1001, P-1002) were installed, P-1004 was used as the PS pump. In 1996, it was converted for use as a scum/FOG pump to provide redundancy with P-1003.

These pumps will see adjustments to both flow and pipe layouts. Flow will be minimized because of the relocation of FOG handling. Therefore, these pumps will not need to accommodate as much flow relative to their current operations. In addition, the existing scum line to the Digesters 1 and 2 process building will be intercepted to provide additional routing to the Digesters 3 and 4 process building.

The total assessed TDH for these two routes at their worst-case condition, which is seen with both pumps on, was found to be 49.8 feet to Digesters 1 and 2, and 50.9 feet to Digesters 3 and 4. These pumps are rated for a TDH of 70 feet, so based on capacity, they do not require replacement at this time. It should also be noted that scum production is currently very limited (as discussed in Section 5). With FOG pumping becoming part of the new FOG facility, and no longer part of the scum system, these scum pumps are expected to operate very infrequently if minor scum pumping is needed.

6.4.3 WAS Pumps (P-2201, P-2202)

WAS pumps P-2201 and P-2202 are located near Aeration Basins 3 and 4. They are rotary-lobe pumps with a 25 hp motor that were installed in 2015 as part of the Resource Recovery project. They are rated for 350 gpm at 20 psi. AFT Fathom modeling assessed their current pump route to the existing WAS-thickening building, as well as to the proposed PS and septage thickening building for redundant WAS-thickening capabilities.

New routing of the WAS line includes tying into the existing line just south of the WAS-thickening building and running it south, eventually turning and entering the PS and septage thickening building from the east.

The total assessed TDH for these two routes at 350 gpm was found to be 13.9 psi and 7.8 psi, respectively. This difference is due to the elevation of the PS and septage thickening building being 15 feet lower than the existing WAS-thickening building, so a lower TDH is required. In other words, the required TDH to the existing WAS-thickening building was evaluated and found to be 32.1 feet; however, the required TDH to the new PS and septage thickening building was evaluated at 18.0 feet. These pumps are rated for a TDH of 46 feet, so replacement of these pumps is not necessary.

6.4.4 Centrate Sump Pumps (Existing P-7151, P-7152)

Centrate sump pumps P-7151 and P-7152 are installed in the basement of the SPB and pull directly from the existing centrate sump. The existing discharge has the option to go to the headworks building or the primary clarifier influent. These Gorman-Rupp centrifugal pumps were installed in 1999, are rated for a TDH of 38.7 feet, and have a 7.5 hp motor.

The adjustments to these pumps include relocating to pull from the existing septage sump, which neighbors the centrate sump. The existing septage sump will be used as an overflow to the centrate sump, and these existing pumps will pump along the same route to the headworks, while pulling from the existing septage sump. These updates can be seen in Figure 6-5 above.

The TDH with these adjustments at 220 gpm is anticipated to be roughly 21.3 feet, or about 9.2 pounds per square inch differential (psid), with an assumed 70 percent efficiency. These pumps are rated for a TDH of 38.7 feet. Therefore, they are able to accommodate the recommended adjustments to the system and do not need replacement at this time.

6.4.5 TSBT Feed Pumps to Digester (P-4510, P-4520, P-4530)

TSBT feed pumps P-4510, P-4520, and P-4530 are currently installed in the southeast corner of the WAS-thickening building. They are all positive-displacement progressive-cavity pumps rated for 30 gpm at 100 psi. They were installed in 2015 during the Resource Recovery project to pump thickened sludge from the TSBT to the digesters.

For the future system, these pumps must accommodate a tie-in and additional pipe length to supply TWAS to Digesters 3 and 4. Proposed routing includes using the existing 6-inch-diameter line to Digester 1 and rerouting to supply TWAS to the new digesters. This tie-in is proposed to be added southeast of the TSBT and go south, eventually turning and entering the west side of the Digesters 3 and 4 process building. Flows to Digester 1 will be reconfigured inside the Digesters 1 and 2 process building to pull from the existing line that feeds Digester 2.

The TDH with these adjustments at 30 gpm was evaluated to be 29.7 feet using the Bingham Plastic model for viscosity of the TWAS. These pumps are rated for a TDH of 231 feet, so replacement of these pumps is not necessary at this time.

7 HVAC and Boiler Systems

The following sections outline the heating, ventilation, and air conditioning (HVAC) aspects of the design as well as the NG boiler system and hot water systems that will serve process and building heating needs.

7.1 General Design Standards and Criteria

The building mechanical systems will be sized using the American Society for Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) design criteria for Bremerton, Washington, which is the weather station with the most similar conditions to CKTP (Table 7-1). The heating design temperature used is the 20-year minimum temperature to reduce the potential for any freezing conditions in 100 percent outside air buildings.

Table 7-1. Outdoor design temperatures

Season	Dry bulb temperature (°F)	Wet bulb temperature (°F)	Notes
Heating	7	-	ASHRAE 20-year minimum
Cooling	86.4	65.6	ASHRAE 0.4% cooing design

The inside room temperatures will be as follows (Table 7-2).

Table 7-2. Indoor design temperatures

Space	Heating temperature (°F)	Cooling temperature (°F)
Electrical Rooms	60	80
Process Rooms	50	-

NFPA 820-2024 provides guidance for potentially hazardous locations within CKTP and has mitigation measures to reduce these hazards, which will be followed. See Table 7-3 for the identified spaces, classifications, and requirements for air changes per hour (ACH).

Ventilation rates will be based on the worst case of NFPA 820 airflows required to reduce space classification, International Building Code (IBC)/International Fire Code (IFC) hazardous-area ventilation rates where applicable, or International Mechanical Code (IMC) ventilation rates.

Table 7-3. NFPA 820 room classification and ventilation requirements

Room	Building	NFPA 820	Classification	ACH	Pressure
Digester pump building	Digesters 1 and 2 Complex	Table 6.2.2(a), row 9b and row 17d	Unclassified	6	Positive
Digester pump building	Digesters 3 and 4 Complex	Table 6.2.2(a), row 9b and row 17d	Unclassified	6	Positive
Boiler room	Digester control building	-	-	-	-
Electrical room	Digester control building	-	-	-	-

Room	Building	NFPA 820	Classification	ACH	Pressure
FOG receiving	FOG building	Table 9.1.1.1.1, row 1	Class I, Division 2	12	Negative
FOG mechanical	FOG building	-	Unclassified[a]	-	Positive
Electrical rooms	FOG building	-	Unclassified[a]	-	Positive
RDT room	Thickening building	Table 6.2.2(a), row 8	Class I, Division 2	12	Negative
Polymer room	Thickening building	-	Unclassified[a]	-	Positive
Electrical room	Thickening building	-	Unclassified[a]	-	Positive

a. Room is not classified per NFPA 820 but must be kept positive because of adjacent classified space.

All HVAC equipment will be constructed of corrosion-resistant materials such as aluminum, stainless steel, or FRP or will be provided with a corrosion-resistant air-dry phenolic coating. HVAC ductwork will be aluminum or stainless steel.

7.2 Boilers and Hot Water Loop

Hot water is required to serve the digesters and to feed the existing SPB. The current hot water needs are met by two Cleaver-Brooks boilers installed in 1978 and refurbished in 2013. These boilers are located in the existing digester control building, which is an unsafe location for this type of equipment and they need to be removed. Because of their age and minimal turndown capacity, the boilers will be replaced with new boilers in the new digester control building. With this change, the existing hot water loop will be evaluated and updated to remove obsolete and unnecessary loads from the system.

The new loads include the digester HEXs and the existing SPB HVAC system. The administration/laboratory building will be removed from the heat loop, under a different contract, and the yard piping will be replaced during construction of this project. For sizing the new boilers, the digesters have a maximum load of 1,990 thousand British thermal units per hour (MBH) and a minimum load of 196 MBH. The existing SPB has two Trane air handlers, manufactured in 2000, that receive heating water from the boilers. These units are beyond their ASHRAE life expectancy but appear to be in fair external condition and no issues were reported during the site visit. For planning purposes, the new boilers will include 800 MBH of heating for the existing air handlers.

The total boiler load varies from 196 MBH to 2,828 MBH. To meet all load conditions, three operating boilers at 1,000 MBH output and a 5:1 turndown will be provided. A single redundant boiler will also be provided. This will provide capacity from 200 MBH to 3,000 MBH, exceeding the required capacity.

The boilers will be NG-fired (with the design assumption that NG service will be established to CKTP prior to, or as part of, this project) and will not have a backup fuel source allowing the use of readily available commercial/industrial boilers with no special requirements for burning digester gas to be used. With this type of boiler, several control and pumping options will be explored during the 60 percent design phase to optimize the flexibility and operation of both the digester HEXs and the HVAC equipment on the heating water loop.

The boilers will be provided with a boiler control panel that integrates with the CKTP supervisory control and data acquisition (SCADA) system to provide feedback and control to the operators.

7.3 Existing Digester Complex HVAC

The existing digester control building does not meet current NFPA 820 standards for air volume and physical separation between classified areas and should be considered a Class I, Division 2 area. There is no clear method to mitigate the issues found and this building will be replaced with a new digester pump building that complies with the current building codes and with NFPA 820-2024.

7.4 New Digester Complex HVAC

Both of the new digester complexes will be physically separated from the digesters to meet the NFPA 820 physical separation requirements for digester control buildings. Six air changes per hour (ACH) of ventilation will be provided from a roof- or grade-mounted, direct-fired NG air handler to reduce the building classification from Class I, Division 2 to Unclassified. The air handler will provide air to both levels of the building and the stairwell with an airflow of 7,200 cfm for each building. A roof-mounted exhaust fan will exhaust each building and will be balanced to maintain the building at a positive 0.1 inch water column (w.c.) in compliance with paragraph 9.2.5 of NFPA 820. All HVAC equipment and intakes will be located at least 10 feet from the digesters to avoid any classified areas.

Controls for the air handler will be standalone. Airflow switches in the supply and exhaust ducts will be provided by instrumentation and controls (I&C) for monitoring and for go/no-go alarms in the space, at entrances, and in the control room.

7.5 Digester Control Building HVAC

The digester control building houses the digester heating water boilers and the electrical service for the digester complexes. It does not require specific ventilation rates per NFPA 820 but will require combustion air for the boilers. The boiler room HVAC system will consist of hydronic unit heaters and a roof-mounted exhaust fan with passive air intakes for ventilation.

The electrical room will be provided with a positive pressurization unit to mitigate corrosion effects and will have ductless split-system heat pumps for heating and cooling.

7.6 Thickening Building HVAC

The thickening building will have three separate HVAC systems, one serving each space. The thickener room requires 12 ACH to reduce the classification to Class I, Division 2. This space will be served by a direct-fired NG makeup air handler and a roof-mounted exhaust fan. The airflow rate for this room will be 11,500 cfm and heating capacity will be 550 MBH to maintain room temperature on a design day. The exhaust rate will be higher than the supply airflow rate so that the room is negatively pressurized in accordance with NFPA 820. The controls will be standalone but this system will have flow detection for monitoring and alarm through the SCADA system.

The polymer room will be served by a separate direct-fired NG makeup air handler and roof exhaust fan. Because this room is unclassified and adjacent to the classified thickener room, it must have a positive pressure to meet NFPA 820, but it does not require additional alarms.

The electrical room will be provided with a positive pressurization unit to mitigate corrosion effects and will have ductless split-system heat pumps for heating and cooling.

7.7 FOG Building HVAC and Hot Water Supply

The FOG building will also have three HVAC systems, one serving each space. The screening room in the FOG building requires 12 ACH to reduce the classification to Class I, Division 2 in accordance with NFPA 820 Table 9.1.1.1.1 row 1. The space also needs to meet NFPA 30 requirements for Class 1 flammable liquids. This space will be served by a direct-fired NG makeup air handler and a roof-mounted exhaust fan. The airflow rate will be 3,250 cfm and will have a 155 MBH heating capacity. The exhaust rate will be higher than the supply airflow rate so that the room is negatively pressurized in accordance with NFPA 820. The controls will be standalone but this system will have flow detection for monitoring and alarm through the SCADA system.

The hot water mechanical room will be served by separated combustion NG unit heaters, and supply and exhaust fans to maintain a positive pressure.

The electrical room will be provided with a positive pressurization unit to mitigate corrosion effects and will have ductless split-system heat pumps for heating and cooling.

7.8 Maintenance Building

The maintenance building HVAC and plumbing design will be developed using the same base ASHRAE standards used in this section. The specific equipment and area needs require further design development to confirm the facility layout; however, the design will meet all pertinent requirements of the IBC/IFC area ventilation rates where applicable, or IMC ventilation rates.

