Biosolids Management Plan

Prepared for
LOTT Clean Water Alliance
Olympia, Washington
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List of Abbreviations

°C	degree(s) Celsius
°F	degree(s) Fahrenheit
AA	average annual
AADF	average annual day flow
BCE	business case evaluation
BOD	biological oxygen demand
Budd Inlet Plant	Budd Inlet Treatment Plant
CAO	Critical Area Ordinances
CARA	Critical Aquifer Recharge Area
CEC	contaminant of emerging concern
CFR	Code of Federal Regulations
CIP	Capital Improvements Plan

DAFT	dissolved air flotation thickener
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Area
EQ	Exceptional Quality
g	gram(s)
gpd	gallon(s) per day
ha	hectare(s)
kg	kilogram(s)
lb/ft^2-day	pound(s) per square foot per day
lb/ft^3-day	pound(s) per cubic foot per day
LOTT	LOTT Clean Water Alliance
Martin Way Plant	Martin Way Reclaimed Water Plant
MCRT	mean cell residence time
mg	milligram(s)
mg/L	milligrams per liter
MPN	most probable number
Mullen Road Plant	Mullen Road Reclaimed Water Plant
NPDES	National Pollutant Discharge Elimination System
O&M	operation and maintenance
P14	peak 2-week
Plan	Biosolids Management Plan
PSRP	process to significantly reduce pathogens
RV	recreational vehicle
RWP	reclaimed water plant
SEPA	State Environmental Policy Act
SOUR	specific oxygen uptake rate
SRT	solids retention time
Station	Septage Receiving Station
TKN	total Kjeldahl nitrogen
TRPC	Thurston Regional Planning Council
TSS	total suspended solids
Tumwater Plant	Tumwater Reclaimed Water Plant
UGA	urban growth area
VSS	volatile suspended solids
WAC	Washington Administrative Code
WAS	waste activated sludge

Section 1

Purpose and Background

1.1 Purpose

The purpose of this Biosolids Management Plan (Plan) is to provide a long-range capital investment and operating strategy for the LOTT Clean Water Alliance (LOTT) consistent with community values and organizational goals. This includes the projected biosolids production rates, evaluation of LOTT's existing biosolids program, recommended short-term improvements, program management considerations, and a road map for implementing long-term planning alternatives.

The Plan also recommends monitoring and mitigation strategies for inherent risks in LOTT's biosolids program. LOTT can continue to effectively position itself for timely biosolids management decisions and avoid sunken investments. This approach is aligned with LOTT's *Wastewater Resource Management Plan* and is targeted at achieving the goals identified in the *Strategic Business Plan.*

1.2 Background

LOTT provides regional wastewater conveyance and treatment services for the cities of Lacey, Olympia, and Tumwater and portions of Thurston County, with a 2012 service area population of approximately 160,000. Most of the wastewater in LOTT's service area is conveyed to the Budd Inlet Treatment Plant (Budd Inlet Plant) in downtown Olympia for treatment. This plant can provide a wet weather treatment capacity of up to 28 million gallons per day (mgd), and a maximum day flow of 55 mgd. LOTT also owns and operates the 2 mgd average annual day flow (AADF) Martin Way Reclaimed Water Plant (Martin Way Plant) in Lacey, which can be expanded up to 8 mgd. The Martin Way Plant discharges solids into the regional sewer system, which are conveyed to the Budd Inlet Plant for further treatment. Final treatment of all solids within LOTT's service area prior to beneficial use occurs at the Budd Inlet Plant. Figure 1-1 shows a location map of the Budd Inlet Plant and Martin Way Plant in relation to LOTT's service area and the urban growth areas (UGAs) of Lacey, Olympia, and Tumwater.

1.3 Budd Inlet Treatment Plant

The Budd Inlet Plant was originally built in 1949 as a primary treatment facility. The secondary treatment facility was largely completed and online in August 1982. In 1994, LOTT completed a nutrient removal expansion that seasonally removes nitrogen. Since then, most capital projects have been focused on repair and replacement of systems as they have reached their expected useful life. However, in 2006 LOTT built a satellite reclaimed water facility that diverts a portion of the plant flow to be treated to Class A reclaimed water standards. Also, in 2014, LOTT will complete an upgrade to expand the primary treatment system.

The Budd Inlet Plant is the regional solids treatment center and receives waste activated sludge (WAS) from the Martin Way Plant and septage from commercial haulers. As of 2012, solids received at the Plant are processed to a U.S. Environmental Protection Agency (EPA)-defined Class B cake biosolids product and distributed to beneficial use facilities for land application.

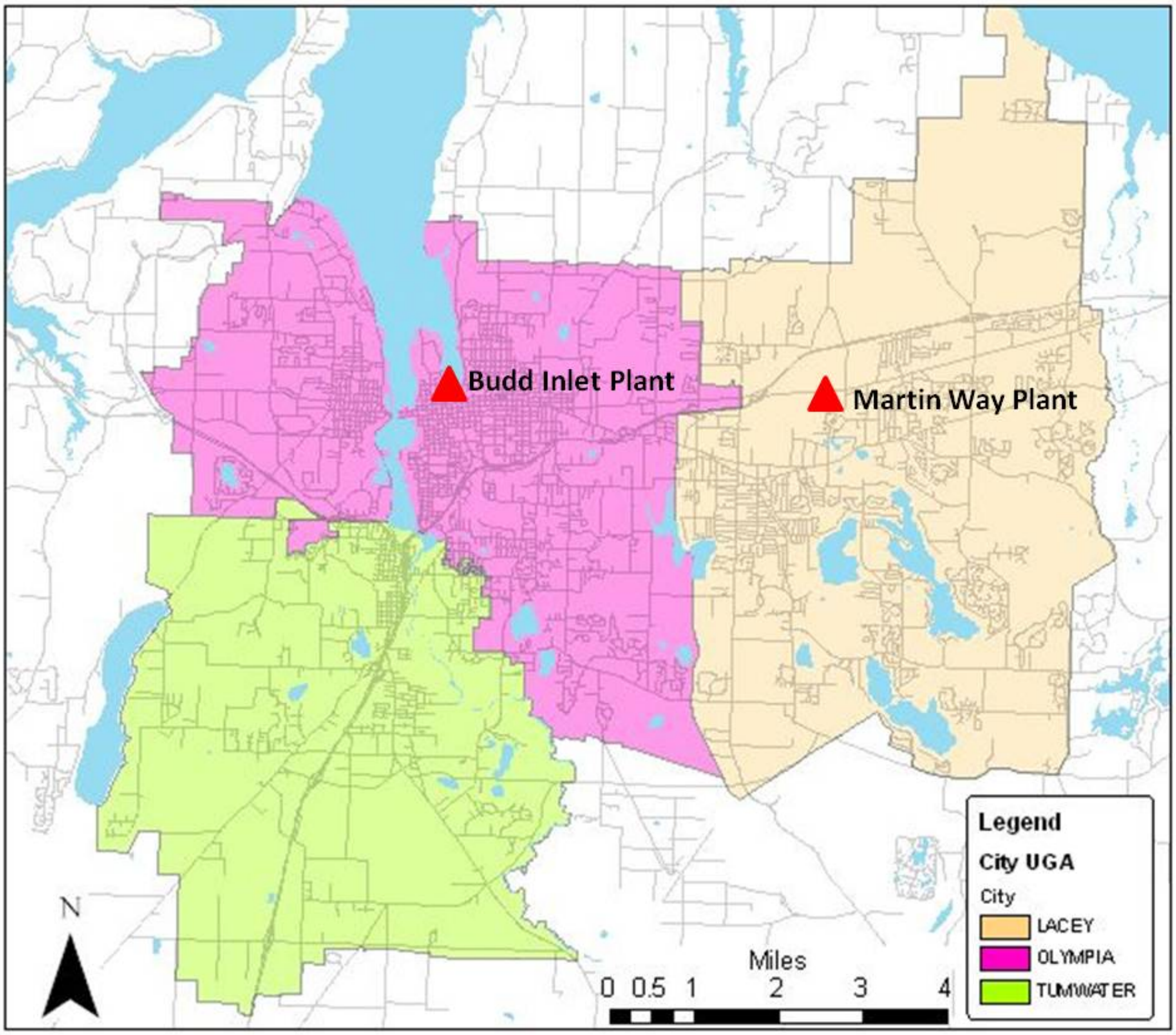

Figure 1-1. LOTT facilities vicinity map

1.3.1 Solids Processing at the Budd Inlet Plant

LOTT's six core biosolids processes at the Budd Inlet Plant include:

1. **Septage receiving:** The Budd Inlet Plant has a septage receiving station for permitted commercial dischargers as well as a recreational vehicle (RV) dump station that is open to the public. The septage receiving station conveys flow to the plant headworks, where materials are screened with other influent wastewater.
2. **Pretreatment:** Grit and screenings removal at the headworks of the Budd Inlet Plant impacts biosolids production. Greater removal of grit and screenings in this pretreatment step leads to reduced accumulation of solids in downstream processes such as primary sedimentation and secondary clarification.
3. **Solids thickening:** Four dissolved air flotation thickeners (DAFTs) are available to thicken primary sludge. However, only one is typically in use at a given time. The thickening process removes excess water from the combined primary and WAS flows.
4. **Digestion/stabilization:** There are four mesophilic anaerobic digesters at the Budd Inlet Plant. Two primary sludge digesters operate in parallel and feed into a secondary digester, while the fourth

digester is used for storage to optimize dewatering and held in reserve to support maintenance activities and emergencies. The digestion process consumes most of the volatile solids needed for bacterial growth, thereby discouraging microbial activity and vector attraction in the final biosolids product; the digested solids produced are Class B biosolids, suitable for land application.

5. **Solids dewatering:** The Budd Inlet Plant uses centrifuges to dewater digested sludge. The centrifuges effectively dewater sludge to approximately 22 to 24 percent solids by weight prior to hauling.
6. **Hauling and beneficial use:** In 2012, LOTT produced 1,780 dry tons of Class B cake biosolids. LOTT contracts with hauling companies to distribute the biosolids to two beneficial use facilities in Washington. Fire Mountain Farms, in Lewis County, received 970 dry tons, and Boulder Park, in Douglas County, received 810 dry tons. The facilities land-apply the Class B cake biosolids product on pastures, feed crops, and forest lands. LOTT also maintains a contract with Boulder Park and Fire Mountain Farms to store biosolids in the event that one of its beneficial use facilities is unable to accept the product.

The solids processes at the Budd Inlet Plant are shown in Figure 1-2, along with the overall treatment process.

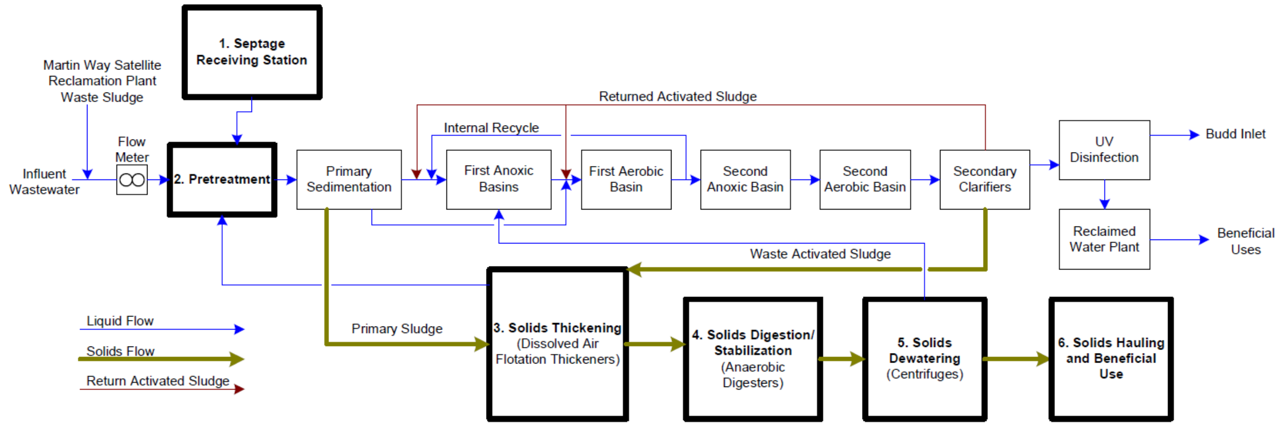

Figure 1-2. Budd Inlet Plant treatment schematic

1.3.2 Budd Inlet Plant Discharge Capacity

LOTT actively monitors and manages discharge capacity as one of the primary factors prioritizing capital investments and operations. LOTT completes a capacity analysis each year to evaluate flow and loading projections and identify process limitations that would require expansion to meet the projections. The Capital Improvements Plan (CIP) is updated annually to reflect any necessary improvements.

Discharge capacity for LOTT is defined as the volume of material (both solids and liquid form) that is permitted to be safely reintroduced to the environment for beneficial use or disposal. The federal, state, and local environmental and public health regulators are responsible for establishing the requirements (volume and quality) of the products, depending upon the end uses. The conditions attached to the discharge capacity establish the performance basis for the plant.

LOTT maintains liquid discharges to separate receiving areas: Budd Inlet (a marine water body), groundwater recharge basins, and a Class A reclaimed water distribution system. Separate regulatory requirements are associated with each of these discharges. These requirements are defined in the National Pollutant Discharge Elimination System (NPDES) permit WA0037061 (both waste discharge and reclaimed water) and the reclaimed water permit for the Martin Way Plant (reclaimed water permit ST 6206).

Management of the residual solids product (biosolids) from the Budd Inlet Plant is regulated by a set of biosolids rules set forth in Washington Administrative Code (WAC) Chapter 173-308, and coverage under a State General Permit for Biosolids Management administered by the Washington State Department of Ecology (Ecology). This permit specifies the public access limits and minimum product quality and treatment processes necessary, depending upon the end use. LOTT's program produces Class B cake product for land application, which requires controlled public access.

The management requirements effectively establish the operating performance conditions for the treatment plant, and the following describes the minimum permit requirements applicable to Class B cake biosolids:

- anaerobic digestion to meet process to significantly reduce pathogens (PSRP) requirements for Class B biosolids production
- a temperature of at least 35 degrees Celsius (°C)
- 38 percent volatile solids reduction to meet vector attraction reduction requirements
- removal of manufactured inerts (met by screening all raw wastewater received at the plant with a 1/4-inch [6 mm] perforated, self-cleaning escalator screen)

1.4 Previous Biosolids Planning

LOTT previously prepared a biosolids management plan in 1994 that recommended land application of Class B cake biosolids and conversion to Class A composting when the Class B cake land application program was no longer viable. The 1994 plan envisioned that regulations or other external pressures would cause LOTT to convert to a Class A process prior to this report (2012). However, LOTT has successfully maintained a Class B cake land application beneficial reuse program that appears to be viable for at least 10 to 20 more years. This viability is strengthened by larger regional municipalities, such as King County and the City of Portland, continuing their Class B land application programs. The Class B program also meets LOTT's established planning and level-of-service goals. This update of the previous biosolids management plan revisits the original plan concepts in the context of updated values and goals and the regulatory and regional landscape.

1.5 Integrated Planning

Integrating detailed biosolids planning with other larger wastewater planning efforts allows uniformity in LOTT's approach application of utility values. LOTT's *Wastewater Resource Management Plan* was developed in 1999 to define and address the needs of LOTT and its partner governments for managing the region's wastewater. This plan identified an approach for a "Highly Managed Plan," which is an environmentally based system for building small units of capacity responding just in time to actual measured conditions. This approach offers multiple benefits—it integrates public values, allows LOTT to take advantage of technology advancements, enables flexibility to respond to changing regulations, and permits LOTT to match treatment capacity to changing growth trends. This Biosolids Management Plan is structured to be consistent with the *Wastewater Resource Management Plan.*

1.6 Biosolids Program Values and Goals

Through extensive surveys, interviews, and public meetings, LOTT identified key public values upon which to base *The Wastewater Resource Management Plan*. In 2008, LOTT developed its *Strategic Business Plan,* which further documents LOTT's organizational philosophy, core values, and level-of-service goals to meeting those public values. LOTT management staff has set specific management goals for the biosolids program in order to meet the required levels of service. The following sections describe the values and goals that drive LOTT's biosolids management program.

1.6.1 Public Values

The *Wastewater Resource Management Plan* identified public values that fall into three categories. These categories are shown below with descriptions applying them to biosolids planning.

1. **Environmental impacts:** LOTT planning must address environmental impacts related to biosolids.
2. **Cost to ratepayers:** LOTT planning must consider the cost of future biosolids equipment and facilities as they compare to other wastewater needs as well as who pays for future improvements.
3. **Meeting future demand:** LOTT planning must consider how to meet future biosolids production values as well as consider which markets demand biosolids reuse.

1.6.2 Core Values

The *Strategic Business Plan* identifies LOTT's core values in four key areas. Each area is shown below in relation to biosolids planning.

1. **Business management:** LOTT must manage funds spent on the biosolids program efficiently and responsibly.
2. **Environmental resource management and stewardship:** LOTT must meet strict regulatory requirements for biosolids management and be an environmental steward.
3. **Education, communication, and partnerships:** LOTT must have public support for its activities, including biosolids management, and seek to develop community partnerships.
4. **Human resources and workplace development:** LOTT must maintain a workforce and workplace capable of adapting to new challenges and new technologies in biosolids management.

1.6.3 Level-of-Service Goals

LOTT further defines level-of-service goals for each core value in the *Strategic Business Plan*. Within the core value of Environmental Resource Management and Stewardship, one of the level-of-service goals is defined as follows: "Produce and reuse renewable resources, including Class A reclaimed water, Class B biosolids, and methane."

As one of the measures of success, LOTT has the goal of 100 percent beneficial reuse of biosolids. LOTT has consistently met this goal for many years.

1.6.4 Management Goals

In order to meet the public values, core values, and levels of service previously described, LOTT management staff has set specific goals for the biosolids program. These objectives guide the planning and decision-making process at the biosolids process level to determine maintenance, upgrades, contracts, staffing, and a variety of day-to-day functions. These management goals include:

- maintain at least two biosolids disposal options available at any one time
- meet 2030 solids loading requirements with the ability to expand the program to meet buildout (2050) requirements
- identify ways to increase treatment efficiency and control operating costs
- foresee changing biosolids management considerations

This Biosolids Management Plan evaluates individual processes within LOTT's biosolids program against these values and goals. Planning data are used to verify if future demands can be met. Regulatory drivers are analyzed to determine environmental stewardship. Strategies are recommended for monitoring biosolids trends. Detailed business case evaluations (BCEs) can now be performed with the risks, benefits, and options presented. Overall, this Plan communicates a road map for sustaining LOTT's values and goals in the biosolids program.

1.7 Plan Contents

This Biosolids Management Plan is separated into the following six additional sections to accomplish the Plan's purpose:

- **Section 2** provides future solids loadings and dewatered biosolids production values.
- **Section 3** overviews the current regulatory environment and identifies potential future regulatory trends.
- **Section 4** reviews existing facilities and capacities, and recommends improvements for each of the solids processes.
- **Section 5** details possible risks to the program, ways to monitor them, and associated mitigation strategies.
- **Section 6** summarizes short-term improvements resulting from a review of the existing biosolids processes.
- **Section 7** aligns LOTT's goals discussed in Section 1 with the biosolids management considerations described in Section 5 to guide long-term biosolids planning.

Section 2

Flow and Loading Projections

This section describes the development and results of flow and loadings projections for LOTT. The solids projections in this section can be used to evaluate the need and timing for future solids treatment projects.

2.1 Background

Figure 2-1 shows the LOTT service area. The existing service area and population were based on the population data presented in the 2013 *Flows and Loadings Report,* which reports a residential population of 97,679 and an employment population of 86,432.

