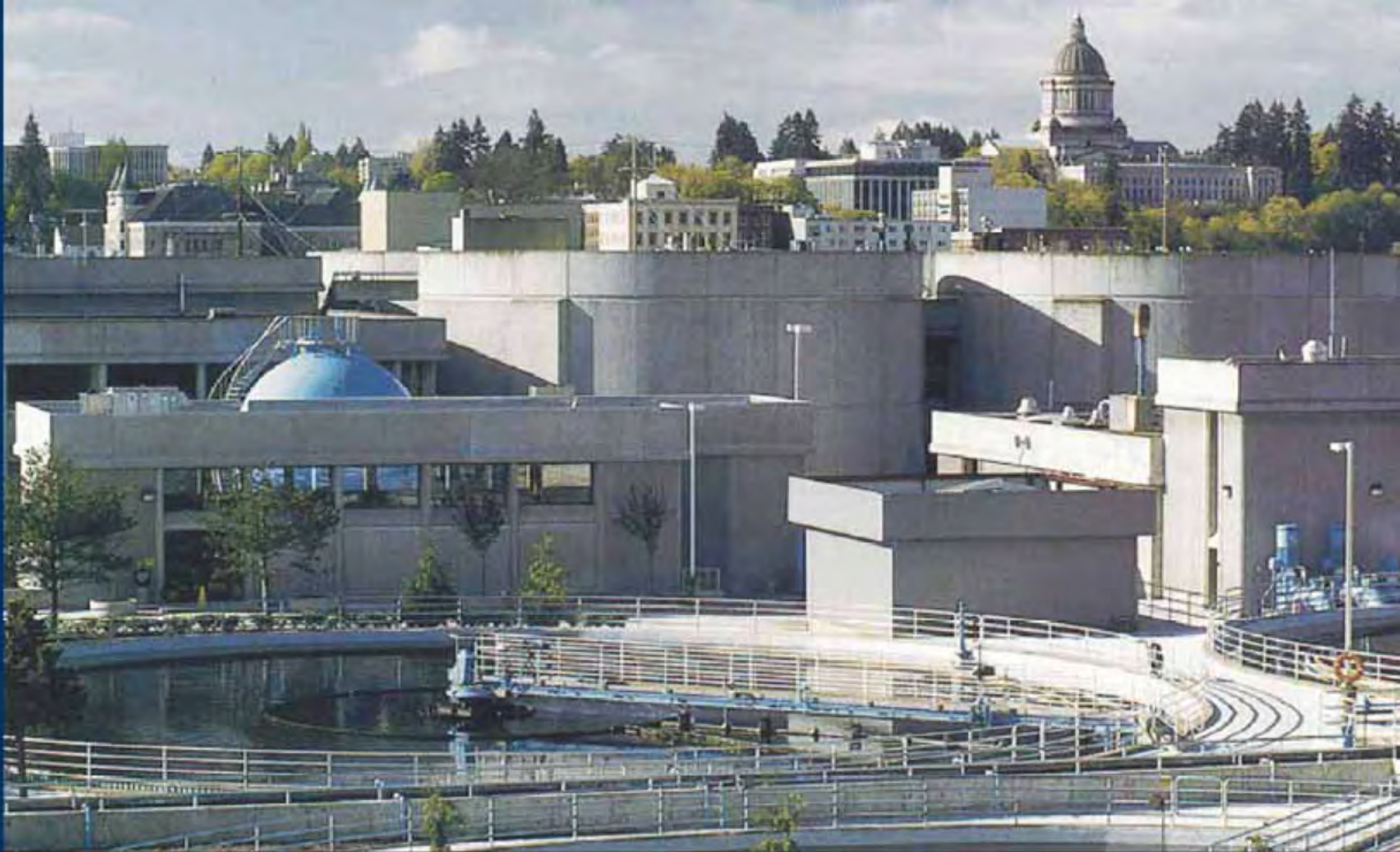
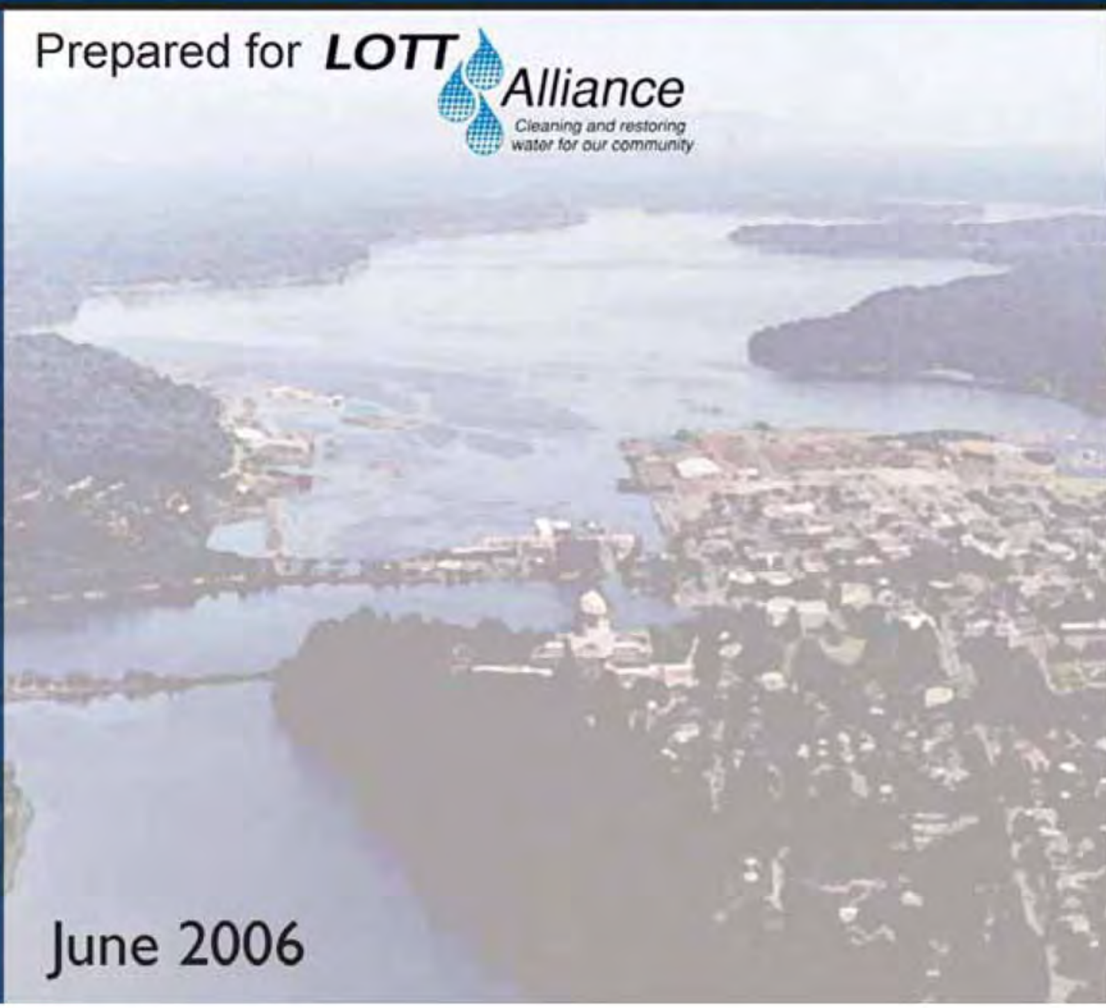


BUDD INLET TREATMENT PLANT MASTER PLAN

Prepared for **LOTT Alliance**

Cleaning and restoring water for our community



June 2006

BROWN AND CALDWELL

Environmental Engineers & Consultants

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EXECUTIVE SUMMARY

In the Fall of 2003, the LOTT Alliance initiated the Budd Inlet Treatment Plant Master Plan to detail the capital and site requirements for the Budd Inlet Treatment Plant (Plant) and to refine the implementation program based on current and future needs. Specifically the Master Plan objectives are:

- Refine improvements outlined in the 1997 *Wastewater Resource Management Plan* (WRMP) including a site specific Master Plan for the Plant site incorporating a strategy to respond to changes in available Budd Inlet discharge capacity.
- Identify ways to increase treatment efficiency and control operating costs.
- Adapt with changing nature of the local surrounding area due to development.
- Coordinate with the Port of Olympia East Bay Master Plan.
- Remain a good neighbor.
- Update the results of Treatment Plant performance testing originally conducted in 1996-7 as part of the WRMP.