7.9 Plumbing and Drainage

Three water sources are available at CKTP. Potable, tepid water (1W) will be provided to emergency fixtures required in the PS and septage thickening building. Areas that require hot washdown water, the FOG building, and polymer rooms will have non-potable water (2W) from the CKTP airgap system. All other washdown systems will use the high-pressure plant water (3W) system that uses treated effluent when it is available or 2W when it is not available.

NG will be provided to CKTP to provide heating fuel for the boilers, air handlers, gas unit heaters, and water heaters. The total process facility NG demand for this project is 3.5 MMBtu/hr or 3,500 ft^3/hr.

For the digester pump building and the digester control building washdown water will be provided in all process rooms and at the exterior of the building using 3W. Makeup water for the boiler system will be provided in the digester control building from 2W. In areas with sludge pumps or piping, drainage will be achieved by using flat-bottom profile trench drains with a sump (and sump pumps) to reduce clogging of any floor drains. Other areas will use heavy-duty cast-iron floor drains.

A new potable water line will be provided to the Solids Processing Building to serve the existing emergency fixtures and sinks that are currently being served by the non-potable, airgap system (2W). The exact number of fixtures and configuration will be determined during final design. A new potable water system will be provided for the fixtures that require potable water rather than re-using any non-potable water piping to avoid any potential existing contamination.

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8 Architectural Design

The architectural approach for the CKTP Hauled-Waste Upgrades facility buildings will be to provide an overall, cohesive design aesthetic that can be applied to all the new CKTP structures. To accomplish this, a coordinated palette of architectural forms, materials, textures, and colors will be used to establish a contemporary aesthetic that will be commensurate for contemporary commercial waste facilities. Although the individual buildings and structures will house different functions, the goal is that the structural and architectural design will incorporate similar construction techniques and expressions for all the new structures that will be applied consistently, regardless of size and functions be. The intent is to establish a design approach that can be carried forward in future projects as CKTP continues to grow.

8.1.1 Building Codes (After March 15, 2024)

The following building codes will be applied to the architectural approach described in this section:

- 2021 IBC
- 2021 IMC
- 2021 IFC
- 2021 Uniform Plumbing Code
- 2021 Washington State Energy Code (WSEC)
- NEC (NFPA 70)
- 2010 Americans with Disabilities Act (ADA) Standards for Accessible Design

8.1.2 Maintenance Building

While the final location is still being determined, for the purposes of this Basis of Design Report, the new maintenance building will be located east of the existing process building areas near the existing main entrance and wetland to make way for the new digester control, thickening, and odor control buildings. The maintenance building will consist of a central drive-through mechanics shop area; a separate multi-purpose shop; tool storage; painting space; a lube/compressor room; and miscellaneous storage. A separate office area with a visitors' entrance will have offices, workspaces, locker rooms and a break room that will be connected off the central shop area. Support rooms, such as the electrical and mechanical rooms and miscellaneous storage rooms, will also be included adjacent to the central shop area. The construction of the maintenance building will be phased to accommodate future additions for increased functionality. The phasing of the maintenance building is discussed further in Section 13.4.

The maintenance building will be constructed with a combination of concrete masonry and a steel frame. The structure will be constructed as Type IIB construction per the IBC. The office area will be occupancy Type B and the shop and support areas will be Type F-1 occupancy. Storage areas will be occupancy Type S-1. These combined B/F-1/S-1 occupancies will require no fire-rated separation walls. The maintenance building will be fully sprinklered.

See Appendix D for the maintenance building space program and conceptual site and floor plans.

8.1.3 Process Buildings

The process buildings that will require architectural treatment are the digester control, thickening, FOG, and WAS buildings. The process buildings will also be classified as Type IIB construction and S-1 occupancies. The exterior materials will be the same as the maintenance building. Because of their sizes and occupancy types, it is not expected that these buildings will be sprinklered; however, a full life-safety analysis will be conducted during the first stage of detailed design to confirm the fire protection features for each building. It is expected that occupied buildings will have smoke and/or fire detection monitoring that will be tied to the CKTP control system.

8.1.4 Architectural Materials

This section describes architectural materials to be used on the project, including exterior, hollow metal doors and frames, and interior finishes.

Exterior

This section describes exterior architectural materials to be used on the project, including exterior walls, roofing, windows, and louvers.

Exterior Walls

The exterior walls will consist of exterior metal siding over R-10 rigid insulation, air barrier, over concrete masonry or metal framing with R-11 batt insulation and interior wall finishes as scheduled. Below-grade concrete walls will have R-10 rigid insulation to 24 inches below grade.

Roofing

Flat roofs will have R-30 rigid insulation and vapor barrier over the roof structure with either an ethylene propylene diene terpolymer (EPDM) or thermoplastic polyolefin (TPO) fully adhered membrane roofing. Roofs over metal decking will have an additional thermal barrier applied directly to the decking.

Sloped roofs will have standing-seam metal roofing applied over the same roofing substrate for flat roofs.

Windows

Exterior windows will be storefront type with insulated, low-E glazing.

Louvers

Exterior louvers will be aluminum to match the exterior metal siding in which they are located.

Hollow Metal Doors and Frames

Hollow metal doors and frames will be field-painted steel and will have insulated glass transoms.

Interior Finishes

The maintenance building will have exposed concrete masonry in the shop areas and mechanical, electrical, and storage rooms with exposed roof structure. The office area, restroom, and locker rooms will have typical commercial interior finishes with tiled walls and floors in the restrooms and locker room wet areas.

The interior finishes of the process buildings will have exposed concrete and concrete masonry with exposed roof structures. Interior painting will be at the County's request.

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9 Structural Design

This section describes structural design standards, criteria, codes, and loads for this project.

9.1 General Design Standards and Criteria

Structural design criteria, applicable codes, and design guidelines are presented in the following sections.

9.2 Applicable Structural Codes and Design Standards

The following codes and standards will be used in the design of the project components and building structures:

- **Building code:** 2021 IBC
- **Referenced standards:**
    - **Structural loads:** American Society of Civil Engineers (ASCE) 7-16 and IBC 2021
    - **Concrete:** American Concrete Institute (ACI) 318-19 and ACI 350-20
    - **Masonry:** The Masonry Society (TMS) 402-16 and 602-16
    - **Structural steel:** American Institute of Steel Construction (AISC) 360-16 and AISC 341-16
    - **Metal decking:** Steel Deck Institute (SDI) RD-2017 and SDI C-2017
    - **Metal joists:** Steel Joist Institute (SJI) 100-20
    - **General:** related American Society of Testing and Materials (ASTM) standards

9.3 Structural Design Loads

The structural design of the buried concrete vaults, structures, digesters, and buildings will be as follows.

9.3.1 Gravity Loading

Gravity loading on the structures includes dead load, live load, and snow load as indicated in Table 9-1. Items noted as TBD will be confirmed in coordination with the geotechnical engineer as part of detailed design.

Table 9-1. Gravity loads

Description	Load
Dead load	
Structural self-weight of structures	
Actual weights of fixed equipment, including contents	
Building roof miscellaneous dead load	10 psf
Roof solar panel dead load	5 psf
Structural fill on top of buried vaults	125 × depth of fill (psf)
Live Load	
Building roof live load Primary roof members over work floor	20 psf or 300 lb point load 2,000 lb
Building floor live load Maintenance or work floors not subject to truck loading Office areas Equipment mezzanine	125 psf or 2,000 lb point load 100 psf 125 psf
Uniform traffic surcharge, equivalent to HL93 truck loading	250 psf [a]
Service uplift based on water surface elevation of	TBD
Snow Load	
Snow load	TBD

a. The combined sewage storage tank has been analyzed for HL 93 loading (moving load + lane loading). The results of the analyses were compared to uniform 250 psf and determined that 250 psf loading is slightly more conservative; therefore, it is decided to use 250 psf uniform loading in the structural models to cut down on the model's running time for moving loads.

9.3.2 Lateral Loading

Lateral earth and groundwater pressures on the combined sewage storage tank and facility building are as indicated in Table 9-2. The overall lateral pressures on the walls are also shown in Table 9-2. Items noted as TBD will be confirmed in coordination with the geotechnical engineer as part of detailed design.

Table 9-2. Lateral loading

Description	Value
Lateral earth and groundwater pressure	
At-rest earth pressure	TBD
Active earth pressure (used with seismic earth pressure)	TBD
Groundwater elevation	TBD
Uniform lateral traffic surcharge	TBD
Maximum fluid pressure inside digesters	TBD
Lateral wind pressures on buildings	
Walls north–south	TBD
Walls east–west	TBD

Description	Value
Roof uplift	TBD
Seismic pressures	
Seismic east–west, inertial loading	TBD
Seismic north–south, inertial loading	TBD
Seismic earth pressures east–west direction, uniform	TBD
Seismic earth pressures north–south direction, uniform	TBD

9.3.3 Seismic Design Criteria

This project has no specific post-earthquake performance objectives other than to meet the 2021 IBC life-safety requirement. However, the County's goal is to minimize damage during a design earthquake to the extent practicable. In addition, the County would like to bring the facility back online following a large earthquake as early as practicable considering the effects of a large earthquake on the County's overall conveyance system. This project will be governed by the 2021 IBC. The key components of the 2021 IBC code and its reference document, ASCE 7-16 Chapters 12, 13, and 15, relevant to ground response and the performance of the facility, include the following:

- The design maximum considered earthquake (MCE) is an event with a 2 percent probability of exceedance over a 50-year exposure period (i.e., a recurrence interval of 2,475 years).
- The design event considers the hazard from all the possible earthquake sources with the defined probability of occurrence. This means that all relevant seismic sources in the project area, including the Seattle Fault, random crustal events, deep intraslab events such as the 2001 Nisqually and 1949 Olympia earthquakes, and offshore Cascadia Subduction Zone events that could result in magnitude 8 to 9 earthquakes, are considered relative to their contribution to seismic shaking of the firm ground beneath the project site.
- The design level of shaking to be used for structural design is two-thirds of the MCE at the ground surface, adjusted for site effects by the site-specific seismic ground response analysis.
- The 2021 IBC's seismic risk category for the project components vary between II and III with importance factors of 1.0 and 1.25, respectively. See Figure 9-1.

IBC design methodologies express the effects of site-specific subsurface conditions on the ground motion response in terms of the "site class." The site class can be correlated to the average standard penetration resistance (N-value) or average shear wave velocity in the upper 100 feet of the soil profile. Based on the subsurface explorations completed at the site, the soil profile would classify as Site Class E. Seismic design parameters, adjusted for Site Class E, are provided in Table 9-3 shown below.

The seismic design criteria for this project are listed in the Geotechnical Design Memorandum (GDM) (S&W 2023). See Table 9-4. Criteria are summarized below:

- Risk Category II or III, Importance Factors: 1.00 or 1.25

- Conform to ASCE 7-16
- Seismic Design Category D, Site Class E
- Per ACI 350-20 Section 21.2.1.5, the storage tank is designed for seismic loads computed using the procedures prescribed in ACI 350.3 and ACI 350-20
- The estimated fundamental periods of the structures are shown in Table 9-3

Table 9-3. Code-based seismic design parameters

2021 IBC parameter	Recommended value
Site class	E
Risk category	II or III
Short-period spectral acceleration, S_S (g)	1.429
1-second period spectral acceleration, S_1 (g)	0.504
Site coefficient (F_a)	1.25
Site coefficient (F_v)	1.00
Design short-period spectral acceleration, S_{DS} (g)	1.143
Design 1-second period spectral acceleration, S_{D1} (g)	0.503
Design earthquake magnitude (M_w)	7.33
Site-adjusted peak ground acceleration (g)	0.726

Table 9-4. Seismic design criteria

Exhibit 6-1: Response Spectrum Parameters

Parameter	ASCE 7-16 Recommended Values
Peak Ground Acceleration (PGA)	0.605g
Short Period Spectral Acceleration (S_S)	1.429
Spectral Acceleration at 1-Second Period (S_1)	0.504
MCE_R Spectral Response Acceleration Coefficient (S_{MS})	1.714
MCE_R Spectral Response Acceleration Coefficient (S_{M1})	0.754
Design Spectral Response Acceleration Coefficient (S_{DS})	1.143
Design Spectral Response Acceleration Coefficient (S_{D1})	0.503
Site Amplification Factor, F_{PGA}	1.2
Site Modified Peak Ground Acceleration, PGA_M	0.726g
Mean Magnitude	7.33

g = acceleration of gravity; MCE_R = risk-targeted maximum considered earthquake

Source: S&W 2023.

