# Technical Memorandum


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| Date: | July 22, 2022 |
| Project: | Wastewater General Sewer Plan |
| To: | Barbara Zaroff, PE, PMP<br>Christopher Sheridan<br>Kitsap County, WA |
| From: | Jefferson Moss, PE<br>Xinyi Xu, EIT |
| Reviewed By: | Miaomiao Zhang, PE, PMP<br>Erika Schuyler, PE, PMP |
| Re: | Central Kitsap WWTP Liquid Hauled Waste Study |


## 1. Introduction

This technical memorandum (TM) establishes the basis of planning for the County's liquid hauled waste (LHW) flows and loads for a 6- and 20-year planning period. The TM also evaluates alternatives for LHW treatment for the 20-year planning period with consideration of the effects on other solids treatment processes at Central Kitsap Wastewater Treatment Plant (WWTP).

## 2. Background

LHW at Central Kitsap WWTP consists of thickened waste activated sludge (TWAS) from the County's Kingston, Manchester, and Suquamish WWTPs, septage, and fats, oils and grease (FOG). Septage includes waste from septic tanks, portable toilets, and other sources. FOG loads are self-identified by septage haulers as being obtained from sources that have high FOG such as restaurants, grease traps, etc.

The County provides septage and FOG disposal services to ensure that rural residents and businesses in the region have a safe and sanitary means of disposal in areas where sewer systems have not been constructed. The County is committed to continuing this critical public service in the future to those residents outside of the Urban Growth Area (UGA).

The following tasks were developed:

- Study Area Characterization and Growth Projection: Review current septage and FOG disposal sites in the Kitsap County to establish a study area. Determine land use designations, establish land development assumptions, and develop a growth curve for the next 20 years.

- Flow and Load Projection: Prepare LHW flow and load projections for the 6- and 20-year planning periods.

- Alternatives Analysis: Develop and evaluate LHW receiving and treatment process alternatives to provide treatment for the near-term as well as 20-year planning periods. Alternatives include options to treat septage and FOG with existing Central Kitsap WWTP processes and as a separate process at Central Kitsap WWTP.

# 3. Study Area Characterization and Growth Projection

## *3.1 Study Area Characterization*

Central Kitsap WWTP is the only facility that receives LHW in Kitsap County. The County Council is committed to providing LHW receiving service to the residents and businesses within the County but outside of the UGA. The study area is defined as unsewered areas within Kitsap County, so sewered areas within the County were identified and removed from consideration. Removed areas include the County's collection system, areas within UGA boundaries of other agencies or municipalities, and military bases.

The unsewered study area was provided to the Puget Sound Regional Council (PSRC) to obtain the population forecasts corresponding to LHW production. The PSRC is led by a group of representatives from the counties, cities, towns, Tribes, port districts and transit agencies in the Puget Sound region. It develops policies and coordinates decisions related to regional growth and transportation and economic planning within Kitsap, King, Pierce, and Snohomish counties. It provides a leading source of data and forecasting for regional and local planning in the Puget Sound area.

The PSRC's population projection is based on their Land Use Vision (LUV) forecast. The LUV dataset reflects the VISION 2040 Regional growth strategy, local policies, and each county's adopted growth targets. The PSRC's Regional Macroeconomic Forecast is apportioned to cities and unincorporated areas using the VISION 2040 Regional Growth Strategy and local growth targets to create annual control totals. The PSRC's land use model, UrbanSim, then uses the annual control totals to determine projected population growth.

For planning purposes, it is assumed that all of the unsewered study area identified will remain unsewered by the end of the 20-year planning horizon.

## *3.2 Growth Curve Development*

The PSRC projections for residential population are defined by household population and group quarters population. Household population includes both single-family and multi-family units. Group quarters are places where people live or stay in a group living arrangement such as group homes, nursing facilities, federal and state prisons, or military quarters. PSRC provided population in 2014 and population forecast in 2030 and 2040. The population was then interpolated to 2028 and extrapolated to 2042. Table 1 presents the projected growth for the unsewered population based on PSRC projections. This projection shows a 11.7 percent growth between 2021 and 2042, which is an annual growth rate of 0.53 percent.

### Table 1. Central Kitsap Unsewered Area Population Projection

| Year | Household | Group Quarters | Total |
|---|---|---|---|
| 2014 | 89,290 | 318 | 89,608 |
| 2021[1] | 96,051 | 340 | 96,391 |
| 2028[1] | 102,812 | 362 | 103,174 |
| 2030 | 104,744 | 368 | 105,112 |
| 2040 | 106,889 | 390 | 107,279 |
| 2042[2] | 107,38 | 394 | 107,712 |

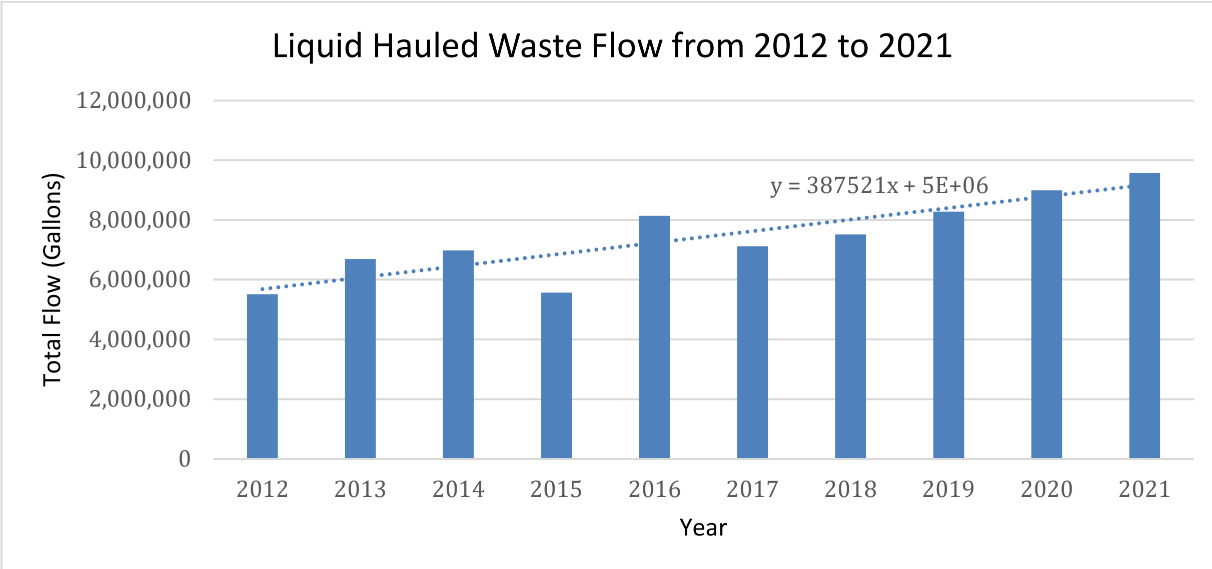
1. PSRC Projections, interpolated between 2014 and 2030
2. PSRC Projections, extrapolated based on yearly growth between 2030 and 2040

# 4. Flow and Load Projection

## *4.1 Current Flows*

The County tracks LHW disposal at Central Kitsap WWTP. Figure 1 shows the total flow and linear trend line of LHW received at the WWTP from 2012 to 2021. The data show an average annual growth rate of 4.1 percent or 387,521 gallons per year. LHW disposal increases steadily over the nine years of data and does not show a substantial deviation from the trend during the COIVD-19 shutdowns and increased working from home in 2020 and 2021. Note that in the fall of 2015 the anaerobic digesters were taken off-line for cleaning and septage receiving was shut down for several weeks. This may contribute to the relatively low flow received in 2015 and high flow received in 2016.

## Figure 1. Liquid Hauled Waste Flow and Growth Rate from 2012 to 2021




More recent data from Central Kitsap WWTP includes greater detail on the source of individual loads of LHW. For data from 2016 to 2021, the septage and FOG components of LHW was extracted to remove the effect of TWAS hauled from other WWTPs. In 2021, septage and FOG represented 94 percent of LHW. Figure 2 shows the total flow and linear trend line of septage and FOG from 2016 to 2021. The observed annual growth rate is 4.5 percent or 397,760 gallons per year.

## Figure 2. Septage and FOG Flow and Growth Rates from 2016 to 2021

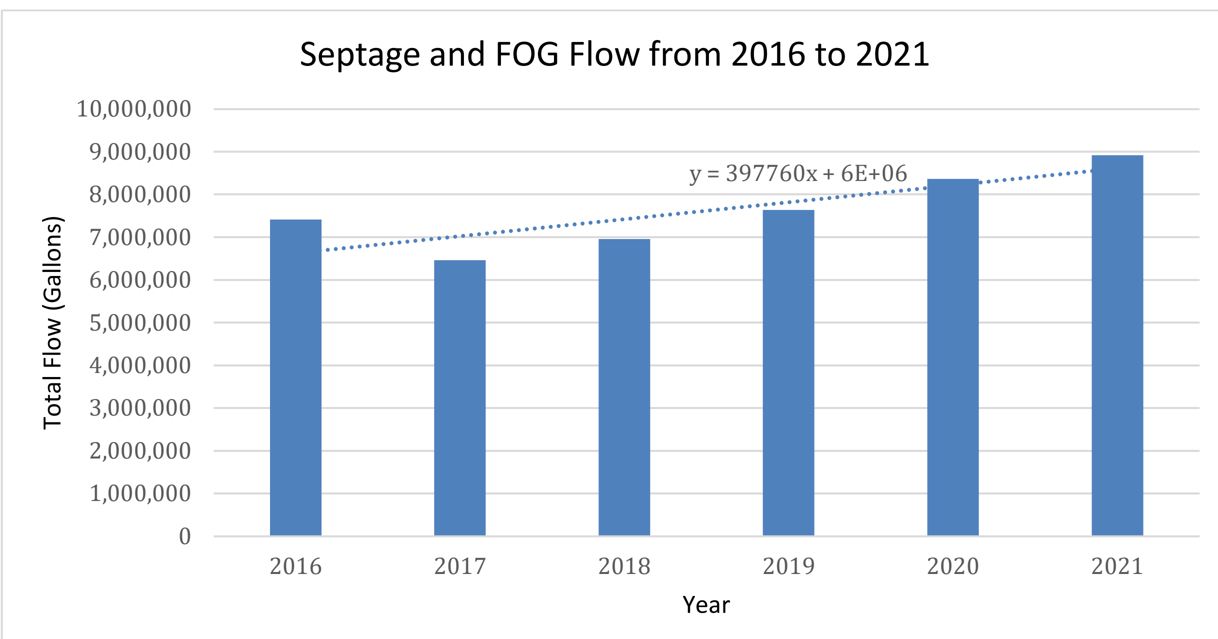
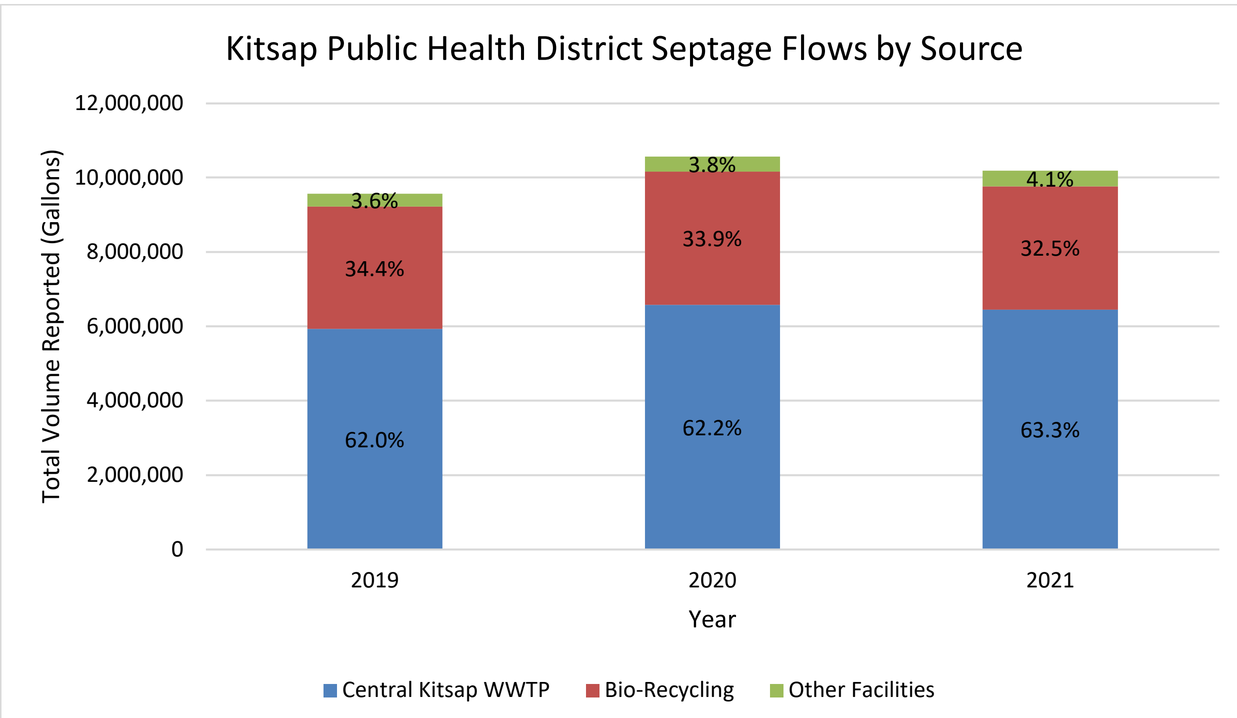


Figure 3 summarizes the total annual septage volume and percentage of septage loads in Kitsap County that different septage treatment service groups received in 2019, 2020 and 2021 per Kitsap Public Health District (KPHD) records. The septage volumes and dump locations are self-reported to KPHD by septage haulers, so the volumes are not as accurate as the volumes calculated at the WWTP, but the data shows that Central Kitsap WWTP consistently receives approximately two third of the septage collected within Kitsap County, with most of the remaining third going to Bio-recycling in neighboring Mason County. Although there is some variability in the reported septage hauling, the KPHD record also shows a clear trend of increase in loading from sources within the County to Central Kitsap WWTP at an annual increase rate of approximately 4.4 percent from 2019 to 2021.