The Budd Inlet Treatment Plant is a Type 2 Essential Public Facility (OMC18.04.060) providing wastewater treatment capacity for the LOTT service area. Within the framework of the Plan, the Plant has the following primary functions:

- Continue to provide wastewater treatment within the seasonal discharge capacity into Budd Inlet.
- Provide *reserve treatment capacity* in the LOTT system to economically allow for new connection requests.
- Provide peak wet weather treatment capacity (up to 28 MGD).
- Provide regional solids treatment.

The Plant is governed by a National Pollutant Discharge Elimination System (NPDES) permit administered by the State Department of Ecology (Ecology) under the authority of the Federal Environmental Protection Agency (EPA). This permit was issued in October, 2005, and carries the limitations summarized in Table ES-1. The permit does not include flow discharge limitations for the summer or shoulder periods. Rather, the key limitations, biochemical oxygen demand (BOD) and total inorganic nitrogen (TIN) in the summer and shoulder seasons, are expressed in terms of load in pounds per day. As flow to the treatment plant increases, so too does the load. In order to discharge the increasing amount of flow, the treatment plant would need to remove a higher proportion of the loading. Effectively, the more flow, the more clean the Plant effluent needs to be.

Table ES-1. NPDES Permit Summary, Budd Inlet Treatment Plant, Effective October 1, 2005[1]

Parameter	Seasonal Condition		
	Summer[2]	Shoulder[3]	Winter[4]
BOD	671 lb/d	900 lb/d	30 mg/L
TIN	288 lb/d	338 lb/d	--
NH3	--	--	26 mg/L
TSS	--	--	30 mg/L
Fecal Coliform	200 per 100 ml sample		
Total Recoverable Copper	0.006 mg/L		
pH	Between 6-9		

1. All values refer to monthly averages. Certain parameters also have weekly or daily limits. The complete permit can be found in Chapter 3 Table 3-3 (Technically speaking these limits become effective November 1, 2006).
2. Summer = June, July, August, September
3. Shoulder = April, May, October
4. Winter = November, December, January, February, March

A Plant capacity study was completed in order to assess the ability of the Treatment Plant to meet its permit limits given expansion of the collection system and service area. Over the period 2005-2025, the LOTT service population is expected to increase by 113 percent. Resulting projected system-wide average annual wastewater flows are expected to increase by 74 percent to a total of 22 MGD. If the treatment plant were to continue to function in its current mode of operation, discharging effluent at a BOD concentration of 9 mg/L and a TIN concentration of 3 mg/L, the NPDES permit would limit discharge to less than half of that flow.

In order to deal with the NPDES discharge limitation, and in keeping with the goals of the WRMP, the LOTT Alliance plans to construct satellite reclamation plants (SRPs) within its service area. These plants will draw flow from the system and treat to Class A Reclaimed Water standards, creating effluent which can be reused for irrigation, commercial and industrial uses, or recharged into the groundwater. In this way, the LOTT Alliance plans to maintain a discharge to Budd Inlet at or near its current level even as system wide flows increase.

Four scenarios were developed for this planning process, reflecting different rates of SRP construction (low, moderate, and high) and a centralized scenario envisioning the Budd Inlet Treatment Plant as the hub for Class A Reclaimed Water production (Budd Inlet Class A scenario).

Capacity in each of the Plant's unit processes was modeled using a combination of computer models, including hydrologic profiling, mass balance accounting, and activated sludge system analysis. Limitations were identified through a series of staff interviews, an evaluation of submittal data, design datasheets, and on-site stress testing. Model scenarios included all four of the SRP scenarios, as well as the three seasonal conditions (Summer, Winter and shoulder periods) designated in the NPDES permit. The end-product of capacity modeling is the capacity chart, a 2-dimensionsal representation of the capacity of each unit process within the treatment plant (an example is plotted on Figure ES-1). The capacity chart is used to estimate the timing and importance of required Plant upgrades and capacity expansion projects. Over fifteen (15) separate charts were prepared to represent the potential limiting conditions and loading scenarios to the plant.

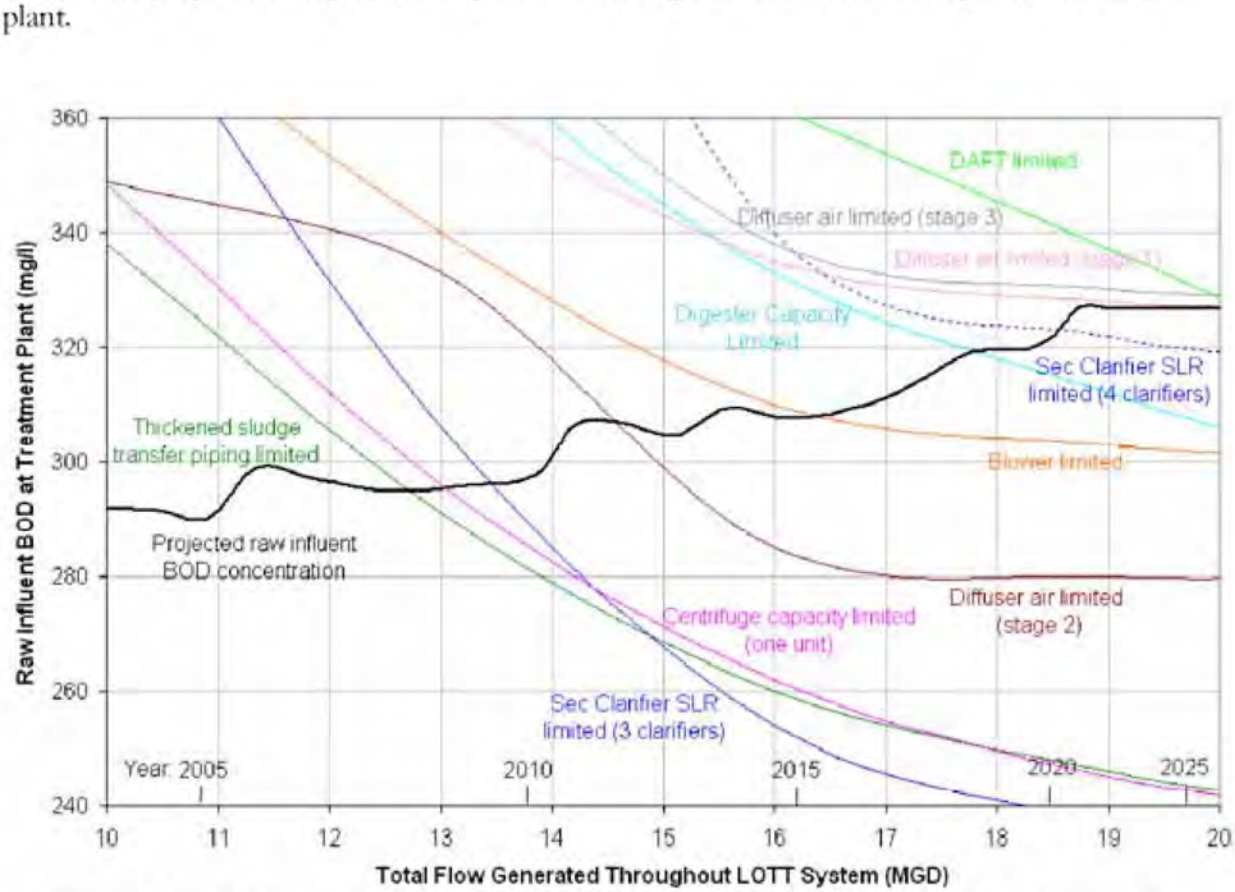

Figure ES-1. Capacity Curve for Summer Condition, Low Rate of SRP Construction, Effluent TIN = 3 mg/L

