Technical Memorandum

Date:	October 19, 2022
Project:	Wastewater General Sewer Plan Update
To:	Barbara Zaroff, PE, PMP Christopher Sheridan Kitsap County, WA
From:	Miaomiao Zhang, PE, PMP Jefferson Moss, PE Xinyi Xu, EIT
Reviewed By:	Erika Schuyler, PE, PMP
Re:	Central Kitsap WWTP Solids Handling Improvement Recommendations

1. Introduction and Background

Kitsap County embarked the General Sewer Plan update on its Central Kitsap Wastewater Treatment Plant (WWTP) and associated sewer basin in 2020. Recognizing the age and condition of the existing solids handling processes at the Central Kitsap WWTP, the County has made assessing and improving the solids processes one of the top priorities during the General Sewer planning effort and hopes to implement the identified improvement in a timely manner to ensure the reliable operation and performance of the solids handling processes.

Over the last two years several tasks focusing on the plant's solids handling processes have been completed to meet the County's goal, including:

- Existing system condition assessment
- Anaerobic digester emergency response and interim operation plan
- Digester rehabilitation
- Liquid hauled waste study
- Class A biosolids evaluation

The purpose of this technical memorandum (TM) is to summarize the previous work, document the evolvement of the process from identifying the needs and evaluating alternatives to determining the best solutions and prioritizing capital improvement projects, and make recommendations on the solids handling improvement strategy with implementation timeline (near-term and long-term).

2. Summary of Previous Work

2.1 Existing Condition Assessment and Deficiency

In September 2020, the Murraysmith team conducted a 3-day field visit to assess the condition and performance of the unit processes at Central Kitsap WWTP. Following the condition assessment, the team evaluated the hydraulic and treatment capacity, as well as treatment performance of all the unit processes and documented the findings and recommendations in Section 6 Wastewater Treatment Facilities Existing Conditions of the Central Kitsap General Sewer Plan (Murraysmith). Each unit process was assigned a condition rating ranging from very good to very poor.

Table 1 below summarizes the findings and improvement recommendations related to the solids handling processes based on this condition assessment and deficiency evaluation. To focus on the purpose of this TM, only solids handling unit processes with a poor to very poor condition or with a capacity or performance issue are listed in Table 1. Only recommendations requiring significant capital investment are listed in Table 1.

Table 1
Solids Handling Process Condition, Capacity and Recommendations

Unit Process	Physical Condition	Capacity/ Performance	Improvement Recommendations
Gravity Thickener	Poor. Over 45 years old. Both mechanical components and concrete are severely corroded	Oversized resulting in potential sludge fermentation	1. Replace the control structure. 2. Replace gravity thickeners with other thickening technology
Anaerobic Digester	Poor. Over 45 years old. Leaking pressure vacuum relief valves (PVRVs) and annular seal	No redundancy. Having challenge of meeting the volatile solids reduction (VSR) requirement in Federal Regulation 503	1. Repair digester annular seal, PVRVs, and any failed coating. 2. Provide additional digester capacity in the near term for redundancy and reliability 3. Replace failing manual valves. Establish a preventative maintenance program to exercise major valves annually
Digester Gas Treatment and Cogeneration	Good	System is down due to the past operational challenges associated with insufficient biogas quantities and pressure	1. Improve digester gas supply and quality 2. Conduct necessary maintenance and improvement before restart the system

Unit Process	Physical Condition	Capacity/ Performance	Improvement Recommendations
In-plant Pump Station	Poor. Both mechanical components and concrete are severely corroded	No pump redundancy. High flows at septage receiving overwhelm station capacity	Replace in-plant pump station with new higher capacity pump station
Fats, Oils and Grease (FOG) Receiving	FOG is dumped to primary clarifier scum pit which is in poor condition	No dedicated FOG receiving and pre-treatment	Construct a dedicated FOG receiving station
Septage Receiving	Good	No redundancy	Construct a redundant septage receiving station
Septage pumps	Poor. Over 45 years old.	Have enough capacity and redundancy	Replace septage pumps
Septage cyclone and classifier	Poor. Over 45 years old.	No redundancy. Limited access to equipment	Replace septage cyclone and classifier

2.2 Anaerobic Digester Emergency Response and Interim Operation

Based on the condition assessment and the plant staff's input, the existing digesters which were placed into service in 1977 have many failing components, including:

- The PVRV and three-way valve upstream of the PVRV are failing, resulting in digester gas leaks, and posing health risks to the plant personnel
- The deteriorating annular seals had failed in the past resulting in sludge leaking
- Digester mixing pump suction pipes had been removed, which may reduce mixing effectiveness
- Coating on the digester cover and skirt was observed to be deteriorated
- The digesters have failed to meet the VSR requirement during high septage receiving periods. The land application site has reported vector attraction of the biosolids from Central Kitsap WWTP.

In November 2021, Murraysmith developed a TM entitled *Central Kitsap WWTP Anaerobic Digester Emergency Response Plan and Interim Operation Plan* (Murraysmith, November 2021) to establish the plans for the County in the event of digester failure and determine the digester interim improvements to prevent the digester failure, as discussed below.

2.2.1 Emergency Response Plan

The Emergency Response Plan includes temporary backup, treatment hauling, and disposal options. It evaluates three sludge management alternatives during emergency situations:

- Alternative 1 - Single digester operation

- Alternative 2 - Sludge processing by other wastewater treatment plants
- Alternative 3 - Landfill disposal of sludge

Alternative 1 - Single digester operation

Although in theory the hydraulic retention time (HRT) of one duty digester at the current sludge loading meets the requirement for pathogen reduction, treating the entire amount of sludge with one digester will likely fail the vector reduction requirement and increase risk of upsetting the digestion process during the real operation, given the VSR challenge that the plant currently experiences with two operational digesters. Therefore, single digester operation is only recommended for short-term (less than six weeks) emergency response when septage receiving is shut down at the plant. Long-term shutdown of septage receiving has a significant impact to County residents who own septic tanks for sewage treatment and also results in an estimated $724,000 per year revenue loss for the sewer utility.

Alternative 2 - Sludge processing by other wastewater treatment plants

Several wastewater treatment utilities were contacted regarding their excess sludge handling capacity and interest of receiving and treating sludge from Kitsap County during emergency, both on a short-term (less than six weeks) or long-term (multiple years) basis. This exercise identified a few potential accepting utilities including the City of Bremerton, West Sound utility District, Lakehaven Water and Sewer District, Pierce County, and the City of Tacoma. This alternative is technically feasible since the combined backup capacity of the accepting utilities exceeds the total volume of sludge treated at Central Kitsap WWTP, although the costs would be high (estimated at $3.8 million per year), and the coordination with and trucking arrangement to various receiving plants would be complicated. Due to the high cost and complexity, this alternative is not recommended.

Alternative 3 – Landfill disposal of sludge

Waste Management was contacted regarding the feasibility of transporting the undigested and dewatered sludge to the landfill for disposal. The regulatory requirement, logistics and operational requirements have been discussed in the TM. Landfill disposal under an emergency or interim situation will likely be approved by the Washington Department of Ecology if the County can provide the approval from the disposal company and the health department with the jurisdiction of the landfill and demonstrate the intent of emergency or short-term operation. The existing digester configuration requires sludge to be sent to one or both digesters and be pumped from there to dewatering process before being loaded to the truck for landfill disposal. New bypass piping is recommended to allow both digesters to be completely bypassed during the landfill disposal. This alternative allows the County to continue accepting septage and is substantially less expensive than Alternative 2. The estimated cost for landfill hauling and disposal is $1 million per year. Therefore, it is a preferred alternative to handle the County's sludge during a long-term emergency digester shutdown. The County is currently in the process of installing the new digester bypass piping in the digester rehabilitation project.