## Figure 3. Septage Loads by Source in Kitsap County




Daily septage and FOG receiving flow data from Central Kitsap WWTP were evaluated using septage receiving reports from January 2019 through December 2021 and are shown in Figure 4. Some seasonality is observed with slightly lower flows in the winter compared to the rest of the year and a general increase in flows over time is observable, consistent with the annual data. Septage receiving was halted for two weeks in the fall of 2021, which resulted in a significant decrease in the 30-day running average.

## Figure 4. Septage and FOG Daily Flowrates from Jan 2019 to Dec 2021

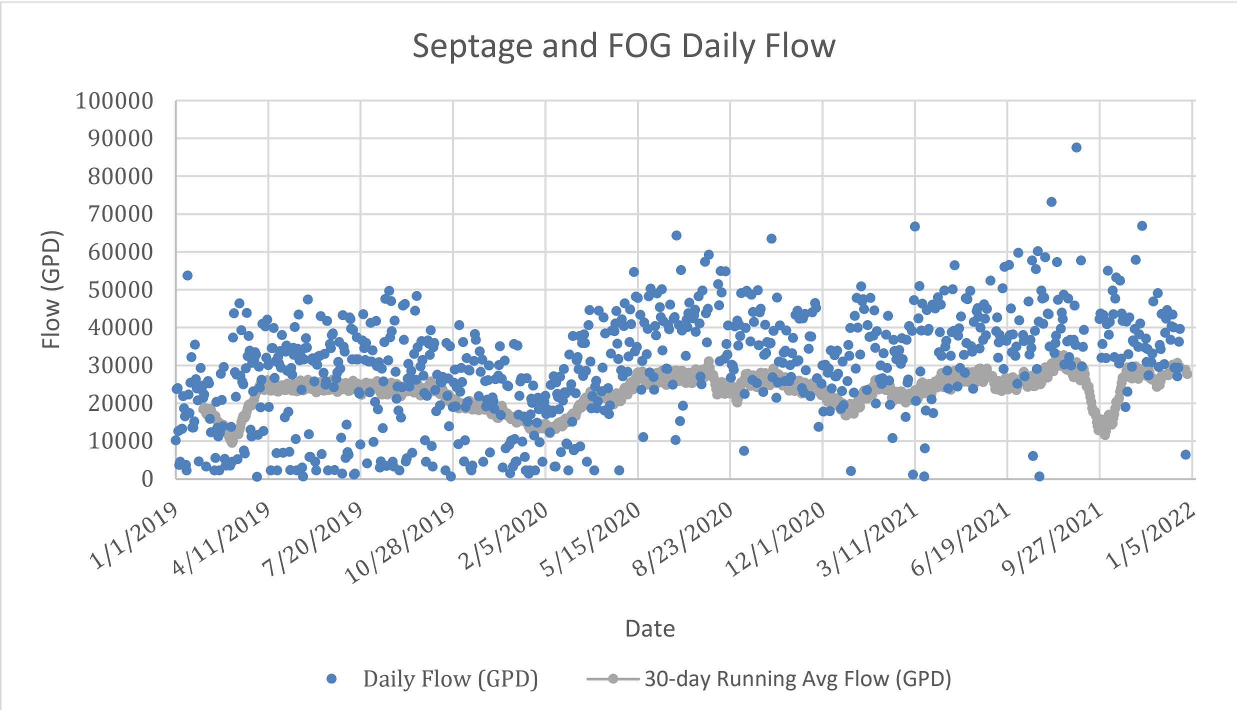



Table 2 summarizes the annual average flow (AAF), maximum month flow (MMF), and peak day flow (PDF) based on the daily septage receiving data 2019-2021. Table 2 also lists the corresponding peaking factors and per capita flow based on the estimated un-sewered population of 96,391 in 2021 reported in Table 1. Assuming a median household size of 2.5 persons and a typical septic tank size of 1,000 gallons (per Washington Administrative Code (WAC)), the septage receiving data indicates the average household's septic tank cleaning frequency is every 4.6 years, which is consistent with EPA recommendations and indicates that the observed septage data is generally consistent with the expected septage loading based on unsewered area population.

## Table 2. 2019-2021 Septage Receiving Flows

| Flow Event | Flow (GPD[1]) | Peaking Factor | Per Capita Flow (gpcpd[2]) |
|---|---|---|---|
| AAF | 23,004 | | 0.24 |
| MMF | 32,681 | 1.42 | 0.34 |
| PDF | 87,600 | 3.81 | 0.91 |

1. GPD = gallons per day
2. gpcpd = gallons per capita per day

Table 3 summarizes the AAF, MMF and PDF of the FOG flows received in 2019 to 2021 and corresponding peaking factors. FOG loading is very intermittent and highly variable which results in higher peaking factors. Per capita flow was not analyzed for FOG because of the variability and indirect correlation between FOG and population.

## Table 3. 2019-2021 FOG Receiving Flows

| | Flow (GPD) | Peaking Factor |
|---|---|---|
| AAF | 1,543 | |
| MMF | 4,825 | 3.13 |
| PDF | 19,200 | 12.4 |

### *4.2 Current Loads*

LHW loads to Central Kitsap WWTP are used to evaluate different treatment alternatives and to determine the required treatment capacities. Septage data from 2019 through 2021 show an average of 2.1 percent of total solids (TS) and 5,780 mg/L of Biological Oxygen Demand (BOD). Current septage TS and BOD daily mass loads were derived for AAF and MMF conditions as shown in Table 4.

## Table 4. 2021 Septage TS and BOD Load

| Parameter | Annual Average Load (ppd[1]) | Max Month Load (ppd[1]) |
|---|---|---|
| TS | 4,042 | 5,743 |
| BOD | 1,109 | 1,575 |

1. ppd = pounds per day

Current FOG TS and BOD daily mass loads and per capita plant loading rates were derived for AAF and MMF conditions as shown in Table 5. Although FOG is not normally sampled at the plant, sampling tests that were done in October 2020 had an average TS of 1.81 percent. It is assumed that the TS and BOD content of grease are similar to those of septage.

## Table 5. 2021 FOG TS and BOD Load

| Parameter | Annual Average Load (ppd) | Max Month Load (ppd) |
|---|---|---|
| TS | 271 | 848 |
| BOD | 74 | 233 |

### *4.3 Projected Flows and Loads*

The unsewered population growth rate projection from the PSRC forecast of 0.53 percent per year is substantially lower than the observed septage receiving growth rate of 4.5 percent per year. It is difficult to determine a conclusive reason for such a dramatic difference in growth rates. However, it is believed the septage receiving growth rate is more accurate for flow projections because it comes directly from the County's septage flow data and the growth has been consistent for the last six years, while the unsewered population is indirectly correlated with the septage production. The septage data and population forecasts were discussed with the County and an estimated septage and FOG growth rate of 4 percent was selected to be used for future flow and load projections. This value is close to, but slightly below, the septage receiving growth rate and was selected because it accurately captures the current trends while also accounting for the lower expected population growth forecast developed from the PSRC data. It should be noted that due to the large difference in growth rates from the PSRC forecast and septage data there is considerable uncertainty regarding the rate of increase of septage that will actually occur.

Table 6 summarizes the projected flows of LHW in 2028 and 2042. The growth rate of septage and FOG received at Central Kitsap WWTP is assumed to be 4 percent per for the next 20 years. The TWAS hauled from the County's other WWTPs were developed in the General Sewer Plan of corresponding WWTP and are reported here to capture all LHW sources.

## Table 6. Projected Liquid Hauled Waste Flows in 2028 and 2042

| LHW Component | 2028 | | | 2042 | | |
|---|---|---|---|---|---|---|
| | AAF | MMF | PDF | AAF | MMF | PDF |
| Septage Flow (GPD) | 30,272 | 43,006 | 115,276 | 52,421 | 74,472 | 199,620 |
| FOG Flow (GPD) | 2,030 | 6,349 | | 3,516 | 10,995 | |
| TWAS Flow from Other WWTPs (GPD) | 2,079 | 3,261 | | 2,937 | 4,685 | |
| **Total LHW Flow (GPD)** | **34,381** | **52,616** | | **58,874** | **90,152** | |

Table 7 and Table 8 summarize the projected TS and BOD loads from LHW in 2028 and 2042. It is assumed that the TS and BOD content of septage and FOG will remain consistent with current observations at 2.11 percent and 5,780 mg/L, respectively. The TWAS loads hauled from the County's other WWTPs were developed in the applicable Population, Flow, and Load Projection Section of the General Sewer Plan of corresponding WWTP and are reported here to capture all LHW sources.

## Table 7. Projected Liquid Hauled Waste TS Loads in 2028 and 2042

| LHW Component | 2028 | | 2042 | |
|---|---|---|---|---|
| | Annual Average | Max. Month | Annual Average | Max. Month |
| Septage TS Load (ppd) | 5,319 | 7,557 | 9,212 | 13,087 |
| FOG TS Load (ppd) | 357 | 1,117 | 619 | 1,935 |
| TWAS TS Load from Other WWTPs (ppd) | 933 | 1,463 | 1,318 | 2,102 |
| **Total LHW TS Load (ppd)** | **6,609** | **10,137** | **11,149** | **17,124** |

## Table 8. Projected Liquid Hauled Waste BOD Loads in 2028 and 2042

| LHW Component | 2028 | | 2042 | |
|---|---|---|---|---|
| | Annual Average | Max. Month | Annual Average | Max. Month |
| Septage BOD Load (ppd) | 1,459 | 2,073 | 2,527 | 3,589 |
| FOG BOD Load (ppd) | 98 | 306 | 169 | 530 |
| TWAS BOD Load from Other WWTPs (ppd) | 100 | 157 | 142 | 226 |
| Total LHW BOD Load (ppd) | 1,657 | 2,536 | 2,838 | 4,345 |

# 5. Existing Solids and Septage Treatment

Central Kitsap WWTP receives and treats sewage, sewage sludge, septage and FOG. According to the latest Statewide General Permit for Biosolids Management issued on June 15, 2022, "when a facility mixes septage, sewage sludge or biosolids together in any combination, the mixture must be treated to the same standards for biosolids produced from the treatment of sewage in a wastewater treatment plant". Consistent with this requirement, Central Kitsap WWTP currently handles septage as "septage managed as biosolids originating from sewage sludge" as defined in WAC 173-308-080. This means the septage treatment at Central Kitsap WWTP will need to meet the sampling requirement in WAC 173-308-140, monitoring requirement in WAC 173-308-150, the pollutant limits in WAC 173-308-160, the pathogen reduction requirements in WAC 173-308-170, and the vector attraction reduction requirements in WAC 173-308-180. Although WAC 173-308-270 allows an alternative which applies septage to the land with less stringent treatment requirement, this alternative is not feasible to the County since it has very particular requirements on site management and access restriction, application rate, and monitoring. It is not possible for the County to identify any land application site near the WWTP that can meet all the requirements. And it is not economical for the County to haul liquid septage to the eastern Washington for land application.

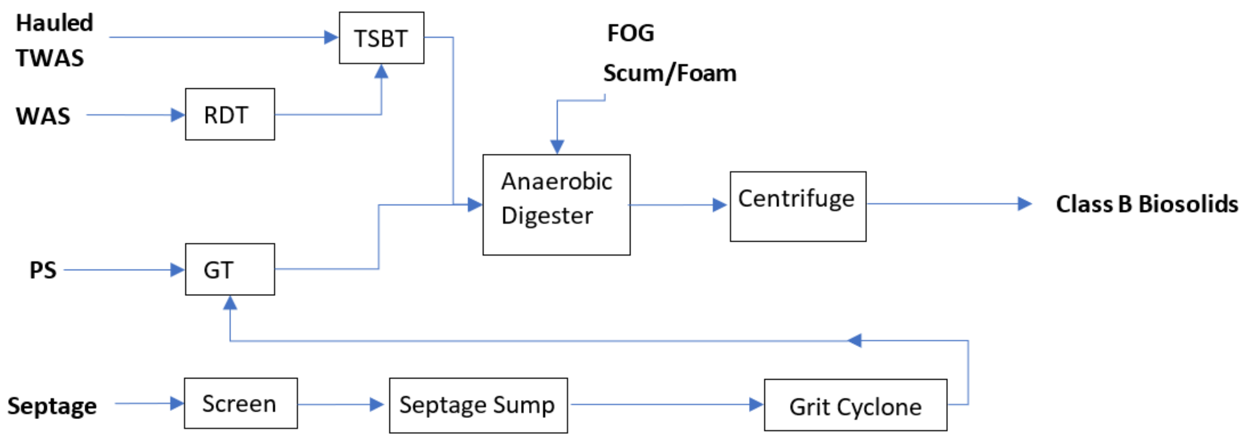
The existing solids and septage handling process diagram at Central Kitsap WWTP is shown in Figure 5. Waste activated sludge (WAS) from Central Kitsap WWTP is thickened in a rotary drum thickener (RDT) and then stored in the thickened sludge blending tank (TSBT), which also receives the TWAS hauled from other WWTPs. Blended sludge from the TSBT is fed into the two anaerobic digesters.