Table 1.5-1 Risk Category of Buildings and Other Structures for Flood, Wind, Snow, Earthquake, and Ice Loads

Use or Occupancy of Buildings and Structures	Risk Category
Buildings and other structures that represent low risk to human life in the event of failure	I
All buildings and other structures except those listed in Risk Categories I, III, and IV	II
Buildings and other structures, the failure of which could pose a substantial risk to human life	III
Buildings and other structures, not included in Risk Category IV, with potential to cause a substantial economic impact and/or mass disruption of day-to-day civilian life in the event of failure	
Buildings and other structures not included in Risk Category IV (including, but not limited to, facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, hazardous waste, or explosives) containing toxic or explosive substances where the quantity of the material exceeds a threshold quantity established by the Authority Having Jurisdiction and is sufficient to pose a threat to the public if released[a]	
Buildings and other structures designated as essential facilities	IV
Buildings and other structures, the failure of which could pose a substantial hazard to the community	
Buildings and other structures (including, but not limited to, facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, or hazardous waste) containing sufficient quantities of highly toxic substances where the quantity of the material exceeds a threshold quantity established by the Authority Having Jurisdiction and is sufficient to pose a threat to the public if released[a]	
Buildings and other structures required to maintain the functionality of other Risk Category IV structures	

[a]Buildings and other structures containing toxic, highly toxic, or explosive substances shall be eligible for classification to a lower Risk Category if it can be demonstrated to the satisfaction of the Authority Having Jurisdiction by a hazard assessment as described in Section 1.5.3 that a release of the substances is commensurate with the risk associated with that Risk Category.

Figure 9-1. Risk category of buildings and other structures for flood, wind, earthquake, and ice loads

Source: ASCE 7-2016: Table 1.5-1.

9.4 Structural Design Load Combinations

The above-listed loads are combined per 2021 IBC guidelines:

1.4D

1.2D+1.6L+0.5(Lr or S or R)

1.2D+1.6(Lr or S or R)+(L or 0.5W)

1.2D+1.0W+L+0.5(Lr or S or R)

1.2D+1.0E+L+0.2S

0.9D+1.0W

0.9D+1.0E

For structures that are subject to earth and fluid pressures:1.4(D+F)

1.2(D+F) +1.6(L+H) +0.5(Lr or S or R)

1.2(D+F) +1.6(Lr or S or R) +1.6 H + (f_1L or 0.5W)

1.2(D+F) +1.0W+ f_1L+1.6H+ 0.5(Lr or S or R)

1.2(D+F) +1.0E+ f_1L+1.6 H + f_2S

0.9D +1.0W+ 1.6 H

0.9(D+F) +1.0E+ 1.6 H

Where:
(D) dead load
(E) seismic load
(S) snow load
(W) wind load
(R) rain load
(F) fluid load
(Lr) live load on roof

f_1 = 1 for places of public assembly live loads in excess of 100 psf (not applicable to this project).

f_2 = 0.7 for roof configuration that do not shed snow off the structure (not applicable to this project), or 0.2 for other conditions.

9.5 New Digesters

Structural design of new digesters will be performed according to ACI CODE-350.3-20 *Code Requirements for Seismic Analysis and Design of Liquid-Containing Concrete Structures (ACI 350.3-20) and Commentary*.

Gravity loading and lateral pressures of water, wind, earth pressures, hydrodynamic, and surcharge will be calculated and applied to a finite-element model (FEM) of the new digesters.

9.6 Existing Digesters and Centrate Tank

Structural analysis of existing digesters and the new centrate tank (existing GT) will be performed according to ACI CODE-350.3-20 *Code Requirements for Seismic Analysis and Design of Liquid-Containing Concrete Structures (ACI 350.3-20) and Commentary*.

Gravity loading and lateral pressures of water, wind, earth pressures, hydrodynamic, and surcharge will be calculated and applied to an FEM of the existing digesters without the digester building in between to check stability, bearing pressure, and structural integrity of the existing structure against current code seismic event.

9.7 Process Buildings

The process buildings are the digester control building, digester process control buildings, thickening building, and FOG building. Structural design of the process buildings will be performed according to IBC 2021, ACI 318-19, TMS 402, TMS 602, AISC 360-16, SJI 100-20, and SDI RD-2017.

Planned construction materials of the process buildings include a steel-framed roof supported on concrete or masonry walls and concrete slab and foundation. Gravity and lateral loads will be calculated and applied to an FEM to determine required framing sizes and spacing, wall thickness and reinforcing, slab thickness and reinforcing, foundation dimensions and reinforcing, and further details. As-needed equipment anchorage and support will be designed per ACI 318-19. The roof decking will function as a structural diaphragm and the walls will function as “special reinforced shear walls” and be designed per ASCE 7-16 and ACI 318-19 or TMS 402.

9.8 In-Plant Pump Station

The IPS is a circular buried pump station (roughly 10 feet in diameter and 14 feet deep) with a valve vault. It will most likely be constructed using precast concrete utility vaults and a manhole. The design will be performed by a precast supplier per HDR’s prescribed loading, drawings, and specifications.

9.9 Maintenance Building

Structural design of the maintenance building will be performed according to IBC 2021, ACI 318-19, TMS 402, TMS 602, AISC 360-16, SJI 100-20, and SDI RD-2017.

Planned construction materials of the maintenance building include a steel-framed roof and steel-framed mezzanine supported on concrete or masonry walls and concrete slab and foundation. Gravity and lateral loads will be calculated and applied to an FEM to determine required framing sizes and spacing, wall thickness and reinforcing, slab thickness and reinforcing, foundation dimensions and reinforcing, and further details. As-needed equipment anchorage and support will be designed per ACI 318-19. The roof decking will function as a structural diaphragm and the walls will function as “special reinforced shear walls” and be designed per ASCE 7-16 and ACI 318-19 or TMS 402.

9.10 Parking and Storage Canopy

Structural design of the parking and storage canopy will be performed according to IBC 2021, ACI 318-19, AISC 360-16, SJI 100-20, and SDI RD-2017.

Planned construction materials of the parking and storage canopy include a steel-framed roof supported on a concrete slab and foundation. Gravity and lateral loads will be calculated and applied to an FEM to determine required framing sizes and spacing, wall thickness and reinforcing, slab thickness and reinforcing, foundation dimensions and reinforcing, and further details. The roof slab will function as a structural diaphragm; the canopy will be designed using cantilever columns per ASCE 7-16, AISC 360, and AISC 341.

10 Electrical Design

CKTP includes electrical system modifications for existing systems and facilities, including the relocation of existing electrical components and equipment. The modifications and improvements to the electrical system are described in this section.

A double-ended motor control center (MCC) will be installed at each of the following locations: thickening building, FOG building, and digester control building. Each of these areas will have an electrical room and each MCC will be installed in the associated electrical room. The MCCs are configured such that scheduled maintenance will not result in full MCC shutdowns; each of the two MCC sections can be shut down independently of each other.

For maintenance building electrical design refer to Section 10.4.

10.1 System Design and Design Criteria

This section presents electrical system design and design criteria for the project.

10.1.1 Electrical Service and Utility Coordination

The existing service from Puget Sound Energy (PSE) for CKTP will remain in place as is. The existing service is received from PSE at 12.47 kilovolts (kV) at switchgear (SWGR) 2940, which was installed as part of the 2016 Resource Recovery project.

A new PSE service will be established for the new maintenance building and will originate from a utility pole on Brownsville Highway. Refer to Section 10.4.

10.1.2 Electrical Distribution System Overview

SWGR 2940 distributes power to SWGR 2950 and SWGR 2970, and SWGR 2940 has a spare fused disconnect section, originally intended for MCC 8902 for reclaimed-water pumping.

SWGR 2970 receives 12.47 kV power from SWGR 2940 and distributes power to two 2,000-kilovolt-ampere (kVA), 12,470-volt (V)–480-wye (Y)/277 V transformers (TFR 2953 and TFR 2954) via fused disconnect switches. Each transformer feeds one side of SWGR 2961. SWGR 2961 is located in the existing SPB.

See Appendix G for a partial CKTP one-line diagram showing existing distribution for SWGR 2970 and SWGR 2961 and proposed modifications to SWGR 2961.

A new standby generator will be added to Bus A of SWGR 2961. SWGR 2961 will feed the new MCCs. Three new MCCs are proposed: thickening MCC, digester control MCC, and FOG and septage MCC. The new MCCs will be split bus, with each side of each new MCC being fed from each side of SWGR 2961.

10.1.3 Electrical Loads

Additional electrical loads are anticipated in each process associated with this project. See individual sections for proposed loads.

10.1.4 Standby Power

The existing 600-kilowatt (kW) generator (GEN 2996) is located east of the existing shop and maintenance building; this generator is proposed to be moved to the area around HH361 and HH313 to the south of the SPB.

The new standby generator output will be routed through existing automatic transfer switch (ATS)-1 in the existing SWGR 2961. The new standby generator is proposed to be 600 kW to match the existing generator. Record drawings suggest that this new generator should be tagged as GEN 2997. It is proposed to locate this new generator next to the relocated GEN 2996.

10.1.5 Uninterruptible Power Supply

Control system components including SCADA computers, programmable logic controllers (PLCs), and essential control and instrumentation equipment will be powered from an uninterruptible power supply (UPS) so that the associated components always have power. UPSs will be designed to carry the estimated load for 20 minutes. UPSs are to provide continuous power to essential control system equipment during brief power outages and/or until the standby generator comes online. Each control panel will have a UPS. SCADA servers will have a rack-mounted UPS. Each SCADA human-machine interface (HMI) workstation will have desktop UPS.

10.1.6 Codes and Standards

The design will be in conformance with adapted codes of the Authority Having Jurisdiction. The following codes and standards latest edition are applicable to this project:

- NFPA 70: NEC, 2014
- Institute of Electrical and Electronics Engineers (IEEE) C2, National Electrical Safety Code
- Illuminating Engineering Society (IES) *Lighting Handbook*
- National Electrical Manufacturers Association (NEMA)
- NEMA MG1, Motors and Generators
- Life Safety Code, NFPA-101-HB85
- American National Standards Institute (ANSI)
- National Electrical Contractors Association (NECA) “Standards of Installation”
- IEEE
- International Society of Automation (ISA)
- Insulated Cable Engineers Association (ICEA)
- Occupational Safety and Health Act (OSHA)
- National Electrical Testing Association (NETA)

- ASTM
- Underwriters Laboratories, Inc. (UL)
- Factory Mutual
- IBC
- WSEC
- NFPA 820

10.1.7 Raceways and Conduits

The minimum size for conduits will be 3/4 inch for interior applications and 1 inch for buried or in duct bank applications. Duct banks will be marked with traceable warning tape located above the duct bank. Roughly 20 percent spare conduits will be provided in duct banks or a minimum of one of each size in the duct bank section.

10.1.8 Boxes, Panels, and Cabinets

Enclosures will be provided based on the location and environmental conditions. See Table 10-1 and Table 10-2 below.

10.1.9 Duct Banks and Separation

Duct banks will be encased in red-dyed concrete and the concrete will be reinforced under roadways and driveways.

Separation will be maintained between power and signal/communications/control systems as required by good engineering practice or code provisions.

10.1.10 Wire and Cable

Copper conductors will be provided for branch circuit wiring and feeders.

Conductors will be constructed from stranded copper and include a 600 V type cross-linked polyethylene high heat-resistant water-resistant-2 (XHHW-2) insulation. Multi-conductor control cables will include No. 14 American Wire Gauge (AWG) conductors with 600 V type XHHW-2 insulation and a common PVC outer jacket. Cables for analog signals will be of the twisted shielded pair (TSP) type and include 600 V insulation and aluminum/synthetic polymer shield, drain wire, and PVC outer jacket. Conductors for VFD-driven motors shall be 600 V type, multi-conductor, shielded power cable to mitigate electromagnetic interference with adjacent wiring circuits.

10.1.11 Material Application and Area Environmental Schedules

Table 10-1 establishes requirements for a given designation. Not all designations are used in this project. Table 10-2 defines the designation for each area of this project. Table 10-1 in conjunction with Table 10-2 show the requirements for each area.