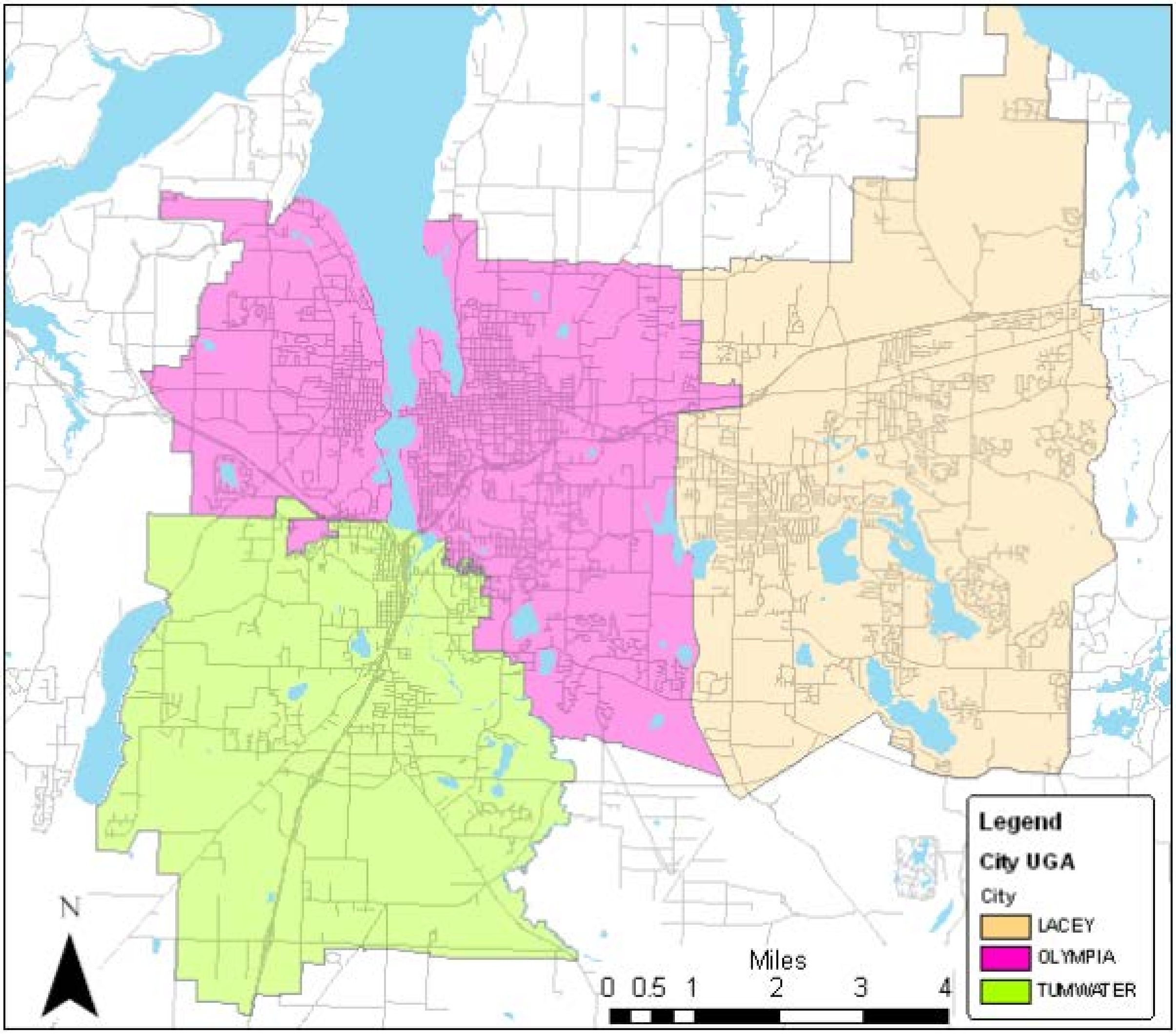

Figure 2-1. LOTT service area by jurisdiction

Source: 2010 Flows and Loadings Report, *LOTT Clean Water Alliance and Brown and Caldwell.*

2.2 Methodology

The 2013 *Flows and Loadings Report* uses population and employment projections developed by the Thurston Regional Planning Council (TRPC) for the existing and future sewered service area. Projections also incorporate additional development information collected by LOTT for specific areas.

For years beyond the TRPC planning horizon of 2035, the employment was assumed to increase at the same rate as the service area population; future employment growth was fractioned to individual basins based upon the TRPC 2035 employment estimate. Projections account for the expansion of the sewer service area.

Flows and loadings were developed from population and employment projections, and considered influent flow, influent biological oxygen demand (BOD), and influent total suspended solids (TSS) data gathered at Budd Inlet Plant and Martin Way Plant, as well as projected biological cell yields for the Budd Inlet Plant and satellite reclaimed water plants (RWPs).

2.3 Assumptions

The following assumptions and design data were used in developing flow and loading projections for biosolids:

- WAS produced by RWPs is discharged to the Budd Inlet Plant at a rate of 25,000 gallons per day (gpd) per mgd of RWP capacity, and with the following characteristics:
  - BOD: 4,000 milligrams per liter (mg/L)
  - TSS: 6,000 mg/L
  - volatile suspended solids (VSS): 5,300 mg/L
  - total Kjeldahl nitrogen (TKN): 400 mg/L
- WAS yield is based on BioWin modeling performed by Brown and Caldwell.
- Primary sludge = influent TSS * primary clarifier TSS removal rate (primary clarifier model is based on performance of existing clarifiers).
- WAS:
  - secondary BOD = influent BOD * (1 – primary clarifier BOD removal rate)
  - WAS load = WAS yield rate * secondary BOD
- Thickening:
  - DAFT feed = primary sludge + WAS.
  - DAFT capacity is based on peak day loading (peak day DAFT feed = 2.5 * average day primary sludge + 1.75 * average day WAS). Firm utilization (utilization with one unit out of service) must not exceed 100 percent of capacity, while total utilization must not exceed 85 percent of capacity.
  - DAFT unit dimensions are 43 feet long, 14 feet wide, and 12 feet deep.
  - DAFT capacity is 60 pounds per square foot per day (lb/ft^2/day) feed.
  - Total DAFT capacity is evaluated with one unit out of service.
  - DAFT capture rate = 85 percent.
  - Thickened sludge is produced with 6.1 percent total solids.
- Digestion:
  - Digester dimensions are 70 feet diameter and 30 feet deep, with a unit volume of 863,652 gallons.

  - Design minimum hydraulic retention time = 25 days.
  - Design maximum volatile solids loading rate = 0.15 pound per cubic foot per day (lb/ft^3/day).
  - Digester capacity, based on a peak 2-week condition, must not exceed 85 percent of capacity.
  - Volatile solids comprise 85.7 percent of the total solids composition of thickened sludge.
  - Anaerobic digestion results in a 63.1 percent reduction in volatile solids.
  - Digested sludge comprises 3.0 percent total solids.
- Dewatering:
  - Centrifuge capture rate is 97 percent.
  - Dewatered solids comprise 23.3 percent total solids.
  - Dewatering capacity, based on a peak 2-week condition, must not exceed 85 percent of capacity.

2.4 Results

A comparison of actual versus projected solids loadings is shown in Table 2-1. This table shows that actual data have been within a reasonable margin of error when compared to projections.

Table 2-1. Projected vs. Actual 2012 Loadings

Parameter	Projected		Observed (2012)		% difference	
	AA (lb/day)	P14 (lb/day)	AA (lb/day)	P14 (lb/day)	AA (%)	P14 (%)
Raw influent TSS	22,400	30,900	22,700	30,100	-1.3%	2.6%
Raw influent BOD	21,500	26,000	21,800	27,000	-1.4%	-3.8%
Primary sludge	14,200	21,000	14,400	25,300	-1.4%	-20.5%
WAS	9,600	14,400	9,700	16,700	-1.0%	-16.0%
Thickener load	23,800	30,300	24,100	32,300	-1.3%	-6.6%
Thickened sludge	20,300	26,700	20,800	28,800	-2.5%	-7.9%
Digested sludge	9,300	15,800	10,100	16,800	-8.6%	-6.3%
Dewatered sludge	9,000	13,000	9,800	14,000	-8.9%	-7.7%

Note: Population projections and flow and loading data developed in the 2013 Flows and Loadings Report were the most recent available when developing the biosolids projections. These data were used when developing the 2014 CIP.

Average annual (AA) and peak 2-week projected (P14) solids loadings for 2013, 2030, and 2050 are summarized in Table 2-2. Average annual dewatered sludge is projected to approximately double by 2030 and approximately triple by 2050.

2.5 Impact of Satellite Treatment Plant Planning Scenarios

The CIP Scenario was considered primarily when evaluating future biosolids loading in this Biosolids Management Plan. However, to determine the potential impact of satellite treatment plant construction/expansion to projected sludge quantities, flows and loadings were developed for the following three scenarios:

1. CIP Scenario
2. 8 mgd Scenario
3. 5 mgd Scenario

Table 2-2. Projected Loadings

Parameter	2013		2030		2050	
	AA (lb/day)	P14 (lb/day)	AA (lb/day)	P14 (lb/day)	AA (lb/day)	P14 (lb/day)
Raw influent TSS	24,593	33,816	37,335	51,336	47,333	65,083
Raw influent BOD	23,727	28,681	33,187	40,116	40,227	48,626
Primary sludge	16,345	24,254	26,625	39,508	34,967	51,887
WAS	10,211	15,316	15,394	23,092	20,327	30,490
Thickener load	26,556	33,846	42,019	53,554	55,294	70,473
Thickened sludge	22,633	29,835	35,813	47,208	47,127	62,121
Digested sludge	10,398	17,677	16,453	27,971	21,651	36,807
Dewatered sludge	10,087	14,483	15,960	22,917	21,002	30,156

The first, termed the CIP Scenario, projects flows and loadings for the planning scenario discussed in the *2013 Capacity Assessment Report* (LOTT, 2013). At buildout, this scenario projects 15 mgd of satellite treatment distributed at the Martin Way Plant and two other satellite facilities, the Mullen Road Reclaimed Water Plant (Mullen Road Plant) and the Tumwater Reclaimed Water Plant (Tumwater Plant). The CIP Scenario would implement satellite plant capacity according to the following schedule:

- 2019: expand Martin Way Plant capacity to 3 mgd
- 2023: expand Martin Way Plant capacity to 5 mgd
- 2024: construct the Tumwater Plant with an initial capacity of 2 mgd
- 2027: expand Martin Way Plant capacity to 6 mgd
- 2031: expand the Tumwater Plant capacity to 3 mgd
- 2032: expand Martin Way Plant capacity to 7 mgd
- 2038: expand Martin Way Plant capacity to 8 mgd
- 2042: expand the Tumwater Plant capacity to 4 mgd
- 2044: construct the Mullen Road Plant with an initial capacity of 1 mgd
- 2053: expand the Tumwater Plant capacity to 5 mgd
- 2053: expand the Mullen Road Plant to 2 mgd

Annual CIP planning will update the satellite treatment plant schedule in accordance with the Highly Managed Plan. However, minor changes to the implementation years of these facilities are not anticipated to be significant.

In the second scenario, termed the 8 mgd Scenario, Martin Way Plant capacity would be implemented according to the schedule above. No new satellite plants would be constructed, and the Budd Inlet Plant would therefore treat an additional 7 mgd of flow compared to the CIP Scenario.

In the third scenario, termed the 5 mgd Scenario, Martin Way Plant capacity would be limited to 5 mgd. No new satellite plants would be constructed, and the Budd Inlet Plant would treat an additional 10 mgd of flow compared to the CIP Scenario.

A comparison of the three different scenarios at buildout (2050) for average annual conditions is presented in Table 2-3.

Table 2-3. Flow and Loading: Scenario Comparisons

Scenario	RWP WAS	Total WAS, AA	Dewatered solids, AA
CIP Scenario, lb/day	18,777	20,327	21,002
8 mgd Scenario, lb/day	10,015	25,253	23,307
5 mgd Scenario, lb/day	6,259	27,343	24,300

The 5 mgd Scenario produces the greatest sludge values. This is because the other scenarios allow for more treatment in RWPs, which remove solids through screening and which produce less WAS than would be generated at the Budd Inlet Plant.

Figure 2-2 shows a graphical comparison of the peak and average dewatered solids projections for the three scenarios along with the planned CIP RWP improvements.

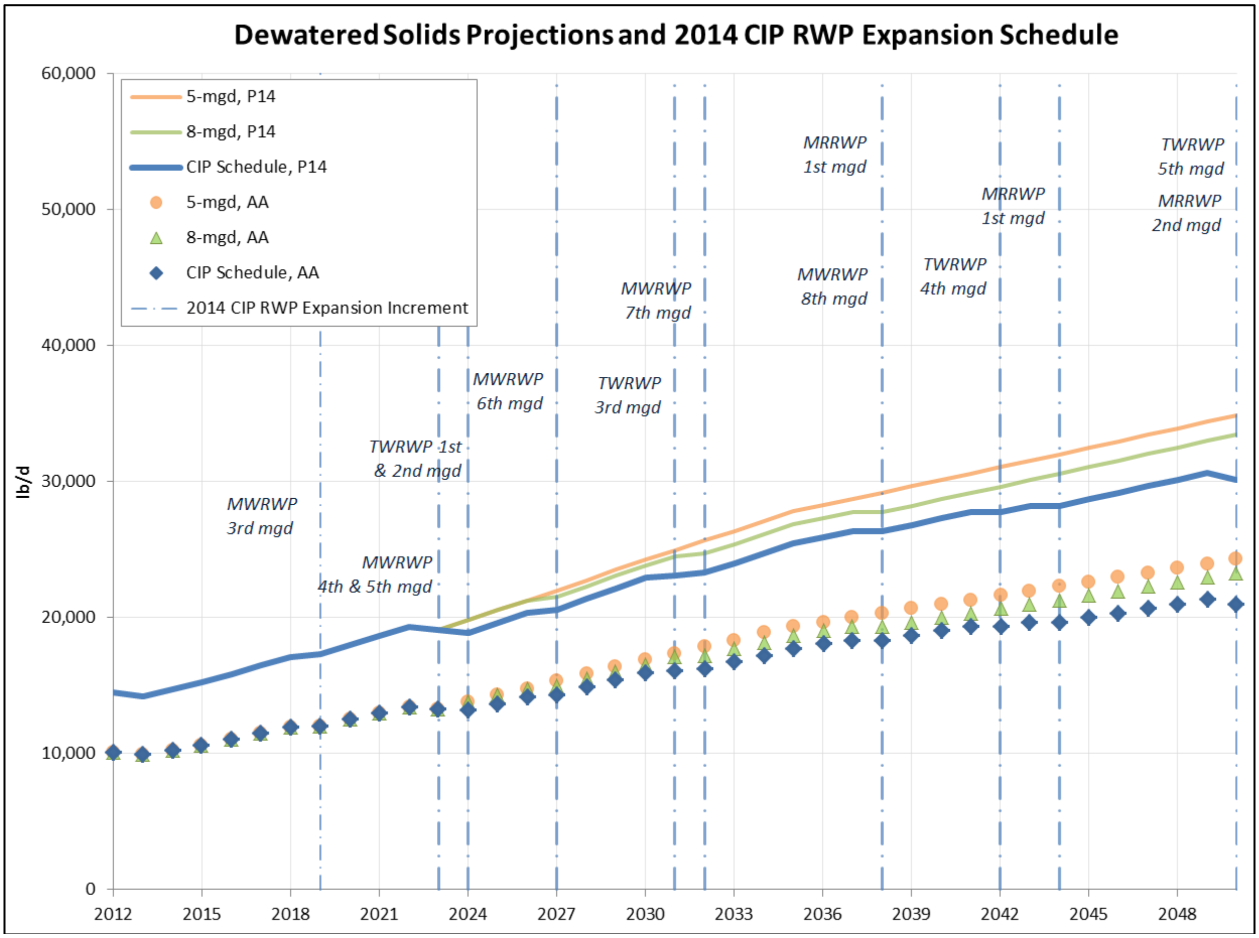

Figure 2-2. Dewatered solids projections with CIP RWP expansions

Note that a shift away from the RWP schedule in the CIP may require adjustments to the solids handling improvement schedule. LOTT should continue to analyze the capacity of major process components as part of annual CIP planning.

Section 3

Biosolids Regulatory Overview

To ensure a successful biosolids management program, public concerns about metals, pathogens, and emerging contaminants in biosolids must be addressed. Regulatory requirements exist at the federal and state levels in Washington to address these concerns, protect the environment, and oversee biosolids management. This section summarizes existing regulations and describes emerging regulatory trends that may impact LOTT's biosolids program in the future.

3.1 Federal Regulations

The EPA Region 9 enforces compliance and regulates land application of biosolids under Code of Federal Regulations (CFR) Title 40 Part 503. These regulations are self-implementing and outline requirements for monitoring, certification, and reporting for a biosolids program. The 40 CFR 503 regulations establish limits on metals concentrations, pathogen reduction, vector attraction reduction, and site management practices for land application of biosolids.

3.2 State Regulations

Biosolids are additionally regulated at the state level by Ecology in WAC Chapter 173-308. Ecology provides oversight and assistance for facilities that generate, treat, and use biosolids. The rule establishes standards, management practices, permitting requirements, and permit fee schedules for facilities that store, treat, and recycle municipal or domestic sewage sludge or biosolids, as well as any sites where the biosolids are land-applied.

The standards set forth in state regulations correspond to those set forth in 40 CFR Part 503. The following sections describe the federal and state regulations that are applicable to LOTT's biosolids program. However, note that Ecology has instituted the manufactured "inerts" rule, which applies to all septage, sewage sludges, and biosolids. This rule went into effect on July 1, 2012, requiring that manufactured inerts be removed through either screening (3/8 inch or less) or other approved process.

3.3 Pathogen Reduction

Municipal wastewater and the sludges generated from its treatment contains pathogens, such as bacteria, viruses, protozoa, and helminthes (parasitic worms). The term "pathogen" is applied in this section to both pathogenic organisms and pathogen-indicating organisms.

Digestion and solids stabilization processes at wastewater treatment plants destroy pathogens through chemical, physical, and biological processes such as high temperature, disinfectants, and predation from other microorganisms. Although not considered part of the treatment process, biosolids that are land-applied may achieve additional pathogen reduction due to unfavorable conditions such as heat, sunlight, and pH.

Federal and state regulations classify biosolids into two categories, based on level of treatment: Class A and Class B. Class A biosolids have reduced pathogen loads to below detection limits and must also comply with vector attraction and low metals content requirements. If the biosolids products are to be given or sold directly to the public or land-applied without restriction they must also meet the Exceptional Quality (EQ) requirements of the 503 regulations for pollutant concentration limits as discussed below in Section 3.5. Class A biosolids products are suitable for application to areas where public access is common, such as golf courses and urban landscape projects. Thermally dried or composted biosolids products are also distributed in bags at the retail level. Local examples of commercially available Class A biosolids products include TAGRO, produced in Tacoma, Washington, and SoundGRO, produced in Pierce County, Washington.

Class B biosolids are generated from a PSRP but still contain detectable levels of pathogens. Therefore, restrictions are applied to the land application sites when Class B biosolids are applied—including buffer requirements, public access, and crop harvesting restrictions. In addition, Class B biosolids cannot be sold or given away in bags or containers or applied on lawns or home gardens. Class B biosolids are generally applied to areas where there will be no unintentional contact by the public. Example uses include land application as agricultural fertilizer, soil amendment, and mine reclamation. LOTT currently produces Class B biosolids for agricultural land application.

3.3.1 Pathogen Reduction for Class A Biosolids

Class A biosolids can be generated by utilities using one of the six alternatives outlined by the EPA. However, only four treatment alternatives are approved for use in the state of Washington:

- **Alternative 1: Thermally treated biosolids.** Under this alternative, requirements for both time and temperature must be met.
- **Alternative 2: Biosolids treated in a high pH-high temperature process.** This alternative includes requirements for pH, time, temperature, and percent solids.
- **Alternative 3: Biosolids treated in a process to further reduce pathogens (PFRP).** Ecology lists seven processes that qualify as a PFRP. These processes are summarized in Table 3-1.
- **Alternative 4: Equivalent PFRP.** Biosolids must be treated in a process that is equivalent to a PFRP. Pathogen equivalency for biosolids must be approved by Ecology and the EPA.