Septage is unloaded from trucks at the septage receiving station. After flowing through a rotary drum fine screen, the screened septage flows by gravity to the septage sump in the solids processing building and is diluted with process water. The diluted septage is pumped by two septage pumps to a grit cyclone and then flows into the gravity thickeners (GTs), which also receive primary sludge (PS). Thickened sludge from the GTs can be pumped either to the TSBT or directly into the anaerobic digesters.

FOG is dumped into the secondary clarifier scum pit and the mixed scum and FOG is pumped directly into the anaerobic digesters. The aeration basin foam wasting station is not normally operated but also pumps into the anaerobic digesters if it is in use.

All the sludge is stabilized in the anaerobic digesters to Class B biosolids. Biosolids from the anaerobic digesters are then dewatered with a centrifuge and loaded to a truck for hauling and land application.

## Figure 5. Existing Solids and Septage Handling Process Diagram




As discussed in the General Sewer Plan, the challenges associated with the existing solids and septage handling process include:

- Existing septage receiving and screening station does not have redundancy to allow for maintenance and it will become increasingly difficult for septage haulers to unload without delay as septage hauling increases.
- Existing septage pumps are 45 years old and have exceeded their typical lifespan of 25 to 30 years.
- Existing septage grit cyclone and classifier are 45 years old and have exceeded their typical lifespan of 25 to 30 years.
- There is no dedicated FOG receiving and treatment station. FOG is dumped to the secondary clarifier scum sump. Existing scum sump and piping are 45 years old.
- Existing GTs are over 45 years old and experience severe corrosion on the roof structure and mechanism. Most of the major equipment associated with the GTs is reaching the end of its expected lifespan.
- Existing GTs are over-sized for thickening purpose thus become the potential cause of sludge fermentation within the GTs and reduced volatile solids reduction (VSR) within anaerobic digesters.
- Existing anaerobic digesters are over 45 years old. Some major equipment associated with the digestion is reaching the end of its expected lifespan. In addition, the two existing digesters do not provide redundancy at current loading rates and do not consistently meet

VSR requirements for vector attraction reduction using the historic VSR calculation methods.

# 6. Alternatives Analysis

The five alternatives presented below were developed to address the challenges identified for the existing process and identify a more reliable LHW and biosolids management strategy for the County to meet all the regulatory requirements.

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

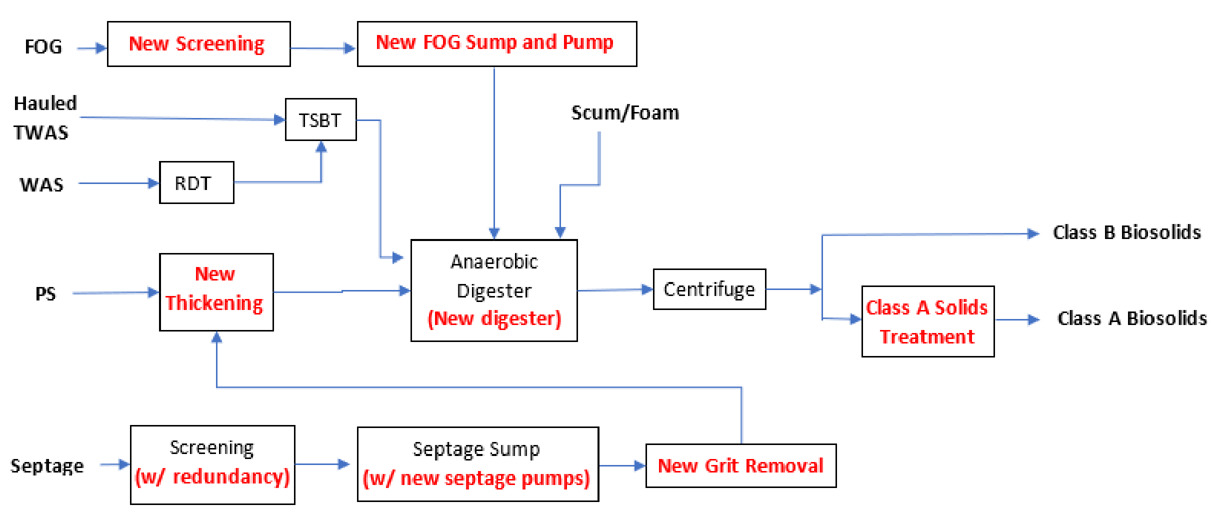
Alternative 5 – Separated Septage Treatment with Wetland and Composting

Each of the alternative is discussed in more detail in the following sections.

## *6.1 Alternative 1 – Treat Septage with Other Solids Streams*

Alternative 1 continues the current approach of mixing septage with other solids streams and treating it using the existing processes by improving the capacity, redundancy, and performance of these processes. Figure 6 shows the process flow diagram of Alternative 1, with new or modified components indicated in red text.

## Figure 6. Alternative 1 Flow Process Diagram

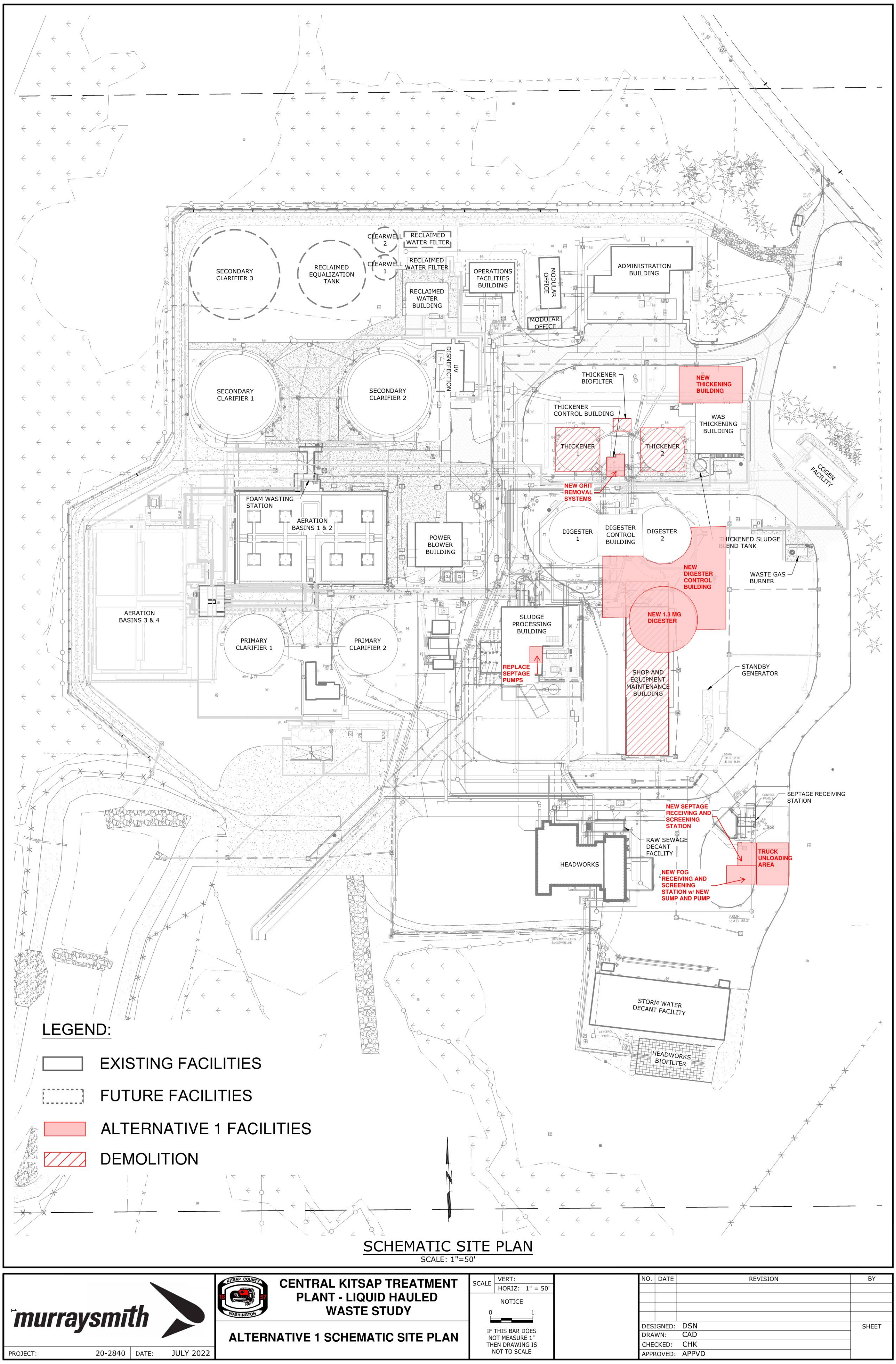



The proposed improvements include:

- 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.
- The existing GTs will be replaced with a new thickening process.
- A third, 1.3-million-gallon (MG) anaerobic digester will be constructed to add digestion capacity for mixed thickened sludge, septage, and FOG.
- All other existing solids treatment components are sufficient to continue operating through 2042.

The proposed site layout of Alternative 1 is shown in Figure 7.

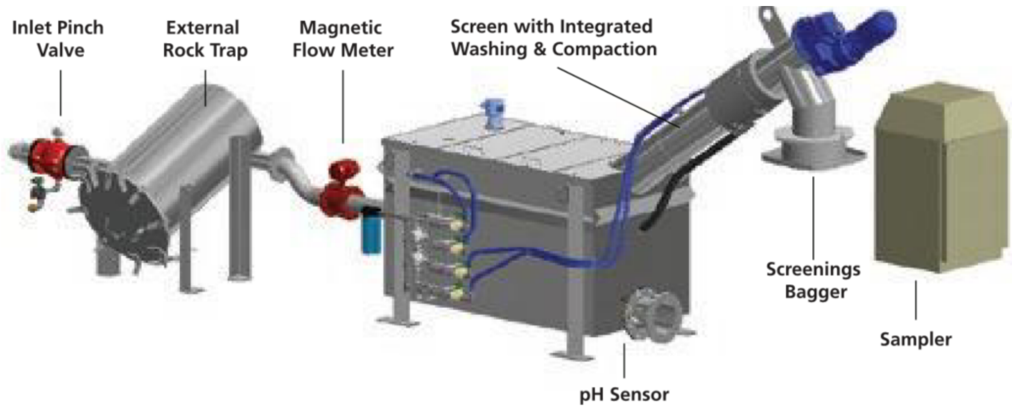
Figure 7. Site Layout of Alternative 1



*Receiving and Pretreatment*

A new septage screening station will be added and the existing grit removal system will be replaced with two new grit removal systems to provide higher capacity and redundancy for these processes. The new septage screening station will match the existing septage screening station and consists of a rock trap and screening equipment to separate coarse and heavy material from septage and FOG, as shown in Figure 8. The presence of a rock trap helps to capture and remove large debris. As septage goes into the screening trough the unwanted solids are captured and removed. The screened septage flows by gravity to the existing septage sump in the solids handling building and is diluted with process water.

## Figure 8. New Septage Screening Station




The diluted septage is pumped by two new septage pumps to two new grit removal systems, which are a combination of cyclone and classifier, as shown in Figure 9. Grit slurry is introduced into the cyclone and a centrifugal force is established to spin the grit into the wall of the cyclone, forcing solids to discharge through the underflow apex orifice, along with some liquid. The remaining liquid and lighter particles are discharged through the overflow pipe.

## Figure 9. Grit Cyclone-Classifier

FOG loads will be received separately from the septage to avoid clogging the septage pipes. A new FOG screening station that is similar to the above septage screening station will be constructed at the septage receiving area to specifically screen the hauled FOG. Then the screened FOG will drain to a new sump in the screening station area and a new grinder pump will be installed to pump the FOG to the digesters.

The existing unloading station for hauled sludge from the County's other WWTPs is in good condition and will continue to be used without modification.

### *Primary Sludge and Septage Thickening*

The existing GTs will be replaced with new RDTs. Two 400-GPM RDTs, one duty and one standby, each with one 540-gallon flocculation tank will be installed in a new building to thicken the combined primary sludge and diluted septage stream. A polymer feed system will be constructed to improve the thickening performance. Approximately 15 to 30 pounds (lbs) of active polymer per dry ton solids will be added. Each unit requires one thickener feed pump to provide the screened septage and one thickened sludge pump to discharge the thickened septage to the digester.

Thickening using RDTs is a familiar process for the plant operation and maintenance (O&M) staff. Compared to GTs, RDTs provides many advantages, including improved performance, easier process control, reduced footprint, and less potential for sludge fermentation and odor generation.

Although the existing WAS building reserves some space for an additional RDT, it is not enough for two additional units. Therefore, a new 3,750-square-foot building will be constructed to house the two new RDTs, ancillary equipment, and associated pumps.

Table 9 summarizes the design criteria of new primary sludge and diluted septage thickeners in 2028 and 2042.