2.2.2 Interim Operation Plan

The Interim Operation Plan includes capital improvements and operational adjustments recommendations to improve digester performance and extend service life of the existing digesters, specifically,

- Annular seal and roof repairs
- Preventative maintenance, spare parts, and backup equipment
- Digester mixing improvements

2.3 Digester Rehabilitation

Due to the increasing concern of the deteriorating digesters, the County has decided to implement a digester rehabilitation and modification project to address some of the immediate needs identified during digester emergency response and interim operation plans. The rehabilitation and modification design was completed in April 2022 and the construction was scheduled to complete by summer 2022. However, the County had to reduce the scope of construction after they received only one bid with a price much higher than expected. The reduced scope includes:

- Nitrogen purging of digester during digester shutdown, startup and sludge transfer
- Annular seal repair on East Digester
- PVRV and three-way valve replacement on both digesters
- Existing manual valve replacement and digester bypass piping installation

The County's decision on this reduced scope of construction was made in the context that the rest of solids handling improvements will need to be accelerated in order to maintain the reliable and successful operation of the solids handling processes. Construction started in late July 2022. The first three work items (above) are scheduled to be completed by mid-September 2022 to minimize the impact on septage receiving and digester operation. The last work item will be completed by February 2023 due to the long lead time of the pipe and valves.

2.4 Liquid Hauled Waste Study

The County currently receives and treats over 23,000 gallons per day of liquid hauled waste (LHW) at its Central Kitsap WWTP. LHW mainly consists of septage, thickened waste activated sludge (TWAS) from the County's other liquids treatment plants, and FOG from restaurants and residential grease traps. The entire LHW load contributes approximately one third of the sludge loading to the digester feed. Since septage is normally fairly stabilized and some of the portable toilet waste contains unknown chemicals, it is believed that LHW is one of the reasons for the observed low digester VSR at Central Kitsap WWTP.

Despite the challenges associated with the septage treatment at Central Kitsap WWTP, the Kitsap Board of County Commissioners (BOCC) is committed to providing continuous septage receiving service to the residents and businesses within the County, including outside of the Urban Growth Area (UGA). The purpose of the Liquid Hauled Waste Study (Murraysmith, July 2022) is to project the LHW quantities and evaluate the solids handling alternatives focusing on improving LHW

treatment as well as solving the other related near-term needs. The study indicated the LHW is anticipated to increase at a rate of approximately 4 percent in the next 20 years. Five alternatives to handle the LHW, specifically septage, have been evaluated from the perspectives of regulatory requirements, technology, equipment design, layout, site plan, cost, and O&M requirements. They are:

Alternative 1 – Treat Septage with Other Solids Streams
Alternative 2 – Separated Septage Treatment with Anaerobic Digestion
Alternative 3 – Separated Septage Treatment with Lime Stabilization
Alternative 4 – Entire Solids Treatment with Sedron Varcor System
Alternative 5 – Separated Septage Treatment with Wetland and Composting

Alternative 4 was determined not feasible due to the limitation of the technology. Table 2 summarizes the comparison of the remaining four alternatives. Table 3 provides a comprehensive comparison of these four alternatives and the baseline (do nothing), from both the non-monetary and monetary perspectives, and a recommendation.

Table 2
Existing Class B Solids Handling Improvement Alternative Evaluation

Alternative	Capital Cost[1]	O&M 20-year Net Present Cost	20-yr Lifecycle Cost	Advantages	Disadvantages
1 – Treat septage with other solids streams	$43M	$7.7M	$50M	• Lowest cost • Familiar technology • No changes from current biosolids management practice • Simple O&M	• Risk of not meeting VSR requirement for vector attraction reduction, although the risk is very low since additional digester will significantly increase digestion HRT and new thickening system will minimize any VSR prior to digestion
2 – Separated septage treatment with anaerobic digestion	$46M	$7.9M	$54M	• Relatively low cost • Familiar technology • Minimal changes from current biosolids management practice • Separating septage eliminates any undesirable impact from septage on the main solids stream • Separating septage allows flexible and customized septage treatment	• More complex O&M • Risk of septage not meeting VSR requirement for vector attraction reduction, although the risk is very low since the dedicated digester with a redundant unit will significantly increase digestion HRT and new thickening system will minimize any VSR prior to digestion

Alternative	Capital Cost[1]	O&M 20-year Net Present Cost	20-yr Lifecycle Cost	Advantages	Disadvantages
3 – Separated septage treatment with lime stabilization	$49M	$16M	$65M	• Separating septage eliminates any undesirable impact from septage on the main solids stream • Lime stabilization provides a reliable method to convert septage to Class A or Class B biosolids	• High cost • Complex O&M • Unfamiliar technology • Lime stabilization could generate higher dust and odor • Removing septage from digestion may reduce biogas production thus cogeneration operation
4 – Entire solids treatment with Sedron Varcor system	N/A	N/A	N/A	• N/A	• Not feasible. Technology not currently available at appropriate scale
5 – Separated septage treatment with wetland and composting	$51M	$5M	$56M	• Separating septage eliminates any undesirable impact from septage on the main solids stream • Provides opportunity to integrate with main solids stream composting for Class A • Relatively simple O&M	• High cost • Large land requirement • Unfamiliar technology • Removing septage from digestion may reduce biogas production thus cogeneration operation

Notes:

1. M = million
2. N/A = Not applicable

Table 3
Existing Class B Solids Handling Improvement Alternative Comparison

Alternative	Comply with regulations	Handle future loads with redundancy	Compatible with existing processes	Improved operation and process control	Easy O&M	Reasonable O&M and capital costs	Recommended
Baseline - Do nothing	✓	✕	✓	✕	✓	✓	N
1 – Treat septage with other solids streams	✓	✓	✓	✕	✓	✓	N
2 – Separated septage treatment with anaerobic digestion	✓	✓	✓	✓	✓	✓	Y
3 – Separated septage treatment with lime stabilization	✓	✓	✓	✓	✕	✕	N
4 – Entire solids treatment with Sedron Varcor system	N/A	N/A	N/A	N/A	N/A	N/A	N
5 – Separated septage treatment with wetland and composting	✓	✓	✕	✓	✕	✕	N

The study recommended Alternative 2 because it provides a more reliable septage treatment with relatively low cost. Other advantages of Alternative 2 include that it proposes familiar technologies to the plant staff, and provides flexibility, redundancy, and ability to customize treatment of septage and other WWTP sludge streams independently.

Alternative 2 includes the following improvements:

- A third, 1.3-MG anaerobic digester will be constructed for thickened sludge and FOG treatment. One of the existing digesters will be used for septage treatment.
- The existing septage receiving station will be expanded to provide redundancy.
- Two existing septage pumps will be replaced with two new septage pumps.
- The existing grit cyclone will be replaced with a new grit removal system.
- A new FOG receiving station and associated sump and pump will be constructed.
- Septage will be thickened separately by new thickening equipment.
- The existing gravity thickeners will be replaced with a new thickening process.

2.5 Class A Biosolids Evaluation

Class A biosolids options were evaluated in a TM entitled "Central Kitsap WWTP Class A Biosolids Evaluation" (Murraysmith, July 2022) in the context of a long-term and holistic biosolids management strategy.

After a preliminary Class A biosolids technology screening, two post-digestion Class A technologies remained for a detailed comparison as they are established technologies, appropriate for the size of Central Kitsap WWTP, are compatible with the existing process, and have reasonable O&M and capital costs. These technologies are Class A composting and heat drying. The conceptual design, product reuse potential and capital, O&M and life cycle costs were developed and evaluated against the existing Class B biosolids operation. Table 4 summarizes the comparison of the alternatives.