Table 3-1. Processes to Further Reduce Pathogens for Class A Biosolids (Alternative 3)

Process	Requirements
Composting	3 days at 55°C for in-vessel or static pile 15 days at 55°C for windrow
Heat drying	Direct or indirect gas drying to ≤ 10% moisture content and solids temperature of 80°C
Heat treatment	Mean cell residence time (MCRT) of 30 minutes at 180°C
Thermophilic aerobic digestion	Liquid biosolids must be agitated with air or oxygen to maintain aerobic conditions and the MCRT of the biosolids must be at least ten days at 55°–60°C
Beta ray irradiation	Biosolids must be irradiated with beta rays from an accelerator at dosages of at least 1.0 megarad at room temperature
Gamma ray irradiation	Biosolids must be irradiated with gamma rays from certain isotopes, such as Cobalt 60 and Cesium 137, at room temperature
Pasteurization	30 minutes or longer at 70°C or higher

Source: WAC 173-308-170.

In addition to meeting one of the operating conditions defined above, one of the following requirements must be met to qualify for Class A pathogen reduction standards:

- Fecal coliform densities must be less than 1,000 most probable number (MPN) per gram (g) total solids.

- Salmonella must be less than 3 MPN per 4 g total solids (dry weight basis) at the time the biosolids are used, at the time the biosolids are prepared for sale or given away in a bag or other container for application to the land, or at the time the biosolids or material derived from biosolids is prepared.

3.3.2 Pathogen Reduction for Class B Biosolids

WAC 308-170 and the Part 503 rule list the following three alternatives for treating Class B biosolids:

- **Alternative 1: Testing.** Monitoring collected at the time the biosolids are used must indicate that fecal coliform densities are less than 2 million MPN or 2 million colony forming units per gram total solids, based on a geometric mean of a minimum of seven samples.
- **Alternative 2: Biosolids treated in a PSRP**. Typical processes that can be used to achieve Class B biosolids in a PSRP are listed in Table 3-2.
- **Alternative 3: Biosolids treated in a process equivalent to a PSRP.** Equivalent processes must be approved by Ecology.

Table 3-2. Class B Biosolids Production in a PSRP (Alternative 2)

Process	Requirements
Aerobic digestion	MCRT of 40 days at 20°C or MCRT of 60 days at 15°C
Air drying	Dry on beds for 3 months, with 2 months ≥ 0°C
Anaerobic digestion	MCRT of 15 days at 35°–55°C or MCRT of 60 days at 20°C
Lime stabilization	Lime addition to pH 12 and maintained for 2 hours

LOTT currently meets the requirements of Alternative 2 with anaerobic digestion. The Budd Inlet Plant has two primary anaerobic digesters with an average retention time of 15 to 50 days. From the primary digesters, contents are pumped to a secondary anaerobic digester for an additional retention time of 11 to 28 days. The digesters' contents are kept heated above 35°C (95 degrees Fahrenheit [°F]) by being continuously re-circulated through heat exchangers. Digester temperatures are monitored daily. In 2012, the digesters maintained a temperature between 96° and 97°F.

3.4 Vector Attraction Reduction

In addition to pathogen reduction requirements summarized in Section 3.3, WAC 173-308 and the Part 503 rule require that vector attraction reduction be accomplished prior to land application of biosolids. Vectors include flies, mosquitoes, rodents, and birds that can transmit pathogens to humans. Vector attraction is reduced when biosolids are processed through digestion, lime stabilization, composting, drying, or when biosolids are tilled into soil. Under the current federal and state rules, vector attraction reduction is evaluated separately from pathogen reduction. Table 3-3 lists 10 alternatives to demonstrate acceptable vector attraction reduction for biosolids applied to land. The Budd Inlet Plant satisfies this requirement through Alternative 1 (volatile solids reduction). Daily grab samples are collected to determine volatile solids reduction; a rolling average is used for monitoring purposes. In 2012, the average volatile solids reduction was between 58 and 67 percent (greater than the required 38 percent reduction).

Table 3-3. Biosolids Vector Attraction Reduction Alternatives

Alternative	Description
1. Volatile solids reduction	Biosolids digestion processes with greater than 38% volatile solids reduction.
1A. Bench-scale test for anaerobically digested solids	Test end-product of anaerobic digestion process: 40-day anaerobic test at 30°–37°C. Acceptable stabilization if less than 17% volatile solids reduction occurs during the test.
1B. Bench-scale test for aerobically digested solids	Test end-product of aerobic digestion process having less than 2% solids: 30-day aerobic test at 20°C. Acceptable stabilization if less than 15% volatile solids reduction occurs during the test.
2. Specific oxygen uptake rate	Facilities with aerobic digestion. Specific oxygen uptake rate (SOUR) test using end-product of digestion process. Acceptable stabilization if uptake is less than 1.5 mg oxygen per g total solids per hour at 20°C.
3. Aerobic process	Time/temperature requirement for composting: 14 days' residence time at temperatures greater than 40°C, with average temperature greater than 45°C.
4. pH adjustment	High pH stabilization. Biosolids pH above 12 for 2 hours and above 11.5 for 24 hours.
5. Percent solids for stabilized solids	Treatment by drying. Not to include unstabilized primary wastewater solids. Total solids content greater than 75% before mixing with other material.
6. Percent solids for unstabilized solids	Treatment by drying; can include unstabilized primary wastewater solids. Total solids greater than 90% before mixing with other materials.
7. Injection	Barrier process. Injection into soil. No biosolids on soil surface 1 hour after application. For Class A biosolids, injection must occur within 8 hours of discharge from the pathogen-reducing process. See WAC 173-308-210, 220,230,240(3)
8. Incorporation	Barrier process. Soil incorporation by tillage within 6 hours of application. For Class A biosolids, application must occur within 8 hours of discharge from the pathogen reducing process. See WAC 173-308-210, 220,230,240(3)

Source: EPA 40 CFR Part 503 and WAC 173-308-180.

3.5 Pollutants

Metals enter wastewater treatment plants via contaminated soils, metal piping, septage receiving, and industrial discharges. Industrial source control programs have dramatically reduced metals concentrations in biosolids products over the last 30 years. LOTT has implemented a very successful source control program for many years throughout its sewer collection system, which has significantly reduced metal concentrations in effluent discharges. To ensure protection of the environment and public health, WAC 173-308-160 sets forth maximum pollutant concentrations for any biosolids distributed for land application. These are listed in the Table 3-4. LOTT's testing results in 2012 are also presented for comparison.

If the maximum concentration in the biosolids meets the requirements listed in Table 3-4 and also meets the Class A pathogen and vector attraction reduction criteria, the biosolids are deemed EQ.

Certain metals commonly found in biosolids can be beneficial when applied correctly. For example, micronutrients such as copper, iron, molybdenum, and zinc are essential for plant growth. The presence of these micronutrients is one reason why biosolids can be more effective in promoting plant growth than conventional mineral fertilizers.

Table 3-4. CFR 503 Metals Limits Requirements

Pollutant	Ceiling concentration (mg/kg)[a]	Monthly average pollutant concentrations (mg/kg)[a]	Annual pollutant loading rate (kg/ha)	LOTT 2012 average testing results (mg/kg)
Arsenic	75	41	2.0	4.47
Cadmium	85	39	1.9	1.333
Copper	4,300	1,500	75	786
Lead	840	300	15	25.6
Mercury	57	17	0.85	0.807
Molybdenum	75	-	-	10.42
Nickel	420	420	21	16.0
Selenium	100	100	5.0	5.7
Zinc	7,500	2,800	140	771

a. *Dry weight basis.*

3.6 Land Application Regulations

Biosolids that are land-applied must meet the requirements for vector attraction reduction, pollutant concentrations summarized in Section 3.5, and either Class A requirements for pathogens or Class B requirements for pathogens with additional site management and access restrictions. Biosolids must be applied to the land at agronomic rates, except when approved by Ecology for land reclamation sites, for research purposes, or in a site-specific land application plan.

The manager of the land application site is responsible for ensuring that biosolids are applied at agronomic rates and that site management and access restrictions are enforced. The biosolids producer is responsible for providing the land application manager with information sufficient to determine those appropriate agronomic rates. The producer must also provide verification that biosolids meets the treatment requirements.

Currently, 100 percent of biosolids produced at Budd Inlet Plant are distributed to land application sites for beneficial use. LOTT maintains contracts with two land application sites in Lewis and Douglas Counties, which are responsible for ensuring land application regulations are met. LOTT does not intend to manage land application sites in the immediate future.

3.7 Specific Permit Conditions

Ecology has issued a statewide general permit for biosolids. Rather than applying for a permit, facilities apply for coverage under the existing general permit. The permit application addresses all aspects of biosolids management and includes review under the State Environmental Policy Act (SEPA), public notice, and potentially public hearings or meetings. Key elements of the permit program include:

- notice of intent
- permit application
- land application plans
- public notice requirements
- hearing and meeting requirements
- record-keeping
- annual reporting

- permit fees

LOTT applied for coverage under the General Permit for Biosolids Management in November, 2010.

3.8 Future Regulatory Trends

Research into the health and safety of biosolids is ongoing. The following sections include a summary of current research topics and potential compound categories being considered for future regulation.

3.8.1 Emerging Contaminants

In recent years, a variety of compounds used in industrial and domestic applications have been detected in trace amounts in wastewater and biosolids. These contaminants can enter the sewer system through pharmaceuticals, personal care products, plasticizers, surfactants, pesticides, and fire retardants. Because most of these compounds enter the wastewater collection system through domestic use, exposure to humans from wastewater or biosolids is less of a concern than potential impacts on downstream environmental systems. Concern exists that these emerging contaminants can be emitted to the environment through wastewater outflows or biosolids application. Biological secondary wastewater treatment processes reduce and remove many of these contaminants through metabolism by wastewater treatment microorganisms and by adsorption on the biosolids. The impacts of these compounds in the environment are currently under extensive investigation. However, research does not currently indicate a threat to public health through biosolids management practices.

Regulatory trends should continue to be tracked as more of these compounds are identified and further investigation on their fate in the environment is conducted.

3.8.2 Pathogen Regrowth

Recent research has investigated the potential for fecal coliform reactivation and regrowth from dewatered biosolids. Findings of these efforts indicate that for some sludges, sudden increases in enumerable fecal coliform occur in digested sludge following centrifuge dewatering. Far fewer instances have been observed with other dewatering technologies. Increasing concentrations of these organisms during storage of biosolids following centrifuge dewatering has also been noted. Reactivation and re-growth of other pathogenic organisms has not been observed, indicating this may be a phenomenon only with fecal coliform.

Reactivation and regrowth has not been observed with some digestion technologies, such as the extended thermophilic anaerobic digestion system. It is also more of an issue with Class A biosolids. LOTT currently utilizes mesophilic anaerobic digestion, is producing Class B biosolids, and has not observed any signs of reactivation. Research in this area is ongoing, and progress should be monitored in the future in order to comply with local laws and regulations and to protect the public health and environment.

3.8.3 Local Regulations

Multiple bills affecting biosolids markets have recently been passed in the state of Washington. House Bill 1489/Senate Bill 5194 restricts the application of phosphorus-containing fertilizers, such as those produced from biosolids. Although the bill initially passed, in 2012 an amendment was passed that states phosphorus containing fertilizer will not be banned for turf use when the phosphorus content is derived solely from EQ biosolids. With this amendment, which took effect on January 1, 2013, Class A EQ biosolids will continue to be allowed as a fertilizer for turf or other landscaping purposes.

In Wahkiakum County, commissioners banned land application of Class B biosolids. The action was in response to recent septage applications on a farm within the county. Ecology is suing the County as this ban is at odds with state law. In October 2012, the Cowlitz County Superior Court ruled that Wahkiakum

County has the right to ban the use of biosolids as farm fertilizer, even though state law permits this practice and Ecology encourages it. This ruling has the potential to impact the statewide use of biosolids, as other counties could set similar policies.

Thurston County recently updated its Critical Area Ordinances (CAO) with provisions that will affect land application of biosolids in the County. In the draft form published for a public hearing on November 18, 2011, the updates to the Critical Aquifer Recharge Areas (CARA) prevent Class B biosolids application within any wellhead protection area or Category I, II, or III Critical Aquifer Recharge Area. The County subsequently revised the CAO to permit biosolids applications that are in accordance with Ecology's regulations, including the land application of Class B biosolids. The final CAO was adopted on July 24, 2012.

Section 4

Biosolids Program Review

Each process component within the biosolids program must support LOTT's values and goals identified in Section 1. LOTT has identified management goals to achieve the level of service of 100 percent beneficial reuse of biosolids. These include:

- maintain at least two biosolids disposal options available at any one time
- meet 2030 solids loading requirements with the ability to expand the program to meet buildout (2050) requirements
- identify ways to increase treatment efficiency and control operating costs
- foresee changing biosolids management considerations

This section reviews each of the six core biosolids components listed below in the context of these management goals. This is accomplished at a planning level through verification of capacity for the planning horizon and identification of advantages and disadvantages. Proposed improvements are then presented.

1. Septage receiving
2. Pretreatment
3. Solids thickening
4. Digestion/stabilization
5. Solids dewatering
6. Hauling and beneficial use

These components are shown schematically with other processes at the Budd Inlet Plant in Figure 4-1. Figure 4-2 shows a general location map.

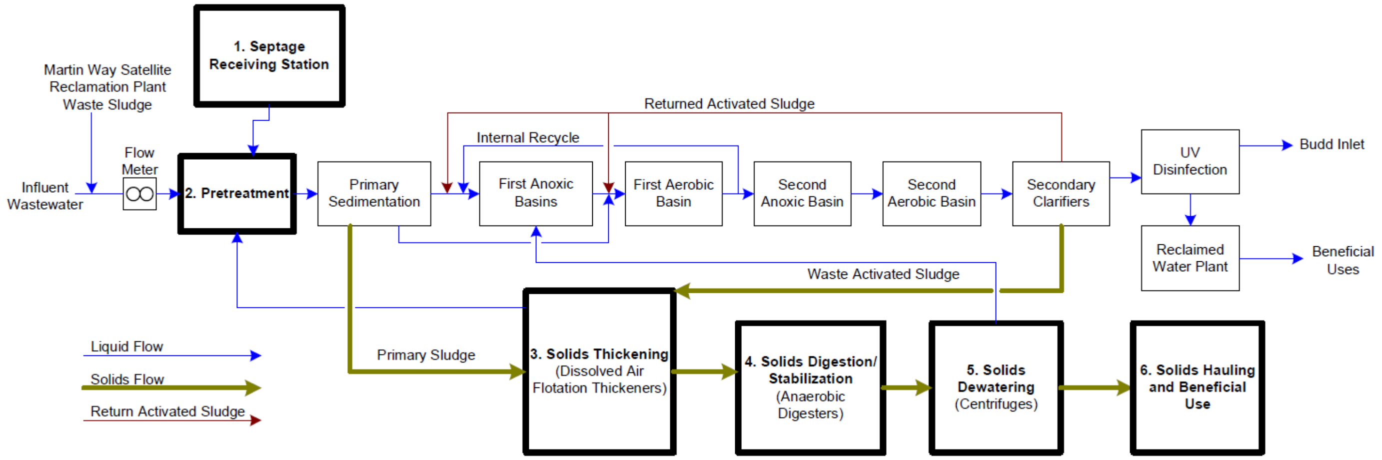

Figure 4-1. Budd Inlet Plant process schematic

Figure 4-2. Budd Inlet Plant site map

4.1 Septage Receiving

The Septage Receiving Station (Station) at the Budd Inlet Plant provides a local facility to collect septage from permitted haulers and convey it to the Budd Inlet Plant Headworks. Septage is the residual waste solids removed from household septic tanks. The Station is located west of the Effluent Pump Building and is in a generally low-traffic area on a public roadway.

4.1.1 Process Overview

Permitted septage haulers discharge contents to an 8,000-gallon underground holding tank, which has a sloped bottom and can discharge to the Headworks via a pipeline and valve at the bottom of the tank. However, this valve is normally closed and the tank is not currently emptied this way. Instead, liquid contents of the tank overflow to a manhole, which discharges to the Headworks. Grit and sludge settle to the bottom of the holding tank, which is emptied as necessary with a vactor truck. Effluent from the holding tank is screened with other plant influent at the Headworks.

Haulers who use the Station must receive a permit from LOTT and are assigned a keycard to unlock and operate the Station. A magnetically activated odor control system directs foul air to the South Odor Scrubber when a vehicle arrives. Flush water automatically activates to dilute septage conveyed to the Headworks. The quantities of the hauled waste loads are based either on truck weights submitted at the end of the month, or the full capacity of the truck. Septage quantity received at the Station from 2009–12 is summarized in Table 4-1.

The Station was originally installed in 1978, and therefore most system components are more than 30 years old. Because these components are primarily piping, valving, and tanks, they can be inspected regularly to verify condition.

Table 4-1. Septage Quantity at the Septage Receiving Station

Year	Septage (MG)
2009	5.8
2010	3.8
2011	3.07
2012	1.77

Source: Annual Biosolids Reports, 2009–12.

The Station also has a direct RV septage disposal area to receive public septage. This area is open to the public during the day and discharges directly to the Budd Inlet Plant influent sewer line. The area is monitored by a security camera and an alarm sounds on the plant's operations system when an RV enters that area.

Figure 4-3 shows a process schematic for the Station. Figure 4-4 shows a view of the Station from Franklin Street, where haulers and public RVs access the station. Figure 4-5 shows the RV septage disposal area.

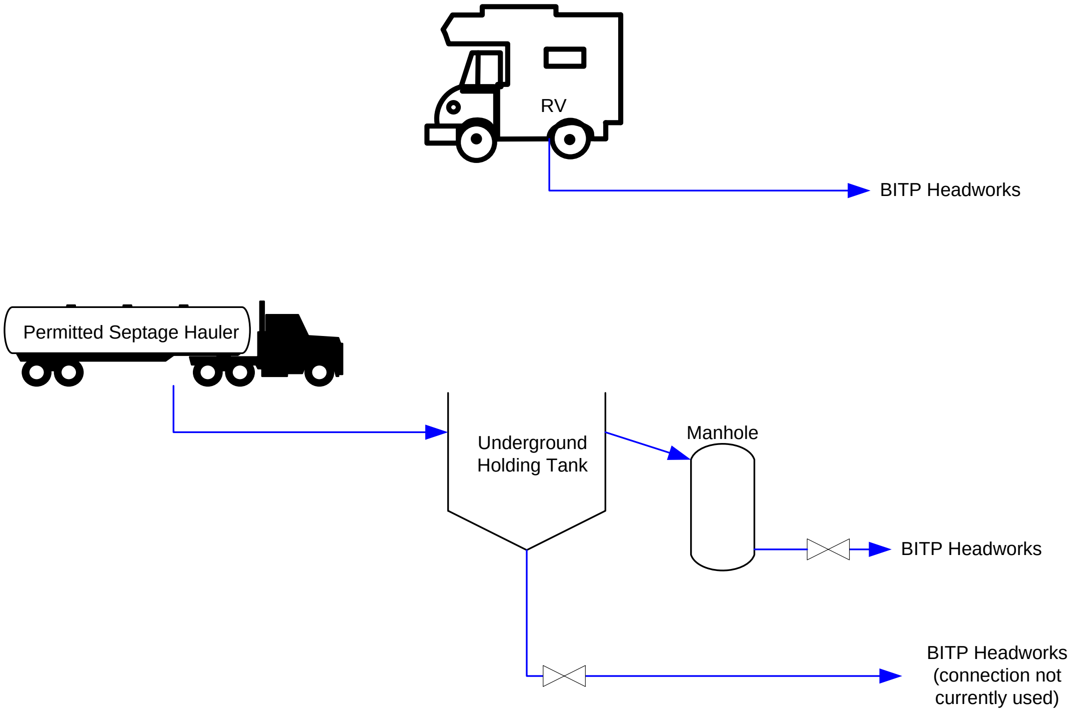

Figure 4-3. Septage Receiving Station schematic

Figure 4-4. Septage Receiving Station

Figure 4-5. RV septage disposal

4.1.2 Capacity and Redundancy Review

The Station has adequate capacity to serve permitted septage haulers, which make up nearly all of the septage waste. Although the Station does not have redundancy, if it must be shut down for maintenance or repair, permitted haulers can reschedule their discharge with minimal impact to the Budd Inlet Plant.

4.1.3 Advantages/Disadvantages Review

Table 4-2 summarizes the planning-level advantages and disadvantages of the Station.