### Table 9. Alternative 1 Thickening Design Criteria

| Parameter | 2028 | | 2042 | |
|---|---|---|---|---|
| | Annual Average | Maximum Month | Annual Average | Maximum Month |
| Primary Sludge and Septage Flow (GPD) | 226,000 | 297,200 | 358,900 | 474,400 |
| Primary Sludge and Septage Solids (ppd) | 11,400 | 14,600 | 17,500 | 22,400 |
| No. of RDTs | 1 Operating + 1 Standby | | | |
| Capacity of Each RDT | 400 GPM | | | |
| Operating Time with one RDT (hrs/week) | 66 | 87 | 105 | 140 |
| Solids Capture (%) | >92% | | | |
| Thickened Solids Content (%) | 6 to 8 | | | |
| Polymer Dosage (lb active/dry ton solids) | 15 to 30 | | | |

#### *Digestion*

A new 1.3-MG digester will be constructed to provide improved digestion performance and higher capacity for the combined thickened sludge stream. This digester volume is equal to the combined capacity of both existing digesters. Under normal operating conditions, the digester feed would be split between one existing digester and the new larger digester, and the other existing digester would provide redundancy. Table 10 summarizes the design conditions of the new and existing anaerobic digesters under normal operating conditions.

### Table 10. Alternative 1 Digester Design Criteria

| Parameter | Combined Digesters (1.3 MG & 645,000 gal) | | | |
|---|---|---|---|---|
| | 2028 | | 2042 | |
| | Annual Average | Maximum Month | Annual Average | Maximum Month |
| Flow (GPD) | 34,100 | 47,600 | 51,000 | 72,100 |
| Solids (ppd) | 16,000 | 21,200 | 23,900 | 31,824 |
| No. of Digesters | 1 new + 1 existing + 1 existing (standby) | | | |
| Total Vol. of Duty Digesters (MG) | 1.945 | | | |
| Residence Time (days) | 57 | 41 | 38 | 27 |
| Solids Loading Rate (lb/ft$^3$/day) | 0.05 | 0.06 | 0.07 | 0.09 |

If the new digester needs to be taken off-line for cleaning, during this temporary maintenance period, the two existing digesters with a combined capacity of approximately 1.3 MG can be used to provide treatment and would still have an average residence time of 25.3 days and a maximum month residence time of 17.9 days. This is a significant improvement comparing to the current condition since the plant will have difficulty to treat the entire solids if one of the existing digesters is off-line.

### *Dewatering*

No change to the dewatering process is required. The existing centrifuges have sufficient capacity to treat all the biosolids from the anaerobic digesters in 2042.

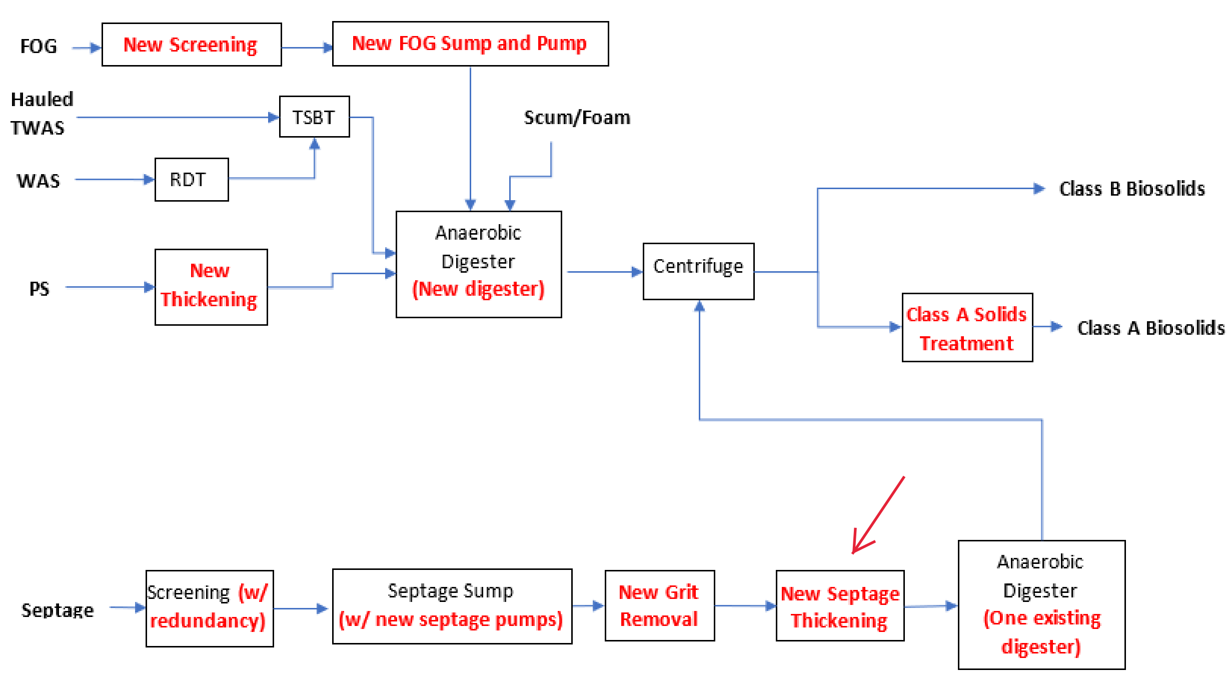
### *Disposal*

No change to the disposal process is required. The dewatered Class B biosolids can be hauled for land disposal or further treated to Class A requirements if desired.

## *6.2 Alternative 2 – Separated Septage Treatment with Anaerobic Digestion*

Alternative 2 separates the septage out from the existing solids treatment processes and treats the septage with a dedicated anaerobic digester to Class B biosolids standards. Improvements are made to the capacity and performance of the main solids stream by updating select processes. Separating the septage treatment allows for the septage and WWTP sludge processes to be optimized independently and provides greater flexibility and control. Figure 10 shows the process flow diagram of Alternative 2, with new or modified components indicated in red text.

Figure 10. Alternative 2 Flow Process Diagram

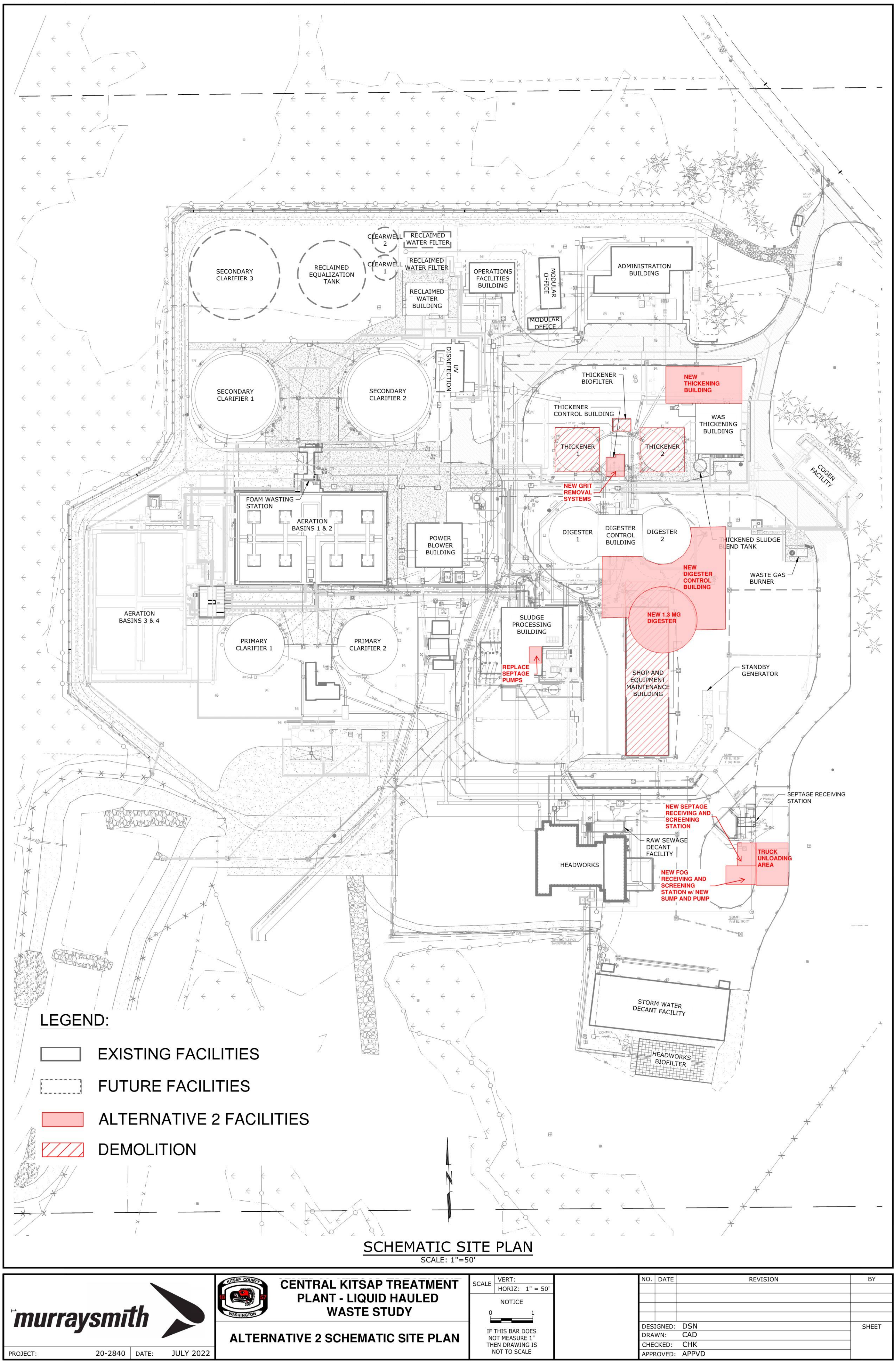



The proposed improvements include:

- 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 GTs will be replaced with a new thickening process.
- 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.
- All other existing solids treatment components are sufficient to continue operating through 2042.

The proposed site layout of Alternative 2 is shown in Figure 11.

Figure 11. Site Layout of Alternative 2



### *Receiving and Pretreatment*

A new septage receiving and screening station and grit removal system will provide higher capacity and redundancy for these processes. A new FOG receiving and screening station will avoid clogging the septage pipe. The septage receiving station, grit removal system, and FOG receiving station are the same as options discussed in Alternative 1.

### *Primary Sludge and Septage Thickening*

The existing GTs will be replaced with new thickening equipment. Separate RDTs will be used for the septage and primary sludge to allow for optimized operation and flexibility.

One 250-GPM RDT with 540-gallon flocculation tank will be installed to thicken the diluted septage. A polymer feed system will be constructed to improve the thickening performance. Approximately 20 to 40 lbs of active polymer per dry ton solids will be added.

One 200-GPM RDT with 540-gallon flocculation tank will be installed to thicken the primary sludge. A polymer feed system will be constructed to improve the thickening performance. Approximately 10 to 20 lbs of active polymer per dry ton solids will be added.

One additional 250-GPM RDT with 540-gallon flocculation tank will be installed as a standby unit to thicken either diluted septage or primary sludge when one of the above two RDTs is offline. The redundant RDT can also be used as a standby for the WAS thickening RDT as the 250-GPM capacity is slightly higher than the existing WAS RDT.

Each RDT requires one thickener feed pump to feed the unit and one thickened sludge pump to pump the thickened solids to the digester. Therefore, a new 4,500-square-foot building will be constructed to house three RDTs, ancillary equipment, and associated pumps.

Table 11 and Table 12 summarizes the performance of new primary sludge thickeners and diluted septage thickeners in 2028 and 2042.

## Table 11. Alternative 2 Diluted Septage Thickener Design Criteria

| Parameter | Diluted Septage Thickener | | | |
|---|---|---|---|---|
| | 2028 | | 2042 | |
| | Annual Average | Maximum Month | Annual Average | Maximum Month |
| Diluted Septage Flow (GPD) | 138,900 | 197,300 | 240,400 | 341,600 |
| Diluted Septage Solids (ppd) | 5,300 | 7,600 | 9,200 | 13,100 |
| No. of Units | 1 Operating + 1 Shared Standby | | | |
| Capacity of Each RDT (GPM) | 250 | | | |
| Operating Time (hrs/week) | 65 | 92 | 112 | 161 |
| Solids Capture (%) | >90% | | | |
| Thickened Solids Content (%) | 6 to 8 | | | |
| Polymer Dosage (lb active/dry ton solids) | 20 to 40 | | | |

## Table 12. Alternative 2 Primary Sludge Thickener Design Criteria

| Parameter | Primary Sludge Thickener | | | |
|---|---|---|---|---|
| | 2028 | | 2042 | |
| | Annual Average | Maximum Month | Annual Average | Maximum Month |
| Primary Sludge Flow (GPD) | 87,100 | 99,900 | 118,500 | 132,800 |
| Primary Sludge Solids (ppd) | 6,100 | 7,000 | 8,300 | 9,300 |
| No. of Units | 1 Operating + 1 Shared Standby | | | |
| Capacity of Each RDT (GPM) | 200 | | | |
| Operating Time (hrs/week) | 51 | 58 | 70 | 77 |
| Solids Capture (%) | >95% | | | |
| Thickened Solids Content (%) | 6 to 8 | | | |
| Polymer Dosage (lb active/dry ton solids) | 10 to 20 | | | |

### *Digestion*

A new 1.3-MG digester will be added to provide better digestion performance and higher capacity for both the septage digestion and WWTP sludge digestion. Under normal operating conditions, the mix of thickened primary sludge, TWAS, and FOG would be treated in the new digester, while the thickened septage will be sent to one of the existing digesters. The other existing digester would provide redundancy. Table 13 and Table 14 summarizes the design conditions of the new and existing anaerobic digesters under normal operating conditions.