The capacity analysis is summarized in the following set of findings:

- Thickened sludge transfer piping is a bottleneck, with capacity limitations occurring near 2007-2008 in nearly all modeled scenarios.
- Centrifuge operation with just one unit in service, 56 hours per week, is not sustainable beyond the 2007-2008 timeframe.
- UV treatment capacity with 6 channels in service will become limited in 2008. With expansion to 7 channels, capacity could be extended to 2017.
- Secondary clarifier Solids Loading Rate (SLR) limitations are broken down as follows:
    - Summer: capacity limitation in 2009-2010 for both the low rate of SRP construction and Budd Inlet Class A scenarios. The limitation is relieved with additional satellite plant diversion.

  - April: with an effluent TIN limit of 2 mg/L, capacity is already exceeded at the Plant. With an effluent TIN limit of 3 mg/L, capacity varies depending on the role of satellite treatment. For both the Budd Inlet Class A and the low rate of SRP construction scenarios, capacity is limited in 2006-2007.

  - Winter: SLR limitation at peak monthly flow is not observed.

  - In all cases, capacity could be extended by even a moderate improvement in sludge settleability.

  - Note that the clarifier assessment has allowed for one clarifier to be left out of service. This has been done to model hydraulic limitations in the mixing box, and to allow for maintenance of any given unit at any time. If all four (4) clarifiers were modeled in service, this would add approximately three (3) years of Plant capacity in most simulated cases.

- Aeration capacity is most limited in summer, when the Plant is operating in biological nutrient removal (BNR) mode. Stage 2 of the first aeration basin suffers from diffuser supply limitations between 2010 and 2013 in most scenarios. Stages 1 and 3 become limited later, around 2022 in the low rate of SRP construction scenario, and in 2014-2015 in the Budd Inlet Class A scenario. In the April condition, capacity limitations are observed in stages 2 and 3 in 2013-2014 for the Budd Inlet Class A case. All of these limitations are relieved with the addition at SRP treatment capacity.

- Blower capacity is linked to aeration capacity. For the low rate of SRP construction case, this becomes limited around 2015. For the Budd Inlet Class A case, the limit moves up to 2012.

- Digester capacity becomes limited in 2017-2018 for both summer and April conditions for the low rate of SRP construction case. More aggressive SRP scenarios relieve this capacity limitation. The Budd Inlet Class A case becomes limited in 2016.

- Dissolved Air Flotation Thickeners (DAFT) capacity is limited in the Budd Inlet Class A scenario in 2019, for both summer and April conditions.

- Plant hydraulic limitations include the following:

  - Effluent pumping capacity to the North Outfall is already limited to 50-MGD. Combined effluent pumping capacity, rated to 80-MGD, would become limited in 2020 for the Budd Inlet Class A Scenario. Capacity to the North Outfall is influenced by a 1,200-foot section of 30-inch pipe running through the State-operated dangerous waste site formerly owned by Cascade Pole Company.

  - Influent Pump Station firm capacity is already exceeded. With an allowance for diversion to equalization tanks, this capacity limit is pushed to 2009 (Budd Inlet Class A and low rate SRP construction cases).

- The overall Plant hydraulic capacity, expressed as overflow capacity in the primary sedimentation basins and channels, will be reached in 2013 (Budd Inlet Class A case) or 2014 (low rate SRP construction case).

- The hydraulic limitation in the mixed liquor distribution box is currently exceeded. The Plant is addressing this limitation as part of its Secondary Clarifier Improvements Project.

- Grit tank single unit capacity is already exceeded. Capacity with both tanks in operation is sufficient throughout the planning period.

- Secondary clarifier overflow rate, with four (4) units in service, can handle projected flows through 2020 (Budd Inlet Class A case) or beyond 2025 for all other scenarios.

The findings of the capacity study were incorporated into a site analysis in order to develop a set of alternatives for dealing with projected Plant capacity limitations over the next 20 years. These alternatives are summarized in Tables ES-2, ES-3, and ES-4. The site plan for the preferred, Alternative 5, is shown as an example on Figure ES-2 (note this includes recommendations for acquiring new property to the east of the Plant)

As a result of interviews with site neighbors and three public workshops conducted during development of the Master Plan, the most significant issues of public concern were identified as:

- Water quality – protect and enhance Budd Inlet water quality

- Odor control – control odors, preferably within the existing fenceline

- Buildings/Structures – if possible, keep process facilities within the existing footprint. If expansion is necessary, building upward or west is preferred. Build structures consistent with commercial/industrial surroundings and minimize obstruction of views and unpleasant aesthetics.

Table ES-2. Alternatives Cost Summary, Liquid Stream[1]

Description	Alternative (year on line)					Construction Cost	Annual Operating Cost	Allied Cost
	1	2	3	4	5	($)	($/yr)	($)
Administration Building / Laboratory								
Separate independent structure			2007			$4,709,205		$1,648,222
Partially Above Primary Sedimentation Tanks, Laboratory Separate	2007	2007		2007	2007	$4,709,205		$1,648,222
Existing Building/Lab Demolition	2006	2006	2006	2006	2006	$548,805		$192,082
Primary Sedimentation Tank								
Conventional	2008			2008	2008	$12,961,573		$4,536,551
Chemically Enhanced		2008				$13,741,105	$791,297	$4,809,387
High Rate			2008			$12,236,238	$786,617	$4,282,683
Existing Tank Demolition	2008	2008	2008	2008	2008	$528,183		$184,864
Aeration Basins								
Folded Tank				2012	2012	$7,760,000		$2,716,000
Demolish First Anoxic				2012	2012	$550,000		$192,500
Secondary Clarifiers[2]								
Replace Existing Mechanisms, other Upgrades	2007	2007	2007	2007	2007	$3,852,399		$1,348,339
1 New Clarifier	2012			2012		$7,103,018		$2,486,056
2nd New Clarifier	2012			2012		$4,735,346		$1,657,371
Disinfection								
Chlorine contact channel		2012			2012	$1,039,650	$27,743	$363,878
UV equipment for 7th channel	2008	2008	2008	2008	2008	$100,000		$142,000
Reclaimed Water Filters								
Expand Dynasand units to 6 mgd (4.5 mgd new)	2012		2012	2012		$12,703,000		$4,446,050
Expand Dynasand units to 12 mgd (10.5 mgd new)						$29,600,000		$10,360,000
New Membrane Tanks (6 mgd)		2012				$15,774,000		$5,520,900
New Membrane Tanks in Place of 1st Anoxic (6 mgd)					2012	$14,300,000		$5,005,000

1. All costs are 2004 $.
2. Secondary clarification projects should be re-evaluated following secondary clarifier mechanism upgrades, to be completed in 2006-7.