Table 4
Class A Solids Handling Improvement Alternative Evaluation

Alternative	Capital Cost[1]	O&M 20-year Net Present Cost	20-year Lifecycle Cost	Advantages	Disadvantages
Existing Class B	$0	$9.3 – 12.0M[2]	$9.3 – 12.0M[2]	• Lowest cost • No changes from current biosolids management practice • Simplest infrastructure and operation	• Limited options for Class B biosolids reuse • High Class B biosolids hauling and land application costs
Class A Composting	$10.6M	(1.1M) – 16.0M (best estimate: $6.7M)[3]	$9.5 – 26.6M (best estimate: 17.2M)[3]	• Relatively low capital cost • Low energy use • Promising market and revenue • Sustainable approach to reduce carbon emission and promote green waste recycle	• High labor demand • Large footprint • Requires time and effort to establish market for compost product
Class A Drying	$16.4M	$10.6M	$27.1M	• Relatively lower labor attention • Relatively smaller footprint • Sustainable approach to reduce carbon emission	• Highest capital and lifecycle costs • High energy (fuel and electricity) use • Less certain market and revenue for dried pellets

Notes:

1. Capital costs do not include cost required to improve performance or capacity of the existing Class B processes, since that cost is the same for all alternatives.
2. The range is based on the Class B biosolids hauling and disposal prices from the County's current and historical contracts.
3. The range is based on the conservative and optimal assumptions on the O&M effort and revenue from compost sales. The best estimate is based on the most likely assumptions on these items.

The conclusions of the Class A biosolids evaluation are:

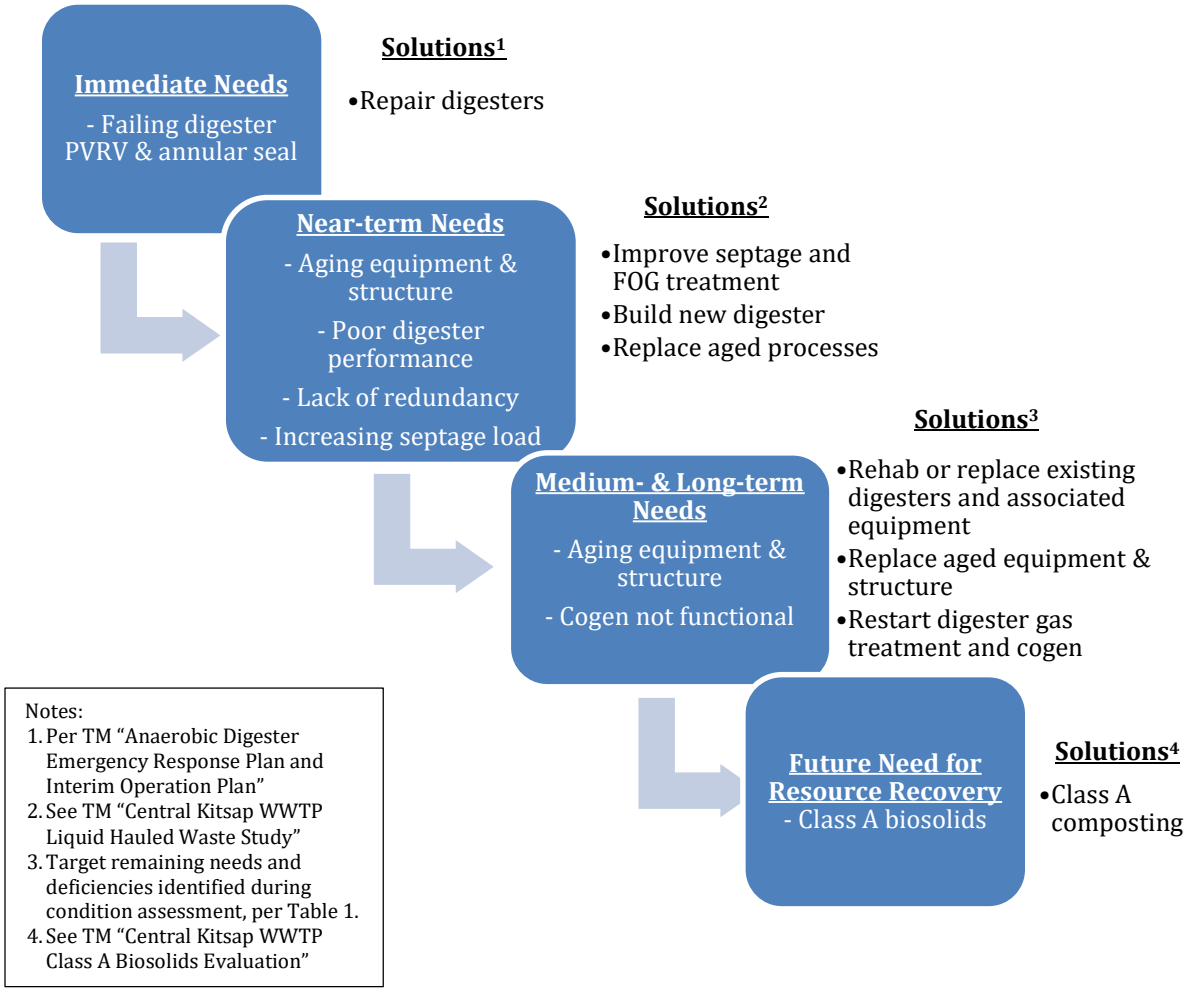
- Continuing the existing Class B process is the lowest cost option, with simplest infrastructure and operation.
- The life-cycle cost of the Class A composting will likely be higher than the existing Class B program, but lower than the heat drying alternative. Because the labor and the revenue from compost product are two main factors impacting the cost analysis and they could significantly vary case by case, effort to optimize labor and develop strong market is critical to a financially successful program.
- Composting also provides a lot of non-financial benefits, such as reducing carbon footprint associated with Class B biosolids hauling to eastern Washington, reducing risk of relying on limited land application sites for Class B product disposal, providing a valuable soil amendment to the local community and home growers, and providing a convenient location for the public to recycle green waste. These non-financial considerations make composting an attractive alternative.
- There is not an immediate need or financial incentive to upgrade the solids handling process to produce Class A biosolids, but there are numerous benefits to constructing and operating a composting process. Other parts of Central Kitsap WWTP need refurbishment or replacement sooner. Therefore, it is recommended to reserve land area for the composting site as other improvements are considered, but delay implementation of the composting until other more critical improvements are addressed or the financial outlook becomes more favorable.

3. Solids Handling Improvements Recommendations

3.1 Solids Handling Improvement Considerations

The previous work collected abundance of information, laid out alternatives, and presented solutions for the County to develop a phased solids handling improvement strategy. Figure 1 illustrates the evolution of the process.

Figure 1
Solids Handling Improvement Strategy Development Process



Besides replacing the aging infrastructure and equipment when they reach their useful life, as identified in the condition assessment, the most important considerations on solids process improvements includes 1) when and how the plant should improve the existing Class B biosolids process including septage treatment; 2) whether, when, and how the plant should implement Class A biosolids process.

3.2 Solids Handling Improvement Recommendations

Based on all the previous work the following phased solids handling capital improvement projects are recommended.

Immediate Improvements (ongoing)

The purpose of the immediate improvements is to repair the failing digester PVRV and annual seal to protect the plant staff's health and safety. The work is being done currently in the digester rehabilitation project. Due to the urgent need for the repair of these critical components and the fact that neither of the digesters cannot be taken offline for an extended duration, the goal of this project is to temporarily address the immediate needs and allow for the design and construction of longer-term improvements that will address other needs related to the entire solids handling processes.

Near-term Improvements (next 5 years)

These improvements address the near-term needs associated with the existing Class B biosolids process.