Table 4-2. Summary of Advantages and Disadvantages for the Septage Receiving Station

Advantages	Disadvantages
• Easily accessible • Low complexity • Flexibility to accommodate varying flows and loads • Location does not interfere with Budd Inlet Plant operations • Discharge for the majority of disposal is controlled through permits and keycard activation	• No automatic tracking of users and quantities • Truck traffic • Holding tank is directly connected to the Headworks and there is no way to reject septage outside permitted discharge parameters • No testing for toxic impact to the Budd Inlet Plant prior to septage disposal • RV septage dumping requires additional plant oversight • Grease affects the downstream Headworks screens

4.1.4 Planned Improvements

No improvements are currently planned to the Station in the 2013 CIP.

4.1.5 Proposed Improvements/Opportunities for Optimization

The Station is a functional part of the Budd Inlet Plant process and is not in need of critical upgrades. However, there are improvements that could potentially bolster site security and minimize the risk of impacts to Budd Inlet Plant from septage. The following list summarizes these potential improvements:

1. Within next 5 years:
    - Inspect the underground storage tank and verify existing condition.
    - Continue to evaluate RV septage operations and their impact on plant staff.
2. When possible:
    - Develop a sampling protocol for the Station. The protocol should evaluate which parameters are most beneficial and feasible to prevent a toxic impact in the Budd Inlet Plant treatment process.

4.2 Pretreatment

The Budd Inlet Plant Headworks provides removal of grit and screenings that may otherwise become solids in downstream plant processes such as primary sedimentation and secondary clarification. For this reason, Ecology imposed a screenings requirement of at least a 3/8-inch bar screen.

4.2.1 Process Overview

The Headworks facility consists of preliminary treatment (screens and grit removal) and influent pumping. The raw sewage influent flow rate entering the plant is measured by a flow meter in the 60-inch-diameter plant influent pipe. A splitter box directs flow through four influent channels and motor-operated sluice gates at the head of each channel control the flow to four 1/4-inch perforated, self-cleaning escalator screens. These screens remove debris from all the raw wastewater and hauled waste (septage or sludge) entering the Budd Inlet Plant. The screens were installed in 2002, and are rated for at least 75 percent removal efficiency of all solids larger than 1/4 inch, removing manufactured inerts in accordance with Ecology regulations (see Section 3.2).

Screenings are conveyed to two screenings pits where chopper pumps convey ground-up screenings to a washer/compactor unit. Dewatered screenings are collected and hauled to a Thurston County landfill for disposal.

After being screened, wastewater enters two aerated grit removal tanks that remove large inorganic and organic particles. Grit collects in hoppers at the bottom of each tank and is removed by 10 grit pumps. Grit is conveyed to the grit screening/handling room, where the grit is processed through a cyclone separator and a grit washer/classifier to remove organic material. Washed grit is stored in hoppers and then hauled to the landfill for disposal. Liquid supernatant from the separator and classifier are recycled to the plant influent splitter box.

The pretreatment process at the Budd Inlet Plant is shown in Figure 4-6.

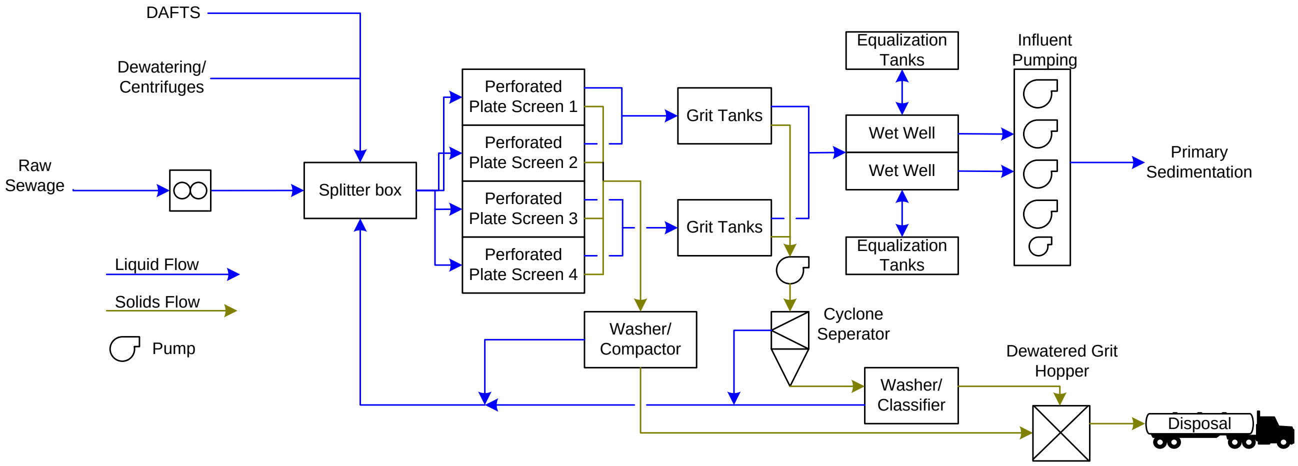

Figure 4-6. Pretreatment process

4.2.2 Capacity and Redundancy

The Influent Pump Station has an operational capacity of 72 mgd, and a firm capacity (one pump out of service) of 54 mgd. During the 2010 CIP planning process, a hydraulic analysis was conducted to determine the impact of the existing 2.5-million-gallon (MG) equalization basins on flow, through the Influent Pump Station. By 2050, the model projected a 20 percent annual risk of flooding (5-year return period) with the existing equalization basins. In order to reduce that risk to 10 percent (10-year return period), the size of the equalization basins must be increased to a total of 4 mgd. LOTT recently acquired an additional 1.4 acres of land near the Budd Inlet Plant for additional equalization basins because the current Budd Inlet Plant site does not have sufficient room for this expansion. With the equalization improvements, the other processes in the Headworks building, including screening and grit removal, are projected to have adequate capacity through buildout.

The design capacity of the pretreatment process is summarized in Table 4-3.

Table 4-3. Headworks Capacity

System	Design capacity
Influent screens	4 @ 25 mgd
Screenings pumps	2 @ 200 gpm
Screenings compactors	2 @ 45 cubic feet per hour
Grit tanks	2 @ 43.9 mgd
Grit pumps	10 @ 25 horsepower (hp) and 150 gpm
Grit separators	2 @ 200 gpm
Grit washer	2 @ 1.5 tons per hour
Grit chamber blowers	3 @ 20 hp
Influent pumps	4 @ 200 hp and 18 mgd
Influent pump	1 @ 50 hp and 5 mgd
Equalization basins	5 each, total volume 2.25 million gallons

4.2.3 Advantages/Disadvantages Review

Advantages and disadvantages of the existing Headworks screening and grit removal are summarized in Table 4-4.

Table 4-4. Summary of Advantages and Disadvantages for Pretreatment at the Budd Inlet Plant

Advantages	Disadvantages
• Meets Ecology requirements for removal of manufactured inerts • Has sufficient capacity through buildout	• Much of the equipment was installed in the 1980s

4.2.4 Planned Improvements

Proposed improvements to the Headworks process in the 2013 CIP are shown in Table 4-5.

Table 4-5. Planned Improvements (based on the 2013 CIP)

Project	Description	Start	Driver	Cost
Budd Inlet Treatment Plant equalization basins	This project will increase the capacity of the equalization basins from 2.5 to 4 mgd and would reduce the risk of flooding at the Budd Inlet Plant to 10 percent.	2028	Capacity	$7,911,000
Equalization basins gates, valves, operators, and diffusers replacement	A number of gates, valves, and their associated operators that control the flow between basins have been identified for replacement through the Asset Management Program. In addition, the grit channel diffusers, which were installed in the 1980s, have deteriorated and must be replaced.	2013	Asset management	$536,000
Grit blower replacement	The grit blowers are failing, inefficient, and past their useful lives. They were originally installed in 1980 with an expected life of 20 years. This project will replace the blowers with a more reliable and efficient model.	2013	Asset management	$34,000

4.2.5 Proposed Improvements/Opportunities for Optimization

No additional improvements or opportunities for optimization of the pretreatment process for solids removal were identified.

4.3 Solids Thickening

The thickening process removes excess water from the combined primary and WAS flows prior to anaerobic digestion. At the Budd Inlet Plant, this process uses DAFT equipment.

4.3.1 Process Overview

The Budd Inlet Plant sludge thickening system consists of four rectangular DAFT tanks. However the plant typically just operates one DRAFT at a given time. DAFT is a unique thickening process in which air is introduced to the liquid stream to increase the buoyancy of the solids, causing them to float and be removed at the liquid surface. Air is introduced by supersaturating a portion of the liquid stream (solids free) under pressure. The pressurized water is combined with the solids stream, at which point the solubility of the air in the liquid decreases and fine bubbles are formed.

Piping exists for separate thickening of WAS and primary sludge; however, the plant does not operate in this separate mode because primary sludge-only thickening results in excessive wear on the mechanical equipment. Historically, the DAFT units have produced a thickened sludge with 5 to 6 percent solids content with polymer addition. Dry polymer is mixed and then may be added in the sludge feed line or to the pressurized flow. Polymer dosage is typically approximately 3.5 pounds per ton. In the past, liquid polymer was also used. However, liquid polymer tanks are now used to store PAX 14, used for microthrix control in the secondary treatment process, and Sumaclear 1000, a flocculent for the reclaimed water plant. The tanks could be available for liquid DAF polymer in the future, if necessary.

Each thickener has a dedicated pressurization system to provide high-pressure air for flotation. To introduce dissolved air into the mixed sludge, a portion of the DAFT effluent is recycled to the pressurization tank, and the pressure is elevated to 40 pounds per square inch, gauge (psig) using the plant's high-pressure service air. Pressurized flow from the tank passes through a pressure release valve, where it combines with the sludge feed to the DAFT tanks. The decompressed air bubbles attach to the sludge particles and thickened sludge floats to the surface. Skimmers collect the thickened sludge and push it to hoppers for transfer to the anaerobic digesters.

Some sludge particles settle to the bottom of the DAFT unit, and are conveyed to bottom hoppers with bottom flight collectors and directed to the thickened sludge pumps, which combines the sludge in a common manifold and conveys the sludge to the digestion system.

Clarified effluent (supernatant) drains to the Headworks for processing with the liquid stream. A process overview of the solids thickening process is shown in Figure 4-7. Figure 4-8 shows a photo of the DAFTs.

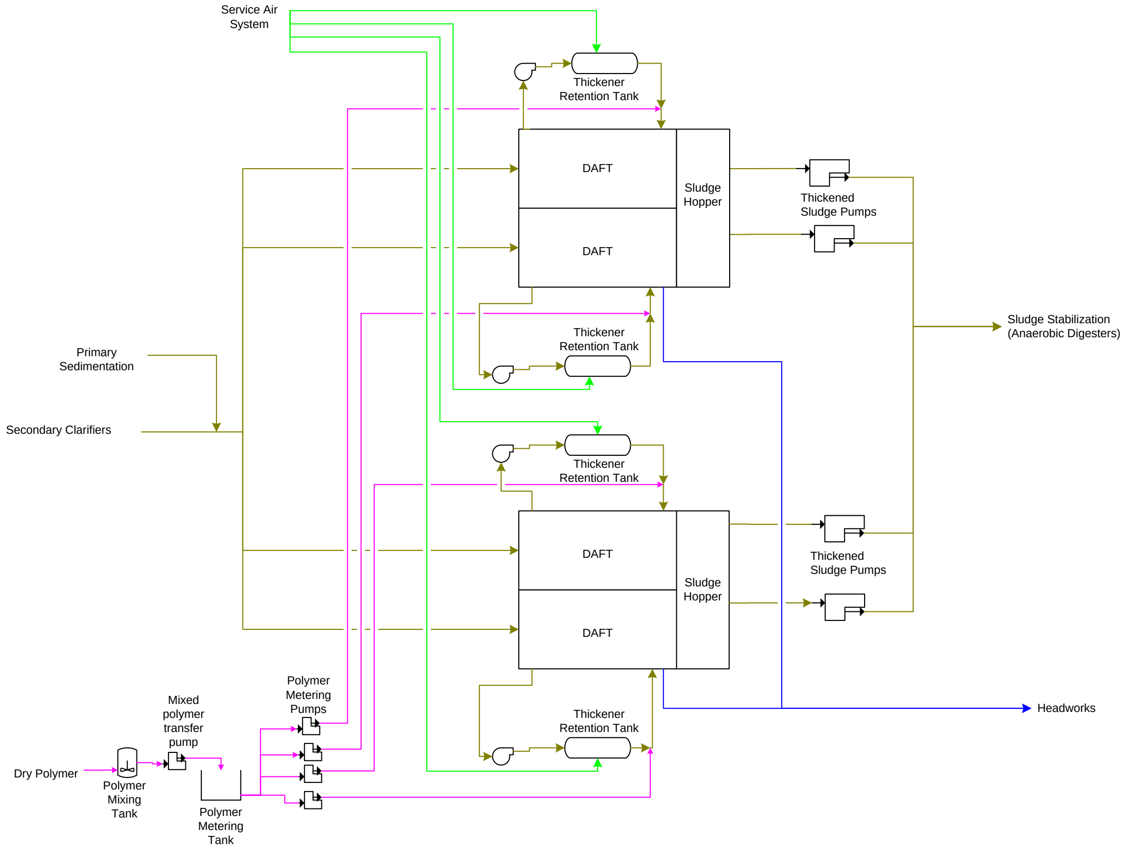

Figure 4-7. Solids thickening process

Figure 4-8. DAFTs

The DAFT system was upgraded in 2004 with some components dating back to the 1980 plant expansion. Table 4-6 summarizes the major thickening equipment and associated installation year.

Table 4-6. Solids Thickening Equipment and Installation Year

Equipment description	Year installed
DAFT polymer metering system	1999 (pumps replaced in 2012)
Thickened sludge pumps	2003
DAFTs 1–4	2011 (refurbished)
Thickener retention tanks	2004

4.3.2 Capacity and Redundancy Review

Although each DAFT unit was originally designed for a maximum loading of 30 $lb/ft^2/d$ solids, these units often receive loadings in excess of 60 $lb/ft^2/d$. Plant performance has demonstrated a capture efficiency of approximately 99 percent. Plant operating experience has demonstrated consistent performance levels up to these increased loading rates.

Flow though this pipeline was previously pressure-limited, to a maximum flow of 54 gallons per minute (gpm) or 77,760 gallons per day (gpd). A project to renovate this system, which was completed in 2011, involved replacement of some of the thickening system equipment, including the piping. Design capacity and estimated actual performance of the DAFTs and these pumps is summarized in Table 4-7.

Table 4-7. Solids Thickening Capacity

System	Design capacity	Actual performance
DAFTs	4 @ 30 lb/ft^2-day	4 @ 60 lb/ft^2/day [a]
Thickened sludge pumps	4 @ 100 gpm	4 @ 54 gpm[b]

a. *Note: actual performance should be verified through stress testing.*

b. *Actual flow restricted to 54 gpm due to piping*

Recent review of DAFT capacity during CIP planning shows that the DAFT capacity is adequate through buildout. Further, it is anticipated that DAFT stress testing will reveal that the DAFTs have additional capacity. Stress testing is recommended to confirm this.

4.3.3 Advantages/Disadvantages Review

Advantages and disadvantages of the existing solids thickening process are summarized in Table 4-8.

Table 4-8. Summary of Advantages and Disadvantages for DAFTs at the Budd Inlet Plant

Advantages	Disadvantages
• DAFTs can run continuously • Provides thickened sludge storage	• DAFT technology is a mechanically complicated system • No room in current location for a fifth DAFT • Ongoing odor issues

4.3.4 Planned Improvements

As previously stated, recent planning information shows that DAFT capacity is adequate. However, the DAFT polymer metering pumps are due for replacement in 2013 as shown in Table 4-9. It is also recommended that stress testing be completed to confirm the true capacity beyond the existing conservative estimates.

Table 4-9. Planned Improvements

Project	Description	Start	Driver	Cost
DAFT Polymer Metering Pump Replacement	Replace DAFT polymer metering pumps	2013	Asset management	$323,000

4.3.5 Proposed Improvements/Opportunities for Optimization

Proposed improvements to the solids thickening system include:

1. Within the next 2 years:
    - Complete stress testing to reevaluate DAFT capacity. Stress testing could be completed over 2–3 days and would measure TSS in subnatant (i.e., capture efficiency), and solids concentration of thickened solids, as well as polymer demand, as solid loading rates to the DAFTs are varied.

4.4 Digestion/Stabilization

The Budd Inlet Plant uses conventional mesophilic anaerobic digestion technology. The purpose of the anaerobic digesters is to biologically stabilize thickened sludge by converting easily degradable portions to carbon dioxide, methane, and water. This process consumes most of the volatile solids needed for bacterial growth, thereby discouraging microbial activity and vector attraction, and producing a digested sludge (Class B biosolids) suitable for land application.

4.4.1 Process Overview

Anaerobic sludge digestion facilities include four 70-foot-diameter, 30-foot-deep concrete tanks with floating covers. Two primary sludge digesters operate in parallel and feed into a secondary digester. A fourth digester is held in reserve.

The Anaerobic Digester Equipment Building located between the digesters contains all process mechanical equipment needed to operate the digestion process. Thickened sludge is fed to the bottom of the digesters through the circulating sludge system in the center of each tank. The digesters are also configured to receive primary sludge directly from the primary sedimentation tanks and thickened WAS from the DAFT units.

Sludge can be transferred between digesters by gravity through an overflow pipe. Although not currently used, supernatant can be withdrawn at three elevations from each digester. Digesters may be drained by gravity to the aerated grit chambers.

Digested sludge is withdrawn from the bottom of the digester and pumped to solids dewatering centrifuges. Circulating sludge is withdrawn from each digester and pumped to sludge heat exchangers before being returned to the digesters to assist in keeping them completely mixed. The heat exchangers are used to maintain the temperature in the digester at a minimum of 95°F, a permit requirement to meet Class B biosolids standards. The digesters are typically maintained at 96° or 97°F.

Each digester is equipped with floating gasholder-type covers, which are supported by digester gas pressure. Each digester contains two separate gas-piping systems. The gas utilization system withdraws gas for use as fuel for the high-temperature heat loop system. The second system uses digester gas to continuously mix the contents of the digester. A dedicated gas compressor re-circulates digester gas through each digester. The sludge stabilization process is shown schematically in Figure 4-9. Figure 4-10 below shows the digester area.

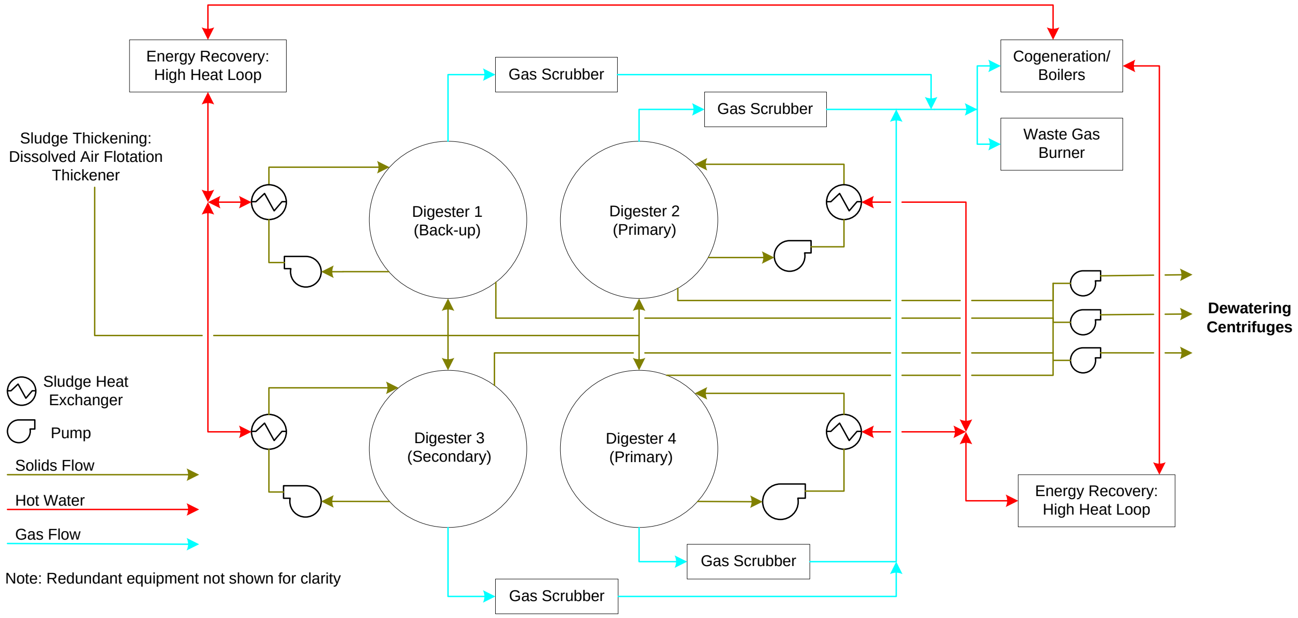

Figure 4-9. Digestion/stabilization process

Figure 4-10. Digester area

Digestion equipment was installed during the 1980 plant expansion, and most digestion equipment is more than 30 years old. Piping and digester gas components were replaced in 2003. Table 4-10 provides a summary of major digester equipment (including quantity) and the associated installation year.