## Table 13. Alternative 2 Thickened Septage Digester Design Criteria

| Parameter | Thickened Septage Digester | | | |
|---|---|---|---|---|
| | 2028 | | 2042 | |
| | Annual Average | Maximum Month | Annual Average | Maximum Month |
| Flow (GPD) | 10,600 | 15,100 | 18,40 | 26,200 |
| Solids (ppd) | 5,300 | 7,600 | 9,200 | 13,100 |
| No. of Digesters | 1 existing + 1 existing (shared standby) | | | |
| Total Vol. of Duty Digesters (MG) | 0.645 | | | |
| Residence Time (days) | 61 | 43 | 35 | 25 |
| Solids Loading Rate ($lb/ft^3/day$) | 0.05 | 0.07 | 0.08 | 0.12 |

## Table 14. Alternative 2 Thickened Sludge Digester Design Criteria

| Parameter | Thickened Sludge Digesters | | | |
|---|---|---|---|---|
| | 2028 | | 2042 | |
| | Annual Average | Maximum Month | Annual Average | Maximum Month |
| Flow (GPD) | 23,500 | 32,500 | 32,600 | 46,000 |
| Solids (ppd) | 10,700 | 13,700 | 14,600 | 18,700 |
| No. of Digesters | 1 new + 1 existing (shared standby) | | | |
| Total Vol. of Duty Digesters (MG) | 1.3 | | | |
| Residence Time (days) | 55 | 40 | 40 | 28 |
| Solids Loading Rate ($lb/ft^3/day$) | 0.05 | 0.06 | 0.07 | 0.08 |

If the new digester needs to be taken off-line for maintenance, the thickened septage will be mixed with other sludge and sent to the remaining digesters. The remaining digesters have a combined capacity of approximately 1.3 MG and would have an average residence time of 38 days and the maximum month residence time of 27 days in 2028 and an average residence time of 25 days and the maximum month residence time of 18 days in 2042.

### *Dewatering*

No change to the dewatering process is required. The existing centrifuges have sufficient capacity to treat all the biosolids from the anaerobic digesters in 2042.

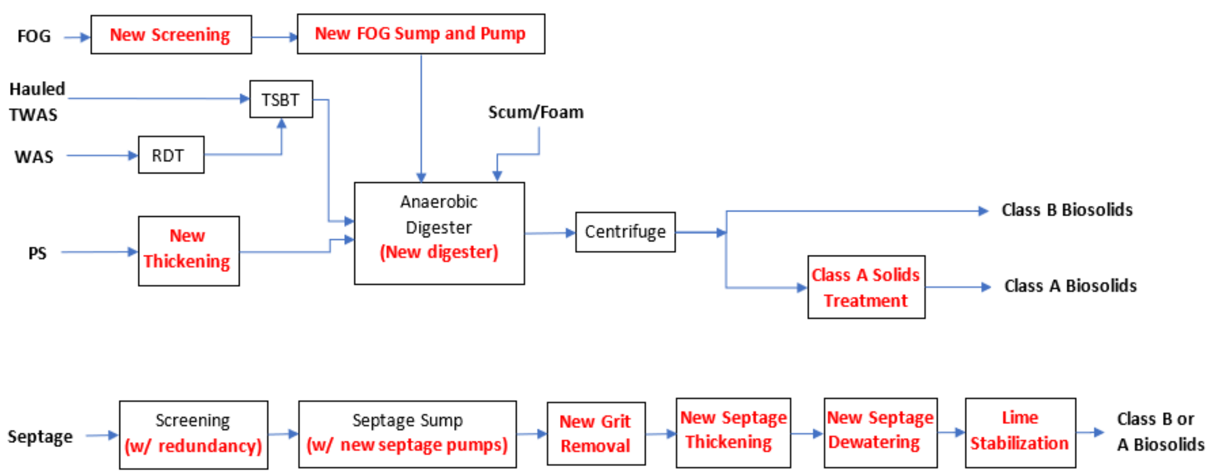
### *Disposal*

No change to the disposal process is required. The dewatered Class B biosolids can be hauled for land disposal or further treated to Class A requirements if desired.

## 6.3 Alternative 3 – Separated Septage Treatment with Lime Stabilization

Alternative 3 separates the septage out from the existing solids treatment processes and treats the septage with pasteurization and lime stabilization. Improvements are made to the capacity and performance of the main solids stream by updating select processes. Separating the septage treatment allows for the septage and WWTP sludge processes to be optimized independently and provides greater flexibility and control. Septage treatment with lime stabilization is a reliable chemical process that eliminates the challenge of digesting partially stabilized septage solids. Figure 12 shows the process flow diagram of Alternative 3, with new or modified components indicated in red text.

### Figure 12. Alternative 3 Flow Process Diagram

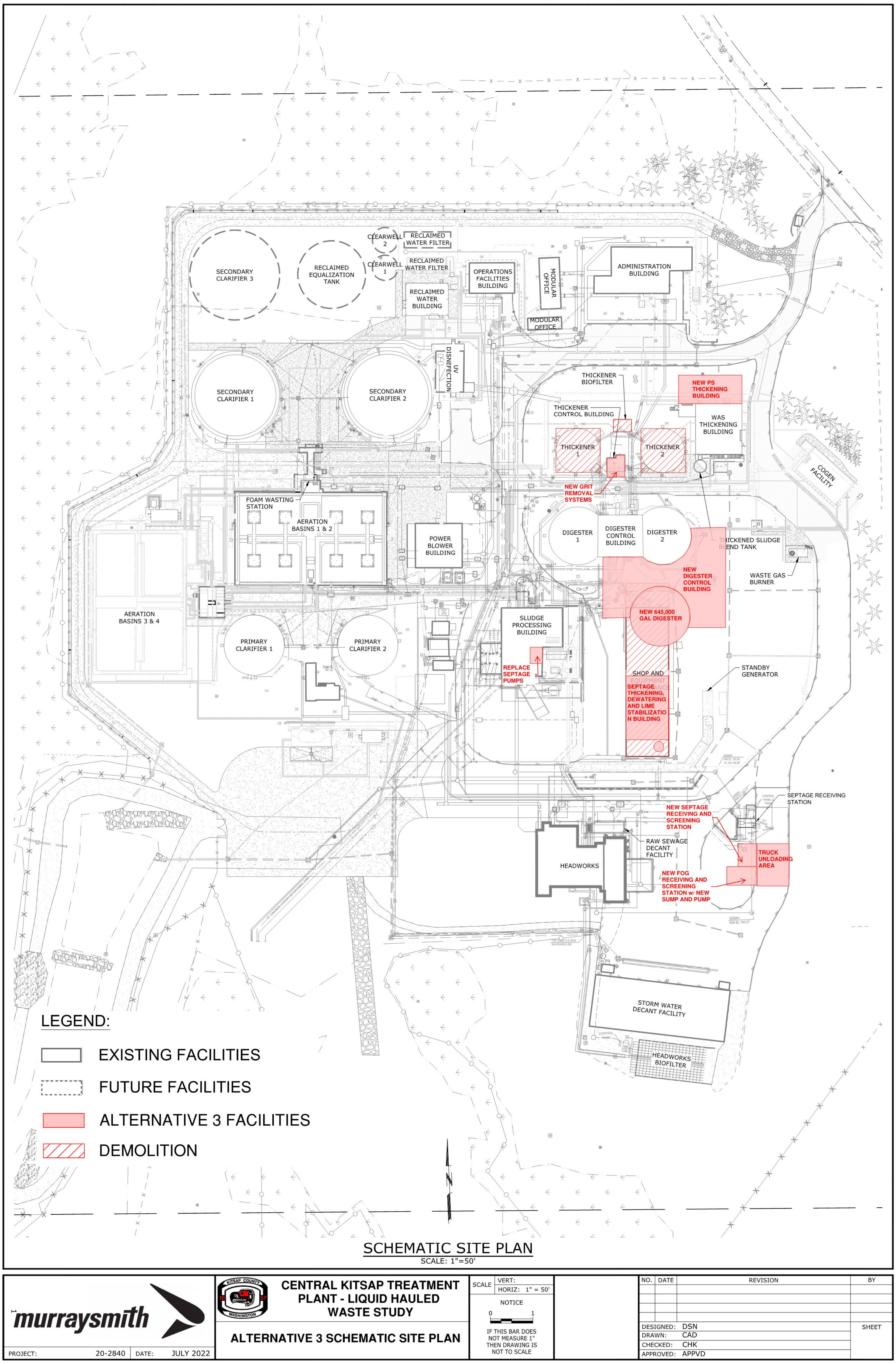



The proposed improvements include:

- 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 treated separately with new thickening and dewatering equipment prior to a pasteurization and lime stabilization system which will stabilize the dewatered septage to either Class B or Class A biosolids.
- The existing GTs will be replaced with a new thickening process.
- A third anaerobic digester at the same size as the existing ones will be constructed to add digestion capacity for thickened sludge and FOG treatment.
- All other existing solids treatment components process are sufficient to continue operating through 2042.

The proposed site layout of Alternative 3 is shown in Figure 13.

## Figure 13. Site Layout of Alternative 3



### *Receiving and Pretreatment*

A new septage receiving and screening station and grit removal system will provide higher capacity and redundancy for these processes. A new FOG receiving and screening station will avoid clogging the septage pipe. The septage receiving station, grit removal system, and FOG receiving station are the same as options discussed in Alternative 1.

### *Primary Sludge and Septage Thickening*

The existing GTs will be replaced with new thickening equipment. Separate RDTs will be used for the septage and primary sludge to allow for optimized operation and flexibility. The RDTs for septage and primary sludge are the same as described in Alternative 2. A new building will be constructed to the north of existing WAS Thickening Building to house primary sludge thickeners and ancillary equipment. The footprint of this new building is approximately 3,000 square feet. Another new building will be constructed at the current location of the Shop and Equipment Maintenance Building to house septage thickeners, centrifuge, pasteurization and lime stabilization system and ancillary equipment. The footprint of this new building is approximately 4,500 square feet.

### *Digestion*

A new 645,000-gallon anaerobic digester will be added to provide better digestion performance and additional capacity for stabilization of thickened primary sludge, TWAS and FOG/Scum. No digestion of the septage is needed for this alternative. The new digester volume is the same as each of the two existing digesters. Under normal operating conditions, thickened sludge would be split between two digesters with the third in standby for redundancy.

Removal of the septage stream will result in an immediate drop of hydraulic load to the digesters and will also remove a relatively inert component of the solids load out of the digesters. This will increase hydraulic residence time and improve VSR performance in the digesters. Table 15 summarizes the design criteria of the new and existing anaerobic digesters under normal operating conditions in 2028 and 2042.

## Table 15. Alternative 3 Digester Design Criteria

| Parameter | Thickened Sludge Digesters | | | |
|---|---|---|---|---|
| | 2028 | | 2042 | |
| | Annual Average | Maximum Month | Annual Average | Maximum Month |
| Flow (GPD) | 23,500 | 32,500 | 32,600 | 46,000 |
| Solids (ppd) | 10,700 | 13,700 | 14,600 | 18,700 |
| No. of Digesters | 1 new + 1 existing + 1 existing (standby) | | | |
| Volume of Duty Digesters (MG) | 1.3 | | | |
| Residence Time (days) | 55 | 40 | 40 | 28 |
| Solids Loading Rate (lb/ft$^3$/day) | 0.05 | 0.06 | 0.07 | 0.08 |

### *Septage Dewatering and Stabilization*

A new centrifuge will be installed to dewater the thickened septage and increase the solids concentration prior to stabilization. It is the same model as the existing centrifuges. A polymer feed system will be constructed to improve the dewatering performance. Approximately 30 to 50 lbs of active polymer per dry ton solids will be added. The existing solids processing building does not have sufficient room to house this centrifuge. It will be co-located with the septage RDTs in a new building, as mentioned above. Table 16 summarizes the design criteria of new septage centrifuge in 2028 and 2042.

## Table 16. Septage Dewatering Design Criteria

| Parameter | 2028 | | 2042 | |
|---|---|---|---|---|
| | Annual Average | Maximum Month | Annual Average | Maximum Month |
| Thickened Septage Flow (GPD) | 9,600 | 13,600 | 16,600 | 23,600 |
| Thickened Septage Solids (ppd) | 4,800 | 6,800 | 8,300 | 11,800 |
| No. of Centrifuges | 1 Operating | | | |
| Capacity of Centrifuge (GPM) | 111 | | | |
| Operating Time (hrs/week) | 10 | 14 | 17 | 25 |
| Solids Capture (%) | 95% | | | |
| Thickened Solids Content (%) | 20 to 30 | | | |
| Polymer Dosage (lb active/dry ton solids) | 30 to 50 | | | |

A lime stabilization system will be installed to treat the dewatered septage sludge to either Class B or Class A standards. The RDP Class A Precision EnVessel Pasteurization system, which combines lime addition and supplemental electrical heat, is the basis of design.