- Installing a new FOG receiving station with new pump
- Replacing existing septage pumps
- Replacing existing septage grit cyclone and classifier
- Thicken septage separately with new thickening equipment
- Replacing existing gravity thickeners with a new thickening process
- Constructing a new 1.3-MG anaerobic digester for thickened sludge and FOG treatment.
- The existing shop and equipment maintenance building will need to be demolished and relocated to make space for this new digester.
- Replacing existing in-plant pump station
- Replacing hot water system associated with the existing digesters, including new hot water pumps and new boilers.

Most of these items are described in detail in the TM *Central Kitsap WWTP Liquid Hauled Waste Study* (Murraysmith, July 2022). The last two items are determined based on the condition of the equipment.

The existing in-plant pump station was installed in 2011. It consists of a 6-ft diameter wetwell constructed with a reinforced concrete pipe, and two submersible pumps. The two 4-inch pump discharges go through a precast concrete valve vault before getting combined and routed to upstream of the aerated grit tanks. The pump station is severely corroded and under-sized for all the flows received at the pump station. A new submersible pump station with new pumps will be installed to completely replace the existing station.

The existing hot water system is located on the ground level of the digester control building. It includes two boilers; two expansion tanks and four hot water recirculation pumps, all of which were installed in 1977. They are reaching their end of the life. A new hot water system will be installed in the new digester control building to supply the heat demand from both the existing and new digesters and other process areas. The existing boilers use diesel as fuel and propane for the pilot. A more advanced and sustainable boiler technology using biogas and natural gas should be considered as a replacement option. Cascade Natural Gas Corporation (CNGC) has been

contacted to discuss the possibility of extending their natural gas pipeline to serve the CK WWTP. According to CNGC's preliminary analysis, an approximately 1.2-mile-long new natural gas pipeline will need to be extended from Greywolf PL and Old Military Rd to the plant. The County will be responsible for approximately $260,000 for the pipeline extension. Further investigation on boiler technology and the need for natural gas will be done in the next phase of the engineering study.

Medium-term Improvements (next 5 to 10 years)

These improvements address the medium-term needs associated with the existing Class B biosolids processes. They are all determined based on the condition of the equipment.

- Improving or replacing existing anaerobic digesters, including structure, equipment and electrical panels, after the new digester is in operation and the existing ones can be taken offline
- Expanding septage receiving station to provide redundancy
- Replacing existing scum grinder and pumps
- Replacing centrifuge sludge feed grinders
- Restarting the biogas treatment and cogeneration system

After the new digester is constructed and put into operation at the end of near-term improvements, the existing digesters could be taken offline for a thorough inspection and rehabilitation to extend their useful life. The equipment associated with the existing digester construction, such as mixing pumps, sludge recirculation pumps, heat exchangers, and motor control center will be replaced. The structural components, such as digesters vessel, covers, control building, will be inspected and evaluated for repair or replacement.

The biogas treatment and cogeneration system are fairly new but have not been successfully operational in the recent years. The biogas production and pressure are expected to improve after the near-term improvements, which will benefit the successful re-commissioning of the biogas treatment and cogeneration system. The need for the biogas storage to improve the cogeneration operation shall be evaluated during this phase.

Long-Term Improvements (next 10 to 20 years)

The long-term improvements would be primarily replacing equipment i.e. those installed in 1999, as they approach the end of their useful life. The equipment includes:

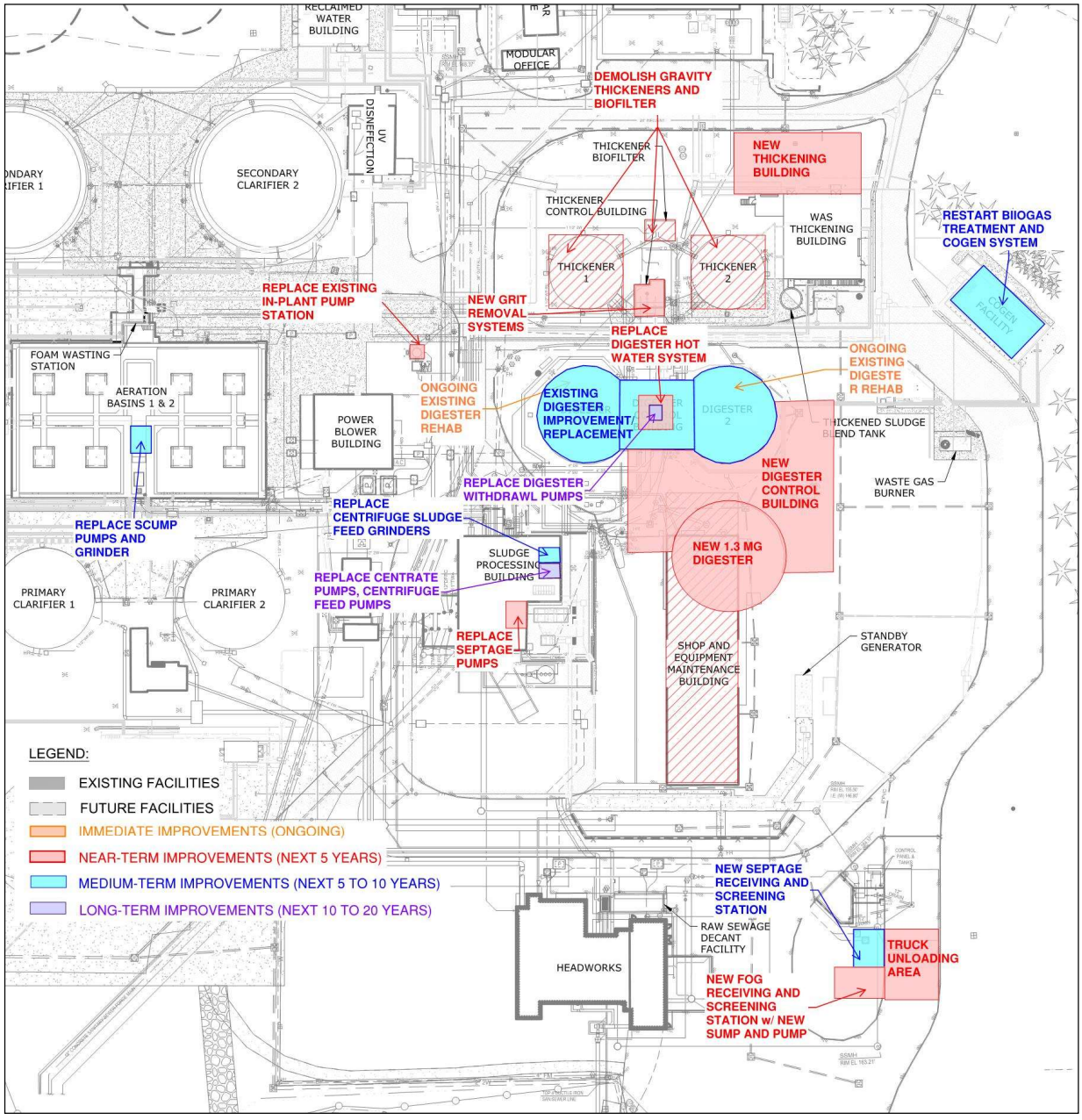
- Centrate pumps
- Centrifuge feed pumps
- Digester withdrawal pumps

Future Considerations

Class A composting should be considered after the more urgent improvements on the existing Class B biosolids processes are completed, as evaluated and recommended in the TM *Central Kitsap WWTP Class A Biosolids Evaluation* (Murraysmith, July 2022).

Figure 2 is a site plan showing the recommended improvements at Central Kitsap WWTP in different phases.

Figure 2
Recommended Phased Solids Handling Improvements at Central Kitsap WWTP



3.3 Cost Estimate

The probable costs are developed for each recommended improvement using the same methods in this General Sewer Plan update effort. All costs were developed based on the preliminary concept, equipment quote and system layout in 2022 dollars should be escalated with the future CCI for use in project budgeting.