Table ES-3. Alternative Cost Summary, Solids Stream

Thickening							
DAFT Mechanical Replacement and Building Enclosure	2015	2015	2015	2015	2015	$793,000	$277,550
Digestion							
Anaerobic Digester Cover Coating Replacement	2006	2006	2006	2006	2006	$240,000	$84,000
Anaerobic Digester Cover Fix in Place	2015	2015	2015	2015	2015	$3,172,000	$1,110,200
Class A Solids							
10 DT/d Class A Dryer	2015	2015	2015	2015	2015	$11,160,000	$3,906,000
Odor Control							
Primary Sedimentation Area	2007	2007	2007	2007	2007	$2,840,000	$994,000
Aeration Basin / Membrane		2012			2012	$1,039,812	$363,934
DAFT Enclosure	2015	2015	2015	2015	2015	$2,840,000	$994,000

1. All costs are 2004 $.

Table ES-4. Alternatives Cost Summary[1]

	Total Capital Cost	Annual Operating Cost
Alternative 1	$92,193,814	--
Alternative 2	$84,217,515	$819,040
Alternative 3	$75,232,820	$786,617
Alternative 4	$103,412,314	--
Alternative 5	$92,393,747	$27,743

1. Only includes items listed in Table 13-2. All costs are 2004 $.

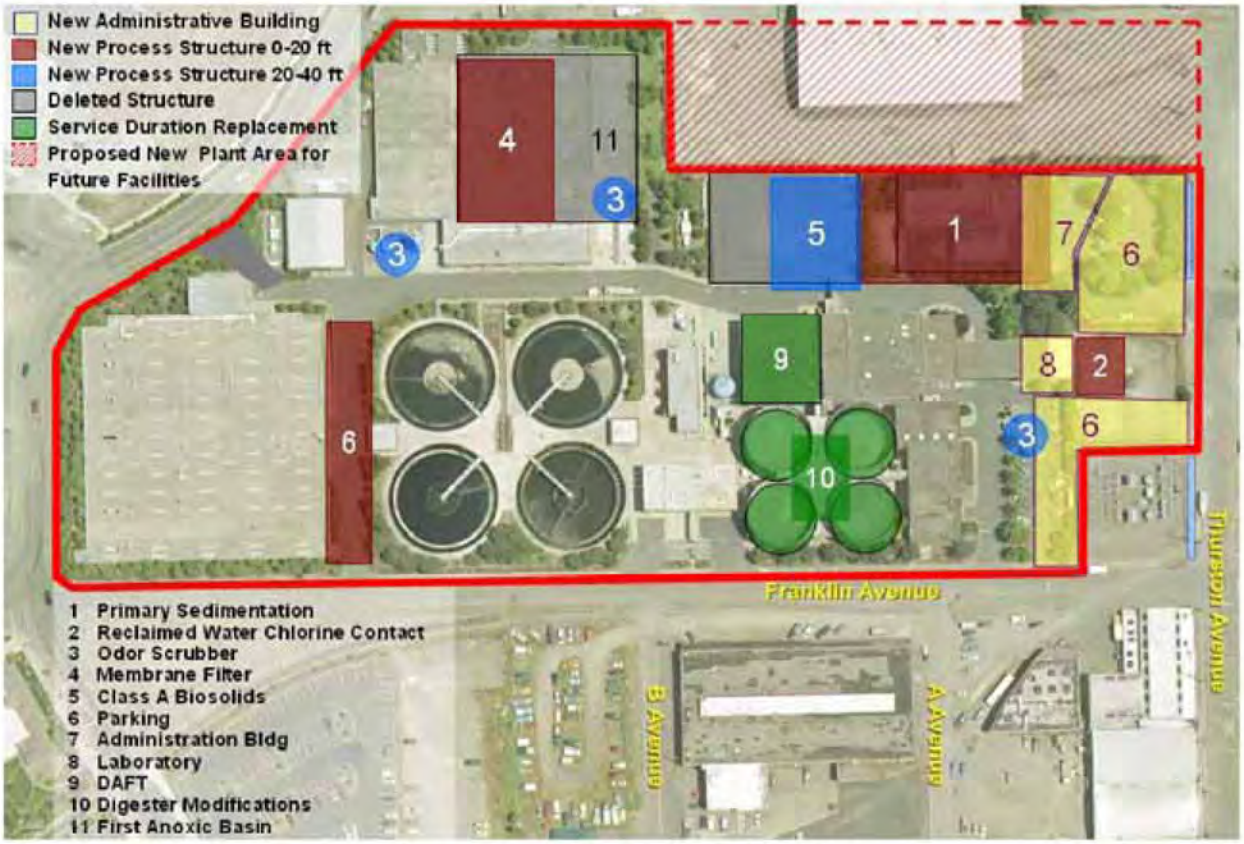

Figure ES-2. Alternative 5 Site Plan

CHAPTER 1

INTRODUCTION

In 1998, the LOTT Partnership (Partnership) adopted the *Wastewater Resource Management Plan* (WRMP) and in 2000, the LOTT Alliance (LOTT) was created specifically to manage the affairs of the regional wastewater utility in accordance with local goals. As LOTT became a separate entity, LOTT assumed financial responsibility and all assets were transferred from the City of Olympia to LOTT. The Plan included capital improvements of approximately $60 million at the Budd Inlet Treatment Plant (Plant) over the 20-year planning period.

The LOTT Plant is one of the utility's most valuable capital assets and is a key feature of the Plan. Located in downtown Olympia, the Plant is a Type 2 Essential Public Facility (OMC18.04.060) providing wastewater treatment capacity for the LOTT service area. Within the framework of the Plan, the Plant has the following primary functions:

- Continue to provide wastewater treatment at least up to the seasonal discharge capacity into Budd Inlet (15 MGD discharge capacity, depending on strength of discharge).
- Provide *reserve treatment capacity* in the LOTT system to economically allow for new connection requests.
- Provide peak wet weather treatment capacity (up to 28 MGD).
- Provide regional solids treatment.

As developed during the WRMP, the seasonal discharge capacity and the Plant treatment capacity were closely matched. However, Budd Inlet water quality considerations continue to put pressure on the available discharge capacity. The treatment and discharge capacity already varies seasonally with Budd Inlet water quality characteristics. Seasonal biochemical oxygen demand (BOD) and nitrogen sensitivity in Budd Inlet increases the level of treatment required at the Plant and reduces the hydraulic capacity. The water quality characteristics and LOTT's National Pollution Discharge Elimination System (NPDES) permit are described in Chapter 3.

In Fall 2003, LOTT initiated the Budd Inlet Treatment Plant Master Plan to detail the capital and site requirements for the Plant and refine the implementation program based on current needs. Specifically the Budd Inlet Treatment Plant Master Plan objectives are:

- Refine improvements outlined in the Plan to develop a site specific master plan for the Plant site including a strategy to respond to changes in available Budd Inlet discharge capacity.
- Identify ways to increase treatment efficiency and control operating costs.
- Adapt with changing nature of surrounding area.
- Coordinate with Port of Olympia East Bay Master Plan.
- Remain a good neighbor.
- Update the results of Plant performance testing originally conducted in 1996-7 as part of the WRMP.

BACKGROUND

The Budd Inlet Treatment Plant was originally built in 1949 as a primary treatment facility. As a primary plant it removed approximately 50 to 60 percent of the incoming pollutants. In the early 1980's, the community expanded the plant site and went to secondary treatment (this effectively removed 90 to 95 percent of the incoming pollutants). In 1994, LOTT completed a nutrient removal expansion which in addition to increasing the removal rate up to 98 percent, also seasonally removes nitrogen. And in 2004, LOTT comleted construction of a 1.5 MGD Class A Reclaimed Water facility to treat a portion of its total flow.