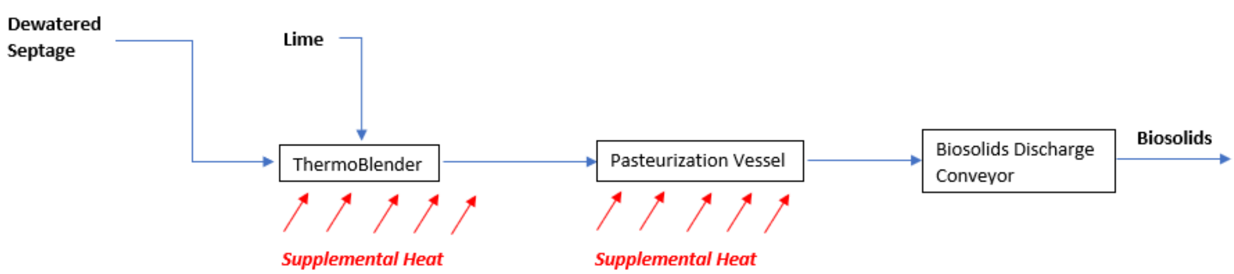
According to Washington Administrative Code (WAC) section 173-308-170, pasteurization is one of processes to further reduce pathogens (PFRP) to produce Class A biosolids. The temperature of the biosolids must be maintained at 70 degree C (158 degrees F) or higher for 30 minutes or longer during pasteurization. At the same time, according to WAC section 173-308-180, vector attraction reduction requirement could be met by raising pH of the biosolids to 12 or higher by alkali addition for two hours and then at 11.5 or higher for an additional 22 hours.

In RDP Class A Precision EnVessel Pasteurization system, as shown in Figure 14, sludge is heated in the ThermoBlender to 158 degrees F. Lime is mixed in to achieve a pH of at least 12.0 to meet the vector attraction reduction requirement. The Pasteurization vessel, which is a 48-inch-wide belt conveyor with an electrically heated and insulated bay, provides over 30 minutes of retention time to meet the PFRP requirement.

If only Class B biosolids is needed, electrical heat could be turned off and the lime dose adjusted to meet Class B pathogen reduction requirement using lime stabilization per WAC section 173-308-170. Sufficient lime must be added to the biosolids to raise the pH of the biosolids to 12 after two hours of contact.

The pasteurization and lime stabilization system will be located in the same building as the new septage thickening and dewatering equipment. The total building footprint will be approximately 4,500 square feet. An odor control system will be provided for this building.

## Figure 14. Lime Stabilization Diagram



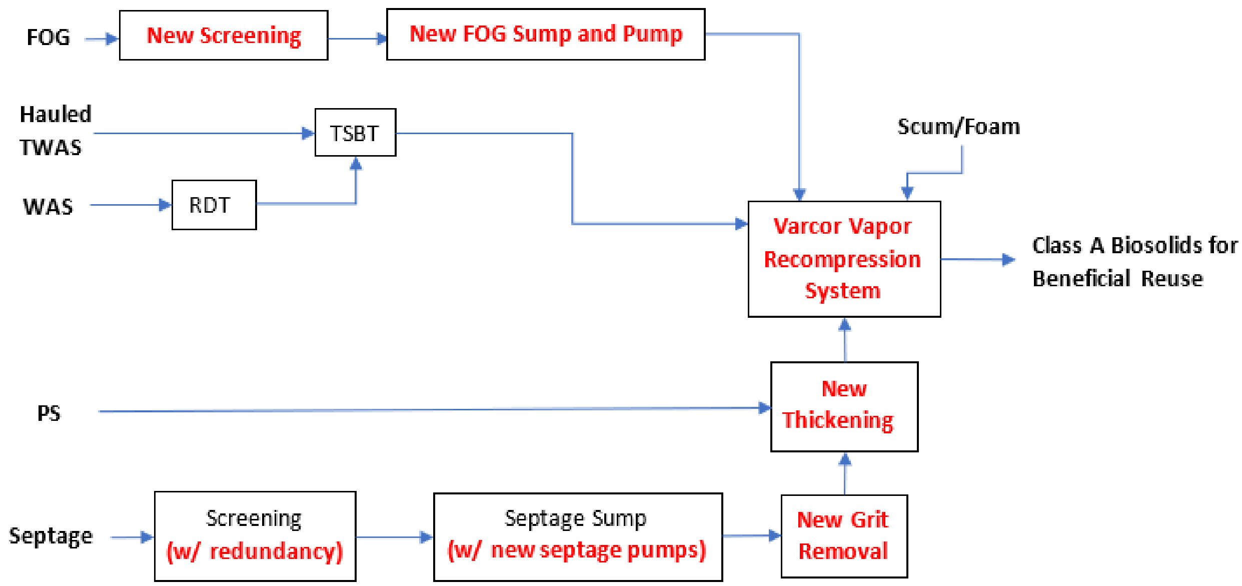

### *Disposal*

No change to the disposal process is required for Alternative 3. The dewatered sludge and septage treated to Class B levels can be hauled for land disposal. If the septage is treated to Class A levels, additional disposal options are allowed.

## *6.4 Alternative 4 – Entire Solids Treatment with Sedron Varcor System*

Alternative 4 treats the septage and all other solids streams with a new vapor recompression machine and also improves the capacity, redundancy, and performance of the septage receiving, and grit removal and thickening processes. Figure 15 shows the process flow diagram of Alternative 4, with new or modified components indicated in red text.

## Figure 15. Alternative 4 Flow Process Diagram




The proposed improvements include:

- 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.
- The existing GTs will be replaced with a new thickening process.
- Varcor system provided by Sedron Technology will be installed to treat all the thickened solids to Class A biosolids, therefore, the existing digesters and dewatering equipment at Central Kitsap WWTP will be abandoned.

### *Receiving and Pretreatment*

A new septage receiving and screening station will provide higher capacity and redundancy for these processes. A new FOG receiving and screening station will avoid clogging the septage pipe. The septage receiving station, grit removal system, and FOG receiving station are the same as options discussed in Alternative 1.

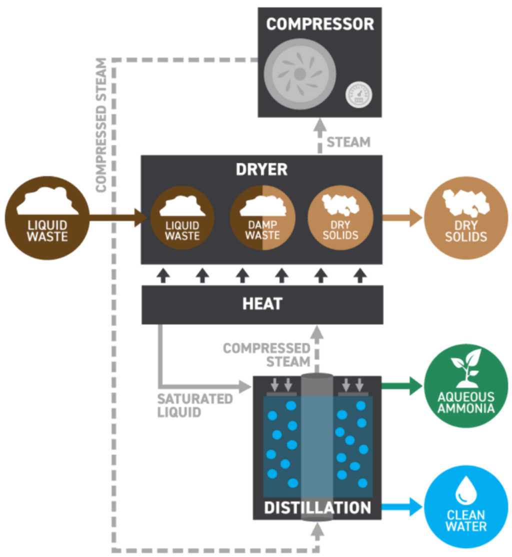
### *Primary Sludge and Septage Thickening*

The existing GTs will be replaced with new thickening equipment. RDTs will be used for the mix of septage and primary sludge to allow for optimized operation and flexibility. The RDTs are the same as described in Alternative 1.

### *Stabilization, Dewatering & Drying*

The Varcor system provided by Sedron Technologies is an emerging technology that will be used to stabilize thickened sludge from all sources at Central Kitsap WWTP. Solids and liquids are separated through thermal evaporation based on different boiling points. At the same time, pathogens are killed under high temperature. The resulting vapor is sent to a compressor for mechanical recompression. The compressed vapor is then used as the heat source for the evaporation process. The resulting dry solids achieve Class A biosolids classification and be used as a nutrient-rich fertilizer, soil amendment, or other beneficial reuse product. The low boiling point constituents (such as ammonia) are concentrated separately through a patented process. Clean water can be sent back to liquid stream process. Figure 16 shows the process of Varcor system.

## Figure 16. Varcor System Process Diagram



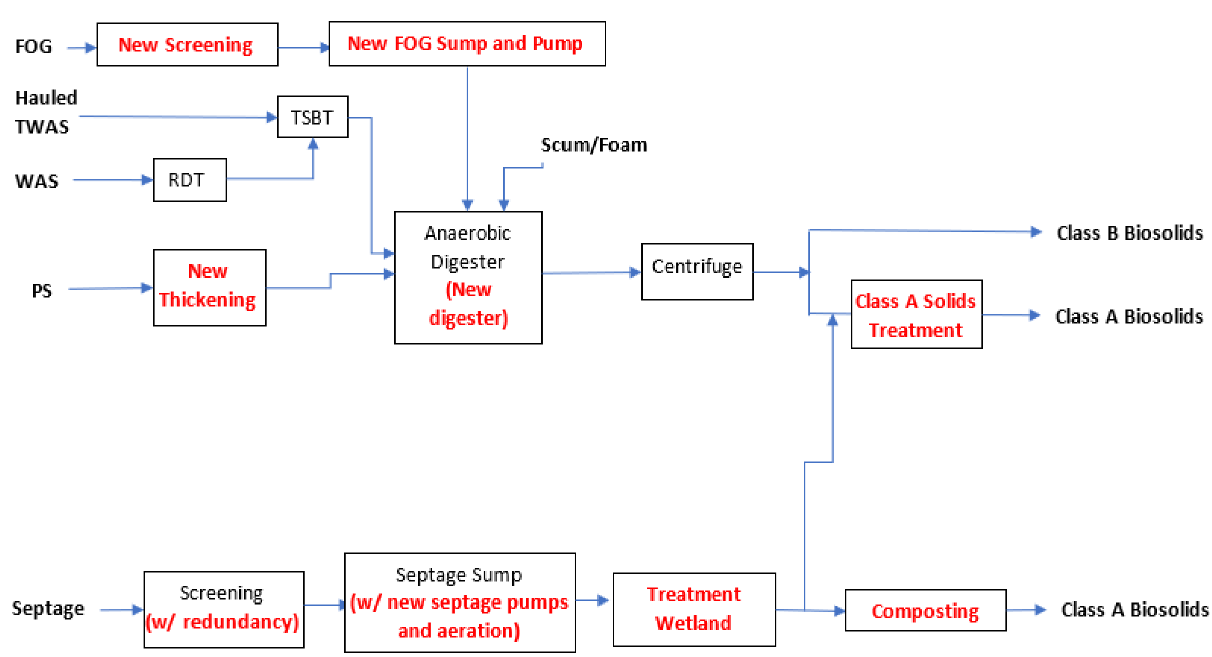

Sedron is the only manufacturer of a vapor recompression system for sludge waste applications. They have installed several similar units for animal sludge waste treatment and currently have a septage treatment installation underway in Sumner, WA, but they have not used the Varcor system for a combined septage and thickened sludge application before. The Sedron business model is to use a long-term contract of 15 to 20 years to provide treatment with the Varcor system. Sedron would construct the Varcor system at the WWTP at no cost to the County and provide both treatment and disposal at an annual or volume-based rate. However, according to Sedron Technologies' evaluation, the flowrate of the combined sludge over the next 20 years is too low to generate enough revenue to justify the capital cost of the system. The Varcor System is typically sized to process a flow rate of 90 to 100 GPM and average flows of less than 75 GPM are typically not cost effective. The 2042 average annual combined sludge stream is only expected to be 35 GPM.

Sedron reported that they are developing a smaller unit that may better suit Central Kitsap WWTP's need, however, they expect it will be approximately 5 years before it can be brought to market. Central Kitsap is facing an immediate need to upgrade several components of the solids treatment process and cannot wait five or more years to determine if a smaller Varcor is appropriate, therefore the existing Varcor system and potential smaller future system are not viable alternatives and will not be considered.

### *Alternative 5 – Separated Septage Treatment with Wetland and Composting*

Alternative 5 completely separates the septage treatment from the existing solids treatment processes and uses a constructed wetland system to dewater the septage followed by composting to provide Class A biosolids treatment. Improvements are also made to the capacity and performance of the main solids stream by updating select processes. Figure 17 shows the process flow diagram of Alternative 5, with new or modified components indicated in red text.