Table 4-10. Digestion Equipment and Installation Year

Equipment description	Year installed
(5) Sludge heat exchanger	1980
(4) Dome covers for digesters	1980
(2) Hot water boiler (Final Effluent Building)	1980
(4) Digesters	1980
(5) Sludge gas re-circulating compressor	2002
(5) Gas compressor suction flame arrestor	2004

4.4.2 Capacity and Redundancy Review

Design capacity for digestion equipment is summarized in Table 4-11. Based on the design capacity, the existing digesters do not have enough capacity to handle projected loadings. A fifth digester will be required in 2029 and a sixth digester in 2046. The CIP will be adjusted in 2014 with this revised estimate. Digester capacity is also rated in terms of the hydraulic retention time, with a minimum 15-day storage required to meet Class B biosolids regulations. At the Budd Inlet Plant, the volatile solids loading limit of 0.15 lb/ft^3/d is more constraining than the hydraulic retention time limit.

Table 4-11. Digestion/Stabilization Capacity

System	Design capacity
Anaerobic digesters	4 @ 137,840 ft^3
Sludge transfer pumps	3 @ 10 hp and 250 gpm
Sludge recirculation pumps	5 @ 10 hp and 310 gpm
Gas circulating compressors	5 @ 20 hp, 25 psig, and 180 standard cubic feet per minute (scfm)
Sludge heat exchangers	5 @ 1,500 million British thermal units (MBtu)/hr

Note: actual performance needs to be verified through stress testing.

The true capacity of the digesters should be verified through stress testing. It is recommended that digester capacity limitations be reevaluated after stress testing and improvements to the primary sedimentation basins, secondary process tanks, and secondary clarifiers/mixed liquor filters have been completed.

4.4.3 Advantages/Disadvantages Review

Advantages and disadvantages for the existing digestion process are summarized in Table 4-12.

Table 4-12. Summary of Advantages and Disadvantages for Digestion

Advantages	Disadvantages
• Low process complexity • Generally low process odor • Positive track record of Class B biosolids production • Use of cogeneration facility for methane gas	• Current gas-mixing system makes digesters more susceptible to foaming events

The conventional anaerobic digestion process currently employed at the Budd Inlet Plant is used extensively throughout the United States. The Budd Inlet Plant maintains its process at mesophilic temperatures (typically 96°–97°F) and a solids retention time (SRT) of at least 15 days (39–59 days in 2011), which meets the Class B pathogen reduction requirements.

4.4.4 Planned Improvements

Additional digesters will be required in 2029 and 2046. Table 4-13 summarizes these planned improvements.

Table 4-13. Planned Improvements

Project	Description	Start	Driver	Cost
Digester 5	The first new digester will be constructed, which is assumed to be identical to the existing digesters. A digester control/equipment building will be included with the new unit.	2029	Capacity	$15,800,000
Digester 6	The second new digester will be constructed, which is assumed to be identical to the existing digesters.	2046	Capacity	$10,500,000

In addition to the planned improvements for digestion, the 2013 CIP identifies a placeholder project in 2021 for $10.2 million for a project to upgrade to Class A biosolids treatment.

4.4.5 Proposed Improvements/Opportunities for Optimization

Proposed improvements for the digestion process include:

1. Within the next 2 years:
   - Complete stress testing to evaluate digester capacity. This test would be conducted over several months. The digesters would be tested individually over a period of approximately 12 weeks. Loading to the test digester would be gradually increased until failure appears imminent. When failure is imminent, all raw solids feed to the test digester should cease. Examples of system parameters to be monitored during the stress test include:
     - influent and effluent flow
     - total solids
     - volatile solids
     - temperature
     - volatile acids
     - alkalinity
     - pH
     - methanogen activity
     - ammonia
     - 5-day biochemical oxygen demand (BOD_5)
     - digester gas production
     - digester gas carbon dioxide (CO_2) content
     - tank level
     - presence of foam

   Proper monitoring of the system before imminent failure and proper operation of the system after imminent failure is critical. Prior to testing, a detailed testing protocol should be established, including procedures for monitoring and recovery.

   - Following digester testing, timing and alternatives for increasing digester capacity should be evaluated. Besides constructing a new digester(s), alternatives could include increasing the tank volume and/or changing the overall process. The process changes would focus on higher loading rates and lowering the SRT.
2. If production of Class A biosolids becomes a goal:
   - Evaluate upgrades to the digesters which would be compatible with Class A biosolids production with other Class A technologies farther downstream in the process (e.g., sludge dryer).

4.5 Solids Dewatering

The purpose of solids dewatering is to remove excess moisture from anaerobically digested sludge and to reduce land application hauling costs. Centrifuges remove excess water from the sludge by mechanically enhancing the effects of gravity. Digested sludge is moved along the wall of the bowl by a screw auger conveyor, which rotates at a slightly slower rate than the bowl. The equipment has several adjustments for process control and optimization, including the following:

- increasing bowl speed to increase the settling velocity and final cake solids concentrations
- increasing scroll speed to reduce the SRT increasing cake solids concentration at the expense of lower solids capture
- increasing centrate residence time by increasing the bowl pond depth (or by reducing sludge feed rate) to improve solids capture with lower final cake solids concentration

4.5.1 Process Overview

The solids dewatering equipment at the Budd Inlet Plant consists of three centrifuge units (two low-capacity and one high-capacity), dewatered sludge conveyance equipment, and loading facilities for sludge hauling trucks. All solids dewatering equipment is contained in the Solids Handling Building.

Sludge transfer pumps in the Digester Equipment Building convey anaerobically digested biosolids (approximately 2–3 percent solids) to the centrifuges. Normally, only one centrifuge (the newer, higher-capacity unit) is in service, concentrating the sludge to levels of approximately 23 percent solids. The two older, lower-capacity units serve as backup.

Polymer may be introduced to the influent solids to each machine to improve dewatering performance. Historically, the plant has used 20–25 lb of dry polymer per ton dry biosolids. The polymer dose rate is computer-controlled, based on an operator-entered set point.

Dewatered biosolids are discharged from the centrifuges into a screw auger conveyor and transferred to the biosolids hauling trucks for land application through a small storage hopper. Closing the storage hopper gate allows the dewatering equipment to operate without shutting down for up to 8 minutes, which allows time for repositioning trucks under the hopper.

Centrate from the centrifuges is monitored automatically for suspended solids. Centrate drains to the Headworks or it can be directed to a centrate storage basin. Due to struvite clogging the centrate pipeline, a pipe bridge was constructed in 1999 to direct the centrate to one of the spare primary sedimentation basins, which now serves as the primary centrate storage basin. This basin is primarily used to control centrate return flows when the Budd Inlet Plant is concerned about the high concentration of ammonia in the centrate. Figures 4-11 and 4-12 show a process schematic and photo, respectively, of the dewatering system.

The two low-capacity centrifuges were installed in the 1980 plant expansion and the high-capacity unit was added in 2000. Table 4-14 provides a summary of major dewatering equipment (including quantities) and associated installation years.

4.5.2 Capacity and Redundancy Review

The two older centrifuge units each have a design solids loading rate of 1,500 pounds per hour (lb/hr), and the high-capacity unit has a design solids loading rate of 2,500 lb/hr (see Table 4-15). While the units have adequate capacity to accommodate projected flows and loadings, the equipment has had issues with reliability and high maintenance costs. The two older units achieve only 18 percent solids. A business case evaluation (BCE) to evaluate the need for dewatering equipment upgrades was completed in 2013. Dewatering technology alternatives evaluated in the BCE are briefly described in the advantages/disadvantages review section below. The detailed BCE is included as Appendix A.

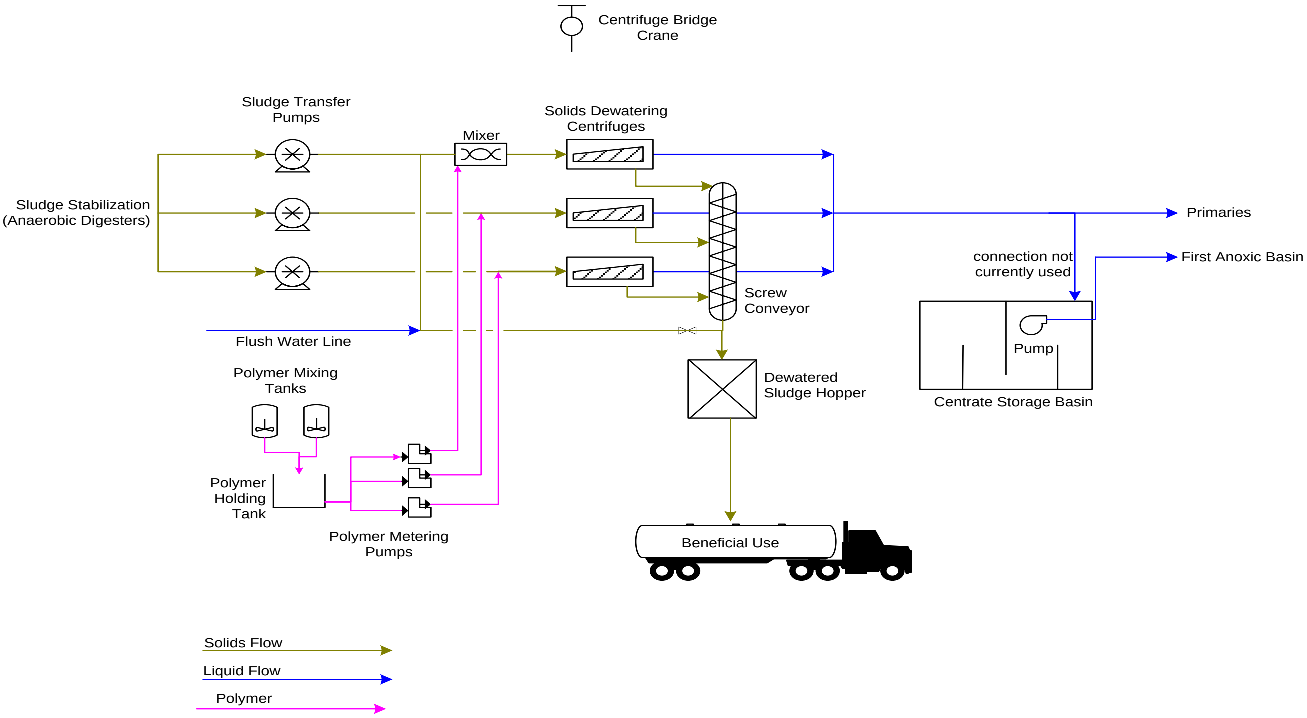

Figure 4-11. Solids dewatering process

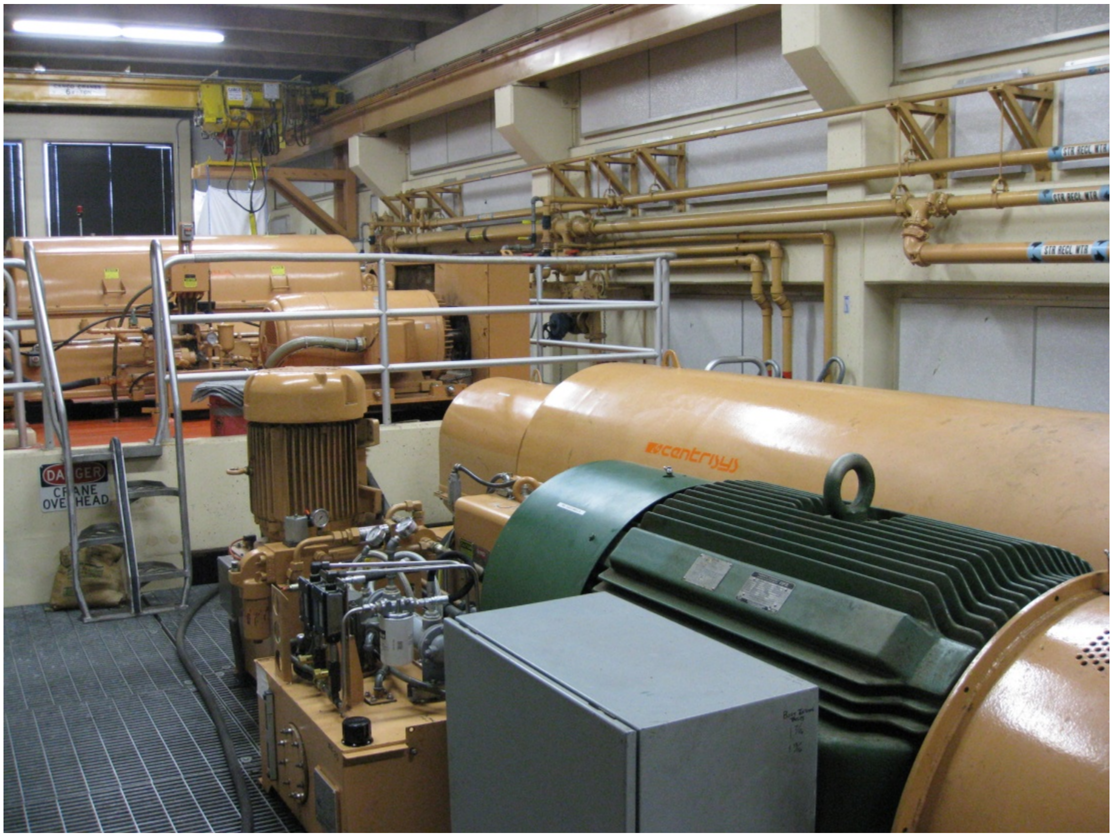

Figure 4-12. Dewatering centrifuges

Table 4-14. Dewatering Equipment

Equipment description	Year installed
Sludge loading hopper	1980
(2) Lower-capacity centrifuge	1980
Dewatered sludge cake conveyor	1980
Dewatered sludge chute	2000
(1) High-capacity centrifuge	2000

Table 4-15. Centrifuge Capacity

System	Design capacity
Sharples dewatering centrifuges 1 and 2 (older unit)	2 @ 1,500 lb/hr
Humboldt	2,500 lb/hr

4.5.3 Advantages/Disadvantages Review

Alternative dewatering technologies that were evaluated in the BCE included the following:

- **Rotary press.** In a rotary press, sludge is fed into a rectangular channel and slowly moves between two parallel revolving screens, which rotate very slowly on a single shaft. The filtrate passes through the screens as the flocculated sludge advances along the channel. The sludge continues to dewater as it passes around the channel, eventually forming cake at the outlet side of the press. A controlled outlet restriction maintains pressure inside the unit, resulting in the extrusion of dry cake. Each disk set is called a channel, and dewatering capacity can be increased by adding channels. Up to six multiple channels can operate on a common gear box and center shaft to minimize energy requirements. Polymer is added to flocculate the solids in a separate flow-through process just prior to the rotary press. The rotary press has enclosed dewatering channels that minimize odor control requirements.
- **Screw press.** A screw press consists of a tapered screw with a surrounding screen; sludge conveyed down the length of the screw is dewatered through compression of the sludge between the tapered screw and the reducing diameter of the surrounding screen. Polymer is added to flocculate the solids in a separate flow-through process just prior to the screw press. The flocculated solids overflow the flow-through process and drop into the feed box on the top of the unit. The flocculated solids move through the unit along the length of a tapered screw enclosed by an outer screen with a reducing diameter. The dewatering is accomplished as gravity drainage allows the filtrate to fall out of solution; as sludge moves along the screw, the internal pressure increases forcing water to drain out through the outer screen.
- **Centrifuges** (existing technology at the Budd Inlet Plant). In a centrifuge, centrifugal force causes suspended solids to migrate through the liquid, away from the axis of rotation due to the difference in densities between the solids and liquids. Increased settling velocity imparted by the centrifugal force, as well as the short settling distance of the particle, creates an efficient sludge dewatering system. Solid bowl-type centrifuges can generally produce cake solid concentrations comparable to or higher than a belt filter press for similar applications.

A table of advantages and disadvantages is not shown in this section due to the detail provided in the BCE (see Appendix A). The BCE recommended that LOTT replace the two older centrifuges with a new unit and maintain its existing higher-capacity centrifuge as a redundant backup unit.

4.5.4 Planned Improvements

The 2013 CIP incorporates the recommendation of the BCE and includes a dewatering system upgrade beginning in 2014 and online by 2015, as shown in Table 4-16.

Table 4-16. Planned Improvements

Project	Description	Start	Driver	Cost
Dewatering system upgrade	Replace the existing centrifuges with a new solids dewatering system	2014	System upgrade	$3,490,000

4.5.5 Proposed Improvements/Opportunities for Optimization

Proposed improvements for the dewatering process include:

1. Within next 5 years:
    - Implement the results of the dewatering BCE, including ancillary components.

4.6 Hauling and Beneficial Use

LOTT currently produces Class B biosolids, which are distributed to land application sites in Lewis and Douglas counties for beneficial use. Biosolids distributed from 2009–12 are summarized in Table 4-17.

Table 4-17. Biosolids Distributed for Land Application

Year	Fire Mountain Farms: Lewis County (dry tons)	Boulder Park: Douglas County (dry tons)	Total (dry tons)
2009	1,920	0	1,920
2010	1,378	515	1,893
2011	892	1,018	1,911
2012	970	810	1,780

4.6.1 Process Overview

Trucks are loaded with biosolids from the dewatered sludge hopper. Truck and trailer combination sets capable of hauling approximately 31 tons each are used to transport biosolids to contracted land application sites. An average of one truckload of biosolids is delivered for land application each day.

One 37-foot-long end-dump trailer is used on a standby basis during times of increased production. This trailer has a capacity of 31 tons and is equipped with a heavy-duty tarping system and a watertight tailgate to reduce odors and eliminate spillage. This process is shown schematically in Figure 4-13. Figure 4-14 shows a typical truck loading operation.

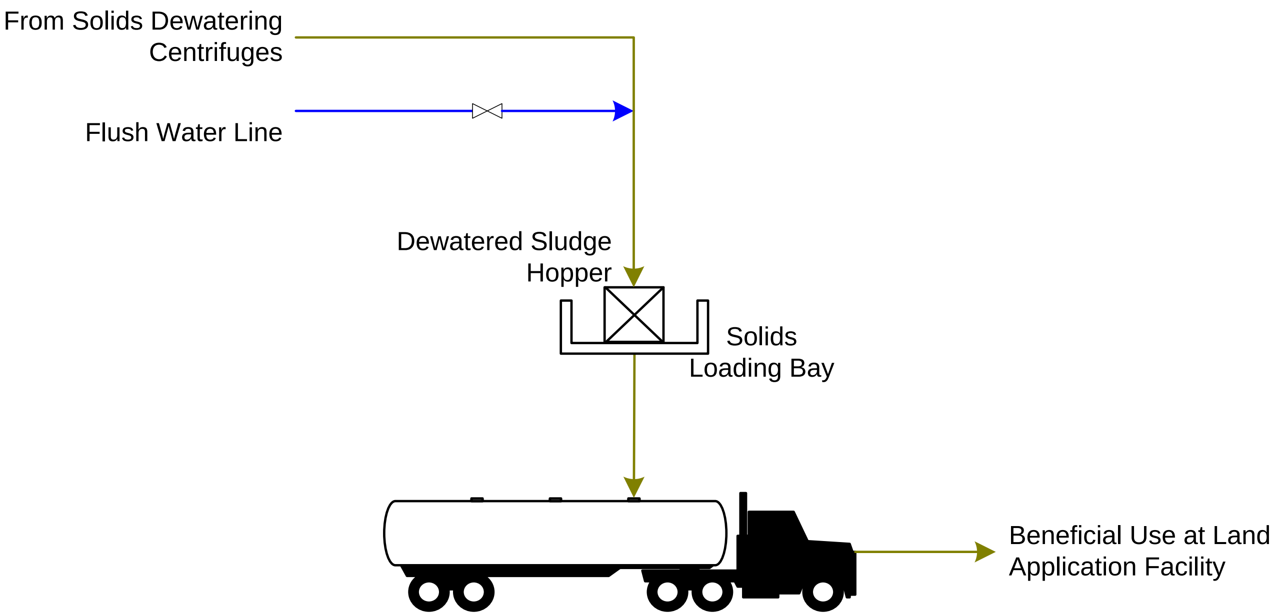

Figure 4-13. Hauling and beneficial use process

Figure 4-14. Truck loading

4.6.2 Capacity and Redundancy Review

Established goals for the biosolids program at LOTT include beneficial use of 100 percent of biosolids produced and availability of at least two biosolids management options at any one time. LOTT currently meets these goals by maintaining multiple contracts with land application sites.