The Plant site illustrated on Figure 1-1 is approximately 14 acres in size. Its effective replacement value is over $250 million and serves over 90,000 people.

Figure 1-1. Budd Inlet Treatment Plant Site

In the future the Plant will undergo many changes to respond to increased levels of treatment for the treated/reclaimed water, biosolids, and air emissions. In addition, capital investment will need to be made to replace facilities as they reach the end of their useful lives (e.g., primary sedimentation tanks, solids thickening.) A summary of the factors causing modification of facilities is contained in Table 1-1.

Table 1-1. Summary of Potential Plant Improvement Drivers

End of Useful Life	Operational Efficiency	Enhanced Performance
▪ Primary sedimentation tanks ▪ Secondary clarifiers ▪ Odor scrubbers ▪ Laboratory ▪ Control system	▪ Primary sedimentation tanks ▪ Aeration basins ▪ Secondary clarifiers ▪ Administration building ▪ Laboratory ▪ Control system	▪ Headworks ▪ Aeration basins ▪ Secondary clarifiers ▪ Reclaimed water filtration ▪ Digester covers ▪ Biosolids treatment ▪ Odor scrubbers

As illustrated in Table 1-1, there are several facilities reaching the end of their useful life that will require replacement. Operational efficiency may also be a driver. This would include items such as reducing the amount of energy used, decreasing chemical usage, etc. In addition, a number of facilities are impacted by needs for enhanced performance requirements to meet upcoming discharge capacity limits or higher quality biosolids. To address these issues LOTT initiated the Budd Inlet Treatment Plant Master Plan and the results of this effort are summarized in this report.

MAXIMIZING USE OF BUDD INLET PLANT SITE

Prior to developing strategies for satisfying the needs identified in Table 1-1, preferences about the best use of the Plant site need to be resolved. Most important is determining the highest and best use of the 14-acre Plant site and appropriate value of this use. This can be expressed in capital cost but also the cost or value in terms of permitted use, construction access, exposure to the public and flexibility.

The Plant site is used for many different purposes in addition to providing wastewater treatment. For the purposes of this discussion, the facilities at the Plant are divided into Process and Non-Process facilities.

- Process – Facilities or structures which provide treatment of the wastewater or wastewater byproducts (e.g., anaerobic digesters, influent pump building). These comprise approximately 80 percent of the Plant site (about 11 acres).
- Non-Process – Facilities or structures not directly or indirectly providing treatment for wastewater derived products. Non-process facilities occupy approximately 20 percent of the site (about 3 acres).

For this effort, non-process facilities include:

- Administration offices
- Laboratory
- Large storage space (spare equipment, infrequently used material, bulk material)
- Maintenance shop
- Employee and visitor parking
- Public reception and education

The shaded areas on Figure 1-2 represent the non-process facilities on the Plant site. The administration and lab building plus the parking represent the largest areas. Also notice these are concentrated in the southeast corner of the site. Consequently, elimination of these facilities on the Plant site could make available some valuable space for process facilities.

Figure 1-2: Location of Major Non-Process Facilities

Another consideration for the non-process facilities is the cost of permitting and site acquisition for locating new ***process*** facilities off the existing Plant site to offset the space consumed by the ***non-process*** facilities. All of the non-process facilities are acceptable land uses of the surrounding area. Consequently, conditional use permits and extensive environmental permitting work would not likely be required. Conversely, locating any **new** process facilities outside the existing Plant boundaries will require this work and time. The cost of this usable space goes well beyond the approximate $1.4 million land value (based on Thurston Co assessed value.) Consequently, preference is given to using the existing 14-acre site for process uses. Non-process uses can be accommodated provided they do not create a construction or process limitation.

Process facility requirements are discussed in Chapters 2 through 13 and non-process facilities are discussed in Chapter 14.

PROPERTY ACQUISITION

Long-term capital facilities needs at the Budd Inlet Treatment Plant may require LOTT to consider acquisition of additional property. These needs may include:

- Area for two additional secondary clarifiers to control the total solids loading rates as satellite facilities represent half of the Plant total solids loading
- Area Class A biosolids production and temporary product storage to meet anticipated future regulatory criteria
- Property setback from essential process facilities for safety, security, aesthetic (visual screening), and odor control purposes.
- Construction staging area for large capital projects. Open space is needed adjacent to the Plant for LOTT to cost effectively add, repair, and/or replace structures and equipment.
- All LOTT staff and services are planned to be located at the Plant. In addition, visitors, vendors, and contractors will often frequent the Plant as they assist LOTT with activities in the service area. LOTT may require up to 70 parking spaces to accommodate these uses. In addition, LOTT will require secure spaces for maintenance and specialty vehicles and overnight shift staff.

LOTT has identified an area of approximately 2 acres immediately east of the Plant site as the best location for these activities. This area is currently owned by the Port of Olympia.

PUBLIC INVOLVEMENT

LOTT has established a long-term commitment to involving the public in their planning and design efforts. During the master plan development, LOTT continued this effort through a "good neighbor" plan involving one-on-one interviews and follow-up contact with Budd Inlet Treatment Plant neighbors and other key stakeholders. As a result, LOTT was able to incorporate suggestions and address concerns raised by those most directly impacted by changes to the plant structure and operation. These considerations, summarized below, were considered in the master planning process in addition to the list of public values LOTT uses to guide all program development. In brief, these include:

- Maximize use of existing treatment capacity
- Meet current and future needs
- Maximize benefits to the environment
- Control facilities costs
- Value treated water as a resource
- Produce multiple community benefits
- Conduct an open planning process

- Assure equitable distribution of costs
- Provide equitable and accountable public representation
- Integrate LOTT plan with other infrastructure requirements

In addition to the stakeholder interviews, LOTT conducted three public workshops during the course of the Budd Inlet Treatment Plant Master Plan process to engage the public and solicit comments about the Plant and its future. Workshop announcements were disseminated to an extensive stakeholder list including all neighbors and participants in the Port of Olympia's concurrent East Bay master planning process. They were also advertised in the Olympian and on LOTT's website. Workshops were held on the following dates:

- December 1, 2003 – Introduce the Master Plan and solicit concerns and suggestions from the general public.
- February 26, 2004 – Discuss process and non-process facilities, present results from public survey, and suggest alternatives.
- November 29, 2004 – Present evaluation findings and solicit comments.

As a result of these efforts, LOTT learned the most important public issues for the Budd Inlet Plan Master Plan are:

- Water quality – protect and enhance Budd Inlet water quality.
- Odor control – control odors, preferably within the existing fenceline.
- Buildings/Structures – if possible, keep process facilities within the existing footprint. However, if expansion is necessary, building upward or west is preferred. Build structures consistent with commercial industrial surroundings and minimize obstruction of views and unpleasant aesthetics.

A complete summary of feedback from all three workshops is included in **Appendix A**. These considerations have been integrated into development and evaluation of alternative strategies for the Budd Inlet Plant site plan.

CHAPTER 2

PLANT HISTORY

The Budd Inlet Treatment Plant (Plant) was opened in 1952 by the City of Olympia. At that time, the plant consisted of little more than a series of settling basins providing basic primary treatment. Sewage was pumped from an influent wet well to a set of three primary settling basins (primary sedimentation basins are still in service today) followed by a chlorine contact tank. Disinfected effluent was discharged to a 36-inch concrete pipe that extended to the north near the present 48" outfall at the KGY Radio Station. Solids accumulating at the bottom of the settling basins were pumped directly into trucks, and taken away for land application or buried in a landfill. Above-grade structures located on the site included a small, metal maintenance shed located near the present day Inventory Control Building, and the pump building.