Table 10-1. Material application schedule

Designation	NEMA 250 enclosure type (including pull and junction boxes)	Conduit material	Outlet and device boxes, mounting plates, and fittings	Mounting hardware	Notes
Indoor hazardous areas	7, suitable for classification	RAC	Cast Aluminum	316 stainless steel	
Wet, corrosive areas	4X, metallic	RAC	Cast Aluminum	316 stainless steel	
Chemically corrosive to metals	4X, nonmetallic	PVC	Nonmetallic	Nonmetallic	
Hazardous and corrosive areas	7 or 4X, suitable for classification	RAC	Cast Aluminum	316 stainless steel	
Wet, indoors	4	RAC	Cast Aluminum	316 stainless steel	
Dry industrial	12	RAC	Cast Aluminum	Galvanized	
Dry, indoor, unfinished	12	RAC	Cast Aluminum	Galvanized	Route conduit concealed where noted
Dry, indoor, finished	1	EMT	Sheet metal	Galvanized	Route conduit concealed
Nonhazardous exterior areas	3R	RAC	Cast Aluminum	316 stainless steel	
Wet, damp exterior area	4X	RAC	Cast Aluminum	316 stainless steel	
Hazardous exterior areas	7 or 4, suitable for classification	RAC	Cast Aluminum	316 stainless steel	
Underground, underslab, or concrete-encased	N/A	PVC	N/A	N/A	

Table 10-2. Area environmental designation and classification schedule

Facility	Room/area	Designation	Notes or exceptions
PS and septage thickening building	Electrical room	Dry, indoor, unfinished	Unclassified See Section 7.1
	Polymer room	Wet, corrosive	Unclassified See Section 7.1
	Thickener (RDT) room	Hazardous and corrosive	Class I, Division 2 See Section 7.1 for NFPA 820 reference and ACH
FOG building	FOG room	Hazardous and corrosive	Class I, Division 2 See Section 7.1 for NFPA 820 reference and ACH
	Utility hot water room	Wet, indoors	Unclassified See Section 7.1
	Electrical room	Dry, indoor, unfinished	Unclassified See Section 7.1
Miscellaneous	Exterior spaces	Wet, exterior	Unclassified
	Site	Underground, underslab, or concrete-encased	Unclassified
Digesters 1 and 2 pump building	Roof level stairway doghouse	Wet, corrosive	See Section 7.1 for NFPA 820 reference and ACH
	Mid level	Wet, corrosive	Unclassified See Section 7.1 for NFPA 820 reference and ACH
	Lower level	Wet, corrosive	Unclassified See Section 7.1 for NFPA 820 reference and ACH
Digesters 3 and 4 pump building	Roof level stairway doghouse	Wet, corrosive	See Section 7.1 for NFPA 820 reference and ACH
	Mid level	Wet, corrosive	Unclassified See Section 7.1 for NFPA 820 reference and ACH
	Lower level	Wet, corrosive	Unclassified See Section 7.1 for NFPA 820 reference and ACH
Digester 1	Inside digester	Hazardous and corrosive	Class I, Division 1 NFPA 820-2024 Table 6.2.2(a), Row 16, Line a

Facility	Room/area	Designation	Notes or exceptions
	Envelope extending vertically 10 ft up from top of digester tank cover and 5 ft horizontally from any wall	Hazardous and corrosive	Class I, Division 1 NFPA 820-2024 Table 6.2.2(a), Row 16, Line a
	Envelope extending beyond Class I Division 1 envelope by an additional 15 ft vertically and 5 ft horizontally	Hazardous and corrosive	Class I, Division 2 NFPA 820-2024 Table 6.2.2(a), Row 16, Line b
Digester 2	Inside digester	Hazardous and corrosive	Class I, Division 1 NFPA 820-2024 Table 6.2.2(a), Row 16, Line a
	Envelope extending vertically 10 ft up from top of digester tank cover and 5 ft horizontally from any wall	Hazardous and corrosive	Class I, Division 1 NFPA 820-2024 Table 6.2.2(a), Row 16, Line a
	Envelope extending beyond Class I Division 1 envelope by an additional 15 ft vertically and 5 ft horizontally	Hazardous and corrosive	Class I, Division 2 NFPA 820-2024 Table 6.2.2(a), Row 16, Line b
Digester 3	Inside digester	Hazardous and corrosive	Class I, Division 1 NFPA 820-2024 Table 6.2.2(a), Row 16, Line a
	Envelope extending vertically 10 ft up from top of digester tank cover and 5 ft horizontally from any wall	Hazardous and corrosive	Class I, Division 1 NFPA 820-2024 Table 6.2.2(a), Row 16, Line a
	Envelope extending beyond Class I Division 1 envelope by an additional 15 ft vertically and 5 ft horizontally	Hazardous and corrosive	Class I, Division 2 NFPA 820-2024 Table 6.2.2(a), Row 16, Line b
Digester 4	Inside digester	Hazardous and corrosive	Class I, Division 1 NFPA 820-2024 Table 6.2.2(a), Row 16, Line a
	Envelope extending vertically 10 ft up from top of digester tank cover and 5 ft horizontally from any wall	Hazardous and corrosive	Class I, Division 1 NFPA 820-2024 Table 6.2.2(a), Row 16, Line a
	Envelope extending beyond Class I Division 1 envelope by an additional 15 ft vertically and 5 ft horizontally	Hazardous and corrosive	Class I, Division 2 NFPA 820-2024 Table 6.2.2(a), Row 16, Line b

Facility	Room/area	Designation	Notes or exceptions
CST	Inside tank	Hazardous and corrosive	Class I, Division 1 NFPA 820-2024 Table 4.2.2, Row 32, Line a
	Envelope extending 3 ft from any tank vent	Hazardous and corrosive	Class I, Division 1 NFPA 820-2024 Table 4.2.2, Row 32, Line a
	Envelope extending beyond Class I Division 1 tank vents by an additional 5 ft	Hazardous and corrosive	Class I, Division 2 NFPA 820-2024 Table 4.2.2, Row 32, Line b
	Envelope extending 3 ft from any non-vent opening in the tank	Hazardous and corrosive	Class I, Division 2 NFPA 820-2024 Table 4.2.2, Row 32, Line b
Digester control building	Boiler room	Dry industrial	Unclassified See Section 7.1
	Electrical room	Dry, indoor, unfinished	Unclassified See Section 7.1
Septage EQ tank	Septage EQ Tank 1 (interior, below-grade)	Hazardous and corrosive	Class I, Division 1 NFPA 820-2024 Table 4.2.2, Row 4, Line a
	Envelope extending 10 ft from open tank or open channel	Hazardous and corrosive	Class I Division 2 NFPA 820-2024 Table 4.2.2, Row 4, Line c
	Envelope extending 10 ft from equipment	Hazardous and corrosive	Class I Division 2 NFPA 820-2024 Table 4.2.2, Row 4, Line c
	Septage EQ Tank 2 (interior, below-grade)	Hazardous and corrosive	Class I, Division 1 NFPA 820-2024 Table 4.2.2, Row 4, Line a
	Envelope extending 10 ft from open tank or open channel	Hazardous and corrosive	Class I Division 2 NFPA 820-2024 Table 4.2.2, Row 4, Line c
	Envelope extending 10 ft from equipment	Hazardous and corrosive	Class I Division 2 NFPA 820-2024 Table 4.2.2, Row 4, Line c
In-plant wastewater pump station	In-plant wastewater pump station (interior)	Hazardous and corrosive	Class I, Division 1 NFPA 820-2024 Table 4.2.2, Row 14, Line a

Facility	Room/area	Designation	Notes or exceptions
	Envelope extending vertically 18 in. from opening (hatch) and 3 feet horizontally from opening (hatch)	Hazardous and corrosive	Class I, Division 2 NFPA 820-2024 Table 4.2.2, Row 14, Line b
Solids-processing building (existing)	Electrical room	Dry, indoor, unfinished	Unclassified
	Control room	Dry, indoor, unfinished	Unclassified
Power/blower building (existing)	Electrical room	Dry, indoor, unfinished	Unclassified
Odor control: thickening	Envelope 3 ft or less from leakage sources such as fans, dampers, flexible connections, flanges, pressurized unwelded ductwork, and odor control vessels	Hazardous and corrosive	Class I, Division 2 NFPA 820-2024 Table 4.2.2, Row 18, Line e
	Envelope more than 3 ft from leakage sources such as fans, dampers, flexible connections, flanges, pressurized unwelded ductwork, and odor control vessels	Wet, exterior	Unclassified NFPA 820-2024 Table 4.2.2, Row 18, Line f
Odor control: FOG	Envelope 3 ft or less from leakage sources such as fans, dampers, flexible connections, flanges, pressurized unwelded ductwork, and odor control vessels	Hazardous and corrosive	Class I, Division 2 NFPA 820-2024 Table 4.2.2, Row 18, Line e
	Envelope more than 3 ft from leakage sources such as fans, dampers, flexible connections, flanges, pressurized unwelded ductwork, and odor control vessels	Wet, exterior	Unclassified NFPA 820-2024 Table 4.2.2, Row 18, Line f
Odor control: centrate	Envelope 3 ft or less from leakage sources such as fans, dampers, flexible connections, flanges, pressurized unwelded ductwork, and odor control vessels	Hazardous and corrosive	Class I, Division 2 NFPA 820-2024 Table 4.2.2, Row 18, Line e
	Envelope more than 3 ft from leakage sources such as fans, dampers, flexible connections, flanges, pressurized unwelded ductwork, and odor control vessels	Wet, exterior	Unclassified NFPA 820-2024 Table 4.2.2, Row 18, Line f

10.1.12 Variable-Frequency Drives

Six-pulse VFDs with input line reactors and active harmonic filters will be provided.

VFDs will be housed in the MCC or in NEMA 1 rated, free-standing enclosures.

10.1.13 Motors and Motor Control Centers

Three-phase motors rated at 480 V will normally be provided on all motors 1/2 hp and greater. Other voltage and phase configurations may be evaluated during final design to accommodate equipment as needed. High-efficiency motors will be required. Where motors are driven by VFDs, they will be required to be inverter duty rated.

MCCs will include motor starters, VFDs, breakers, panelboards, transformers, surge protection devices, power monitoring, and other devices as required for motor control and power distribution.

10.1.14 Pilot Devices

Pilot devices will be 30-millimeter (mm) size.

Provide push buttons according to the following convention:

- Red for STOP or OPEN
- Black for START or CLOSE

Indicator lights will be light-emitting diode (LED) type.

Provide indicator lights according to the following convention:

- Green for STOP or CLOSED
- Red for RUNNING or OPEN
- Amber for FAULT

10.1.15 Local Disconnects

Local disconnects will be provided at the equipment powered from MCCs. A power disconnect switch will be provided for HVAC equipment located at the equipment. Disconnects will be fused if required by the equipment manufacturer to maintain UL listing of the equipment.

Where equipment is VFD-driven, the use of a local disconnect will be individually evaluated during final design.

10.1.16 Panelboards

Panelboards will be used for the distribution and protection of branch circuits to receptacles, lights, and other low-voltage loads. Thermal magnetic circuit breakers will be used.

Panelboards will be 3-phase unless otherwise required by equipment served.

10.1.17 Power System Analysis and Arc Flash Study Labeling

The contractor will be required to update the County's Arc Flash Study and Protective Device Coordination Study for new electrical equipment installed. New electrical equipment will be required to carry arc flash labeling.

10.1.18 Grounding

For new structures and buildings, provide a ground ring ground system around the foundation in accordance with the NEC.

10.1.19 Lighting

To the greatest extent possible, energy-saving LED fixtures will be provided suitable for the application.

Emergency illumination will be provided in all appropriate spaces as required by code to ensure life safety, property, and equipment protection. "Bug-eye" type LED lights will be provided for emergency illumination. Battery backup capable of sustaining egress lighting for 90 minutes will be provided for the emergency lights.

10.1.20 Surge Suppression

Surge protection devices will be provided at each of the following power distribution equipment locations within the electrical system: switchboard, MCC, and panelboard.

10.1.21 Seismic Criteria

The project will comply with IBC seismic criteria for electrical equipment, anchorage, support, and bracing.

10.1.22 Identification

The project will use I&C system loop tag numbers for all motors, I&C system devices, and process equipment. Major electrical equipment will be designated with unique identification equipment designations. The specifications will require the contractor to label each cable and conduit.

10.1.23 Power Monitoring

Each of the new MCCs will be provided with an integral power monitor for each power feed.

10.2 Special Electrical Systems

This section presents electrical design for special electrical systems for the project, including the communications and fiber-optic systems.

10.2.1 Communications System

No telephone or paging communication system will be provided for the thickening, FOG and septic, and digester control buildings.

10.2.2 Fiber-Optic Network System

The existing fiber-optic network is used for Ethernet communications of the process control equipment. This includes communications between PLCs, and the HMI workstations. The fiber-optic network will be expanded to connect new process control equipment.

10.3 Equipment Sole-sourcing and Preferences

This section presents electrical equipment sole-sourcing and preferences for the project, including the switchgear, switchboard, MCCs, VFDs, generators, ATSs, and panelboards.

10.3.1 Switchgear

The County does not have any sole-source arrangements or preferences regarding switchgear.

10.3.2 Switchboard

The County does not have any sole-source arrangements or preferences regarding switchboards.

10.3.3 Motor Control Centers

MCCs shall be Allen-Bradley 2100. This is necessary to maintain consistency with the selected drives system (VFD) discussed in the following section.

10.3.4 Variable-Frequency Drives

VFDs shall be Allen-Bradley PowerFlex 753 series. This is necessary to maintain consistency with existing equipment and to provide a drive system that plant staff are trained to repair and can more readily maintain (including spare parts).

10.3.5 Generators

Generators shall be Cummins and operate on diesel fuel. This is necessary to maintain consistency with existing equipment and to provide equipment that plant staff are familiar with and can reliably maintain.

10.3.6 Automatic Transfer Switches (ATS)

The County does not have any sole-source arrangements or preferences regarding ATSs.