Boulder Park, Inc., in Douglas County, is a permitted beneficial use facility that receives biosolids from LOTT during the winter months. Biosolids are distributed to farms for land application as fertilizer. Public support in Douglas County is very strong. Because the Boulder Park facility is located in eastern Washington, there have been periods during the winter when inclement weather has prevented transport of biosolids from the Budd Inlet Plant. LOTT mitigates this risk by maintaining contracts with additional sites on the western side of the state.

LOTT's biosolids option of choice in western Washington is Fire Mountain Farms, a permitted beneficial use facility in Lewis County. A 5-year contract with an optional 5-year extension was signed with the facility in December 2008. Fire Mountain Farms is responsible for managing LOTT's biosolids for land application to feed crops and forest lands during a 6-month period of April through September. Fire Mountain Farms can also be used as a backup disposal option in the winter, during periods when Douglas Park is inaccessible. LOTT has also established an additional backup contract with Boulder Park and Fire Mountain Farms.

4.6.3 Advantages/Disadvantages Review

Advantages and disadvantages of the existing hauling and land application program are summarized in Table 4-18.

Table 4-18. Summary of Advantages and Disadvantages for Hauling and Beneficial Use

Advantages	Disadvantages
• Class B biosolids production and land application is supported by the Department of Ecology • Meets LOTT's goal to have at least two biosolids management options at any one time • Meets LOTT's goal that 100% of biosolids should be beneficially used	• Existing loading area lacks a truck scale • No odor control • Truck traffic is a concern for LOTT and will increase over time

4.6.4 Planned Improvements

The 2013 CIP lists installation of the truck scales in 2013 as shown in Table 4-19 below.

Table 4-19. Planned Improvements

Project	Description	Start	Driver	Cost
Biosolids truck scales	LOTT currently loads the hauling contractor's biosolids trucks without the use of scales. It is difficult to estimate the weight of the biosolids load based on gallons of sludge dewatered because of the changing characteristics of centrifuge performance (percent solids, polymer dosage, and centrate solids).This results in trucks frequently leaving the facility with either under-weight or over-weight loads. This project will install a new truck scale.	2013	System upgrade	$92,000

4.6.5

4.6.6 Proposed Improvements/Opportunities for Optimization

Proposed improvements to the hauling and beneficial use process include:

1. Within next 5 years:
    - Construct a truck scale at the Budd Inlet Plant biosolids loading area as planned. The existing system does not have a truck scale, which results in over- or under-loading of trucks. Overloading trucks can result in Department of Transportation fines and unsafe driving conditions. Under-loading of trucks can lead to increased hauling costs.
    - Continue and adjust public outreach as required. Track Class B biosolids trends as described in Section 5 of this report.
2. When possible:
    - Additional emergency or backup disposal options should be evaluated on an ongoing basis, as needed. At least two biosolids disposal options should be maintained at all times.

4.7 Summary of Capacity

LOTT produces an annual report that evaluates the capacity of LOTT systems and identifies necessary expansion projects to accommodate projected flows and loads. The capacity of each of the solids processes, as determined in a recent capacity analysis for CIP planning, are summarized below.

- Septage receiving station was determined to have adequate capacity through the planning period.
- Equalization basins additional capacity will be required by 2030. Construction is currently planned to begin in 2028 (online by 2030).
- The solids thickening system will not require expansion before buildout in 2050.
- The digesters will reach 85 percent of capacity by 2028. With one additional unit, the Plant would have capacity through buildout in 2050, at which point the digesters would be at 89 percent capacity.
- The dewatering system upgrades, currently planned to begin in 2014 (online in 2015), will provide capacity through plant buildout in 2050.

The improvements necessary to ensure adequate capacity, reliability, and redundancy are summarized in Table 4-20.

Table 4-20. Proposed Improvements			
Solids treatment process area	Project	Description	Start year
Pretreatment	Equalization basins gates, valves, operators, and diffusers replacement	A number of gates, valves, and their associated operators that control the flow between basins have been identified for replacement through the Asset Management Program. In addition, the grit channel diffusers, which were installed in the 1980s, have deteriorated and must be replaced.	2013
Pretreatment	Grit blower replacement	The grit blowers are failing, inefficient, and past their useful lives. They were originally installed in 1980 with an expected life of 20 years. This project will replace the blowers with a more reliable and efficient model.	2013
Solids thickening	DAFT polymer metering pump replacement	Replace DAFT polymer metering pumps.	2013
Hauling/beneficial use	Truck scale	Construct a truck scale at the Budd Inlet Plant solids handling facility.	2013
Solids thickening	DAFT stress testing	Complete stress testing on the DAFTs to verify capacity. Then reevaluate timing and upgrade options.	2013–15
Digestion/ stabilization	Digester stress testing	Complete stress testing on the digesters to verify capacity. Then reevaluate timing and upgrade options.	2013–15
Septage receiving	Inspection	Inspect the underground septage receiving tank and verify existing condition.	2013–18
Septage receiving	Evaluate ongoing operations	Continue to evaluate ongoing operations at the Septage Receiving Station based on recent operating hours limitations to RV dumping.	2013–18
Dewatering system	Dewatering system upgrade	Replace the existing centrifuges with a new solids dewatering system.	2014
Long-term, ongoing, or non-critical projects			
Septage receiving	Sampling protocol	Develop a sampling program to minimize risk of toxicity impact to the Budd Inlet Plant treatment process.	When possible
Septage receiving	Schedule septage deliveries	Limit septage deliveries to a specific schedule. This approach will allow Budd Inlet Plant staff to be aware of likely septage deliveries and be present during deliveries.	When possible
Digestion/ stabilization	Construct additional digester capacity	The first new digester will be constructed, which is assumed to be identical to the existing digesters. This will include a new control building.	2029
Pretreatment	Budd Inlet Plant equalization basins	This project will increase the capacity of the equalization basins from 2.5 to 4 mgd and would reduce the risk of flooding at the Budd Inlet Plant.	2028
Digestion/ stabilization	Construct additional digester capacity	Potential project for the second new digester to be constructed, which is assumed to be identical to the existing digesters.	2046
Hauling/beneficial use	Alternative disposal options	Additional emergency or backup disposal options should be evaluated on an ongoing basis, as needed. At least two biosolids disposal options should be maintained at all times.	Ongoing

Section 5

Management Considerations

The existing biosolids program currently meets LOTT's core values and applicable level-of-service goals. However, LOTT should monitor and mitigate inherent risks in this program to adapt as necessary. This approach is aligned with the "Highly Managed Plan" approach concept employed by LOTT to manage wastewater treatment capacity. By identifying, monitoring, and mitigating program risks, LOTT can position itself for timely biosolids management decisions and avoid sunken investments.

Table 5-1 below details these possible risks, ways to monitor them, and their associated mitigation strategies. The possible risks are grouped into the main categories summarized below.

Biosolids Regulations (Local, State, or Federal) Change. If regulations provide incentives to produce Class A biosolids, or establish more stringent regulation on Class B biosolids, then a shift in LOTT's biosolids program may be beneficial. Or perhaps LOTT's ongoing monitoring of biosolids characteristics begins trending toward exceeding regulations. Also, new regulations, such as those on trucks or hauling, have the potential to indirectly affect the program.

Public Perception of the Beneficial Use of Biosolids Becomes More Negative or More Positive. Public perception of biosolids can directly affect a utility's options for biosolids disposal. This includes special interest groups and media. If public perception of land application, hauling, or odors becomes more negative, LOTT may shift its focus to a Class A program. If public perception of biosolids becomes more positive in Thurston County, LOTT may wish to evaluate providing a Class A product locally or directly to the public, or evaluate the potential for a Class B land application site in Thurston County.

Neighboring Utilities Begin to Approach Biosolids in a New Way. Neighboring utilities, such as King County, Pierce County, and Tacoma, have biosolids management programs that track and evaluate risks and goals similar to those impacting LOTT's program. If there is a general shift in the approach to biosolids management programs of these similar communities, LOTT may want to consider reevaluating its own program in this context. This risk also includes the possibility of regional partners developing biosolids plans that could potentially include LOTT.

New Public Policies Develop That Indirectly Affect Biosolids. Public policy can have effects on various aspects of LOTT's operations, even if they are not directly related. Such policies as the reduction of a carbon footprint, jobs creation, or direction to coordinate with regional partners could shape LOTT's biosolids management decisions. For example, a public policy to meet new green energy production goals at LOTT's cogeneration facility may lead to a detailed evaluation of the digestion process to increase methane gas production.

Future Projects at the Budd Inlet Plant Site Limit Upgrade Potential of the Existing Solids Processes. As the Budd Inlet Plant site expands and is upgraded, LOTT must consider the future limitations (if any) that would be placed on the biosolids processes. Process and space impacts should be key considerations.

LOTT's Class B Program Becomes More Costly than a Class A Program. If Class B program costs begin to rise more sharply than a viable Class A program, LOTT should evaluate an existing system change or process change altogether. Class B changes could include improvements to digestion or dewatering performance. Consideration should also be given to any grant funding or low interest loans that may be possible for conversion to a Class A program. By determining baseline costs for various Class A program upgrades as well as operation and maintenance (O&M) impacts, LOTT can be ready to further evaluate the Class B vs. Class A issue at the proper time.

LOTT's Biosolids Product Quality Begins to Decline. Biosolids product quality is closely tracked and measured against applicable regulations and historical analysis results. However, if biosolids product quality is declining, then either process changes to improve Class B production or process upgrades to implement Class A production should be evaluated.

LOTT's Staff Resources Used for the Biosolids Program Begin to Be Significantly Limited. If limited staff resources make operation of the existing program difficult, then LOTT may consider evaluating additional efficiency measures or outsourcing.

Class B Land Application Becomes Limited. LOTT currently maintains contracts with two beneficial use facilities that operate land application sites. While current demand is strong, these sites accept biosolids from multiple treatment plants. If future supply from these plants exceeds this demand, Class B land application could become limited. Additionally, these sites are susceptible to changing regulations, crop requirements, and public perception. A shift in these factors could impact the sites' ability to accept Class B product.

Table 5-1. LOTT Biosolids Management Considerations

Possible risk	How would I notice?	Possible risk mitigation strategies
Biosolids regulations (local, state, or federal) change	• Are more or less stringent regulations on Class B land application being considered by regulators? • Have new government incentives been developed that promote the use of Class A biosolids? • Is grant funding available for conversion to a Class A program? • Does LOTT's ongoing biosolids quality testing show a trend toward exceeding a current or upcoming regulation? • Has a new truck or hauling restriction been enacted that is going to affect biosolids hauling?	• Monitor trends in proposed regulations. Be proactive in advocating for the science-based approaches in proposed regulatory changes. • Track research trends including contaminants of emerging concern (CECs) and pathogen regrowth and determine if there may be a future regulatory impact. • Review available grant funding on a recurring basis. • Review trends in biosolids quality and compare them to regulatory limits.
Public perception of the beneficial use of biosolids becomes more negative or more positive	• Do LOTT's public survey responses show a deviation from a baseline? • Has activity or scrutiny from special interest groups increased? • Has media coverage on the issue of biosolids increased? • Are odor and/or noise complaints increasing and, if so, can they be attributed to LOTT's biosolids program? • Have complaints about truck traffic or biosolids hauling increased?	• Understand the baseline public perception of biosolids and then integrate more biosolids questions into future surveys. • Track media coverage of biosolids both in general terms and related to LOTT's program. • Track odor, noise, and truck traffic complaints that can be attributed to LOTT's biosolids program. • Inspect every biosolids load for quality. • Use staff as advocates of the product and as a foundation for broader positive public perception. • Continue to build public acceptance of the beneficial use of biosolids (e.g., WWTP tours, Web site, demonstration gardens, and outreach/sponsorships to farmers). • If considering a Class A biosolids program, verify public acceptance of the end product and market in the planning phase(s). • Produce an annual biosolids report that targets the public (similar to those used for water quality). • Track public perception of neighboring agencies' biosolids management programs, as an indicator of public perception trends toward LOTT's program.
Neighboring utilities begin to approach biosolids in a new way	• Have other local/comparable jurisdictions (e.g., King County and Portland) upgraded their Class B programs or converted to Class A? • Have neighboring utilities or other regional partners approached LOTT to coordinate on biosolids project(s)?	• Perform a scheduled review of neighboring utilities' biosolids programs. • Leverage the Northwest Biosolids Management Association as a resource for regional information. • Evaluate opportunities with regional partners on a case-by-case basis as they arise.
New public policies develop that indirectly affect biosolids	• Has new public policy emerged related to any of the following? – Carbon footprint – Green power – Changes in level of service (e.g., reliability, program diversity) – Jobs creation – Other jurisdiction coordination (such as composting or waste-to-energy)	• Track ongoing policy from the Board of Directors. • Perform a carbon footprint analysis with a focus on biosolids to use as a baseline.
Future projects at the Budd Inlet Plant site limit the upgrade potential of the existing solids processes	• Does a proposed LOTT project affect any of the biosolids processes? • Would any proposed biosolids projects require an expanded footprint or additional space?	• Consider future upgrades and limitations, including space limitations, in all future business case evaluations involving the biosolids processes. • Evaluate biosolids process changes that may be required from a related Budd Inlet Plant upgrade. Develop a plan(s) to upgrade biosolids processes in order to allocate space on the Budd Inlet Plant site so that planning for other process facility upgrades at Budd Inlet Plant can take these into account.
LOTT's Class B program becomes more costly than a Class A program	• Has there been a significant increase in related biosolids costs, including any of the following? – Disposal – Hauling – Energy – Labor – Testing (possibly due to increased regulations)	• Prepare planning-level costs for various Class A programs and use standard indices to adjust them each year. Compare these costs to the annual cost of the current biosolids Class B program. If these costs are similar, perform a business case evaluation. • Consider the impact of grant funding on the above analysis.
LOTT's biosolids product quality begins to decline	• Has there been a decline in Class B product quality that would be considered a trend (e.g., "Exceptional Quality" is in jeopardy or no longer possible)? • Have there been impacts to downstream processes that can be attributed to biosolids (e.g., increased ammonia in the centrate)?	• Evaluate biosolids treatment processes. Determine if corrections can be made to the biosolids processes to get the product back to previous quality levels; if not, evaluate alternatives through a business case evaluation. • Monitor the centrate and impacts to downstream processes; consider upgrades such as sidestream treatment if constituents such as ammonia become a problem.
LOTT's staff resources used for the biosolids program begin to be significantly limited	• Has there been a significant decrease in LOTT staff over time that has affected the biosolids program? • Have the demands of the biosolids program increased, requiring more staff resources?	• Evaluate if outsourcing is needed and if greater staff efficiencies are still possible. Determine if improved automation or other training are options for leveraging staff resources.
Class B land application becomes limited	• Is the Class A market growing and Class B market shrinking? • Have options for contract haulers become limited? • Is the number of Class B land application sites shrinking? • Is there increased urbanization of existing Class B application sites, particularly those used by LOTT's contract haulers?	• Have at least two hauling contracts in place that provide for biosolids disposal at different locations. Each should have capacity for nearly 100% of LOTT's biosolids production. • Have an emergency disposal option available (e.g., a landfill or temporary storage)

Section 6

Short-Term Planning

This section describes short-term improvements for a 5-year planning horizon to address system needs identified in an existing biosolids process review. In addition to capital improvements, this section also presents O&M improvements and non-facility projects that LOTT will undertake to improve the performance of the solids processes at Budd Inlet Plant.

6.1 Project Prioritization

The need for the capital projects is described in Section 4. The primary consideration in prioritizing projects is to ensure that level-of-service goals are maintained and sufficient capacity is available in the system to accommodate projected growth rates. CIP projects will continue to be prioritized as part of the annual CIP update and LOTT's ongoing asset management program.

6.2 Project Descriptions

The following subsections describe the short-term solids process improvements for each general biosolids process. These improvements have been either described in the 2013 CIP or identified in this Biosolids Management Plan. Scheduling and planning-level cost estimates for these projects are shown in Table 6-1.

6.2.1 Septage Receiving Station

Projects at the Septage Receiving Station are recommended to increase security and/or ease of operation at the Station. Project recommendations include:

- Formally inspect the underground storage tank and verify the existing condition. If damaged, begin planning for replacement or repair.
- Continue to evaluate operations at the Station based on recent changes to security and RV dumping.

6.2.2 Pretreatment

No short-term pretreatment improvements are planned.

6.2.3 Solids Thickening

Projects related to solids thickening include:

- As stated in Section 4.2, the DAFTs at the Budd Inlet Plant frequently operate in excess of the original design capacity. In order to accurately determine the capacity of the DAFTs, stress testing should be performed. This will allow LOTT to schedule CIP projects in accordance with the "just in time" philosophy developed in the Wastewater Resource Management Plan. Stress testing of the DAFTs could be completed over 2–3 days and would measure TSS in the subnatant (i.e., capture efficiency), solids concentration of thickened solids, and polymer demand with varying solids loading rates to the DAFTs. After stress testing is complete, the timing and upgrade options for DAFTs should be evaluated in conjunction with the annual CIP process.

6.2.4 Digestion/Stabilization

Stress testing is recommended to evaluate digester capacity. This test would be conducted over 12 weeks and is described in more detail in Section 4. Prior to testing, a detailed testing protocol should be established, including procedures for monitoring and recovery.

Following testing, timing and alternatives for increasing digester capacity should be evaluated. Besides constructing a new digester(s), alternatives could include increasing the tank volume and/or changing the overall process. The process changes would focus on using a more aggressive digester technology that would allow for higher loading rates and lower solids retention time (SRT).

6.2.5 Dewatering

As part of the biosolids planning process, a BCE was completed to determine the most beneficial alternative for replacing the existing centrifuges. A technical memorandum describing the BCE is included in Appendix A. The results of this BCE show that replacing the two older, lower-capacity centrifuges with one high-capacity centrifuge is the most cost-effective alternative over the planning period. The existing high-capacity centrifuge would serve as a backup. This approach allows LOTT to meet projected loadings through plant buildout. The dewatering system upgrade project is currently planned to be online by 2015.

6.2.6 Hauling and Beneficial Use

The existing biosolids loading area does not have a truck scale, which requires estimation of truck weight based on solids processed. Overloaded trucks can result in unsafe driving conditions or fines and underloaded trucks result in unnecessary hauling costs (cost per truckload vs. cost based on weight). A truck scale at the Budd Inlet Plant biosolids loading area is planned for construction in 2013.

Short-term improvements are summarized in Table 6-1.