### Figure 17. Alternative 5 Flow Process Diagram



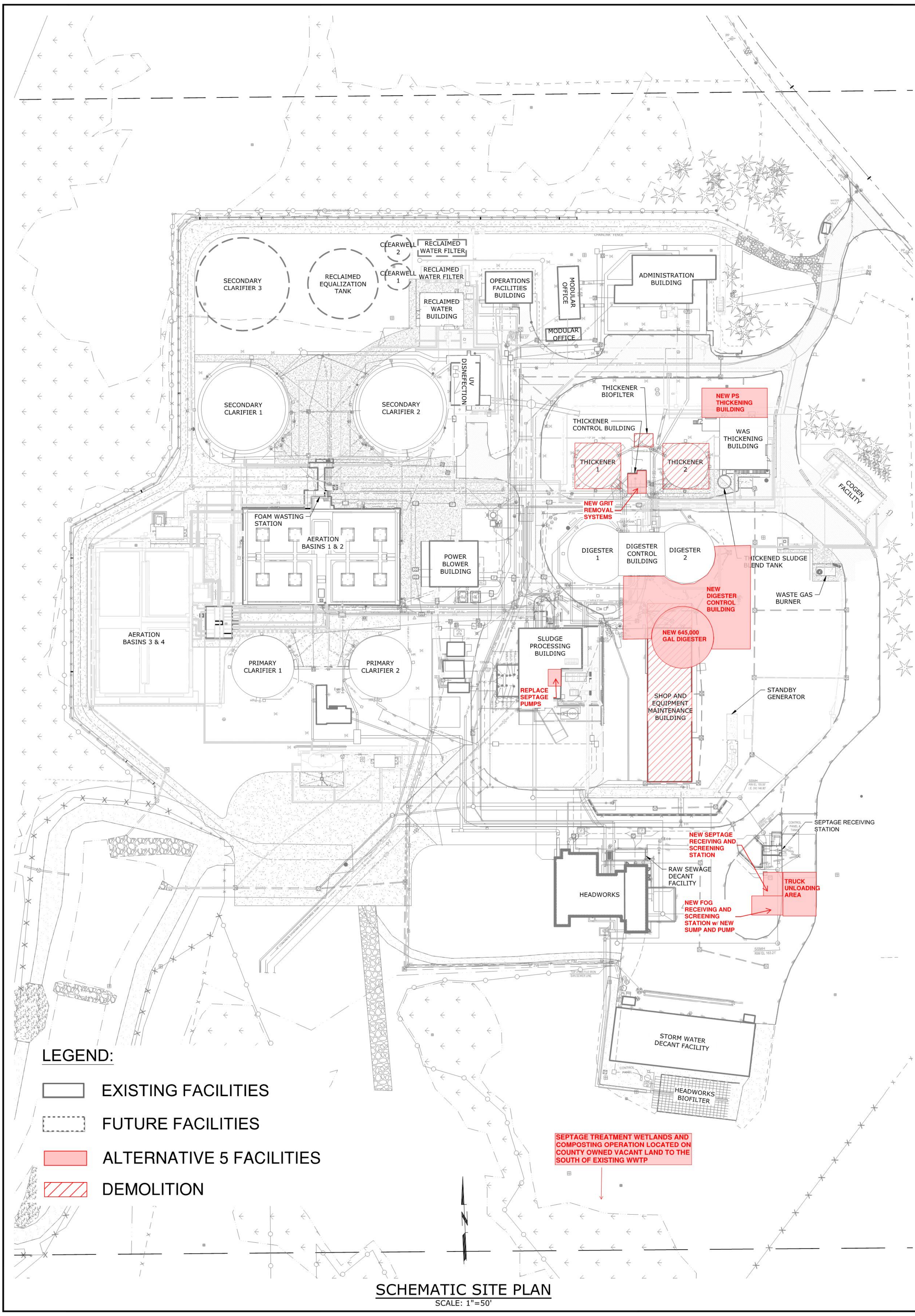

The proposed improvements include:

- 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 is not required.
- A new FOG receiving station and associated sump and pump will be constructed.

- A constructed wetland and composting system will be constructed to treat the septage to Class A standard.
- The existing GTs will be replaced with a new thickening process.
- A third anaerobic digester will be constructed to add digestion capacity for thickened sludge and FOG.
- All other existing solids treatment components are sufficient to continue operating through 2042.

The proposed site layout of Alternative 5 is shown in Figure 18.

## Figure 18. Site Layout of Alternative 5




| murraysmith | CENTRAL KITSAP TREATMENT PLANT - LIQUID HAULED WASTE STUDY | SCALE VERT: HORIZ: 1" = 50' | NO. | DATE | REVISION | BY |
|---|---|---|---|---|---|---|
| PROJECT: 20-2840 DATE: JULY 2022 | ALTERNATIVE 5 SCHEMATIC SITE PLAN | NOTICE 0 1 IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE | DESIGNED: DSN DRAWN: CAD CHECKED: CHK APPROVED: APPVD | | | SHEET |

### *Receiving and Pretreatment*

A new septage receiving and screening station will provide higher capacity and redundancy for these processes. The septage receiving station is the same as discussed in Alternative 1. Treatment wetlands systems do not require grit removal, so the grit removal system is not necessary. Aeration will be added to the septage sump to reduce odors that may occur when the septage is applied to the treatment wetland. A new FOG receiving and screening station will avoid clogging the septage pipe. The FOG receiving station is the same as discussed in Alternative 1.

### *Primary Sludge and Septage Thickening and Dewatering*

A treatment wetland for septage is similar to a conventional sand drying bed but is planted with wetlands plants which improve process efficiency. Figure 19 shows a septage treatment wetland in Ontario, Canada that is typical of these systems. Septage will be applied to the surface of the filters via a pipe distribution system and the solids are retained on a sludge layer that gradually accumulates and composts in place while the water percolates down through the sludge and gravel substrate. The plants facilitate dewatering and digestion of the sludge by limiting formation of surface crust and facilitating a diverse ecosystem in the subsurface. Sludge accumulates at a rate of approximately 3 to 4 inches per year and can be applied for 5 to 10 years before it must be removed. In addition to removing solids, treatment wetlands also provide greater than 80% removal of chemical oxygen demand and ammonia from the leachate stream, which will be sent directly to the aeration basins for further treatment. This nutrient removal will reduce loading on the aeration basins and may improve performance.

Figure 19. Typical Septage Treatment Wetland

Approximately 10 to 12 acres of wetlands beds would be required to treat the 2042 septage flow. The wetlands beds are divided into several independent cells so that each cell can be loaded for a period of up to three days, then rested for approximately 12 days. The modular nature of the cells makes it easy to construct the system for near term flows and expand with additional cells as needed in the future. Only half of the area is needed to treat current flows, so, it would be possible to only construct a portion of the system and add on as needed as flows increase. The only viable location with enough room for the treatment wetland is the undeveloped 40-acre parcel to the south of the existing WWTP. This parcel has identified wetlands and is adjacent to residential properties, so although there is sufficient space for the treatment wetlands there could be permitting, land use, and public perception challenges to develop this area.

The existing GTs will be replaced with a new thickening equipment to treat the primary sludge only. The options for the primary sludge thickener are the same as described in Alternative 2.

#### *Stabilization and Disposal*

Septage treatment wetlands provide air drying, which is an approved method to achieve Class B biosolids pathogen reduction requirements, however, they do not meet vector attraction reduction (VAR) requirements without further treatment. If a composting system is constructed for the main sludge stream, as discussed in the draft TM "*Central Kitsap WWTP Class A Biosolids Evaluation*" (Murraysmith, July 2022), the septage solids could be easily incorporated to meet VAR requirements and attain Class A biosolids classification. If a composting facility is not constructed for the main sludge stream, the septage sludge can be composted with a smaller system operated intermittently as needed when the cells are cleaned.

A new 645,000-gallon anaerobic digester will be added to provide better digestion performance and higher capacity for stabilization of the primary sludge, TWAS, FOG, and scum, as previously described in Alternative 3. No change to the dewatering process is required for the anaerobically digested biosolids. The existing centrifuges have sufficient capacity to treat all the biosolids from the anaerobic digesters.

## *6.5 Cost Analysis*

The probable costs are developed for each feasible alternative based on average costs estimated based on RSMeans Heavy Construction Cost Data, recent Kitsap County project bid tabs, County input, engineer experience, and local contractor and supplier costs. All costs were developed based on the preliminary concepts and layouts of the system components in 2022 dollars should be escalated with the future CCI for use in project budgeting.

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*.

Construction and capital cost estimates for the 20-year planning period are summarized below in Table 17. 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% for engineering, legal, and administration costs associated with project delivery. The detailed estimates for each alternative and included in Appendix A.

## Table 17. Alternatives Cost Estimate

| Alternatives | Construction Cost | Capital Cost |
|---|---|---|
| Alternative 1 – Treat Septage with Other Solids Streams | $34,000,000 | $43,000,000 |
| Alternative 2 - Separated Septage Treatment with Anaerobic Digestion | $37,000,000 | $46,000,000 |
| Alternative 3 – Separated Septage Treatment with Lime Stabilization | $40,000,000 | $49,000,000 |
| Alternative 5 - Separated Septage Treatment with Wetland and Composting | $40,000,000 | $50,000,000 |

# 7. Discussion and Recommendations

All four viable alternatives provide some common benefit as below:

1. Improved septage receiving and pre-treatment capacity and reliability.
2. Improved FOG receiving reliability.
3. Improved primary sludge and septage thickening condition and performance.
4. Improved anaerobic digestion capacity and reliability.

Table 18 summarizes some specific advantages and disadvantages of each alternative.

## Table 18. Alternatives Comparison

| Alternative | Advantages | Disadvantages |
|---|---|---|
| 1 – Treat septage with other solids streams | • Lowest cost<br>• Familiar technology<br>• No changes from current biosolids management practice<br>• 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 |

| Alternative | Advantages | Disadvantages |
|---|---|---|
| 2 – Separated septage treatment with anaerobic digestion | • Relatively low cost<br>• Familiar technology<br>• Minimal changes from current biosolids management practice<br>• Separating septage eliminates any undesirable impact from septage on the main solids stream<br>• Separating septage allows flexible and customized septage treatment | • More complex O&M<br>• 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 |
| 3 – Separated septage treatment with lime stabilization | • Separating septage eliminates any undesirable impact from septage on the main solids stream<br>• Lime stabilization provides a reliable method to convert septage to Class A or Class B biosolids | • High cost<br>• Complex O&M<br>• Unfamiliar technology<br>• Lime stabilization could generate higher dust and odor |
| 5 – Separated septage treatment with wetland and composting | • Separating septage eliminates any undesirable impact from septage on the main solids stream<br>• Provides opportunity to integrate with main solids stream composting for Class A<br>• Relatively simple O&M | • High cost<br>• Large land requirement<br>• Unfamiliar technology |

Based on the comparison presented in Table 18, Alternative 2 is recommended for a more reliable septage treatment with relatively low cost. Alternative 2 proposes the same technologies for thickening and stabilization which will allow the County staff to quickly adjust to new treatment approach. Although O&M effort will be slightly higher the use of familiar technologies and equipment can minimize additional effort. Alternative 2 provides flexibility, redundancy, and ability to customize treatment of septage and other WWTP sludge streams independently which will help ensure consistent and efficient operation.

Central Kitsap WWTP has several immediate needs for upgrades to the LHW and solids processes.

- The septage grit cyclone and classifier, gravity thickeners, and gravity thickener control building have all exceeded their typical lifespan and are in poor condition. Each of these components should be replaced as soon as possible.

- The plant does not have a dedicated FOG receiving and pumping system. The existing scum/FOG sumps and piping have exceeded their lifespan and have no redundancy. A new FOG receiving and screening station with dedicated sump, pumps and piping should be constructed as soon as possible.
- The anaerobic digesters do not provide sufficient redundancy and do not consistently meet VSR requirements, so the new digester should be designed and constructed as soon as possible, followed immediately by a rehabilitation of the existing digesters.

The septage receiving station is in good condition but does not have redundancy, therefore, the new septage receiving station construction is not an immediate need and can be scheduled in the near term as soon as capital budget allows. The septage pumps have exceeded their expected lifespan but are operating well, so they should be monitored and replaced when their condition or reliability deteriorates.

# Appendices

Appendix A – Detailed Cost Estimate

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# APPENDIX A

Project: Central Kitsap Facility Plan Update Amendment 2 Liquid Hauled Waste
Client: Kitsap County
Project No.: 20-2840.00. 0100.32
Date: 7/21/2022

Class 5 Estimate

| Items | Construction Cost | Capital Cost |
|---|---|---|
| Alternative 1: Treat Septage with Other Solids Streams | $34,000,000 | $43,000,000 |
| Alternative 2: Separated Septage Treatment with Anaerobic Digestion | $37,000,000 | $46,000,000 |
| Alternative 3: Separated Septage Treatment with Lime Stabilization | $40,000,000 | $49,000,000 |
| Alternative 5: Separated Septage Treatment with Wetland and Composting | $40,000,000 | $50,000,000 |

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 (time to completion? time of commencement? Speed of execution?), 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 Amendment 2 Liquid Hauled Waste
Client: Kitsap County
Project No.: 20-2840.00.0100.32
Date: 7/21/2022