Originally, the Budd Inlet Treatment Plant was designed to serve only the City of Olympia. With time, the plant began to accept flows, on a contract basis, from parts of the City of Lacey, most of the City of Tumwater, and, starting in 1956, from the Olympia Brewery. Table 2-1 summarizes when each of the major areas of the Plant were constructed, when they were modified, and (if applicable) decommissioned. The City of Olympia owned, operated, and maintained the Budd Inlet Treatment Plant since its commissioning in 1950. Ownership of the Plant was transferred to LOTT in 2001.

The LOTT Wastewater Management Partnership was formed in 1976 as an intergovernmental partnership between the Cities of Lacey, Olympia, Tumwater, and Thurston County to allow for each partner to have a stake in the policies directing regional wastewater conveyance and treatment. The four government partners consolidated their operations and used City of Olympia staff to operate and manage all LOTT infrastructures including the Budd Inlet Treatment Plant. As the manager and operator, the City of Olympia also assumed all financial obligations of the LOTT assets including debt and title ownership. Olympia staff operating the LOTT Plant had efforts dedicated to the wastewater system; with drinking water and storm water systems shifted to other City of Olympia departments.

PLANT UPGRADES IN THE 1970s

In 1971, a 36-inch diffuser section was added to the existing North Outfall near the KGY Radio Station, and a secondary Outfall was constructed to outlet into the Fiddlehead Bay. In 1979, the diffuser section was removed from the Fiddlehead Outfall in order to allow for expansion of the nearby harbor.

In 1979, a set of four large secondary clarifiers were constructed. This project included the construction of the aerated distribution channel along with pumps for return activated sludge (RAS) and waste activated sludge (WAS).

Table 2-1. Summary of Major Budd Inlet Plant Improvements by Process Area

Process	Year Constructed	Major Upgrades	Decommissioned
Influent Pumps	1952	1983, 1994	
Headworks	1983	2003	
Primary Sedimentation Tanks	1952	1983, 1997	
UNOX Deck	1983		1994
Cryogenic Plant	1983		1994
1st Anoxic	1994		
1st Aeration	1994		
2nd Anoxic	1994		
2nd Aeration	1994		
Blower Building	1979	1992	
Intermediate Pump Station	1994		
Secondary Clarifiers	1979	1994	
RAS Pumps	1979		
WAS Pumps	1979		
Solids Handling Building	1983	1998	
DAF	1983		
Dewatering Centrifuges	1983	1998	
Anaerobic Digester	1983	2002	
Methane Storage Tank	1979		2005
Chlorine Contact Tank	1952	1983	1994
Ozone Contact Tank	1983		1994
Ozone Generation Building	1983		1992
UV Building	1994		
Final Effluent Building	1983	1997	
Fiddlehead Outfall	1971	[1]	[1]
North Outfall (KGY)	1952	1971, 1992, 1997	
Reclaimed Water Facility	2005		
South Odor Scrubber	1983	2004	
North Odor Scrubber	1983		
Carbon Odor Towers	1994		
Administration Building	1983		
Laboratory	1983		
Maintenance Building	1952	1983	
Garage	1983		

1. Diffusers removed in 1979, ceased regular discharge in 1997. Used as emergency outfall.

1983 EXPANSION

The Clean Water Act (CWA) of 1972 mandated the City upgrade its wastewater treatment facilities. Taking advantage of Federal grants made available through the CWA, the City began designing new treatment plant facilities at the Budd Inlet Treatment Plant site. The first stage of this, construction of the secondary clarifier, was completed in 1979. The full plant expansion project began in 1979, with commissioning in 1983. The construction of the 1983 expansion was paid for mainly by Federal CWA grants (90 percent). The remaining 10 percent was divided equally between the State and the City of Olympia.

Influent flow was rerouted to a new headworks building. Treatment processes installed at this time included mechanically cleaned bar screens, an aerated grit chamber, and influent pumping that sent flow from the headworks building to the primary settling basins.

The existing primary sedimentation basins were expanded by adding two more treatment trains, and the entire system was enclosed within a building. The existing three primary sedimentation basins were retrofitted with new scraping machines to match the new basins. An odor control facility was also constructed for treatment of the primary sedimentation basin foul air.

Activated sludge treatment processes were introduced in the form of a covered "UNOX" deck, which consisted of a series of basins aerated with pure oxygen, generated in an adjacent cryogenic plant.

Originally, secondary treated effluent was to be disinfected with ozone. An ozone generator building was constructed, with a chlorine facility available as a backup. However, the ozonation system never provided an acceptable level of disinfection, and gaseous chlorine treatment was expanded to provide the sole form of disinfection at the plant.

Solids treatment was introduced with the 1979 expansion, with the construction of a solids handling building, including dissolved air flotation (DAF) and dewatering centrifuges. Four anaerobic digesters were constructed, along with all the pumps and piping for solids handling. A number of other new buildings and improvements were added, including an administration building, a plant laboratory, a maintenance building and a garage. Two other odor-control scrubbers were constructed: a south scrubber to handle the headworks building and equalization basins and a north scrubber to deal with the new solids handling and digester buildings.

1994 EXPANSION

Due to an increase in brewery loading in the late 1980's, the Plant began to experience difficulties in maintaining its NPDES permit limits. In particular, BOD and TSS limits were becoming increasingly constraining. At this time, city residents began complaining about large algal blooms in Capitol Lake and Budd Inlet. The Plant was identified as one of the primary contributors of nitrogen to the basin, and a decrease in dry weather loading was seen as the key in restoring the Lake and Inlet. Concurrently, City fire officials were growing increasingly concerned over the large amounts (6-8 tons) of gaseous chlorine being stored at the Plant. Particularly, given the Plant's location near downtown Olympia, this was seen as a critical safety hazard which required remediation.

All of these factors contributed to LOTT's decision to expand the plant. Construction began in 1992, with commissioning in 1994. In order to deal with the issue of nitrogen, the Plant switched from its pure oxygen secondary treatment to a four-stage biological nutrient removal system. The existing UNOX deck was converted to an anoxic basin, from which flow would be routed to a newly constructed aerobic basin. From there, the flow would pass through a second set of anoxic and aerobic basins constructed as part of the expansion. This modification required the purchase and installation of new blowers, and the removal of the cryogenic plant.

To eliminate gaseous chlorine, LOTT decided to switch to ultraviolet (UV) disinfection. The old ozone generators were removed, and a new UV disinfection building was constructed at the site of the existing chlorine contact channels. Other improvements included the addition of a soda ash storage tower (which to date has never been used), the construction of two activated carbon odor-towers for the first and second aeration basins, and an upgrade of the control systems to a DCS-Distributed Control System. The DCS consisted of three computer-controlled systems distributed throughout the Plant and connected to one central control computer. A fiber optic loop was added to provide reliability and redundancy. Capacity modifications also included raising the wall height of the secondary clarifiers by 18 inches, and the addition of a methanol storage tank, delivery system, and containment well. Puget Sound Energy added a second dedicated electrical line, and power substations E/F, and G/H were constructed.

Conveyance modifications included a gated bypass after the primary sedimentation tanks. Overflows flow to the disinfection channels and a diversion structure at the eastern end of the mixed liquor channel. The KGY outfall pipe was increased from 30- to 48-inches throughout most of its length. The final 300-feet was left at 30 inches due to construction restrictions in the shoreline zone. An additional run of 1,200-feet was left at 30 inches due to its location within a State-operated dangerous waste site formerly owned by the Cascade Pole Company. This portion of pipeline was repaired using in-situ forming. Influent pumps were upgraded from 100hp to 200hp, and the intermediate pumping station (pumping from the first anoxic basin to the first aeration basin) was constructed.