Table 6-1. Proposed Short-Term Improvements

Solids treatment process area	Project	Description	Start year	Estimated project cost
Solids thickening	DAFT polymer metering pump replacement	Replace DAFT polymer metering pumps	2013	\$323,000[a]
Solids thickening	DAFT stress testing	Complete stress testing on the DAFTs to verify capacity	2014	\$18,000
Digestion/ stabilization	Digester stress testing	Complete stress testing on the digesters to verify capacity	2014	\$75,000
Septage receiving[b]	Inspection	Inspect the underground septage receiving tank and verify existing condition	2013–2017	\$3,500
Digestion/ stabilization	Digester capacity assessment	Evaluate timing and upgrade options for digesters	2014–2015	\$25,000
Dewatering system	Dewatering system upgrade	Replace the existing centrifuges with a new solids dewatering system	2014	\$3,494,000[a]
Hauling/beneficial use	Truck scale	Construct a truck scale at Budd Inlet Plant solids handling facility	2013	\$92,100

a. *Based on the 2013 CIP.*

b. *Assumed LOTT completes these projects internally.*

Section 7

Long-Term Planning

LOTT is successfully maintaining a Class B cake land application beneficial reuse program that achieves its goals and values. Although this program should be viable for at least 10 to 20 more years, risk management and monitoring are essential. As these inherent risks such as cost pressures or regulations shift, LOTT may expand to other Class B markets or invest in a Class A program. This section identifies long-term biosolids program upgrades and potential markets available to LOTT.

7.1 Proposed Long-Term, Ongoing, or Non-Critical Projects

LOTT has developed a CIP that includes a placeholder for a Class A biosolids program upgrade. However, general LOTT planning has established expansion of the existing biosolids processes to maintain Class B treatment and meet future projected loadings. BC also identified minor improvements to the existing solids program in Section 4 that could be performed over time. These projects are shown in Table 7-1.

Table 7-1. Proposed Improvements

Solids process	Project	Description	Start year	Estimated project cost
Septage receiving	Sampling protocol	Develop a sampling program to minimize risk of toxicity impact to the Budd Inlet Plant treatment process.	When possible	$7,200
Septage receiving	Schedule septage deliveries	Limit septage deliveries to a specific schedule. This approach will allow Budd Inlet Plant staff to be aware of likely septage deliveries and be present during deliveries.	When possible	Not applicable
Pretreatment	Budd Inlet Plant equalization basins	This project will increase the capacity of the equalization basins from 2.5 to 4 mgd and would reduce the risk of flooding at the Budd Inlet Plant to 10%.	2028	$4.0M
Digestion/ stabilization	Construct additional digester capacity	A new digester will be constructed along with associated equipment and controls.	2029	$5.0M
Digestion/ stabilization	Construct additional digester capacity	A new digester will be constructed along with associated equipment and controls.	2046	$5.0M
Hauling/beneficial use	Alternative disposal options	Additional emergency or backup disposal options should be evaluated on an ongoing basis, as needed. At least two biosolids disposal options should be maintained at all times.	Ongoing	Not applicable

7.2 Determining Timing for Program Changes

The management considerations identified in Section 5 can be used by LOTT to measure the success of the biosolids program and to guide its future direction. As the following inherent risks in LOTT's biosolids program begin to change, LOTT should reevaluate the program to maintain level-of-service goals:

- biosolids regulations (local, state, or federal) change
- public perception of the beneficial use of biosolids becomes more negative or more positive
- neighboring utilities begin to approach biosolids in a new way

- new public policies develop that indirectly affect biosolids
- future projects at the Budd Inlet Plant site limit the upgrade potential of the existing solids processes
- LOTT's Class B cake program becomes more costly than a Class A program
- LOTT's biosolids product quality begins to decline
- LOTT's staff resources used for the biosolids program begin to be significantly limited
- Class B cake land application becomes limited

7.3 Class B Biosolids Market Diversification

Agricultural land application in the manner LOTT uses for Class B cake beneficial reuse is the most common Class B market in the Pacific Northwest. Market demand at LOTT's land application sites in Lewis and particularly Douglas counties is strong and expected to grow in the coming years as LOTT's solids production increases. One of LOTT's two contracts is with Boulder Park, Inc., which is one of the largest agricultural land application sites in Washington. Approximately 120 farmers participate in Boulder Park's program in Douglas County, providing more than 50,000 acres of available land area. Boulder Park's contracts include over 30 wastewater treatment agencies in Washington, further strengthening the program's reliability.

The primary disadvantage of land application in Washington is that most agricultural application sites are located east of the Cascade Mountains, and inclement weather can often make access unreliable in the winter months. This market is also dependent on public perception and demand for the product. If LOTT seeks to diversify to other potential Class B markets, then silviculture, biofuel production, land reclamation, and biomass production are potential options. These markets are explained in further detail below.

7.3.1 Silviculture

Similar to agriculture, forested lands can be fertilized with biosolids to increase tree growth and yields. Capital costs can be higher than in agricultural land application because capital funds are required to support construction of equipment trails through the forest and specialized equipment must be purchased and maintained. Depending on whether the site has a low or high potential for public exposure, forested sites that land-apply Class B biosolids must restrict public access for between 30 days and 1 year.

7.3.2 Biofuel Production

Published research from Oregon State University has shown that biosolids fertilization of certain oilseed crops can increase yields and reduce irrigation requirements compared to conventional fertilizers. For example, at the Natural Selection Farms project in the Yakima Valley, local farmers use biosolids to improve soils and fertilize a variety of crops, including hops, fruit, corn, grapes, wheat, and rangeland. National Selection Farms worked with the University of Washington to develop the "Biosolids to Biodiesel" program. The program entailed using biosolids to fertilize canola, crushing the seeds at an onsite farm facility to make crude oil, and selling the oil to biodiesel producers.

7.3.3 Land Reclamation

Class B biosolids could be used for land reclamation at both mines and landfills. Both of these markets require a soil amendment that provides the benefit of establishing vegetation. High organic content and nutrient concentrations aid in reestablishing plant life. Biosolids are applied at rates much higher than agronomic levels because the biosolids are used to establish a soil-like system instead of merely supplementing an already productive agricultural soil system. For mining activities that have produced large areas of disturbed land, revegetation of cleared areas is necessary to improve aesthetics and reduce spreading of mine tailings and soil erosion. Reestablishment of vegetation on disturbed sites can be difficult without amending the soil. A major advantage of remediating mine sites with biosolids is the potential for greenhouse gas (GHG) credits. A carbon sequestration credit can be achieved by reestablishing a productive land site. Metro Vancouver in British Columbia has employed mine reclamation for large portions of its biosolids.

Biosolids can also be mixed with soil and used as a final landfill cover. For example, Cowlitz County, Washington, has applied its biosolids to the cover of a nearby closed landfill to promote the growth of vegetation on the landfill site. Tacoma, Washington also had a successful project to apply biosolids to grow grass on a landfill cover when hydroseeding had failed. However, each market is limited to a localized need and requires a limited number of solids applications to restore the site. Once a site has been rehabilitated, another site must be identified for continued biosolids reuse. For this reason, land reclamation should not be considered as a replacement market for an entire biosolids program.

7.3.4 Biomass Production (Willow Coppice)

Coppice refers to the commercial production of trees through short-rotating growth and harvest periods. Once established, trees are harvested every 1 to 4 years for biomass. The wood biomass is chipped and combusted for energy production. The amount of carbon released during cultivation and transport of trees is roughly equal to the carbon input into the soil. This is because the new trees in the rotation are propagated from the stumps of harvested trees. The underground biomass or roots remain, and decompose adding carbon to the soil. Therefore, coppice production is carbon-neutral and burning of wood chips can offset fossil fuels to reduce emission of GHGs to achieve a negative carbon footprint. Application of biosolids provides similar nutrient benefits to pasture and crop additions. Substituting fertilizer with biosolids can increase biomass production and decrease operational costs.

7.4 Class A Program Implementation and Potential Markets

If a shift to a Class A biosolids program becomes necessary, biosolids market options expand because regulations are less restrictive and there is generally greater public acceptance of the end product. Challenges associated with implementing a Class A program generally include the higher capital costs associated with additional infrastructure and potentially higher energy costs for operating a Class A facility.

7.4.1 Class A Program Implementation

The 2012 CIP identifies a potential project to implement Class A biosolids in the future, but does not identify specific upgrade alternatives or processes. Although other alternatives exist, LOTT should consider the following three options to convert to a Class A biosolids program:

1. **Upgrade the digestion process.** One alternative would be integration of temperature-phased anaerobic digestion (TPAD) with batch tanks. TPAD is an anaerobic digestion process designed to occur in two stages. The first stage of the process occurs at thermophilic temperatures (typically 131°F). A majority of the volatile solids reduction and pathogen destruction occur in this stage. The second stage of the TPAD process is completed at mesophilic temperatures (typically 95°F). Class A TPAD would be met by definition if batch thermophilic tanks were placed between the thermophilic and mesophilic phases. Other proprietary approaches with digestion also could be explored, although site-specific equivalency may be needed.
2. **Install a dryer system.** A second alternative is to install a biosolids dryer system offsite. The sludge dryer would fall under Alternative 5 in the 40 CFR 503 regulations. The Class A requirements are met by reducing the solids moisture content to less than 10 percent with temperatures of the solids exiting the dryer or the gas in contact with the solids reaching 80°C. Drying does not provide any additional volatile solids destruction but will remove significant amounts of water, thus lowering the mass for disposal considerably. The dryer option can be integrated with the current digestion and

dewatering scheme at the Budd Inlet Plant. However, a 2011 study by LOTT concluded that a dryer system would need to be installed offsite due to space constraints. The purchase of additional property, construction of a building to house a dryer, and associated equipment and a fuel source would constitute most of the initial capital investment.

3. **Install or partner in a composting facility.** Composting typically requires mixing biosolids with a carbonaceous bulking agent such as sawdust, wood chips, or ground woody yard debris. It can be a treatment process using time and temperature to produce a final product that meets Class A pathogen reduction criteria and is highly marketable. The three major composting processes are aerated static pile, windrow, and enclosed vessel. The aerated static pile process maintains aerobic conditions by blowing air through the piled media instead of physical manipulation of the material. Windrow involves piling materials into long rows and then manually turning the piles for aeration. The third process, in-vessel composting, occurs in an enclosed reactor and often involves mechanical turning for aeration as well. An enclosed system allows more process control including collection and treatment of any foul air.

   Composting can also be done with the addition of a thermally dried biosolids product that already meets Class A requirements. Composting biosolids product that has already been treated in a Class A process such as thermophilic digestion or thermal drying simplifies permitting requirements for an independently managed offsite facility. For this reason, LOTT partnering with a compost facility would be the preferred option.

Lime pasteurization is a fourth alternative to those described above, but it is counter to LOTT's previous investments. Lime pasteurization does not require digestion and LOTT has invested considerable capital in digestion and the use of digester gas. If and when LOTT decides to implement a Class A program, further investigation to identify specific expansion alternatives would be required. The CIP would then be revised to include the selected alternatives.

7.4.2 Class A Biosolids Products

Upgrading the LOTT digestion process as described above would create Class A cake solids product from the existing dewatering process. If a dryer system was installed, the resulting biosolids product would be a thermally dried pellet. A compost facility would create only compost. The following subsections describe the Class A biosolids products and potential markets where they could be used.

Fertilizer. Conventional fertilizers are used to increase plant yield. Biosolids fill this same objective but also provide additional benefits to the soil while requiring less energy for production. A thermally dried Class A EQ biosolids product has the ability to be marketed as a fertilizer to the general public or for use in commercial applications. Pierce County SoundGRO is an example of a dried product that is marketed as a slow-release fertilizer that is ideal for lawns and gardens. It is distributed through private operators, by bulk order, or through landscaping services.

Topsoil Blend. Biosolids blended with sawdust, woodchips, yard clippings, or crop residues make excellent mulches and topsoils for horticultural and landscaping purposes. Common soil product mixes combine dewatered Class A cake with an amendment of sawdust and sand at an appropriate ratio. Alternatively, thermally dried biosolids can be mixed with smaller amounts of amendment. Sand is used to increase porosity, provide structure, and improve drainage. The sawdust is a bulking agent that provides airspace, makes the mixture more permeable, and serves as a moisture absorbent. The City of Tacoma currently produces a topsoil blend product as part of its TAGRO program.

Compost. Finished compost is highly marketable because of its user-friendly, soil-like appearance. It can be distributed in bulk for commercial use or provided in smaller quantities directly to the public. As previously discussed, composting can be performed as a treatment process to produce a Class A product or with Class A biosolids used as an addition to composting other materials. King County has been providing a local compost producer, GroCo Inc., with Class A biosolids to be developed into a compost product since 1976.

Energy. Thermally dried biosolids can be used as a fuel source alternative directly at a waste-to-energy (WTE) facility or as a fuel substitute to coal. These alternatives are further described below:

- **Waste-to-energy:** WTE is a general description of the process of converting a product such as municipal solid waste or biosolids into a usable form of energy. In general, biosolids are fed into the bottom of a combustion chamber, and drying and combustion of the fuel takes place within the fluidized bed of the chamber, while combustion gases are retained in the freeboard above the bed. The heat from combustion is recovered by devices located either in the bed or at the point of exit. Typically, no auxiliary fuel is required and energy production is usually at least double that of the power required to operate the system.
- **Fuel substitute:** Dried biosolids can be utilized as a substitute to coal, but are mostly applied as a fuel substitute in cement kilns. Dried solids can be co-fired with coal to heat the process. Also, biosolids ash is similar to cement feedstock in composition and with a few minor adjustments can be used as part of the raw material feed for cement production. The ability to utilize this market is driven by demands and the availability of a cement manufacturer willing to accept biosolids.

7.4.3 Class A Biosolids Markets

Four main biosolids markets align with the Class A biosolids upgrade options identified above. These markets, the primary LOTT upgrade required, and the resulting biosolids product are listed below in Table 7-2.

Table 7-2. Potential Class A Biosolids Markets

Biosolids market	Primary upgrade options required	Biosolids product options
Recreational areas, golf courses, public use	• Upgrade digestion • Install a solids dryer • Install a compost facility	• Compost or fertilizer
Horticulture and landscaping	• Upgrade digestion • Install a solids dryer • Install a compost facility	• Topsoil blend, compost, or fertilizer
Energy production (waste-to-energy)	• Install a solids dryer (and a waste to energy partner)	• Dried pellet/energy
Fuel substitute (cement kiln or coal plant)	• Install a solids dryer (and partner with a cement kiln or coal plant)	• Dried pellet/energy

7.5 Backup Disposal

Revised Code of Washington (RCW) Chapter 70.95.255 prohibits the disposal of sewage sludge or septage in landfills for final disposal except on a temporary, emergency basis, if the jurisdictional health department determines that a potentially unhealthful circumstance exists. It is also LOTT's policy that 100 percent of all biosolids be beneficially reused. Therefore, it is not recommended that LOTT pursue disposal as a potential market alternative in the future. LOTT maintains a contract with the City of Everett Water Pollution Control Facility, which can store LOTT biosolids produced in the event that a beneficial use facility is not able to accept them.

7.6 Market Criteria

BC and LOTT developed a set of criteria to review potential biosolids markets. Table 7-3 describes each criterion and why it is important to a successful biosolids program for the utility.

Table 7-3. Biosolids Market Criteria

Criterion	What does this mean to LOTT?	Why?
1. Market reliability	Does the market have long-term viability and the ability to distribute/dispose of the entire produced product?	LOTT has to distribute and/or dispose of the entire product produced over time. Beneficial use is preferable.
2. Public perception	Will the public perceive that LOTT should be involved in the market?	LOTT should be careful to be involved in a market only as far as the public will perceive it should.
3. Future regulatory compatibility	Will the market and its associated product meet anticipated future regulatory standards?	Avoid large capital investments that may not meet future regulatory requirements. Proven technology generally has a lower risk of financial investment.
4. Industry proven	Does the market have demonstrated examples (including the technology and end product) that can prove to the public that it is not experimental?	Avoid a perception that this is experimental in any way, which could tend to raise questions/doubts.
5. Consistency with LOTT planning	Is the market consistent with the public values identified in LOTT's long-range planning and past biosolids planning efforts?	Be consistent with the public values identified during LOTT's previous long-range planning effort. Be consistent with LOTT's strategic planning and other resource recovery programs.
6. Potential for regional partnership	Will the market allow for, but not rely on, partnership with LOTT operating as the lead partner?	Partnerships increase market security.
7. Impact to operations and planning	To what degree will the market and associated technology components impact plant operations and other related capital projects?	It is important to understand the degree of impact to operations in the context of other major capital projects.
8. Net environmental benefit	Taking into account relevant environmental factors, is there a net environmental benefit for using biosolids in this market?	It is important to the public perception and the LOTT Board to be consistent with LOTT's mission of providing environmental protection.
9. Use as a resource	Do the market and its associated product allow consistency with other resource recovery and use programs such as reclaimed water and methane?	Beneficial use reinforces the high quality and strong environmental ethic LOTT has been demonstrating with other programs.
10. Potential revenue	Although not a critical factor, does the market provide the potential for revenue?	Documentation of revenue aids in public perception and helps to offset program costs.

7.7 Market Assessment

BC applied the market criteria to the potential Class A and Class B markets identified. Table 7-4 shows how favorable each market meets the criteria and gauges the degree of modification required of LOTT's current Class B program. LOTT's decision to maintain a Class B cake program meets its values and goals and the approach of the Highly Managed Plan. By monitoring risks and the changing marketplace, LOTT can effectively select appropriate future biosolids markets.

Table 7-4: Potential Biosolids Markets and Assessment Criteria

Legend

🟧	Meets criteria, but is less favorable than other market options
🟨	Meets criteria
🟩	Meets criteria more favorably than other market options

				Assessment Criteria									
Class A or B	Potential market	Biosolids product	Degree of modification required of current program	Market reliability	Public perception	Future regulatory compatibility	Industry proven	Consistency with LOTT planning	Potential for regional partnership with LOTT as lead partner	Impact to operations and planning	Net environmental benefit	Use as a resource	Potential revenue
Class B	**Agricultural land application**	Cake	None: current program	🟩 Requires partnership with contract haulers and land application. But is reliable for at least 10 more years.	🟨	🟨	🟩	🟩	🟨	🟩	🟩	🟩	🟧
	Silviculture	Cake	Minor: contract change	🟨 Requires partnership with timber company or state/federal land owners	🟨	🟨	🟩	🟨	🟨	🟩	🟩	🟩	🟧
	Land reclamation	Cake	Minor: contract change	🟨 Once a mine is reclaimed it no longer needs additional applications.	🟩	🟨	🟩	🟨	🟨	🟩	🟩	🟩	🟧
	Biofuel production	Cake	Moderate: contract change requiring more LOTT staff resources for partnerships	🟨	🟩	🟨	🟩	🟨	🟨	🟨	🟧	🟨	🟨 Raw biodiesel
	Biomass production	Cake	Moderate: contract change requiring more LOTT staff resources for partnerships	🟨	🟧	🟧 Thurston County had a previous moratorium on biomass.	🟧 Operations are fairly limited in the United States	🟨	🟨	🟧	🟧	🟨	🟨 Wood chips
Class A	**Recreational areas, golf courses, public use**	Compost or fertilizer	Significant: construction of a compost facility or solids dryer	🟨 Other competitors in marketplace.	🟩	🟩	🟩	🟩	🟨	🟨	🟨	🟩	🟨 Marketable end product, but market competitors and program may need to start with free distribution.
	Horticulture and landscaping	Topsoil blend, compost, or fertilizer	Significant: thermophilic digestion upgrade, construction of a compost facility or a solids dryer	🟨 Other competitors in marketplace.	🟩	🟩	🟩	🟩	🟨	🟨	🟨	🟩	🟨 Marketable end product, but market competitors and program may need to start with free distribution.
	Energy production (waste to energy)	Dried pellet/energy	Significant: construction or partnership in a waste to energy facility as well as a solids dryer facility	🟨	🟨	🟧 Thurston County's previous moratorium on biomass could affect such a facility.	🟩	🟨	🟨 May require partnership with regional utilities to offset capital costs of developing a WTE facility.	🟧	🟧	🟨 Producing a thermally dried product is fairly energy intensive.	🟨 May receive some revenue from selling produced electricity back to the grid
	Fuel substitute (cement kiln or coal plant)	Dried pellet/energy	Significant: construction of a solids dryer and partnership with a coal plant or cement kiln	🟨 Requires partnership with a private market entity.	🟧 The cement kilns in Seattle have been cited for multiple environmental infractions.	🟨	🟩	🟨	🟨	🟨	🟨	🟨	🟧

Appendix A: Dewatering Alternatives BCE Report

724 Columbia Street NW, Suite 420
Olympia, Washington 98501

T: 360.943.7525
F: 360.943.7513

Technical Memorandum

Prepared for: LOTT Clean Water Alliance

Project Title: Biosolids Management Plan

Project No.: 140716

Technical Memorandum

Subject: Dewatering Alternatives BCE Report

Date: September 2013

To: Ken Butti

From: Matt Kennelly

Prepared by: Ali Polda

Reviewed by: Matt Kennelly, P.E.