10.3.7 Panelboards

The County does not have any sole-source arrangements or preferences regarding panelboards.

10.4 Maintenance Building

The electrical system for the maintenance building will be designed to provide a suitable working environment for office space and to conduct inspections, do repairs, and complete testing of equipment (see Appendix D for planning layout of the facility). The maintenance building estimated area is 19,000 ft^2 in Phase 1, and will increase in future Phases 2 and 3 to about 44,000 ft^2.

For the maintenance building, the electrical loads served by the new service transformer(s), new secondary service feed, and new service entrance equipment will be in the following spaces:

- Central drive-through welding
- Fabrication shop area
- Mechanics shop area
- Multi-purpose shop
- Maintenance and operation specialist room
- SCADA control room
- Office areas
- Visitors' entrance
- Locker rooms
- Break room
- Central shop area
- Restrooms
- Main electrical room
- Electrical room(s)
- Mechanical room(s)
- Information technology (IT)/server/communications room
- Miscellaneous storage rooms

10.4.1 Building Interior Electrical System

Design of the electrical system will eliminate single point of failure to the extent possible to minimize downtime of this facility.

Location of the electrical equipment in shop areas will be based on large loads and its power source being close to reduce the number and length of conduit runs.

10.4.2 Main Electrical Room

New service entrance switchgear rated 480/277 V, four-wire, 60 hertz (Hz), located in the main electrical room, will receive power from the new pad-mounted outdoor service transformer via concrete-encased duct bank. The size of this transformer will be determined by the County based on information in the service application and the summary of the maintenance building loads to be developed during design.

An ATS with bypass will allow transferring critical building loads to a standby generator to ensure occupants' life and safety and to continue operations. A minimum of 48 hours of critical load protection will be provided by the standby generator fuel storage.

10.4.3 Building Critical Loads

For the purposes of this report, the building critical loads (which would need to be maintained during a power loss) are assumed to be as follows:

- UPS
- Central Emergency Lighting System (CELS)
- IT Communications Equipment and Network Equipment
- Security System
- Fire Detection and Alarm System
- Fire Suppression System.

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11 Instrumentation and Control Design

This section describes I&C design standards, criteria, control schemes, and new or modified process control for this project.

11.1 General Design Standards and Criteria

The intention of the I&C installed in CKTP is to monitor and control the process. There are various types of instrumentation (mostly installed in-pipe to monitor the process directly), while controls consist mostly of valves and motors to open/close or start/stop to allow or deny the process to proceed, as well as the electronics that process what is going on. Details and general preferences for both instrumentation and controls are called out below.

11.1.1 Instrumentation

Various instruments will be required to monitor the process. The County has expressed a preference for certain types of instruments in certain places. See Appendix K for details on County's instrumentation requirements.

11.1.2 Control Systems

The primary component of the control systems at CKTP will be PLCs. The County has standardized on Rockwell Automation's CompactLogix PLCs using model 1769-L33ER processors as its main processor. The County's preference is to use solely full PLC racks, with no RIO racks. See Appendix K for details on the County's control system hardware preferences. Deviations from the client's preferred PLC hardware are likely based on preliminary design, though they will be minimized to the extent possible.

The overall preference is that each major building or process will be monitored and controlled by an individual PLC. Table 11-1 shows quantity and naming of the proposed PLCs. Currently, there would be a total of nine new PLCs, though it is likely that some of these will change.

Table 11-1. Proposed PLC names and locations

PLC number	Location	Purpose
PLC-100	Maintenance building	Maintenance building monitoring and control
PLC-510	Septage and FOG building	Septage and FOG monitoring and control
PLC-550	Thickening building	Thickening building monitoring and control
PLC-610	Digesters 1 and 2	Digesters 1 and 2 valve and instrumentation monitoring and control
PLC-611	Digester control building	Digesters 1 and 2 motor monitoring and control
PLC-630	Digesters 3 and 4	Digesters 3 and 4 valve and instrumentation monitoring and control

PLC number	Location	Purpose
PLC-631	Digester control building	Digesters 3 and 4 motor monitoring and control
PLC-680	Digester control building	Digester control building monitoring and control
PLC-700	Centrate storage	Centrate storage monitoring and control

PLC Cabinets

Each new PLC shall be enclosed in a standard enclosure sufficiently large to hold the PLC and all associated equipment. Temperature rise calculations shall be performed, and ventilation or air conditioning shall be provided on each PLC cabinet to limit the temperature rise.

Enclosures

Each PLC provided shall be within an enclosure made of stainless steel. Each enclosure shall be rated appropriately for the location—NEMA 4 for any exterior cabinet and NEMA 12 for any interior cabinet. Enclosures shall include a data pocket to hold drawings for that enclosure and shall have a heat- and oil-resistant door seal with a heavy-gauge hinge running the full height of the enclosure.

Network Connection

PLC cabinets will have a small managed network switch mounted within them. If the distances called for require it, a small fiber patch panel to terminate fiber-optic communications cables may be added. Detailed design will call out requirements for each PLC cabinet.

Intrusion Detection

Each PLC cabinet will be equipped with intrusion detection switches that will activate when the cabinet is opened. The operator will be able to disable the associated alarm for a set period in SCADA, but after the set period, the alarm will be re-enabled automatically.

Backup Power

Each new control panel will be provided with a UPS. The UPS will be sized to provide power for the total connected load as follows:

- **Less than 450-watt (W) load** to be supplied with 700 W rated model
- **450–1,200 W load** to be supplied with 1,500 W rated model
- **Greater than 1,200–2,200 W load** to be supplied with 3,000 W rated model

Remote monitoring of the UPS systems will be handled via both a network connection and hardwired signals. The network connection will be to power monitoring software or SCADA, while the three hardwired signals will go to the PLC it powers. The three hardwired signals shall consist of the following: UPS on battery power, UPS failure or bypass, UPS battery low.

System Communications

Process-critical controls shall be communicated over hardwired connections. Network communications will be allowed only in circumstances where both devices communicate over the same network protocol, and even then, it should be used solely for supplemental data, not for process control. All network communications shall take place over standard Ethernet or fiber-optic network hardware—no serial network connections will be allowed.

Variable-Frequency Drives and Soft Starters

VFDs and network-connected soft starters will communicate with the CKTP control system though both hardwired and networked communications. Process-critical communications (including all equipment commands and basic monitoring) will happen solely over hardwired connections to the CKTP PLC. Network communications will be reserved for non-critical monitoring, specifically including data like energy or power usage and alarm and warning data. All network communications shall be over a network protocol that is understood by both the device communicating (the VFD or soft starter) and the PLC.

Vendor Packages

Network communications for vendor packages will be limited to non-process-critical information such as equipment statuses and alarms. All process-critical information (such as measured process variables, for example) will be sent over hardwired connections to the local CKTP PLC.

UPS and Power Quality Monitors

UPSs and power quality monitors will be equipped with network connections to allow them to connect to a dedicated power monitoring network. They shall be isolated from the normal industrial control system network, and the only information the PLCs shall know about them will be via hardwired connections to PLC input/output (I/O).

Control System Workstations

Each new building shall be equipped with a SCADA workstation that allows operators to view and control the entirety of the SCADA system. Each SCADA workstation shall consist of a standard workstation computer, a UPS backup sized for at least 30 minutes of runtime, and whatever communications equipment is necessary for the SCADA workstation to communicate with the rest of the plant.

11.1.3 Networking Segmentation

Devices communicating over the network at CKTP will be highly segmented into several networks. There will be a minimum of three separate networks—the management, power monitoring, and industrial control system networks. In addition, each individual PLC may have its own isolated network to communicate with VFDs or other local network-enabled equipment. When possible, network communications shall take place over a network using a redundancy network technology such as a device level ring. See Appendix K and network diagrams for details on network segmentation.

11.2 Control Schemes

This section describes I&C control schemes for this project, including process control narratives (PCNs) and equipment controls.

11.2.1 Process Control Narratives

During design, the engineer shall develop (in consultation with the County) a PCN for each process within CKTP. This PCN shall define how the process equipment will respond to changing process conditions, under what conditions alarms will be annunciated, software interlocks, and similar details of how devices are controlled. A short description of Remote-Auto control for each area is provided in the subsections of Section 11.3 below—more thorough versions will be developed as part of detailed design.

A detailed process control description will consist of the following sections, at minimum:

- Brief overview of the system being controlled
- Remote-Manual control
- Remote-Auto control
- Local control
- Interlocks (software and hardwired)
- Alarms

11.2.2 Equipment Controls

Most process equipment will be controlled from one of two places—either directly in front of the equipment (called “locally”) or remotely through the SCADA system. To determine which mode is active for a piece of equipment, most process equipment will be equipped with hand switches that determine the mode for that piece of equipment. For valves, these hand switches are called OPEN/CLOSE/REMOTE (OCR) switches, while for motors they are called HAND/OFF/AUTO (HOA) switches. Vendor control panels will be equipped with similar switches, though the switch may apply to the entirety of the vendor package rather than individual pieces of equipment with it, as specified for each vendor.

Valves: OPEN/CLOSE/REMOTE

Valves that can respond to commands from the PLC will be equipped with an OCR switch. If a valve is not equipped to respond to commands from the PLC (it is hand-actuated or has only limit switches installed, for example) it will NOT be equipped with an OCR switch.

OCR Switch: OPEN Position

When the OCR switch is in the OPEN position, the valve will continuously move toward the opened position until it is fully opened, at which point it will remain opened. The PLC will be unable to control the valve when the OCR switch is in OPEN, and the operator who moves the switch to OPEN will have full control and responsibility for operation of that valve.

OCR Switch: CLOSE Position

When the OCR switch is in the CLOSE position, the valve will continuously move toward the closed position until it is fully closed, at which point it will remain closed. The PLC will be unable to control the valve when the OCR switch is in CLOSE, and the operator who moves the switch to CLOSE will have full control and responsibility for operation of that valve.

OCR Switch: REMOTE Position

When the OCR switch is in the REMOTE position, the PLC has full control of the valve. PLC control will be provided with both automatic and manual control modes for the operator to control the equipment remotely.

Remote automatic control, when selected by the operator at the SCADA HMI, will control the equipment automatically as defined by the applicable control narrative.

Remote manual control, when selected by the operator at the SCADA HMI, will allow the operator to assume full responsibility for starting and stopping of the equipment identical to the controls provided for local control at the equipment.

Motors: HAND/OFF/AUTO

Motors that can respond to commands from the PLC will be equipped with an HOA switch. Motors that cannot respond to commands from the PLC will not be equipped with and HOA switch, though this is anticipated to be rare.

HOA Switch: HAND Position

When the HOA switch is in the HAND position, the motor will run and remain running so long as the HOA switch remains in the HAND position. If the motor is equipped with a VFD to vary the speed of the motor, the operator will be able to vary the speed of the motor by changing settings on the HMI module of the VFD. The PLC will be unable to control the motor when the HOA switch is in HAND, and the operator who moves the switch to HAND will have full control and responsibility for operation of that motor. The sole exception to this is hardwired interlocks—if a hardwired interlock activates, the motor will stop even if the HOA switch is in the HAND position.

HOA Switch: OFF Position

When the HOA switch is in the OFF position, the motor will stop and remain stopped. The PLC will be unable to control the motor when the HOA switch is in OFF, and the operator who moves the switch to OFF will have full control and responsibility for operation of that motor.

HOA Switch: AUTO/REMOTE Position

In the AUTO or REMOTE switch position, the PLC has full control of the motor, including speed of the motor if it is equipped with a VFD. PLC control will be provided with both automatic and manual control modes for the operator to control the equipment remotely.

Remote automatic control, when selected by the operator at the SCADA HMI, will control the equipment automatically as defined by the applicable control narrative.

Remote manual control, when selected by the operator at the SCADA HMI, will allow the operator to assume full responsibility for starting and stopping of the equipment identical to the controls provided for local control at the equipment.

Vendor Panels

Vendor-supplied equipment will be specified to match project I&C standards. Any exception for allowing non-standard equipment will require approval by the County during final design. Primary control of the equipment will be provided by the area PLC unless a PLC is part of the standard control package from a vendor for its equipment. When a vendor-supplied PLC is provided, communications with the SCADA system will occur directly via Ethernet communications and not be routed through an area PLC.

Emergency Shutdown

At various points throughout CKTP (as determined during detailed design) there will be Emergency Shutdown (also called E-Stop) buttons. Operation of any of these buttons will cause all equipment associated with that shutdown button to immediately move to a minimum energy state and cease otherwise functioning. Manual reset of the switch will be required to resume normal operation of equipment.

An example of this would be an Emergency Shutdown button at the entrance to a boiler room—if an operator noticed that something was extremely wrong with the boiler, he/she could press the E-Stop button on his/her way out the door to ensure that the boiler shut down immediately.