This Class 5 cost estimates were prepared in accordance with the guidelines of the Association for the Advancement of Cost Engineering (AACE), for planning-level evaluations with a range of -50 percent to +100 percent, based on the *AACE International Recommended Practice No. 18R-97 Cost Estimate Classification System - As Applied in Engineering, Procurement, and Construction for the Process Industries - TCM Framework: 7.3 - Cost Estimating and Budgeting*.

Table 5 summarizes the Class 5 cost estimate for these recommended improvements for the near-term, medium-term, and long-term improvement projects. Construction costs include the estimated cost of construction work plus markups for mobilization, general contractor markups, overhead, and profit, taxes, and a construction contingency. The capital costs include an additional markup of 25 percent for engineering, legal, and administration costs associated with project delivery. The detailed estimates for each improvement are included in **Appendix A**.

Table 5
Cost Estimates of Recommended Solids Handling Improvements

Improvements	Construction Cost	Capital Cost
Near-term	$41 M	$51 M
Medium-term	$11 M	$14 M
Long-term	$1.1 M	$1.4 M
Future	$7.9 M	$10.6 M

Table 6 shows the cost breakdown of each of the major components of the near-term improvement work.

Table 6
Cost Breakdown of Recommended Near-term Solids Handling Improvements

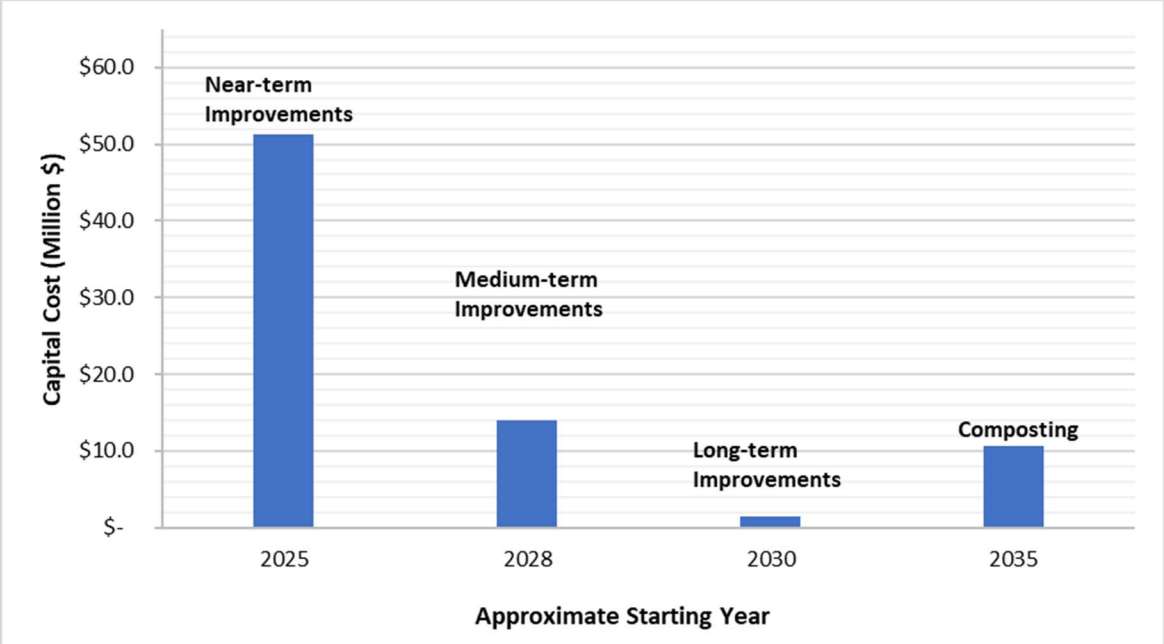
Near-Term Improvements	Construction Cost	Capital Cost
New FOG receiving station	$1.2 M	$1.5 M
New septage pumps and grit cyclone and classifier	$0.9 M	$1.1 M
New septage thickening	$5.8 M	$7.3 M
New primary sludge thickening	$5.6 M	$7.0 M
New digester and building	$20.3 M	$25.4 M

Near-Term Improvements	Construction Cost	Capital Cost
New in-plant pump station	$0.6 M	$0.7 M
New hot water system[1]	$2.3 M	$3.3 M
O&M shop relocation	$4.0 M	$5.0 M
Total	**$40.8 M**	**$51.3 M**

1. Cost of constructing natural gas pipeline by Cascade Natural Gas to serve the plant's new boilers is included in the new hot water system.

Figure 3 illustrates the anticipated capital expenditure (in 2022 dollars) and approximate timeline for the above projects.

Figure 3
Solids Handling Improvement CIPs and Approximate Timeline



Appendices

Appendix A – Detailed Cost Estimates

APPENDIX A

Project: Central Kitsap Facility Plan Update Solids Handling Improvement Recommendations
Client: Kitsap County
Project No.: 20-2840.00. 0100.09
Date: 10/18/2022

Class 5 Estimate

Horizon	Items	Construction Cost	Capital Cost
Near-Term	New FOG Receiving Station	$1,157,000	$1,447,000
	New Septage Pumps and Grit Cyclone and Classifier	$910,000	$1,137,000
	New Septage Thickening	$5,823,000	$7,279,000
	New Primary Sludge Thickening	$5,620,000	$7,025,000
	New Digester and Building	$20,346,000	$25,433,000
	New In-plant Pump Station	$557,000	$696,000
	New Hot Water System	$2,328,000	$3,244,000
	Shop and Equipment Maintenance Building Relocation	$4,026,000	$5,033,000
	NEAR-TERM TOTAL	**$40,767,000**	**$51,294,000**
Medium-Term	Existing Digesters Improvements and Replacements	$9,917,000	$12,396,000
	New Septage Receiving Station	$776,000	$970,000
	Existing Scum Grinder and Pumps Replacement and Centrifuge Sludge Feed Grinders Replacement	$511,000	$638,000
	MEDIUM-TERM TOTAL	**$11,204,000**	**$14,004,000**
Long-Term	Centrate Pumps Replacement, Centrifuge Feed Pumps Replacement, Withdrawal Pumps Replacement	$1,121,000	$1,401,000
	LONG-TERM TOTAL	**$1,121,000**	**$1,401,000**

Murraysmith's construction cost estimate ("estimate") is in 2022 dollars valued as of the date of this estimate. This estimate is an opinion of probable cost based on information available at the time of its development. Final costs will depend on

- actual field conditions.
- actual material and labor costs.
- market conditions for construction.
- regulatory factors.
- final project scope.
- method of implementation.
- schedule, and
- other variables.

This estimate is based on our perception, which is based on experience and research, yet nevertheless, an assessment, of current conditions at the project location. This estimate reflects our professional opinion of current costs and is subject to change as the project design evolves. Murraysmith has no control over, nor can it forecast variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means, and methods of executing the work, or of determining prices, of the impact of competitive bidding or market conditions, practices, or bidding strategies. Murraysmith neither warrants nor guarantees that proposals, bids, or actual construction costs will reflect the costs presented, which are for illustrative purposes only.