POST 1994 IMPROVEMENTS

In 1997, LOTT undertook an upgrade of its final effluent building and pumps. The two, 100hp existing pumps were replaced with 200hp models, and three new pumps were added (two 200hp and one 150hp). Around this same time, LOTT staff replaced the flights, scrapers, and chains in the primary sedimentation tanks, and upgraded the drives in all basins.

In 1998, another dewatering centrifuge in the solids handling building was added (single, high capacity solids machine) which nearly doubled the dewatering capacity. A new crane was purchased to handle the new, larger centrifuge. Additionally, new a polymer system was introduced, and the solids handling control room was modified.

From 1992-present, the Plant has been undergoing systematic roof replacement. The primary sedimentation basin building was repaired in 1992, followed by the blower building and digester building in 1994-1995. The administration building got a new roof in 1996, followed by the final effluent building in 1998, and, finally, the maintenance and headworks buildings in 2003.

In 2002, several digester gas piping failures led to a complete overhaul of the low pressure digester gas piping system. This project included the installation of new pipes, plus a new set of gas compressors. A headworks retrofit project was undertaken in 2003, to replace all influent bar screens. Phase I (two new screens and screenings washing/compacting system) was completed in October 2003, and Phase II (two new screens and a second washer/compacter unit) was completed in 2004.

Failure of one of the secondary clarifier launders in early 2004 prompted an emergency replacement of all secondary clarifier launders. This project included electrical upgrades, new sluice gates and operators, new access platforms for safety, and new stainless steel scum boxes.

A variety of aesthetic improvements were made around the Plant in 2004. These projects included the construction of a concrete screenwall near the reclaimed water facility and the installation of streetlights and sidewalk along Franklin Street and Marine Drive (the latter in partnership with the Port of Olympia). Finally, an influent flow meter was installed in September 2004, providing for real-time flow information integrated into the Plant's control system.

In 2005, a newly constructed Class A reclaimed water facility was comissioned at the Plant. The Dynasand filtration system has peak capacity up to 1.5-MGD producing Class A reclaimed water from Plant secondary effluent. Concurrent with this project was the replacement of the Plant's south odor scrubber.

The balance of this report will discuss the capacity of the Plant unit processes as they exist in 2005 and a capital and operating strategy to meet future needs.

CHAPTER 3

PLANT DISCHARGE CAPACITY

Discharge capacity for wastewater facilities planning is defined as the volume of material (both solids and liquid form) which is allowed to be transferred to another location for 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 use and receiving body. The conditions attached to the discharge capacity establish the performance basis for the Plant.

DISCHARGE CAPACITY – LIQUID

The LOTT Plant maintains liquid discharges to two separate receiving areas; Budd Inlet, a marine water body and a Class A reclaimed water distribution system. There are also separate regulatory requirements associated with each of these discharges.

The Budd Inlet discharge capacity is controlled by the National Pollution Discharge Elimination System (NPDES) permit administered by the State Department of Ecology (Ecology) under the authority of the Federal Environmental Protection Agency (EPA). A NPDES permit is required for all discharges to any navigable water body. These are issued at startup, are generally renewed on a 5-year basis and describe the requisite water quality conditions for discharge. The reclaimed water discharge capacity is controlled by two factors; demand for the product and a reclaimed water use permit administered by Ecology in conjunction with the State Department of Health. The reclaimed water permit defines the requisite water quality and application for identified uses. The actual demand, however, is subject to the number of users identified and when the users can accept delivery.

Operating permits are required by federal, state, and local agencies for the operation and maintenance of wastewater management services. These permits are generally focused on the wastewater treatment facilities.

The LOTT Plant operations and performance are largely determined by its discharge permit. Chapter 173-220 of the Washington Administrative Code transferred management of the National Pollutant Discharge Elimination System (NPDES) Permit program from the U.S. Environmental Protection agency (EPA) to the jurisdiction of the Washington Department of Ecology (Ecology). The permit program addresses point source discharge of pollutants into navigable waters of the state. LOTT discharges to Budd Inlet, a Class B estuarine reach of Puget Sound.

DISCHARGE CAPACITY – SOLIDS

The discharge capacity for the residual solids product (biosolids) from the Plant is regulated by a set of biosolids rules set forth in Chapter 173-308 WAC, and coverage under a State General Permit for Biosolids Management administered by Ecology. This permit specifies the public access limits and minimum product quality and treatment processes necessary depending upon the end use. LOTT currently elects to produce Class B product for land application which requires controlled public access.

Since the discharge capacity effectively establishes the operating performance conditions for the treatment plant, the following text describes the permit details.

Permit History

Until 2005, LOTT was regulated by an NPDES permit issued on December 17, 1993. This permit was originally intended to be effective through June 30, 1997, but a number of permit extensions had been instituted as LOTT moved through development of the WRMP, and the EPA moved through its regulatory cycle. This permit set forth Plant effluent limits of 15-MGD during dry weather months (June through September), with a maximum month flow of 22-MGD, and peak hour flow of 55-MGD. The permit also limited discharge constituents which may adversely impact water quality. As indicated in Table 3-1, these included biochemical oxygen demand (BOD), total suspended solids (TSS), fecal coliforms, ammonia nitrogen, and seasonal total inorganic nitrogen.

Table 3-1. Previous LOTT NPDES Permit (1993-2005)

Criteria	Limit[1]
Flows	
Annual average flow	17 mgd
Dry weather average	15 mgd
Maximum monthly average	22 mgd
Maximum day	36.5 mgd
Peak hourly to treatment plant	55 mgd
Biochemical Oxygen Demand	
Maximum Monthly Average	
(November 1- March 31)	5,504 lb/day
(April 1 - October 31)	3,670 lb/day
Maximum Weekly Average	
(November 1- March 31)	8,256 lb/day
(April 1 – October 31)	7,898 lb/day
Total Suspended Solids	
Maximum Monthly Average	5,265 lb/day
Maximum Weekly Average	7,898 lb/day
Fecal Coliform	
Maximum Monthly Average	200/100 mL
Maximum Weekly Average	400/100 mL
Ammonia Nitrogen Concentration *(November 1-March 31)*	
Maximum Monthly Average	26 mg/L
Maximum Daily	36 mg/L
Total Inorganic Nitrogen Concentration *(April 1-October 31)*	
Maximum Monthly Average	3.0 mg/L

New Permit

Budd Inlet is identified as a water body seasonally failing to meet federal water quality standards for several different constituents as contained in the 303(d) list (see Table 3-2). Budd Inlet is considered part of the Deschutes River watershed. In 2003 Ecology began a formal process to determine the achievable water quality conditions in the watershed and the total maximum daily loading (TMDL) to sustain these conditions. Scheduled to be completed in 2007, the TMDL process will further define the Plant performance and discharge capacity by establishing total pollutant mass emissions for Budd Inlet.