Interlocks

Interlocks are conditions that override normal process control for equipment. There are two types: hardwired and software.

Hardwired Interlocks

Interlocks that are deemed critical to the protection of the equipment and personnel will be hardwired to the motor control circuits. Isolation contacts will be used to transmit the critical interlocks to the PLC for monitoring and alarming. Upon activation, the piece of equipment that is interlocked will immediately cease functioning.

Software Interlocks

Interlocks that are deemed non-critical to the protection of the equipment and personnel will be wired to the PLC. Within the PLC, software will turn off the associated piece of equipment, regardless of remote auto or remote manual commands. All interlocks will be displayed on the SCADA system to explain why the equipment is no longer functioning.

Duty/Standby Equipment

In multiple places throughout CKTP, equipment is designed for a DUTY/STANDBY operation. DUTY/STANDBY is an arrangement in which if any equipment is called to run, the DUTY equipment will start and operate as the process requires. If at any point during that operation the DUTY equipment fails and stops, the STANDBY pump will immediately start running in its place to ensure continuity of the process. If required, the operator can choose how and when the DUTY/STANDBY designations are assigned to equipment. There are several possible control schemes regarding when DUTY/STANDBY is determined:

- **Manual:** The operator will designate a piece of equipment as DUTY and another one as STANDBY. Assignments will not change automatically.
- **Alternation:** When all equipment stops, the DUTY/STANDBY designation automatically changes. This helps to ensure that the pumps have the same number of starts on them.
- **Runtime:** When all equipment stops, the piece of equipment with the lowest number of runtime hours will be designated the DUTY equipment, and the other will be designated STANDBY. This also helps to ensure that runtime is spread fairly evenly across equipment.
- **Time-based:** When a timer has gone off (for example, once per day at midnight), the DUTY and STANDBY assignments change. This can be helpful for equipment that would not otherwise shut down to allow alternation, such as hot water circulation pumps.

The advantages to using an automatic DUTY/STANDBY designation include the following:

- Helps to ensure process uptime with minimal operator intervention, despite equipment failure
- Helps to even out equipment starts and runtimes across all available equipment

Despite the advantages of DUTY/STANDBY designations, they can be used only when both pieces of equipment are physically set up to pump to the same destination. In addition, piping and valving must be set up to allow both pieces of equipment to start up at any time.

11.3 New or Modified Processes

This section describes controls strategies for new or modified processes for this project.

11.3.1 Existing Digesters (Digesters 1 and 2)

The existing digesters are being overhauled significantly, including new mixing equipment, transfer pumps, motor-controlled valving, and HEX systems.

Digester Instrumentation

Each digester is equipped with various instruments to monitor it. This includes both ultrasonic and pressure-based level detection and pressure monitoring within the headspace of the digester. If desired, alarms can be set off when the two level transmitters differ from each other by more than a set amount. This would indicate either a transmitter failure or a buildup of foam within the digester, either of which would require operation attention.

Each digester is also equipped with both vacuum and overpressure relief valves to ensure that the pressure within the headspace stays within acceptable ranges.

Digester Valving

Flow into each digester can come from any or all of several sources, including the FOG building, WAS thickeners, clarifier scum box, sludge-thickening building, or even other digesters. All but the flow from other digesters has a valve that determines whether that flow is allowed into the digester. Each source of sludge will select which digester will receive flow from that source.

For each digester, an operator enters various set points concerning influent flows. For each valved influent flow (FOG, TWAS, clarifier scum, thickened sludge), the operator will either ALLOW or DENY flow from that source for each digester. In addition, if an operator designates a digester as OUT OF SERVICE, all influent valves to that digester shall close and all operator selections shall be set to DENY.

The PLC shall review the operator selections for each type of digester influent and sum them up in a permission signal that is sent to the source of that flow. For example, if none of the digesters were set to allow flow from the TWAS system, the digester PLC would deny the TWAS PLC permission to pump to the digesters. An alarm would also be sounded to notify operators that TWAS did not have an appropriate destination.

Digester Heat Exchangers

Recirculation pumps are variable speed, and they provide sludge flow through the HEX. It is anticipated that the VFDs on the recirculation pumps will be used solely to tweak flow rates slightly – no automatic speed control is currently planned.

Each digester is equipped with a recirculation pump, hot water supply pump, and HEX. DIG from the digester is pumped through the HEX, where heat from the hot water provided by the boilers raises the temperature of the sludge going through the HEX. The inlet and outlet temperature of both the sludge and hot water is monitored to enable efficiency calculations for the HEX. Temperature control is achieved using a three-way valve on the hot water line. If the sludge leaving the HEX is too cool, the three-way valve diverts a little more hot water to the HEX. If the sludge leaving the HEX is too warm, the three-way valve diverts a little less hot water to the HEX. In all circumstances, the hot water supply pump runs. If the three-way valve is entirely open, the HEX is fed with 100% “new” hot water from the boilers. If the three-way valve is entirely closed, the HEX is fed with 100% recycled water from the discharge of the HEX.

If required, piping is in place to allow the recirculation pump from Digester 1 to pump to either Digester 1 or Digester 2. Similarly, piping is in place to allow the HEX for Digester

1 to supply heat to the recirculated sludge for Digester 1 or Digester 2. It is not anticipated that this will be used during normal operations, but it can be used in the case of equipment failure.

The sludge recirculation pumps that provide DIG to the HEXs will modulate the flow rate of the sludge to maintain a specified discharge temperature on the HEX associated with that recirculation pump, per the operator Direct or Indirect selection. If the temperature of the sludge entering the HEX is above an operator set point, the VFD will shut off and recirculation will stop. This is intended to prevent overheating of the DIG.

Digester Mixing Equipment

Digesters 1 and 2 are together equipped with a total of three mixing pumps, which take DIG from the digester and force it through several mixing nozzles within the digester. Four mixing nozzles are always in use and one mixing nozzle is controlled by a control valve, called a “foam buster” nozzle. The operator will enter a time of day and duration, and the control valve on the foam buster nozzle will open at that time and stay open for that duration.

Mixing Pump 1 will be dedicated to Digester 1 and Mixing Pump 3 will be dedicated to Digester 2, while the swing Mixing Pump 2 can be assigned by the operator to either Digester 1 or Digester 2. There is no automatic alternation—if a mixing pump fails, an operator must confirm that valving has been changed before reassigning the swing pump to cover the failed pump.

During normal operation, only two mixing pumps will operate, and they will modulate speed to provide an operator-entered flow rate to each digester. If a foam buster nozzle is being used on a digester, the mixing pump associated with that digester will change speed to produce a different operator-entered flow to maintain a comparable flow rate through each mixing nozzle. Total flow for each digester mixing flow is calculated.

If either of the measured levels in the digester drops below an operator-entered level, the mixing pumps will stop.

Digester Transfer Pumps

Digesters 1 and 2 are each equipped with a grinder and digester transfer pump that pumps DIG out of the digester. Based on the position of various valves, discharge flow from the transfer pump can be sent to the other digesters as well as the centrifuge building for dewatering. The speed of the transfer pump is modulated to meet an operator-entered flow rate.

To operate the transfer pumps, the operator will enter a flow rate and select between a duration or volume set point, then initiate a transfer. The transfer pump will then start up and start transferring DIG to the destination at the entered flow rate. The flow meter on the transfer line will start a totalizer to determine how many gallons of sludge has been transferred. The transfer will continue until either the duration or volume pumped has been reached, whichever was selected. If at any time during the transfer the operator changes the set points related to the transfer, the changed set point will take immediate effect.

If at any time either of the measured levels on the digester drop below an operator set level, the transfer pump for that digester will stop.

The digester grinder will start when the transfer pump starts and it will stop when the transfer pump stops.

11.3.2 New Digesters (Digesters 3 and 4)

The new digesters are similar in design and instrumentation to the revamped existing digesters. The primary difference between Digesters 3 and 4 and Digesters 1 and 2 is the expandable gas chamber above Digesters 3 and 4.

The expandable gas chamber in the headspace of each digester is intended to act as a storage space for digester gas. The vendor package that comes with it includes three instruments—a digester gas chamber level sensor, an air chamber pressure sensor, and a lower explosive limit (LEL) sensor in the air chamber to detect any gas leaks from the gas chamber. Because the level sensor in the new digesters measures the gas chamber height instead of the digester fluid level, all calculations involving the digester level for Digesters 3 and 4 will depend solely on the pressure level transmitter, rather than the combination of level sensors possible in the other digesters.

11.3.3 Digester Control Building

Boilers will be running on NG. A more complete PCN will be provided as part of detailed design.

11.3.4 Sludge-Thickening Building

This section describes new or modified processes for the sludge-thickening building, including thickening equipment, the polymer system, and odor control.

Thickening Equipment

The purpose of the sludge-thickening building is to thicken sludge received from the WAS pumps, septage EQ pumps, or PS pumps. Each of the above incoming lines is instrumented with a flow meter and a total suspended solids (TSS) analyzer. If required, flow from the septage EQ pumps and PS pumps can be run through an inline sludge mixer that runs so long as there is flow through it.

After being metered, sludge to be thickened enters one of three parallel trains of thickening equipment. Each train of thickening equipment consists of an inline mixing valve, a flocculation tank, an RDT, and finally a thickened sludge pump. Directly after the meters, sludge from the various sources is combined and then flows through an inline mixing valve, which mixes in a diluted polymer solution. Sludge then enters a flocculation tank, which is equipped with a single-speed mixer and a tank overflow level switch. The mixer operates based on level—if there is enough level in the tank for the mixer to safely operate, it does so. If needed, an operator can empty the floc tank for cleaning using a drain line with a manual valve.

Blended sludge within the flocculation tank can overflow into the nearby RDT, which separates filtrate from the now-thickened sludge. If needed, a solenoid can open to allow CKTP water into the RDT for cleaning or dilution. Filtrate flows out through a dedicated filtrate line to the CKTP drain system, while thickened sludge leaves the RDT and falls into a small hopper. The hopper is equipped with a solenoid-controlled flush line for cleaning and a pressure transmitter for level measurement of the thickened sludge within the hopper. A thickened sludge pump is directly connected to the hopper, and the pump changes speed to maintain a constant operator-entered level in the hopper. The discharge of the thickened sludge pump is monitored for excessive pressure, and the pump shuts down if either the discharge pressure gets too high or the level in the hopper gets too low. Post-dilution water can also be added on high pressure as a means to thin the solids for easier pumping.

Downstream from the thickened sludge pump, the flow from each of the three RDTs is combined and sent through a flow meter to the operator's selection of digesters. There is provision in piping and instrumentation for two digesters to be fed simultaneously. If neither flow meter is registering flow while at least one thickened sludge pump is running, an alarm will notify operators of a likely pump malfunction. Per the digester control narrative, the digester must be expecting to receive flow from the RDTs.

Polymer System

The polymer solution that is fed into the sludge lines immediately before the sludge enters the flocculation tanks is provided by the polymer system. Polymer is stored in two separate totes, and the polymer system is set up to allow operators to potentially have different types of polymers in each tote without them mixing.

The polymer system consists of two polymer totes with an associated polymer feed pump, mixing chamber, and solution tank. Each solution tank is instrumented with a non-contact level transmitter as well as both high- and low-level switches. When the level in the solution tank reaches the low level, the polymer feed pump starts and pumps neat polymer to the polymer mixing chamber, where it is mixed with dilution water before going into the solution tank. Through opening or closing manual valves, either mixing chamber can send polymer solution to either solution tank.

Downstream of the polymer solution tanks, three polymer feed pumps provide polymer solution to the three RDTs. If required, each polymer feed pump can pump to any of the three RDTs, but it is anticipated that they will instead be dedicated to an individual RDT. Speed control for the polymer feed pumps is an operator selection between three options—constant polymer flow, polymer to sludge flow ratio, and polymer to solids flow ratio. In all three modes, the polymer feed pump modulates to maintain a flow set point to the associated RDT. In constant polymer flow mode, that flow set point is a constant operator-entered value. In polymer to sludge flow ratio mode, the target flow set point is instead calculated as a ratio of the incoming sludge flow. In the polymer to solids flow ratio, the TSS meter and flow meter on the incoming sludge flow is used to calculate an incoming dry solids value, and the operator enters the polymer concentration and both values are used to calculate a flow rate that will provide the operator-determined number of pounds of polymer per incoming dry tons of solids. These modes will be expanded upon in more detail in the final engineering design.

After the polymer feed pumps, the operator has an option to allow additional dilution water into the polymer line. If the operator allows it, the solenoid on the dilution water line automatically opens when the polymer flow rate is above 0.5 gpm.

Odor Control

The many pieces of equipment within the sludge-thickening building are equipped with foul-air piping that draws foul air away from the equipment. Those foul-air lines converge and go to the odor control system. The odor control system consists of two odor control blowers running in parallel. In normal operation, a single blower runs at an operator-entered speed. If it should fail for some reason, the standby blower will automatically start up at the same speed. Each blower is equipped with a pressure differential transmitter, as well as a downstream filter.