Project: Central Kitsap Facility Plan Update Solids Handling Improvement Recommendations
Client: Kitsap County
Project No.: 20-2840.00. 0100.09
Date: 10/18/2022

Class 5 Estimate

New FOG Receiving Station

Item No.	Item	Unit	QTY	Unit Price Materials & Equipment	Unit Price Labor	Total
Civil Site Prep/Earthwork						
	Excavation	CY	33	$	60.00	$1,973.33
	Backfill	CY	5	$ 45.00	$ 18.00	$310.80
	FOG Yard Piping (4'')	LF	500	$ 100.00	$ 30.00	$65,000.00
	Subtotal					**$67,284.13**
Structural						
	FOG Sump	SF	50	$400.00		$20,000.00
	Subtotal					**$20,000.00**
Mechanical						
	FOG Receiving and Screening Station	LS	1	$ 273,840.00	$ 82,152.00	$355,992.00
	FOG Pump	EA	2	$ 40,000.00	$ 12,000.00	$104,000.00
	Subtotal					**$459,992.00**
Electrical, Instrumentation, and Controls						
	EI&C	EA	1	$91,998.40		$91,998.40
	Subtotal					**$91,998.40**
Construction Material & Labor Subtotal:						**$639,274.53**

Markups		
Mobilization (10%)	$	63,927.45
General Conditions (8%)	$	51,141.96
Contractor O&P (12%)	$	76,712.94
Subtotal	**$**	**831,056.89**
Tax (9.2%)	$	76,457.23
Construction Contingency (30%)	$	249,317.07
Total Construction Cost	**$**	**1,156,831.20**
Engineering, Legal, and Administration (25%)	$	289,207.80
Total Project Cost	**$**	**1,446,038.99**

Project: Central Kitsap Facility Plan Update Solids Handling Improvement Recommendations
Client: Kitsap County
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Date: 10/18/2022

Class 5 Estimate

New Septage Pumps and Grit Cyclone and Classifier

Item No.	Item	Unit	QTY	Unit Price Materials & Equipment	Unit Price Labor	Total
Civil Site Prep/Earthwork						
	Excavation	CY	106	$	60.00	$6,378.67
	Backfill	CY	16	$ 45.00	$ 18.00	$1,004.64
	Demolition of septage pumps	LS	1	$	5,000.00	$5,000.00
	Demolition of grit cyclone	LS	1	$	5,000.00	$5,000.00
	Subtotal					**$17,383.31**
Structural						
	Equipment support modification	LS	1	$	100,000.00	$100,000.00
	Subtotal					**$100,000.00**
Mechanical						
	Septage Pumps	LS	2	$ 50,000.00	$ 15,000.00	$130,000.00
	Septage Grit Removal System	LS	1	$ 146,880.00	$ 44,064.00	$190,944.00
	Subtotal					**$320,944.00**
Electrical, Instrumentation, and Controls						
	EI&C	EA	1	$64,188.80		$64,188.80
	Subtotal					**$64,188.80**
Construction Material & Labor Subtotal:						**$502,516.11**

Markups		
Mobilization (10%)	$	50,251.61
General Conditions (8%)	$	40,201.29
Contractor O&P (12%)	$	60,301.93
Subtotal	**$**	**653,270.94**
Tax (9.2%)	$	60,100.93
Construction Contingency (30%)	$	195,981.28
Total Construction Cost	**$**	**909,353.15**
Engineering, Legal, and Administration (25%)	$	227,338.29
Total Project Cost	**$**	**1,136,691.43**

Project: Central Kitsap Facility Plan Update Solids Handling Improvement Recommendations
Client: Kitsap County
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Class 5 Estimate

New Septage Thickening

Item No.	Item	Unit	QTY	Unit Price Materials & Equipment	Unit Price Labor	Total
Civil Site Prep/Earthwork						
	Excavation	CY	400	$	60.00	$24,000.00
	Backfill	CY	60	$ 45.00	$ 18.00	$3,780.00
	RDT Yard Piping (6")	LF	200	$ 125.00	$ 37.50	$32,500.00
	Subtotal					**$60,280.00**
Structural						
	Thickener Building	SF	2250	$	400.00	$900,000.00
	Subtotal					**$900,000.00**
Mechanical						
	Septage RDT	LS	1	$ 374,136.00	$ 112,240.80	$486,376.80
	Septage Thickening Ancillary Equipment	LS	1	$ 673,000.00	$ 201,900.00	$874,900.00
	Odor Control	LS	1	$ 400,000.00	$ 120,000.00	$520,000.00
	Subtotal					**$1,881,276.80**
Electrical, Instrumentation, and Controls						
	EI&C	EA	1	$376,255.36		$376,255.36
	Subtotal					**$376,255.36**
Construction Material & Labor Subtotal:						**$3,217,812.16**

Markups		
Mobilization (10%)	$	321,781.22
General Conditions (8%)	$	257,424.97
Contractor O&P (12%)	$	386,137.46
Subtotal	**$**	**4,183,155.81**
Tax (9.2%)	$	384,850.33
Construction Contingency (30%)	$	1,254,946.74
Total Construction Cost	**$**	**5,822,952.88**
Engineering, Legal, and Administration (25%)	$	1,455,738.22
Total Project Cost	**$**	**7,278,691.11**

Project: Central Kitsap Facility Plan Update Solids Handling Improvement Recommendations
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Class 5 Estimate

New Primary Sludge Thickening

Item No.	Item	Unit	QTY	Unit Price Materials & Equipment	Unit Price Labor	Total
Civil Site Prep/Earthwork						
	Excavation	CY	400	$	60.00	$24,000.00
	Backfill	CY	60	$ 45.00	$ 18.00	$3,780.00
	Demolition	LS	1	$	30,000.00	$30,000.00
	RDT Yard Piping (6")	LF	300	$ 125.00	$ 37.50	$48,750.00
	Subtotal					**$106,530.00**
Structural						
	Thickener Building	SF	2250	$	400.00	$900,000.00
	Subtotal					**$900,000.00**
Mechanical						
	Primary Sludge RDT	LS	1	$ 297,936.00	$ 89,380.80	$387,316.80
	Primary Sludge Thickening Ancillary Equipment	LS	1	$ 647,500.00	$ 194,250.00	$841,750.00
	Odor Control	LS	1	$ 400,000.00	$ 120,000.00	$520,000.00
	Subtotal					**$1,749,066.80**
Electrical, Instrumentation, and Controls						
	EI&C	EA	1	$349,813.36		$349,813.36
	Subtotal					**$349,813.36**
Construction Material & Labor Subtotal:						**$3,105,410.16**

Markups		
Mobilization (10%)	$	310,541.02
General Conditions (8%)	$	248,432.81
Contractor O&P (12%)	$	372,649.22
Subtotal	**$**	**4,037,033.21**
Tax (9.2%)	$	371,407.06
Construction Contingency (30%)	$	1,211,109.96
Total Construction Cost	**$**	**5,619,550.23**
Engineering, Legal, and Administration (25%)	$	1,404,887.56
Total Project Cost	**$**	**7,024,437.78**

Project: Central Kitsap Facility Plan Update Solids Handling Improvement Recommendations
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Class 5 Estimate