Class 5 Estimate

**Alternative 1: Treat Septage with Other Solids Streams**

| Item No. | Item | Unit | QTY | Unit Price Materials & Equipment | Unit Price Labor | Total |
|---|---|---|---|---|---|---|
| **Civil Site Prep/Earthwork** | | | | | | |
| | Excavation | CY | 6734 | $ | 60.00 | $404,064.54 |
| | Dewatering | LS | 1 | $ | 500,000.00 | $500,000.00 |
| | Backfill | CY | 1010 | $ 45.00 | $ 18.00 | $63,640.16 |
| | Demolition | LS | 1 | $ | 50,000.00 | $50,000.00 |
| | RDT Yard Piping (6") | LF | 500 | $ 125.00 | $ 37.50 | $81,250.00 |
| | Digester Yard Piping (4") | LF | 500 | $ 100.00 | $ 30.00 | $65,000.00 |
| | FOG Yard Piping (4'') | LF | 500 | $ 100.00 | $ 30.00 | $65,000.00 |
| | **Subtotal** | | | | | **$1,228,954.70** |
| **Structural** | | | | | | |
| | Thickener Building | SF | 3750 | $400.00 | | $1,500,000.00 |
| | FOG Sump | SF | 50 | $400.00 | | $20,000.00 |
| | **Subtotal** | | | | | **$1,520,000.00** |
| **Mechanical** | | | | | | |
| | Septage Acceptance Plant | LS | 1 | $ 273,840.00 | $ 82,152.00 | $355,992.00 |
| | Septage Pump | LS | 2 | $ 40,000.00 | $ 12,000.00 | $104,000.00 |
| | Septage Grit Removal Systems | LS | 1 | $ 146,880.00 | $ 44,064.00 | $190,944.00 |
| | FOG Receiving and Screening Station | LS | 1 | $ 273,840.00 | $ 82,152.00 | $355,992.00 |
| | FOG Pump | EA | 1 | $ 40,000.00 | $ 12,000.00 | $52,000.00 |
| | Rotary Drum Thickening Equipment | LS | 1 | $ 437,784.00 | $ 131,335.20 | $569,119.20 |
| | Thickening Ancillary Equipment | LS | 1 | $ 825,000.00 | $ 247,500.00 | $1,072,500.00 |
| **Anaerobic Digester (structural, mechanical & EIC)** | | LS | 1 | $ | 10,680,000.00 | $10,680,000.00 |
| | **Subtotal** | | | | | **$13,380,547.20** |
| **Electrical, Instrumentation, and Controls** | | | | | | |
| | EI&C | EA | 1 | $2,676,109.44 | | $2,676,109.44 |
| | **Subtotal** | | | | | **$2,676,109.44** |
| | | | | | | |
| **Construction Material & Labor Subtotal:** | | | | | | **$18,805,611.34** |

| Markups | |
|---|---|
| Mobilization (10%) | $ 1,880,561.13 |
| General Conditions (8%) | $ 1,504,448.91 |
| Contractor O&P (12%) | $ 2,256,673.36 |
| **Subtotal** | **$ 24,447,294.74** |
| Tax (9.2%) | $ 2,249,151.12 |
| Construction Contingency (30%) | $ 7,334,188.42 |
| **Total Construction Cost** | **$ 34,030,634.28** |
| Engineering, Legal, and Administration (25%) | $ 8,507,658.57 |
| **Total Project Cost** | **$ 42,538,292.85** |

Project: Central Kitsap Facility Plan Update Amendment 2 Liquid Hauled Waste
Client: Kitsap County
Project No.: 20-2840.00. 0100.32
Date: 7/21/2022

Class 5 Estimate

**Alternative 2: Separated Septage Treatment with Anaerobic Digestion**

| Item No. | Item | Unit | QTY | Materials & Equipment | Labor | Total |
|---|---|---|---|---|---|---|
| **Civil Site Prep/Earthwork** | | | | | | |
| | Excavation | CY | 6868 | $ | 60.00 | $412,064.54 |
| | Dewatering | LS | 1 | $ | 500,000.00 | $500,000.00 |
| | Backfill | CY | 1030 | $ 45.00 | $ 18.00 | $64,900.16 |
| | Demolition | LS | 1 | $ | 50,000.00 | $50,000.00 |
| | RDT Yard Piping (6") | LF | 500 | $ 125.00 | $ 37.50 | $81,250.00 |
| | Digester Yard Piping (4") | LF | 500 | $ 100.00 | $ 30.00 | $65,000.00 |
| | FOG Yard Piping (4'') | LF | 500 | $ 100.00 | $ 30.00 | $65,000.00 |
| | **Subtotal** | | | | | **$1,238,214.70** |
| **Structural** | | | | | | |
| | Thickener Building | SF | 4500 | $ | 400.00 | $1,800,000.00 |
| | FOG Sump | SF | 50 | $400.00 | | $20,000.00 |
| | **Subtotal** | | | | | **$1,820,000.00** |
| **Mechanical** | | | | | | |
| | Septage Acceptance Plant | LS | 1 | $ 273,840.00 | $ 82,152.00 | $355,992.00 |
| | Septage Pump | LS | 2 | $ 40,000.00 | $ 12,000.00 | $104,000.00 |
| | Septage Grit Removal System | LS | 1 | $ 146,880.00 | $ 44,064.00 | $190,944.00 |
| | FOG Receiving and Screening Station | LS | 1 | $ 273,840.00 | $ 82,152.00 | $355,992.00 |
| | FOG Pump | EA | 1 | $ 40,000.00 | $ 12,000.00 | $52,000.00 |
| | Primary Sludge RDT | LS | 1 | $ 297,936.00 | $ 89,380.80 | $387,316.80 |
| | Septage RDT | LS | 1 | $ 374,136.00 | $ 112,240.80 | $486,376.80 |
| | Thickening Ancillary Equipment | LS | 1 | $ 1,320,500.00 | $ 396,150.00 | $1,716,650.00 |
| **Anaerobic Digester (structural, mechanical & EIC)** | | LS | 1 | $ | 10,680,000.00 | $10,680,000.00 |
| | **Subtotal** | | | | | **$14,329,271.60** |
| **Electrical, Instrumentation, and Controls** | | | | | | |
| | EI&C | EA | 1 | $2,865,854.32 | | $2,865,854.32 |
| | **Subtotal** | | | | | **$2,865,854.32** |
| | | | | | | |
| **Construction Material & Labor Subtotal:** | | | | | | **$20,253,340.62** |

| Markups | |
|---|---|
| Mobilization (10%) | $ 2,025,334.06 |
| General Conditions (8%) | $ 1,620,267.25 |
| Contractor O&P (12%) | $ 2,430,400.87 |
| **Subtotal** | **$ 26,329,342.81** |
| Tax (9.2%) | $ 2,422,299.54 |
| Construction Contingency (30%) | $ 7,898,802.84 |
| **Total Construction Cost** | **$ 36,650,445.19** |
| Engineering, Legal, and Administration (25%) | $ 9,162,611.30 |
| **Total Project Cost** | **$ 45,813,056.48** |

Project: Central Kitsap Facility Plan Update Amendment 2 Liquid Hauled Waste
Client: Kitsap County
Project No.: 20-2840.00. 0100.32
Date: 7/21/2022

Class 5 Estimate

**Alternative 3: Separated Septage Treatment with Lime Stabilization**

| Item No. | Item | Unit | QTY | Materials & Equipment | Labor | Total |
|---|---|---|---|---|---|---|
| **Civil Site Prep/Earthwork** | | | | | | |
| | Excavation | CY | 3108 | $ | 60.00 | $186,501.72 |
| | Dewatering | LS | 1 | $ | 500,000.00 | $500,000.00 |
| | Backfill | CY | 466 | $ 45.00 | $ 18.00 | $29,374.02 |
| | Demolition | LS | 1 | $ | 50,000.00 | $50,000.00 |
| | RDT Yard Piping (6") | LF | 500 | $ 125.00 | $ 37.50 | $81,250.00 |
| | Digester Yard Piping (4") | LF | 500 | $ 100.00 | $ 30.00 | $65,000.00 |
| | FOG Yard Piping (4'') | LF | 500 | $ 100.00 | $ 30.00 | $65,000.00 |
| | **Subtotal** | | | | | **$977,125.74** |
| **Structural** | | | | | | |
| | Primary Sludge Thickening Building | SF | 3000 | $400.00 | | $1,200,000.00 |
| | Septage Thickening, Dewatering and Lime Stablization Building | SF | 4500 | $400.00 | | $1,800,000.00 |
| | FOG Sump | SF | 50 | $400.00 | | $20,000.00 |
| | **Subtotal** | | | | | **$3,020,000.00** |
| **Mechanical** | | | | | | |
| | Septage Acceptance Plant | LS | 1 | $ 273,840.00 | $ 82,152.00 | $355,992.00 |
| | Septage Pump | LS | 2 | $ 40,000.00 | $ 12,000.00 | $104,000.00 |
| | Septage Grit Removal System | LS | 1 | $ 146,880.00 | $ 44,064.00 | $190,944.00 |
| | FOG Receiving and Screening Station | LS | 1 | $ 273,840.00 | $ 82,152.00 | $355,992.00 |
| | FOG Pump | EA | 1 | $ 40,000.00 | $ 12,000.00 | $52,000.00 |
| | Primary Sludge RDT | LS | 1 | $ 297,936.00 | $ 89,380.80 | $387,316.80 |
| | Septage RDT | LS | 1 | $ 374,136.00 | $ 112,240.80 | $486,376.80 |
| | Thickening Ancillary Equipment | LS | 1 | $ 1,320,500.00 | $ 396,150.00 | $1,716,650.00 |
| | Septage Centrifuge | LS | 1 | $ 517,704.00 | $ 155,311.20 | $673,015.20 |
| | Dewatering Ancillary Equipment | LS | 1 | $ 136,230.00 | $ 40,869.00 | $177,099.00 |
| | Lime Stabilization | LS | 1 | $ 2,232,000.00 | $ 669,600.00 | $2,901,600.00 |
| **Anaerobic Digester (structural, mechanical & EIC)** | | LS | 1 | $ | 7,476,000.00 | $7,476,000.00 |
| | **Subtotal** | | | | | **$14,876,985.80** |
| **Electrical, Instrumentation, and Controls** | | | | | | |
| | EI&C | EA | 1 | $2,975,397.16 | | $2,975,397.16 |
| | **Subtotal** | | | | | **$2,975,397.16** |
| **Construction Material & Labor Subtotal:** | | | | | | **$21,849,508.70** |

| Markups | |
|---|---|
| Mobilization (10%) | $ 2,184,950.87 |
| General Conditions (8%) | $ 1,747,960.70 |
| Contractor O&P (12%) | $ 2,621,941.04 |
| **Subtotal** | **$ 28,404,361.31** |
| Tax (9.2%) | $ 2,613,201.24 |
| Construction Contingency (30%) | $ 8,521,308.39 |
| **Total Construction Cost** | **$ 39,538,870.94** |
| Engineering, Legal, and Administration (25%) | $ 9,884,717.74 |
| **Total Project Cost** | **$ 49,423,588.68** |

Project: Central Kitsap Facility Plan Update Amendment 2 Liquid Hauled Waste
Client: Kitsap County
Project No.: 20-2840.00. 0100.32
Date: 7/21/2022

Class 5 Estimate

**Alternative 5: Separated Septage Treatment with Wetland and Composting**

| Item No. | Item | Unit | QTY | Materials & Equipment | Labor | Total |
|---|---|---|---|---|---|---|
| **Civil Site Prep/Earthwork** | | | | | | |
| | Excavation | CY | 3535 | $ | 60.00 | $212,123.05 |
| | Dewatering | LS | 1 | $ | 500,000.00 | $500,000.00 |
| | Backfill | CY | 530 | $ 45.00 | $ 18.00 | $33,409.38 |
| | Demolition | LS | 1 | $ | 50,000.00 | $50,000.00 |
| | RDT Yard Piping (6") | LF | 500 | $ 125.00 | $ 37.50 | $81,250.00 |
| | Digester Yard Piping (4") | LF | 500 | $ 100.00 | $ 30.00 | $65,000.00 |
| | Septage Yard Piping (6") | LF | 1000 | $ 125.00 | $ 37.50 | $162,500.00 |
| | FOG Yard Piping (4'') | LF | 500 | $ 100.00 | $ 30.00 | $65,000.00 |
| | **Subtotal** | | | | | **$1,169,282.43** |
| **Structural** | | | | | | |
| | Thickener Building | SF | 3000 | $400.00 | | $1,200,000.00 |
| | FOG Sump | SF | 50 | $400.00 | | $20,000.00 |
| | **Subtotal** | | | | | **$1,220,000.00** |
| **Mechanical** | | | | | | |
| | Septage Acceptance Plant | LS | 1 | $ 294,960.00 | $ 88,488.00 | $383,448.00 |
| | Septage Pump | LS | 2 | $ 40,000.00 | $ 12,000.00 | $104,000.00 |
| | Septage Sump Aeration | LS | 1 | $ 10,000.00 | $ 3,000.00 | $13,000.00 |
| | FOG Receiving and Screening Station | LS | 1 | $ 273,840.00 | $ 82,152.00 | $355,992.00 |
| | FOG Pump | EA | 1 | $ 40,000.00 | $ 12,000.00 | $52,000.00 |
| | Treatment Wetlands | LS | 1 | $ | 4,680,000.00 | $4,680,000.00 |
| | Composting | LS | 1 | $ | 2,280,000.00 | $2,280,000.00 |
| | Primary Sludge RDT | LS | 1 | $ 297,936.00 | $ 89,380.80 | $387,316.80 |
| | Thickening Ancillary Equipment | LS | 1 | $ 647,500.00 | $ 194,250.00 | $841,750.00 |
| **Anaerobic Digester (structural, mechanical & EIC)** | | LS | 1 | $ | 7,476,000.00 | $7,476,000.00 |
| | **Subtotal** | | | | | **$16,573,506.80** |
| **Electrical, Instrumentation, and Controls** | | | | | | |
| | EI&C | EA | 1 | $3,314,701.36 | | $3,314,701.36 |
| | **Subtotal** | | | | | **$3,314,701.36** |
| | | | | | | |
| **Construction Material & Labor Subtotal:** | | | | | | **$22,277,490.59** |
| | | | | | | |
| | Markups | | | | | |
| Mobilization (10%) | | | | | | $ 2,227,749.06 |
| General Conditions (8%) | | | | | | $ 1,782,199.25 |
| Contractor O&P (12%) | | | | | | $ 2,673,298.87 |
| | | | | | **Subtotal** | **$ 28,960,737.77** |
| Tax (9.2%) | | | | | | $ 2,664,387.87 |
| Construction Contingency (30%) | | | | | | $ 8,688,221.33 |
| | | | | | **Total Construction Cost** | **$ 40,313,346.98** |
| Engineering, Legal, and Administration (25%) | | | | | | $ 10,078,336.74 |
| | | | | | **Total Project Cost** | **$ 50,391,683.72** |