Downstream of the two blowers, mist is injected into the foul air, which then enters a biofilter, where additional water is sprayed on top of it in two places. All three locations that water is provided are controlled by a sprinkler control system that operates independently of the CKTP PLC system.

11.3.5 Septage and FOG Facility

This section describes new or modified processes for the septage and FOG facility, including septage handling, EQ basins, and EQ wet well; FOG handling; and odor control.

Septage Handling

A large portion of equipment control within the septage-handling system is done by a large vendor-supplied system. This overall process summary describes the operation of the entire system, but many portions that are part of the vendor-supplied system are covered in scant detail.

The septage system starts with the facilities to connect to a septage-hauling truck. From the septage-hauling truck, septage will flow through a valve to one of the septage influent boxes. These influent valves will normally be open during a septage unloading process, but they will close automatically if an abnormal pH is detected in the septage being offloaded from the truck. The two septage influent boxes are separated from each other by a septage influent overflow box. They are both equipped with level transmitters, while the septage influent overflow box has a level switch to determine if it is starting to fill. Each of the three septage influent boxes is also equipped with both a manual bar screen and the ability to wash down the box using clean water.

From any of the three septage influent boxes, septage will flow through a valve network to either the degritting systems or a gravity bypass to the decant facility. After a septage load is completed (as detected by the measured level dropping below an operator-entered set point), a solenoid will open to allow clean water into the septage piping downstream of the septage influent box that was just emptied. The downstream piping will be flushed continuously until an operator-set duration has passed. In addition, operators can manually command the solenoid to open to allow for additional flushing of the septage influent piping.

From the influent septage piping, septage flows in the screening and degritting vendor packages. Operational details of these packages are currently unknown, but level within the package, and both pH and flow of the influent coming into it, will be sent to the CKTP

SCADA system. Included within the vendor packages are small skimmers to remove grease and pumps to convey that grease to the FOG-receiving tank.

Septage EQ Basins

Downstream of the septage-handling equipment, incoming septage flow then enters one of two septage EQ basins. For each degritting system, operators will choose which septage EQ basin flow from the system will enter. Motorized valves will then open or close as needed to allow flow from either degritting package to either of the septage EQ tanks. Operator selection of destination for flow from each degritting system can be independent, as there are sufficient motorized valves to handle any configuration.

Each EQ tank is equipped with a single-speed mixer. When the level rises above an operator-entered level set point, the mixer will run. When the level drops below an operator-entered level set point, the mixer will stop.

Each EQ tank is equipped with a pH probe and a non-contact level transmitter. The PLC system will calculate the volume of septage in each tank based on the level transmitter and the geometry of the tank. Equations will be provided as part of detailed design.

Flow will leave the EQ tanks in one of two ways—through the slide gate installed for that purpose or through the overflow into the other EQ tank. The slide gates are open/close only—if an operator indicates that they should be open, they fully open, and if not, they fully close. This allows an operator to choose which EQ tank is hydraulically connected to the Septage EQ Wet Well. If one EQ tank is very full, it will overflow using the built-in overflow structure between the two EQ tanks, allowing flow to enter the other tank.

Septage EQ Wet Well

The EQ wet well downstream of the EQ tanks accepts flow from the two slide gates on the EQ tanks. The wet well is equipped with a non-contact level measurement instrument, a backup high-level float switch, and two submersible pumps to pump the septage out of the wet well. The pumps are equipped as duty/standby pumps, and therefore only one pump should be running at any given time. If the duty pump fails for some reason, the standby pump will immediately take over. Both pumps are equipped with VFDs, and they can be run in either of two operator-selected modes and one non-operator selected mode. Fill and Drain, Set Volume and Level Hold are the operator-selected modes, while Max Constant Flow is the override mode.

Because of downstream process limitations, the septage wet well pump should never run at full speed. Doing so would provide more flow than the downstream equipment can handle. As a result, if in any control mode the flow reaches an operator-entered maximum flow rate, the running pump will lower its speed until the flow set point is reached.

In Fill and Drain mode, the duty pump turns on at an operator-defined speed when the level in the wet well reaches an operator-defined high level. The pump continues to run at that operator-defined speed until the level in the wet well reaches an operator-defined low level, at which point it turns off and the cycle restarts.

In Set Volume mode, the operator will enter a volume of desired flow and a duration over which that flow should be pumped. The PLC will then convert those inputs to a flow set point. If that calculated flow set point is higher than the operator-entered maximum flow set point, the maximum flow set point is used instead. The duty pump will then start and vary speed to maintain the flow set point. The duty pump will continue varying speed to maintain the flow set point until a totalizer based on the flow meter downstream indicates that the operator-entered volume has been reached, at which point the duty pump will turn off.

In Level Hold mode, the operator will enter a level setpoint that the pumps should maintain within the wet well. There are two PID loops that run in series to accomplish this – the Level PID and the Flow PID. The speed of the duty pump is controlled based on the Flow PID, and the setpoint for the flow PID is automatically changed based on the output of the Level PID. The maximum flow called for by the Level PID shall be no more than the Maximum Constant Flow.

In addition to the two operator-entered modes above, the PLC will enforce a Max Constant Flow mode. If the level in the wet well reaches the high-level switch, the PLC will record the current mode and then switch to Max Constant Flow mode. In this mode, the duty pump will start and modulate speed to maintain the operator-entered maximum flow rate for the system. Once this mode has been started, this mode will continue until the level in the wet well reaches an operator-defined low level, at which point the previous mode will be resumed.

In all modes, if the level in the wet well drops to an operator-entered low setpoint, all Septage EQ wet well pumps will immediately stop.

FOG Handling

The FOG-receiving system is quite similar to (though slightly simpler than) the septage system. It consists of a single truck unloading connection leading to a rock trap and a vendor-supplied FOG-screening system. Following the screening system, flow will go into a receiving tank, and from there be pumped to the selected digesters.

The front half of the FOG-receiving system normally operates in a batch mode, and each batch would start off with a driver entering his/her credentials into the vendor-provided panel near the unload point. Once the credentials have been accepted, the driver would connect to the truck unload connection and begin unloading the truck. Flow would go through a vendor-controlled valve, through a small rock trap, then into the FOG-screening system, which is a large vendor-provided package. The screening system will remove some debris from the flow, and the rest will be sent to the FOG-receiving tank.

The FOG-receiving tank is equipped with a non-contact level instrument as well as a drain line and a water flushing line. Prior to a truck unloading, the level in the receiving tank will be relatively low, allowing the tank to receive the flow from the entire truck in one go. Upon level in the receiving tank reaching an operator-entered high-level set point, one of the two FOG feed pumps will start to pump FOG to the selected digesters. See the digester PCN for details on how which digester is fed is determined. Once the level in the receiving tank reaches an operator-entered low-level set point, the FOG feed pumps stop and a flushing sequence starts. Each pump is equipped with a hot water line controlled by a solenoid for flushing. Each pump is also equipped with a dedicated flow meter that measures how much FOG each pump moves.

Because the FOG system will need frequent flushing, a flushing sequence is provided. The flush sequence will run after any pumping cycle is complete or when triggered manually by an operator. A flushing sequence consists of the following: with the level in the receiving tank low, two solenoids open to allow hot CKTP water into the piping upstream of the receiving tank and directly into the receiving tank washing spray heads. This hot water fills the receiving tank until an operator-entered level is reached. When the level is reached, the solenoids close and the FOG feed pumps pump the receiving tank down to the same low level as before.

Odor Control

The many pieces of equipment within the septage and FOG building are equipped with foul-air piping that draws foul air away from the equipment. Those foul-air lines converge and go to the odor control system. The odor control system consists of two odor control blowers running in parallel. In normal operation, a single blower runs at an operator-entered speed. If it should fail for some reason, the standby blower will automatically start up at the same speed. Each blower is equipped with a pressure differential transmitter and a downstream filter.

Downstream of the two blowers, mist is injected into the foul air, which then enters a biofilter, where additional water is sprayed on top of it in two places. All three locations that water is provided are controlled by a sprinkler control system that operates independently of the CKTP PLC system.

11.3.6 In-Plant Pump Station

An IPS receives flows from various sources around CKTP, including sump pumps, drain lines, the CST, and digesters. The IPS system is entirely vendor-controlled, and is equipped with three submersible pumps, a non-contact level transmitter, and high- and low-level switches. A flow meter is installed on the discharge.

Two pumps will serve as duty pumps in a lead/lag arrangement, with the third pump as standby. If a duty pump fails for any reason, the standby pump will take its place promptly.

The In-Plant Pump Station can operate in several modes: Fill and Drain and Level Hold.

In Fill and Drain mode, the lead duty pump turns on at an operator-defined speed when the level in the wet well reaches an operator-defined high level. If the level continues, the lag duty pump will also turn and the two pumps will be operated to match speed and flow. The pump(s) continue to run at that operator-defined speed until the level in the wet well reaches an operator-defined low level, at which point they turn off and the cycle restarts.

In Level Hold mode, the operator will enter a level setpoint that the pumps should maintain within the wet well. There are two PID loops that run in series to accomplish this – the Level PID and the Flow PID. The speed of the duty pump(s) are controlled based on the Flow PID, and the setpoint for the flow PID is automatically changed based on the output of the Level PID. If desired, the operator can disable the Level PID and manually enter a flow setpoint into the Flow PID.

11.3.7 Centrate Storage System

This section describes new or modified processes for the centrate storage system, including centrate storage and odor control.

Centrate Storage

This project involves multiple changes to the existing CKTP's centrate system. In addition to the existing centrate pumps (which are being retained), new centrate pumps are being added to pump from the existing centrate sump. They will operate in fill-and-drain mode, where when the centrate sump reaches an operator-entered high-level set point, the duty pump will activate to pump centrate from the existing centrate sump to the new CST. When the centrate sump reaches an operator-entered low-level set point, the duty pump will stop. Each centrate pump is equipped with both suction and discharge pressure gauges and switches, activation of which will stop the associated pump. When they run, the centrate pumps pump centrate through a common discharge flow meter, which meters how much centrate they pump.

Downstream of the centrate pumps is the refurbished CST, which is equipped with a non-contact level transmitter and two discharge pipes. The first (preferred) discharge pipe leads to a control valve, while the second acts as an overflow. Both pipes lead to a common flow meter before going to the IPS. The control valve on the main discharge line normally operates based on the measured flow rate of centrate leaving the storage tank.

Odor Control

The IPS and the centrate storage systems are equipped with foul-air piping that draws foul air away from the equipment. Those foul-air lines converge and go to the odor control system. The odor control system consists of two odor control blowers running in parallel. In normal operation, a single blower runs at an operator-entered speed. If it should fail for some reason, the standby blower will automatically start up at the same speed. Each blower is equipped with a pressure differential transmitter as well as a downstream filter.

Downstream of the two blowers, mist is injected into the foul air, which then enters a biofilter, where additional water is sprayed on top of it in two places. All three locations that water is provided are controlled by a sprinkler control system that operates independently of the CKTP PLC system.

12 Preliminary Civil Design

The following sections outline the design standards for the overall site civil design, including primary utilities. Preliminary-level site plans and major process piping corridors are discussed and included in Appendix H.

12.1 Design Components

The site civil design will incorporate the following key assumptions and design criteria:

- The maintenance building and associated road circulation, storage, fencing, and parking (approximately 3 acres of new improvements).
- New road access from Brownsville Highway into the newly acquired property to the east of CKTP.
- Site topography, grading, and access to the following structures:
  - Three new odor control facilities (biofilters and fans)
  - New centrate tank refurbished from the existing GT
  - Two existing digesters (refurbished) with a new centrally located process control building
  - Two new digesters (refurbished) with a new centrally located process control building
  - Septage-receiving station and vaults (includes access for haulers and truck washdown)
  - FOG building and receiving station (includes access for haulers and truck washdown)
  - Digester control building (boilers and electrical)
  - PS and septage thickening building
  - New maintenance building to replace the existing facility, which will be demolished
- Site drainage for new improvements will be collected and conveyed to an existing facility for pumping and treatment. No improvements to the existing stormwater systems are anticipated.
- Site water supply as follows:
  - Supply lines will be based on the existing 1W, 2W, 3W, and fire protection water (FP). These lines are outlined in the 2015 site utility schematic plan (Appendix H).
  - 1W will be used for the maintenance building primarily, with additional connections for the existing potable water fixtures in the solids processing building and for safety showers or an eyewash in the polymer room of the PS and septage thickening building. 1W from existing on-site water mains is

assumed to be sufficient to provide necessary pressure and flow, and metered upstream of all improvements.