New Digester and Building

Item No.	Item	Unit	QTY	Unit Price Materials & Equipment	Unit Price Labor	Total
Civil Site Prep/Earthwork						
	Site Grubbing and Clearing	SF	18000		$0.50	$9,000.00
	Excavation	CY	5909		$60.00	$354,540.00
	Dewatering & Dewatered GW Treatment	LS	1		$500,000.00	$500,000.00
	Backfill	CY	886	$45.00	$18.00	$55,840.05
	Digester Yard Piping (4")	LF	500	$100.00	$30.00	$65,000.00
	Subtotal					**$984,380.05**
Structural						
	RC - Slab on Grade	CY	1288	$500.00	$150.00	$837,287.21
	RC - Elevated Slab	CY	370	$600.00	$180.00	$288,888.89
	RC - Walls	CY	1491	$900.00	$180.00	$1,610,641.52
	Steel Fixed Cover	EA	1	$990,000.00	$297,000.00	$1,287,000.00
	Digester Wall Painting and Coating	SF	8671	$80.00		$693,663.66
	Equipment Pad	CY	10	$500.00	$150.00	$6,500.00
	Subtotal					**$4,723,981.28**
Mechanical						
	Mixing Pumps	EA	2	$124,994.35	$37,498.31	$324,985.31
	Recirculation Pumps	EA	2	$25,000.00	$7,500.00	$65,000.00
	Withdrawl Pumps	EA	2	$100,000.00	$30,000.00	$260,000.00
	Heat Exchangers	EA	2	$81,000.00	$24,300.00	$210,600.00
	Cover Insulation	EA	1	$15,000.00	$4,500.00	$19,500.00
	Mixing Piping - 16'' HDPE	LS	1	$500,000.00		$500,000.00
	Mechanical Piping - 16'' DI (DS mixing)	LF	100	$700.00	$210.00	$91,000.00
	Mechanical Piping - 6'' DI (DS heating)	LF	100	$200.00	$60.00	$26,000.00
	Mechanical Piping - 6'' DI (THS)	LF	200	$200.00	$60.00	$52,000.00
	Mechanical Piping - 6'' DI (DS)	LF	200	$200.00	$60.00	$52,000.00
	Fittings	LB	2763	$4.50	$4.50	$24,862.50
	Mechanical Valves	LS	1	$300,000.00	$90,000.00	$390,000.00
	Digester Gas Safety Equipment	EA	1	$400,000.00	$120,000.00	$520,000.00
	Digester Gas Sediment Trap	EA	1	$100,000.00	$30,000.00	$130,000.00
	Digester Gas Piping - 4" SST (DG)	LF	200	$60.00	$60.00	$24,000.00
	Building HVAC	LS	1	$500,000.00		$500,000.00
	Building Plumbing and Lighting	LS	1	$500,000.00		$500,000.00
	Subtotal					**$3,689,947.81**
Electrical, Instrumentation, and Controls						
	EI&C	EA	1	$1,844,974		$1,844,973.91
	Subtotal					**$1,844,973.91**
Construction Material & Labor Subtotal:						**$11,243,283.04**

Markups		
Mobilization (10%)	$	1,124,328.30
General Conditions (8%)	$	899,462.64
Contractor O&P (12%)	$	1,349,193.96
Subtotal	**$**	**14,616,267.95**
Tax (9.2%)	$	1,344,696.65
Construction Contingency (30%)	$	4,384,880.39
Total Construction Cost	**$**	**20,345,844.99**
Engineering, Legal, and Administration (25%)	$	5,086,461.25
Total Project Cost	**$**	**25,432,306.24**

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Class 5 Estimate

New In-plant Pump Station

Item No.	Item	Unit	QTY	Unit Price Materials & Equipment	Unit Price Labor	Total
Civil Site Prep/Earthwork						
	Existing Wetwell Dewatering	EA	1		$100,000.00	$100,000.00
	Existing Wetwell Cleaning	EA	1		$1,280.00	$1,280.00
	Existing Wetwell Demolition	LS	1		$5,000.00	$5,000.00
	New Wetwell and Valve Vault Excavation	CY	132	$25.00	$60.00	$11,184.39
	New Wetwell and Valve Vault Backfill	CY	26	$ 45.00	$ 18.00	$1,657.92
	Subtotal					**$119,122.32**
Structural						
	RC-Slab on Grade - New Wetwell & valve vault	CY	4.2	$500.00	$150.00	$2,726.76
	RC - Wall - New Wetwell & valve vault	CY	14	$600.00	$180.00	$10,864.58
	Subtotal					**$13,591.34**
Mechanical						
	New Sump Pump	EA	1	$33,220.14	$9,966.04	$43,186.18
	Associated Piping and Valves	LS	1	$20,000.00	$6,000.00	$26,000.00
	Subtotal					**$69,186.18**
Electrical, Instrumentation, and Controls						
	Pump Disconnect Panel	EA	1	$8,000.00	$2,400.00	$10,400.00
	Control Panel (PNL-1067)	EA	1	$50,000.00	$15,000.00	$65,000.00
	Yard electrical	LS	1	$30,000.00		$30,000.00
	Subtotal					**$105,400.00**
Construction Material & Labor Subtotal:						**$307,299.84**

Markups		
Mobilization (10%)	$	30,729.98
General Conditions (8%)	$	24,583.99
Contractor O&P (12%)	$	36,875.98
Subtotal	**$**	**399,489.80**
Tax (9.2%)	$	36,753.06
Construction Contingency (30%)	$	119,846.94
Total Construction Cost	**$**	**556,089.80**
Engineering, Legal, and Administration (25%)	$	139,022.45
Total Project Cost	**$**	**695,112.25**

Project: Central Kitsap Facility Plan Update Solids Handling Improvement Recommendations
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Class 5 Estimate

New Hot Water System

Item No.	Item	Unit	QTY	Unit Price Materials & Equipment	Unit Price Labor	Total
Civil Site Prep/Earthwork						
	Subtotal					**$0.00**
Structural						
	Subtotal					**$0.00**
Mechanical						
	Existing Demolition	EA	3		$5,000.00	$15,000.00
	New Boilers (Replace Existing)	EA	2	$ 320,000.00	$ 96,000.00	$832,000.00
	New Boiler Stack (SS)	LS	1	$ 20,000.00	$ 6,000.00	$26,000.00
	New Hot Water Recirculation Pumps	EA	4	$ 6,150.00	$ 1,845.00	$31,980.00
	New Expansion Tanks	EA	2	$ 15,000.00	$ 4,500.00	$39,000.00
	Hot water piping - 5"	LS	1	$ 12,000.00	$ 3,600.00	$15,600.00
	Natural Gas Piping and Connection	LS	1	$ 30,000.00		$30,000.00
	Subtotal					**$989,580.00**
Electrical, Instrumentation, and Controls						
	EI&C	LS	1	$296,874.00		$296,874.00
	Subtotal					**$296,874.00**
Construction Material & Labor Subtotal:						**$1,286,454.00**

Markups		
Mobilization (10%)	$	128,645.40
General Conditions (8%)	$	102,916.32
Contractor O&P (12%)	$	154,374.48
Subtotal	**$**	**1,672,390.20**
Tax (9.2%)	$	153,859.90
Construction Contingency (30%)	$	501,717.06
Total Construction Cost	**$**	**2,327,967.16**
Engineering, Legal, and Administration (25%)	$	581,991.79
Natural Gas Pipeline Extension by Cascade Natural Gas	$	333,075.60
Total Project Cost	**$**	**3,243,034.55**

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Class 5 Estimate

Shop and Equipment Maintenance Building Relocation

Item No.	Item	Unit	QTY	Unit Price Materials & Equipment	Unit Price Labor	Total
Civil Site Prep/Earthwork						
	Existing Shop Demolition	LS	1		$50,000.00	$50,000.00
	Yard Piping Modification	LS	1		$50,000.00	$50,000.00
	Subtotal					**$100,000.00**
Structural						
	New Shop and Equipment Maintenance Building	SF	10324	$200.00		$2,064,800.00
	Subtotal					**$2,064,800.00**
Mechanical						
	Equipment Relocation	LS	1	$30,000.00		$30,000.00
	Subtotal					**$30,000.00**
Electrical, Instrumentation, and Controls						
	EI&C Relocation	LS	1	$30,000.00		$30,000.00
	Subtotal					**$30,000.00**
Construction Material & Labor Subtotal:						**$2,224,800.00**
	Markups					
Mobilization (10%)						$ 222,480.00
General Conditions (8%)						$ 177,984.00
Contractor O&P (12%)						$ 266,976.00
					Subtotal	**$ 2,892,240.00**
Tax (9.2%)						$ 266,086.08
Construction Contingency (30%)						$ 867,672.00
					Total Construction Cost	**$ 4,025,998.08**
Engineering, Legal, and Administration (25%)						$ 1,006,499.52
					Total Project Cost	**$ 5,032,497.60**