Limitations:

This is a draft memorandum and is not intended to be a final representation of the work done or recommendations made by Brown and Caldwell. It should not be relied upon; consult the final report.

This document was prepared solely for The LOTT Clean Water Alliance in accordance with professional standards at the time the services were performed and in accordance with the contract between The LOTT Clean Water Alliance and Brown and Caldwell dated March 11, 2011. This document is governed by the specific scope of work authorized by The LOTT Clean Water Alliance; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by The LOTT Clean Water Alliance and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

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Section 1: Background

The physical process of solids dewatering is the final biosolids processing step at the Budd Inlet Treatment Plant (Plant). The purpose of this unit process is to reduce water content, and thus increase solids concentration in digested sludge. Once dewatered, the solids are distributed by commercial haulers to beneficial-use facilities in Lewis and Douglas counties that land-apply the Class B cake biosolids product as on pasture feed crop and forest lands.

The Plant currently accommodates three centrifuges, located in the Solids Handling Building, to dewater digested sludge. Two of the existing centrifuges, manufactured by Sharples, have been in service since the 1980 Plant expansion. The third centrifuge, manufactured by Humboldt, was installed in 2000. Sludge transfer pumps in the digester equipment building convey anaerobically digested biosolids (approximately 2–3 percent solids) to the centrifuges. The Plant uses primarily the newer, higher-capacity Humboldt centrifuge, which concentrates the sludge to approximately 23 percent solids. The two older, lower-capacity Sharples units serve as backup operation.

Polymer is dosed to the influent solids at each machine to improve dewatering performance. Historically, the Plant has used 20–25 pounds (lb) of dry polymer per ton of dry biosolids. The polymer dose rate is computer-controlled, based on an operator-entered set point.

Figure 1 shows a photograph of the existing centrifuges. Figure 2 illustrates the process schematic for the existing system.

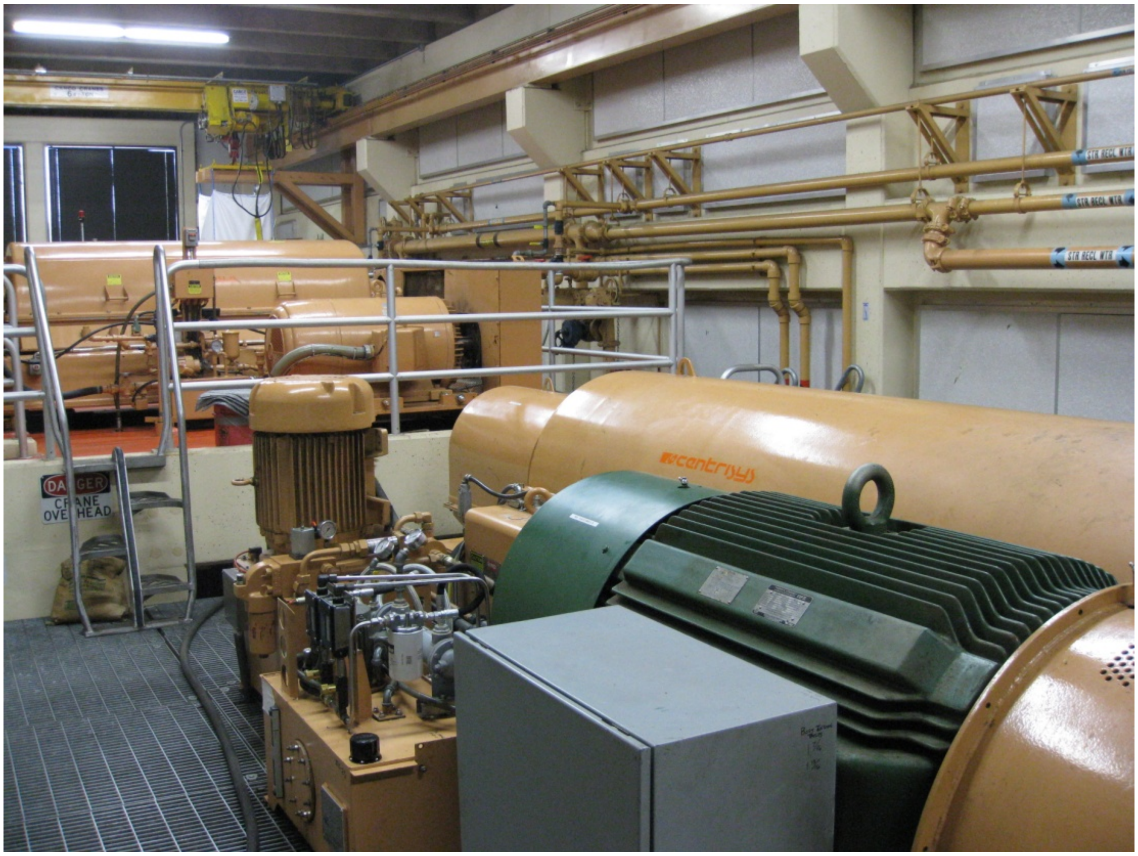

Figure 1. Existing centrifuges

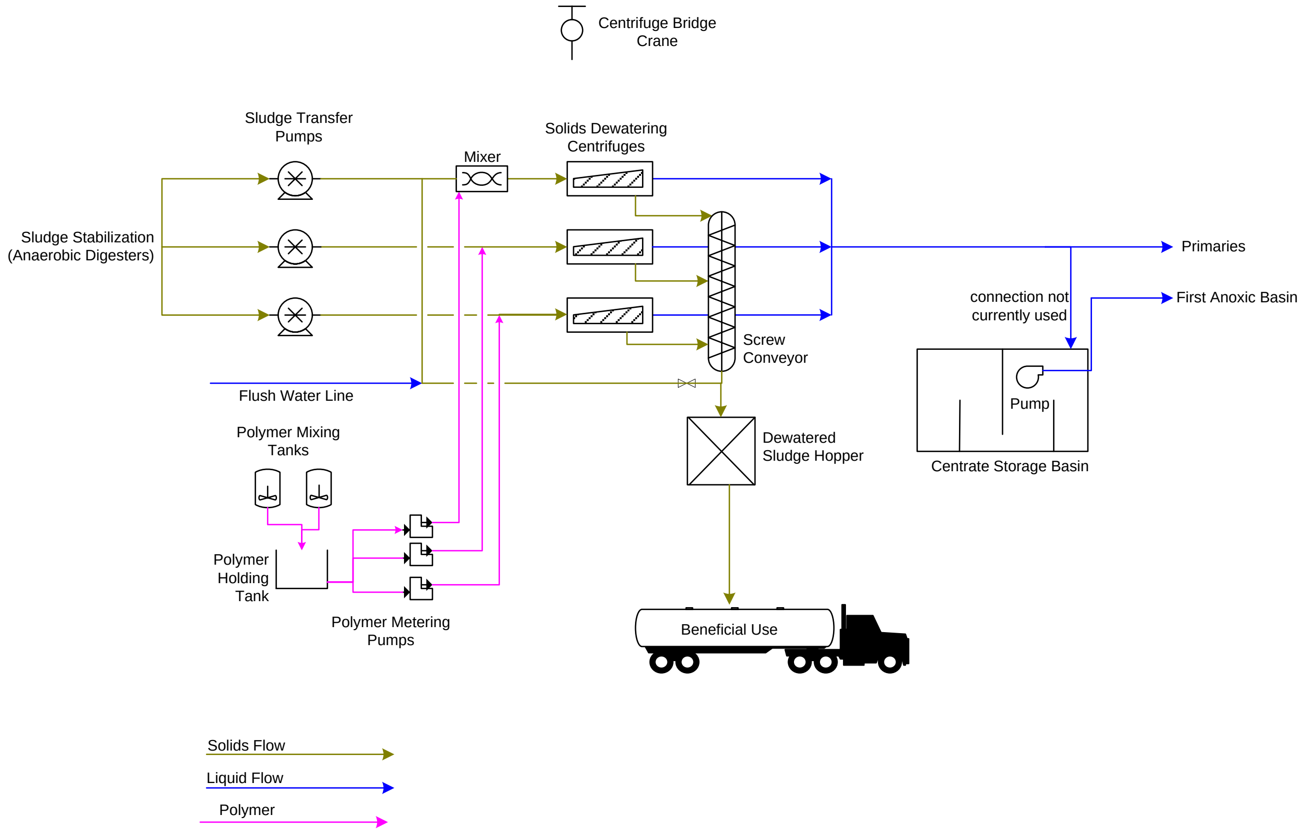

Figure 2. Existing solids dewatering process schematic

The existing dewatering system has experienced previous problems with reliability. Corrective maintenance requirements have exceeded expectations for the Humboldt unit. This requires operation of the less-efficient Sharples units, which results in increased operating costs. This technical memorandum summarizes various alternatives for providing more efficient, reliable sludge dewatering, through a business case evaluation (BCE) that was developed to determine the most cost-effective alternative. The BCE measures the capital, operations and maintenance (O&M), and repair and replacement (R&R) costs for each alternative. Costs associated with identified risks and benefits were also included for each alternative.

1.1 Decision-Making Process

Brown and Caldwell (BC) and LOTT staff formed a Core Team to evaluate and discuss dewatering equipment issues at a series of meetings. The Core Team consisted of the following members:

- Ken Butti, LOTT
- Eric Hielema, LOTT
- Matt Kennelly, BC
- Laurie Pierce, LOTT
- Ali Polda, BC
- Mike Seelig, LOTT
- Brian Topolski, LOTT
- Tyle Zuchowski, LOTT

Core Team meetings were held on the following dates:

- December 9, 2011
- January 25, 2012
- April 20, 2012
- August 6, 2013

Support for the decision-making process also involved other staff members from BC and LOTT not listed as part of the Core Team.

1.2 Problem Statement and Level of Service

The Core Team agreed upon a problem statement and associated levels of service to frame the BCE. The problem statement was worded as follows:

Select the least costly replacement of Budd Inlet Wastewater Treatment Plant dewatering equipment that enables LOTT to maintain the desired level of service.

The following levels of service need to be provided to address the problem:

- Remove excess moisture from anaerobically digested sludge to produce a solids content (by weight) of at least 18 percent. This requirement is a minimum value and not the goal.
- Effectively dewater sludge 24 hours per day, 5 days per week, with appropriate redundancy. Costs should be applied to dewatering equipment that exceeds this threshold.
- Meet 2043 solids loading requirements with the ability to expand (if needed) within the existing building to meet buildout (2050) requirements.
- Operate within the existing allowable footprint for dewatering equipment.
- Allow plant staff adequate access to the equipment for maintenance and operation.

Additional considerations that impact the BCE analysis include the following:

- **Maintenance costs:** Dewatering equipment that has more moving parts and/or a higher complexity of operation will have higher annual maintenance costs.
- **Replacement costs:** The anticipated replacement cycle of the equipment influences the life-cycle cost. Systems that include a longer projected useful life before replacement may offer reduced long-term costs. The existing centrifuges are expected to have a shorter projected life.
- **Energy efficiency:** Equipment that has lower power requirements will have reduced operating costs.
- **Hauling costs:** Equipment that is more effective at removing water from sludge decreases the number of truck trips required to deliver biosolids to beneficial use facilities.
- **Chemical usage:** Equipment that uses less polymer to achieve similar dewatering performance will have reduced operating costs. However, without performing a pilot test, it is not possible to accurately estimate polymer consumption. Manufacturers of all technologies evaluated reported similar ranges of typical polymer usage. Therefore, polymer usage was evaluated but determined not to impact the alternatives.

The BCE considers only differential costs. For example, while the existing Humboldt centrifuge achieves 24 percent solids on average and a new centrifuge is estimated to achieve 25 percent solids, only the 1 percent difference is applied in calculations for BCE analysis.

1.3 Projected Solids

Projecting future digested sludge (sludge that feeds the dewatering equipment) production allows a calculation of future required dewatering capacity. These capacity requirements are then compared to dewatering equipment capacities to determine the number of units required. Table 1 shows the average and peak digested sludge values for 2013, 2020, 2030, and 2050 buildout. The calculations are based on the 2013 Flows and Loadings Report developed by the Thurston Regional Planning Council (TRPC). The BCE considers dewatering equipment required for projected solids through 2043 (30-year horizon) and the ability to expand to meet buildout conditions according to the level-of-service goal described above.

Table 1. Projected Solids

Parameter	2013[a]		2020		2030		2040		2050	
	AA (lb/day)	P14 (lb/day)	AA (lb/day)	P14 (lb/day)	AA (lb/day)	P14 (lb/day)	AA (lb/day)	P14 (lb/day)	AA (lb/day)	P14 (lb/day)
Digested sludge	12,795	19,448	12,938	21,995	16,453	27,971	19,593	33,308	21,651	36,807

a. *Values for this year were extrapolated based on modeled values for the years 2020, 2030, 2040, and 2050.*

1.4 Solids Dewatering Technologies

Solids dewatering is achieved through physical separation of solids particles from liquid. The effectiveness of the separation mechanism can depend upon hydraulic flow rate, solids loading rate, and the quantity of chemicals used to increase particle size (e.g., polymer flocculation).

The 2012 Capital Improvements Plan (CIP) identifies a project to replace the existing centrifuges with a new dewatering system. However, the CIP does not recommend a specific solids dewatering technology, deferring that decision to this Biosolids Management Planning effort. The Core Team selected the following three dewatering technologies for consideration in this BCE:

1. Centrifuge
2. Screw press
3. Rotary press

1.4.1 Centrifuge

In a centrifuge, the applied centrifugal force causes suspended solids to migrate through the liquid, away from the axis of rotation due to the difference in densities between the solids and liquids. The solids are then conveyed via auger, also called a scroll, to one end of the machine for discharge. The liquid filtrate overflows a weir and is discharged from the opposite end of the machine. The increased settling velocity imparted by the centrifugal force, as well as the short settling distance of the particle, creates an efficient sludge dewatering system. The bowl and the scroll are controlled by separate drives and rotate at different speeds. The section of the bowl near the solids discharge location is inclined to allow for separation of the solids from the liquid pool and further dewatering of residual liquid. The solids are discharged at the end of the bowl inclined section.

The centrate is returned to the liquid treatment process and the dewatered solids are captured and transported to a truck for disposal. Sludge conditioning with polymers is required to prevent floc shear and to improve centrate quality and solids capture. Centrifuge dewatering is also a closed process, which makes containment of odors easier.

1.4.2 Screw Press

A screw press consists of a tapered screw with a surrounding screen. Sludge conveyed down the length of the screw is dewatered through compression of the sludge between the tapered screw and the reducing diameter of the surrounding screen. In a screw press operation, polymer is added to flocculate the solids in a separate flow-through process just prior to the screw press. The flocculated solids overflow the flow-through process and drop into the feed box on the top of the unit. The flocculated solids move through the unit along the length of a tapered screw enclosed by an outer screen with a reducing diameter. The dewatering is accomplished as gravity drainage allows the filtrate to fall out of solution. As sludge moves along the screw, the internal pressure increases, forcing water to drain out through the outer screen. The dewatering screw is designed to rotate very slowly, gradually placing pressure on the sludge by decreasing the volume in the screw flight with water draining from the outside perforated cylinder.

1.4.3 Rotary Press

In a rotary press, sludge is fed into a rectangular channel and slowly moves between two parallel revolving screens, which rotate very slowly on a single shaft. The filtrate passes through the screens as the flocculated sludge advances along the channel. The sludge continues to dewater as it passes around the channel, eventually forming cake at the outlet side of the press. A controlled outlet restriction maintains pressure inside the unit, resulting in the extrusion of dry cake. Each disk set is called a channel, and dewatering capacity can be increased by adding channels. Up to six multiple channels can operate on a common gear box and center shaft to minimize energy requirements. Just as in a screw press and centrifuge, polymer is added to flocculate the solids in a separate flow-through process just prior to the rotary press. The rotary press has enclosed dewatering channels that minimize odor control requirements.

1.5 BCE Alternatives

During the initial evaluation in 2012, the Core Team selected the following alternatives for evaluation in the BCE:

- **Alternative 1:** Continue to maintain the existing three centrifuge units
- **Alternative 2:** Replace units with centrifuge
  - **Alternative 2B:** Replace the existing Sharples units with one new larger centrifuge and keep the Humboldt as backup
  - **Alternative 2C:** Replace the existing Sharples units with two new centrifuges
  - **Alternative 2D:** Replace all existing centrifuges with three new centrifuges
  - **Alternative 2E:** Replace all existing centrifuges with two new centrifuges
- **Alternative 4:** Replace units with rotary press
  - **Alternative 4A:** Replace all existing centrifuges with rotary presses

In 2012, the screw press alternative (Alternative 3) was not evaluated due to spatial constraints associated with the unit sizes and maintenance clearances required. However, due to screw press manufacturer modifications and reduced biosolids projections, the screw press technology alternative was revisited. This alternative was termed “Alternative 5” in order to distinguish it from the previous evaluation. Two screw press manufacturers, FKC and Huber, were evaluated.

- **Alternative 5:** Replace units with screw presses
  - **Alternative 5A:** Replace all centrifuges with FKC screw presses
  - **Alternative 5B:** Replace all centrifuges with Huber screw presses

1.6 Comparative Analysis

The primary factors considered in the comparison of solids dewatering alternatives are described below:

- **Capital costs** for centrifuges were based on quotes from equipment manufacturers. Related capital improvements were estimated using industry values and cost estimating practices.
- **Benefits** include the potential salvage value of the existing centrifuge equipment. This was estimated to be $25,000 each for the Sharples units and $50,000 for the Humboldt unit.
- **O&M costs** include power requirements for each alternative and projected hauling costs based on dewatering solids concentration for each alternative.
- **Risks costs:** As previously stated, equipment with less efficient dewatering increases the number of truck trips required to deliver biosolids to beneficial-use facilities. Therefore, the BCE included risk cost associated with more trucks on the road. The risk cost was calculated as the product of average risk cost per mile and the number of miles required for each alternative through 2043. The screw presses also have longer runtimes due to their lower loading capacities. A risk was included for dewatering disruption during unmanned shifts for equipment running in excess of 16 hours per day. The risk cost was calculated as the product of labor required for restoring dewatering service, the probability of a failure of dewatering equipment, and the amount of hours in excess a unit was operating during unmanned shifts.

Section 2: Business Case Evaluation Results

Results of the BCE are presented in Table 2. Based on theis evaluation, the most cost-effective alternative is to replace the old Sharples units with one larger centrifuge (Alternative 2B).

Table 2. Solids Dewatering Technology Business Case Evaluation

Alternative	Description	Capital	Benefit	O&M	Risk	R&R costs	Net present value (NPV)	Rank
1	Maintain the existing centrifuge units	0	0	11,669,626	7,445	2,765,974	(14,443,045)	**3**
2B	Replace Sharples with one larger centrifuge; Humbolt as backup	2,475,932	50,000	10,993,891	0	699,800	(14,119,624)	**1**
2C	Replace Sharples with two smaller centrifuges; Humbolt as backup	2,670,235	50,000	10,916,643	0	808,151	(14,345,029)	**2**
2D	Replace all units with three new centrifuges	3,634,034	100,000	10,916,643	0	1,043,813	(15,494,490)	**4**
2E	Replace all units with two new centrifuges	4,634,408	100,000	10,993,891	0	1,261,687	(16,789,986)	**6**
4A	Replace all centrifuges with rotary presses	4,754,058	100,000	14,795,738	73,019	1,247,614	(20,770,428)	**8**
5A	Replace all centrifuges with screw presses (FKC)	4,269,640	100,000	11,109,822	9,699	1,060,612	(16,349,773)	**5**
5B	Replace all centrifuges with screw presses (Huber)	5,376,248	100,000	11,080,234	11,828	1,407,188	(17,775,498)	**7**

a. *The preferred alternative is highlighted in green.*

b. *BCE assumes an escalation rate of 4% and a discount rate of 5% for calculation of NPV.*

c. *The BCE covers the period from 2013 through 2043, assuming the new solids dewatering system is installed in 2013.*