- Process water uses for 2W and 3W will be routed to individual facilities as needed. Water uses at each facility are outlined in Section 7.
- FP will be provided, extended from the existing 8-inch-diameter fire protection loop, for new hydrants where required and a new fire sprinkler supply line to the maintenance building. Existing FP water mains are assumed to be sufficient to provide necessary fire flow, and metered upstream of all improvements.

- Sanitary sewer will be extended from the existing sewer system on site by gravity side sewers from sewer mains in proximity to the new improvements.
- Curbs, paving, and other improvements necessary for demolition will be provided to allow construction of new improvements.
- Routing and pads for underground power supply, communications, and NG (if required) will be shown on the civil plans for coordination; see other sections for specifics of the equipment using these utilities.
- NG will be brought to the site by the County in conjunction with the local utility. As part of this project, it is assumed that an NG pipe loop will need to be established around the project area to allow for service to the existing WGB, new boilers (digester control building), and other HVAC equipment that will use NG (see Section 7).
- Yard piping, support systems, and slabs for process systems will be shown on the civil plans for coordination purposes.

12.1.1 Design Vehicles

New roadways will be designed to accommodate multiple types of vehicles including passenger vehicles and passenger trucks, which will be used as site vehicles. The controlling vehicle for design will be the 40-inch wheelbase truck (WB-40). Turning radii around the site where the WB-40 will access will accommodate the vehicle. In addition, the roads will need to be designed to provide fire access as required by the local fire authority.

12.1.2 Pavement and Surfacing

Roadways for vehicular traffic will include asphalt paving based on geotechnical recommendations.

The pavement design shall provide, at a minimum, the following:

- Unpaved areas will be surfaced to prevent soil erosion by wind and water, support pedestrians and light vehicles (including four-wheel-drive vehicles), and repress undesirable vegetation.
- Paved on-site roads will have a design speed of 20 miles per hour.
- Maximum road grade shall be 10 percent for paved roadways and 12 percent for gravel roadways.

- Cross slopes for finished surfaces shall promote drainage and shall be a minimum 0.5 percent for concrete and 1.0 percent for asphalt. Roads may be inverted crown with drainage down the center (not preferred but allowable if alternates do not exist), sloped one way or crowned to provide drainage to concrete curb.

12.2 Grading

Grading for the site will target a balance to maintain cut and fill on site where possible and minimize import or export. To achieve this, materials on site are assumed to be suitable for this purpose. A soils report will be completed and evaluated during the detailed design to provide guidance for the design. New buildings and foundation slabs will be a minimum of 6 inches above surrounding grades and the grade will be sloped away to ensure that water flows away from the buildings.

12.3 Clearing and Demolition

Demolition and clearing activities for this site will consist of removal of specific existing facilities, re-leveling, clearing, and grubbing new construction areas. Other demolition activities will include saw-cutting the existing pavement; removal of curb, asphalt, and utilities to make way for new improvements; and installation of utilities and driveway connections.

Specific major areas of demolition (not including general site civil or piping/utilities) will include the following:

- Existing digester control building between Digesters 1 and 2
- Buried diesel fuel tank south of Digesters 1 and 2 (no longer needed once boilers are replaced per Section 7)
- Existing maintenance building
- Existing septage-receiving station
- One existing GT and the associated grit handling/control building (the remaining GT will be repurposed as the centrate EQ tank)
- Existing IPS

12.4 Erosion Control

Erosion control will be implemented prior to construction activities on the site. Erosion control systems will include best management practices for prevention of erosion during construction. Because of the dispersed location of improvements on the site phasing will likely be included in the approach to erosion control. Erosion control systems will consist of various measures, some of which are as follows:

- Stabilized construction entrance
- Inlet protection
- Clear demarcation of clearing limits
- Perimeter protection such as filter fabric fences or straw wattles

- Temporary sedimentation collection ponds
- Sweeping
- Water truck for dust control
- Described phasing and construction sequencing

12.5 Stormwater

Stormwater is currently collected on site and conveyed to an existing collection facility for treatment and discharge. New facilities will be connected or reconnected to the existing collection facility. Existing conveyance systems are assumed to be sufficiently deep and of capacity to allow connection and gravity flow. No pumping systems are anticipated for stormwater.

12.6 Utility Piping

Materials of construction anticipated for new utilities will be as follows:

- **1W:** PVC Schedule 80/copper Type K (less than 4 inch diameter, PVC preferred); PVC C900 (4 inch diameter and larger)
- **Sanitary sewage:** PVC standard dimension ratio (SDR) 35/ductile iron (Class 52)
- **Stormwater:** PVC SDR 35/Advanced Drainage Systems (ADS) N-12
- **NG:** ASTM A53 steel
- **3W/2W):** PVC Schedule 80/ASTM A53 steel
- **General process (sewage/sludge):** ductile iron (Class 52; various linings)

12.7 Site Layout

See Appendix H for preliminary site layout drawings with the proposed location of new structures and primary routing corridors for major process piping.

13 Permitting, Project Delivery, and Project Cost

This section details the expected permitting, delivery method, and opinion of probable construction cost (OPCC) for the project.

13.1 Project Permit Matrix

Implementing a major CKTP upgrade requires extensive permitting as well as State Environmental Policy Act (SEPA) review and compliance with the State Environmental Review Process (SERP). Kitsap County will be SEPA lead agency with application and threshold determination likely at 60% with submittal of the Conditional Use Permit – Minor Amendment application. Through the preliminary planning and design effort, the project team developed a summary of necessary permits associated with the proposed upgrades. The management of the permitting process included a strategic and integrated approach. This approach included engaging regulatory agencies early and often regarding the project and fostering a close relationship throughout the process, to help to avoid unexpected requirements and delays in the approval of permits. The permits listed in Table 13-1 have been identified and are in various stages of procurement as the design has progressed. The draft SEPA checklist is provided in Appendix J.

Table 13-1. Project permit matrix

Agency	Permit/approval	Typical processing times	Design level for application
USACE	*Clean Water Act (CWA) Section 404 Permit*	12–18 months	60%
	National Historic Preservation Act (NHPA) Section 106 Review	3–6 months	0%–30%
USFWS/NOAA	*Section 7 Endangered Species Act (ESA) Compliance*	Concurrent w/ USACE	30%
DAHP	*EO 21-02 Compliance*	3–6 months	0%
Ecology	*CWA Section 401 Water Quality Certification*	12–13 months	30%
	Coastal Zone Management (CZM) Consistency Determination	Concurrent with CWA 404, if needed [a]	60%
	Ecology notification on capital project with existing NPDES permit	As needed	N/A
	State Environmental Review Process (SERP)	Concurrent with project development and permitting	N/A
WDFW	*Hydraulic Project Approval (HPA)*	1.5 months	60–90%
PSCAA	NOC/Order of Approval	20 days minimum	90%

Agency	Permit/approval	Typical processing times	Design level for application
Kitsap County DCD	Pre-application	14 days	0%–30%
	Building Permit (Commercial)	TBD	60%–90%
	Site Development Activity Permit: Grading Level 1, 2, or 3	TBD	60%
	State Environmental Policy Act (SEPA)	2 – 4 months	60%
	Conditional Use Permit – Minor Amendment	2 - 4 months	60%
	Road Approach Permit	2–3 months	90%
PSCAA	NOC: modified air pollution source	1 month	90%

Permits in italics are to be confirmed with field studies and on-site truthing.
a. If a Section 404 is required, the USACE consults with USFWS, NMFS, DAHP, and Ecology as part of its review.

13.2 Delivery Method

The proposed improvements at CKTP are required to avoid potential existing digester failure. As such, time is of the essence in designing and constructing the upgrades. Part of the preliminary design process included a broad review of possible project delivery methods. The *Collaborative Delivery Workshop Report*, included in Appendix L, presents the results of a workshop held on July 18, 2023, to evaluate methods for delivering the design, construction, and operation of the project. The purpose of this workshop was to make a recommendation to the Public Works Division (PWD) of Kitsap County on the most beneficial delivery method for the project. The project delivery methods considered include the following:

- Design-Bid-Build (DBB)
- General Contractor/Construction Manager (GC/CM)
- Design-Build (DB)
- Progressive Design-Build (PDB)
- Design-Build Operate (DBO)

The project delivery options were discussed and ranked against evaluation criteria. CKTP staff preferred options that prioritized cost and scheduling certainties because of safety factors of continuing operation of existing digesters at the end of their service life.

The DBB method was used as a baseline to compare against other delivery methods. As a conventional, linear-based delivery method, DBB continues to have success over decades of use. Strengths of the DBB approach include its well-understood risk allocation, predictable schedule, proven and familiar methodology, and traditional roles.

However, multiple contracts, deliverables, and procurements are required, as well as a comparably extended timeline.

GC/CM is a collaborative delivery method in which the County hires a design engineer and a GC/CM under separate contracts. In many ways it is similar to the DBB method but has the additional benefit of collaboration between the Designer and the Contractor.

The DB methods, which include PDB and DBO deliveries, have a single contract for design and construction. This collaboration can shorten the project schedule and reduce project costs. However, these methods can add complexity and require a more involved procurement phase.

Based on CKTP staff's criterion ranking, the GC/CM and PDB alternatives outweighed the DBB, DB, and DBO methods. The County elected to pursue permission from the Project Review Committee (PRC) as the next step in the pursuit of using GC/CM. The PRC controls the ability of agencies in the state of Washington to use alternative project delivery methods. CKTP staff, along with HDR, presented to the PRC on September 28, 2023, and received unanimous approval to use the GC/CM process for the project.

13.3 CKTP Process Upgrades Phasing

Currently, the construction is set to be phased with the following items undergoing construction first:

- New thickening building
- New digester control building
- New digesters
- New septage receiving

These items are critical to CKTP's continued operations and permit compliance. Thickening and digester control facilities must be constructed prior to construction of the new digesters or at the same time. Commissioning of the new digesters should include the new septage receiving facility because of its new capabilities of metering loads.

The second-phase items will follow closely and possibly overlap the first phase of construction:

- FOG receiving
- Centrate equalization and storage
- Existing digester rehabilitation
- IPS
- Maintenance building

These items are all part of the project but may be constructed following the first phase of construction. Rehabilitation of the existing digesters may not take place until the new digesters are fully commissioned. The maintenance building will connect to many of the site's utilities, but it does not perform a direct treatment function and has greater flexibility with its construction schedule.

13.4 Maintenance Building Phasing

To facilitate construction of the new digesters, the existing maintenance building will need to be demolished. A new maintenance building will be constructed to serve CKTP staff. The building layout is included in Appendix D and includes the following spaces;

- Office areas for electrical/I&C, mechanics, and facility/pump station O&M workgroups
- Multi-function conference room and kitchenette
- Secured and unsecured tool storage areas, with loading dock
- Mechanics shop with drive aisle and loading dock
- Welding shop
- Fabrication shop
- Electrical/I&C shop
- Locker rooms
- Covered storage
- Restrooms (per code)
- Utility areas (per code)
- Handwash sink/emergency eyewash (per code)
- Building electrical room
- Fire riser room
- Employee/visitor parking
- Uncovered parking areas for mechanics workgroup fleet vehicles

In the future, additional spaces may be needed to accommodate County staff needs for workspaces and storage. The Maintenance Building will be designed with this consideration in mind, however design of future phases is not being pursued at this time.

13.5 Opinion of Probable Construction Cost

Through this BOD development, HDR has prepared an OPCC for the expected CKTP upgrades. The level of detail and contingency for the OPCC follow the Association for the Advancement of Cost Engineering (AACE) International Recommended Practice 18R-97 guidelines for a Class 4 estimate, which includes preliminary elements and has an accuracy range of -15 percent to -30 percent on the low side and +20 percent to +50 percent on the high side.

The OPCC is intended to be used as a check that the project is within the assumed budget and is based on the best judgment of experienced professionals generally familiar with the industry. However, because of the uncertainty of labor/materials prices and market/bidding conditions, the OPCC is not guaranteed to be the same as the actual construction cost.

The total OPCC for the proposed upgrades, as defined herein and detailed in Appendix M, is $98,557,000.

13.5.1 Operational Costs

Annual operational costs for the major processes listed in this report are summarized for three main items:

- Natural gas (building heating and digester heating)
- Electrical load (major process equipment)
- Polymer use (for thickening of primary sludge and septage)

The 20-year present value for these three operational costs assumes a 3 percent escalation and a 5 percent discount rate, along with the following:

- Emulsion polymer totes = $4,000 each
- Electrical cost = $0.08 per kilowatt-hour (kWh)
- Natural gas = $1.20 per therm (100,000 Btu)

It should be noted that many of these costs include facilities that are already in operation (such as the existing digesters) and consequently are not added costs to the current system, but a high-level estimate of the overall operational cost for these categories relative to the processes that are part of this project (whether they are completely new systems or replacements of existing systems). Process and NG uses were assumed as ratios of the maximum rates, with increasing quantities over the 20-year period.

The operational cost 20-year present value was estimated at $11.3 million.

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