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Class 5 Estimate

Existing Digesters Improvements and Replacements

Item No.	Item	Unit	QTY	Unit Price Materials & Equipment	Unit Price Labor	Total
Civil Site Prep/Earthwork						
	Dewatering & Dewatered GW Treatment	LS	1	$500,000.00		$500,000.00
	Digester Gas Purge	EA	4	$13,000.00		$52,000.00
	Digester Drainage, Cleaning & Inspection	EA	2	$325,000.00		$650,000.00
	Subtotal					**$1,202,000.00**
Structural						
	Equipment Pad	CY	4	$500.00	$150.00	$2,600.00
	Structural & Coating Repair	SF	12252	$80.00		$980,177
	Cover and Skirt Repair or Replace	EA	2	$660,000.00	$198,000.00	$1,716,000
	Subtotal					**$2,698,776.91**
Mechanical						
	Demolition	LS	1	$20,000.00		$20,000.00
	Mixing Pumps Replace	EA	2	$124,994.35	$37,498.31	$324,985.31
	Mixing Piping - 16'' HDPE	LS	1	$500,000.00		$500,000.00
	Heat Exchangers Replace	EA	2	$81,000.00	$16,200.00	$194,400.00
	Recirculation Pumps Replace	EA	2	$25,000.00	$5,000.00	$60,000.00
	Subtotal					**$1,099,385.31**
Electrical, Instrumentation, and Controls						
	MCC Replacement	EA	1	$200,000.00	$60,000.00	$260,000.00
	EI&C Lump Sum	LS	1	$219,877		$219,877.06
	Subtotal					**$479,877.06**
Construction Material & Labor Subtotal:						**$5,480,039.28**

Markups		
Mobilization (10%)	$	548,003.93
General Conditions (8%)	$	438,403.14
Contractor O&P (12%)	$	657,604.71
Subtotal	**$**	**7,124,051.06**
Tax (9.2%)	$	655,412.70
Construction Contingency (30%)	$	2,137,215.32
Total Construction Cost	**$**	**9,916,679.08**
Engineering, Legal, and Administration (25%)	$	2,479,169.77
Total Project Cost	**$**	**12,395,848.85**

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Class 5 Estimate

New Septage Receiving Station

Item No.	Item	Unit	QTY	Unit Price Materials & Equipment	Unit Price Labor	Total
Civil Site Prep/Earthwork						
	Excavation	CY	20	$	60.00	$1,173.33
	Backfill	CY	3	$ 45.00	$ 18.00	$184.80
	Subtotal					**$1,358.13**
Structural						
	Subtotal					**$0.00**
Mechanical						
	Septage Acceptance Plant	LS	1	$ 273,840.00	$ 82,152.00	$355,992.00
	Subtotal					**$355,992.00**
Electrical, Instrumentation, and Controls						
	EI&C	EA	1	$71,198.40		$71,198.40
	Subtotal					**$71,198.40**
Construction Material & Labor Subtotal:						**$428,548.53**

Markups		
Mobilization (10%)	$	42,854.85
General Conditions (8%)	$	34,283.88
Contractor O&P (12%)	$	51,425.82
Subtotal	**$**	**557,113.09**
Tax (9.2%)	$	51,254.40
Construction Contingency (30%)	$	167,133.93
Total Construction Cost	**$**	**775,501.43**
Engineering, Legal, and Administration (25%)	$	193,875.36
Total Project Cost	**$**	**969,376.78**

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Class 5 Estimate

Existing Scum Grinder and Pumps Replacement and Centrifuge Sludge Feed Grinders Replacement

Item No.	Item	Unit	QTY	Materials & Equipment	Labor	Total
Civil Site Prep/Earthwork						
						$0.00
						$0.00
						$0.00
	Subtotal					**$0.00**
Structural						
	Equipment Pad	CY	5	$ 600.00	$150.00	$3,750.00
	Subtotal					**$3,750.00**
Mechanical						
	Existing Scum Grinder and Pumps Demolition	LS	3		$ 5,000.00	$15,000.00
	New Scum Pumps	EA	2	$ 30,058.00	$ 9,017.40	$78,150.80
	New Scum Grinder	LS	1	$ 28,000.00	$ 8,400.00	$36,400.00
	Pump Seal Water Assembly	LS	3	$ 2,000.00	$ 600.00	$7,800.00
	Mechanical Piping and Fittings	LS	1	$ 5,000.00	$ 1,500.00	$6,500.00
	Existing Centrifuge Sludge Feed Grinders Demolition	EA	2		$ 5,000.00	$10,000.00
	New Centrifuge Sludge Feed Grinders	EA	2	$ 27,500.00	$ 8,250.00	$71,500.00
	Centrifuge Mechanical Piping and Fittings	LS	1	$ 5,000.00	$ 1,500.00	$6,500.00
	Subtotal					**$231,850.80**
Electrical, Instrumentation, and Controls						
	EI&C Replacement	EA	1	$46,370.16		$46,370.16
	Subtotal					**$46,370.16**
Construction Material & Labor Subtotal:						**$281,970.96**

Markups		
Mobilization (10%)	$	28,197.10
General Conditions (8%)	$	22,557.68
Contractor O&P (12%)	$	33,836.52
Subtotal	**$**	**366,562.25**
Tax (9.2%)	$	33,723.73
Construction Contingency (30%)	$	109,968.67
Total Construction Cost	**$**	**510,254.65**
Engineering, Legal, and Administration (25%)	$	127,563.66
Total Project Cost	**$**	**637,818.31**

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Class 5 Estimate

Centrate Pumps Replacement, Centrifuge Feed Pumps Replacement, Withdrawal Pumps Replacement

Item No.	Item	Unit	QTY	Materials & Equipment	Labor	Total
Civil Site Prep/Earthwork						
						$0.00
						$0.00
						$0.00
						$0.00
	Subtotal					**$0.00**
Structural						
	Equipment Pad	CY	5	$ 600.00	$150.00	$3,750.00
						$0.00
	Subtotal					**$3,750.00**
Mechanical						
	Existing Centrate Pumps Demolition	EA	2		$ 5,000.00	$10,000.00
	New Centrate Pumps	EA	2	$ 6,150.00	$ 1,845.00	$15,990.00
	Mechanical Piping and Fittings	LS	1	$ 10,000.00	$ 3,000.00	$13,000.00
	Existing Centrifuge Feed Pumps Demolition	EA	2		$ 5,000.00	$10,000.00
	New Centrifuge Feed Pumps	LS	2	$ 49,400.00	$ 14,820.00	$128,440.00
	Mechanical Piping and Fittings	LS	1	$ 10,000.00	$ 3,000.00	$13,000.00
	Existing Digester Withdrawl Pumps Demolition	EA	2		$ 5,000.00	$10,000.00
	New Digester Withdrawl Pumps	LS	2	$ 100,000.00	$ 30,000.00	$260,000.00
	Mechanical Piping and Fittings	LS	1	$ 10,000.00	$ 3,000.00	$13,000.00
	Subtotal					**$473,430.00**
Electrical, Instrumentation, and Controls						
	EI&C Replacement	LS	1	$142,029.00		$142,029.00
	Subtotal					**$142,029.00**
Construction Material & Labor Subtotal:						**$619,209.00**

Markups		
Mobilization (10%)	$	61,920.90
General Conditions (8%)	$	49,536.72
Contractor O&P (12%)	$	74,305.08
Subtotal	**$**	**804,971.70**
Tax (9.2%)	$	74,057.40
Construction Contingency (30%)	$	241,491.51
Total Construction Cost	**$**	**1,120,520.61**
Engineering, Legal, and Administration (25%)	$	280,130.15
Total Project Cost	**$**	**1,400,650.76**