Table 3-2. Washington State's Water Quality Assessment [303(d)] List for 1998[1] WRIA 13 (Deschutes River Watershed)

Water Body	Parameter	
Budd Inlet (Inner)	2-Methylnaphthalene	Dibenzofuran
	Acenaphthene	Dissolved Oxygen
	Acenaphthylene	Fluoranthene
	Anthracene	Fluorene
	Benz(a)anthracene	Indeno(1,2,3-cd)pyrene
	Benzo(a)pyrene	Mercury
	Benzo(b)fluorene	Naphthalene
	Benzo(b,k)fluoranthenes	PAHs
	Benzo(ghi)perylene	PCB 1254
	Benzo(k)fluorene	pH
	Bis(2-ethylhexyl)phthalate	Phenanthrene
	Butylbenzylphthalate	Pyrene
	Chromium	Sediment Bioassay
	Chrysene	Total PCBs
	Copper	Zinc
	Dibenz(a,h)anthracene	
Budd Inlet (Outer)	Dissolved Oxygen	
	pH	
Capitol Lake	Fecal Coliform	
	Total Phosphorus	
Deschutes River	Fine Sediment	pH
	Instream Flow	Temperature
	Large Woody Debris	

1. The 1998 list is the most recent assessment.

In summer 2004, Ecology proposed guidelines for a new NPDES permit, which became effective on October 1, 2005. Since Budd Inlet is on the 303(d) list, EPA requires the new NPDES permit is a performance-based discharge limit with mass emission limits rather than flow. Performance limits represent the maximum discharges LOTT has historically released into Budd Inlet.

The new permit for the water quality limited periods in Budd Inlet redefines seasonal periods into the summer period from June through September, and adds a spring/fall "shoulder" period comprised of the months April, May, and October. Allowable BOD5 and Total Inorganic Nitrogen (TIN) loads are controlled by the limits contained in Table 3-3. The permit allows a 2-year period of adjustment during which permit limits would be relaxed (Table 3-3).

Table 3-3. Department of Ecology NPDES Permit Limits, Budd Inlet WWTP, Effective October 1, 2005

		Average Monthly			Average Weekly		Max Daily	Outfall[1]
		Load (lb/d)	Concentration (mg/l)	Removal	Load (lb/d)	Concentration (mg/l)	Concentration (mg/l)	
Interim Permit (Present – October 31, 2006)								
Summer[2]	BOD5	1050	9	85%	1576	13.5	--	1,2
	TIN	350	3	--	--	--	--	1,2
Shoulder[3]	BOD5	1251	10	85%	1876	15	--	1,2
	TIN	375	3	--	--	--	--	1,2
Final Permit (Spring, 2007) – subject to TMDL process								
Summer[2]	BOD5	671	7	85%	1006	10.5	--	1,2
	TIN	288	3	--	--	--	--	1,2
Shoulder[3]	BOD5	900	8	85%	1350	12	--	1,2
	TIN	338	3	--	--	--	--	1,2
Final Permit (no interim limits)								
Winter[4]	BOD5	5640	30	85%	8460	45	--	1,2
	NH3-N	--	26	--	--	--	36	1
	NH3-N	--	22	--	--	--	31	2
Year	TSS	5265	30	85%	7898	45	--	1,2
Round	Fecal Coliform	--	200/100	--	--	400/100	--	1,2
	Total Recoverable Copper	--	0.006	--	--	--	0.0075	2
	pH	Daily minimum is equal to or greater than 6, daily maximum equal to or less than 9						1,2

1. Outfalls 1 and 2 refer to North and Fiddlehead Outfalls, respectively
2. Summer = June, July, August, September
3. Shoulder = April, May, October
4. Winter = November, December, January, February, March

The seasonal limits are primarily mass-based, but include limits on average monthly and weekly concentration for certain constituents. As flow at the Plant increases, the mass-based values will become more limiting, as expressed in Figures 3-1 and 3-2 for the summer and shoulder periods respectively.

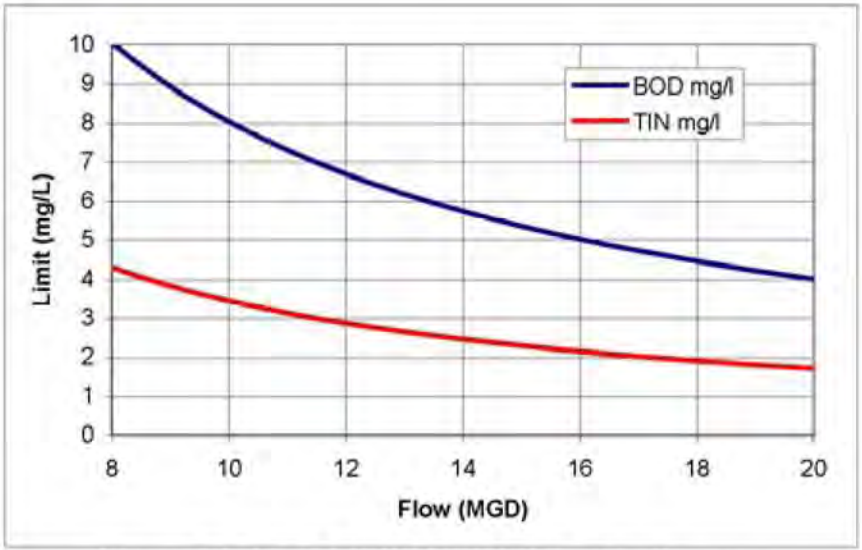

Figure 3-1. Final LOTT NPDES Permit, Summer

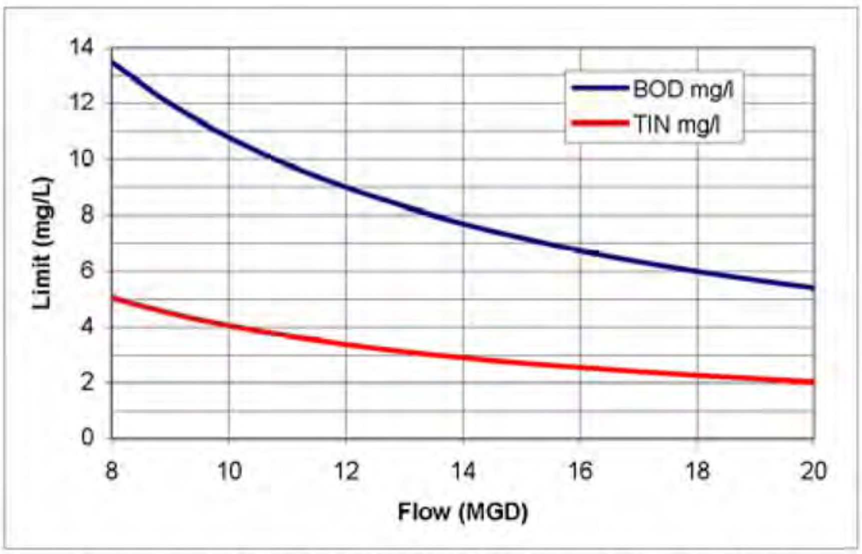

Figure 3-2. Final LOTT NPDES Permit, Spring/Fall

RECLAIMED WATER STANDARDS

The 1997 Washington State Standard for Water Reclamation and Reuse (Reuse Standards) were developed jointly by Washington State Departments of Ecology and Health and establish four (4) classes of reclaimed water (A, B, C and D). Class A represents the highest quality water and is suitable for human contact not including drinking. The Reuse Standards require wastewater to be oxidized, coagulated, filtered, and disinfected to meet the Class A standards. Water that is intended for groundwater recharge is subject to a higher standard of treatment. Although the Plant's Reclaimed Water Facility is not currently tied to groundwater recharge, groundwater standards shall be presented to allow for future expansion. Although the final permitted standards for reclaimed water produced at the treatment plant have not yet been published, the State provides the following typical values to serve as a permitting template. Table 3-4 summarizes typical Class A water quality standards and describes the additional treatment required for groundwater recharge.

Table 3-4. Summary of Class A Reclaimed Water Standards[a]

Constituent (units)	Class A Reclaimed Water Standards		Class A Reclaimed Water Standards (Groundwater Recharge)		Comment
BOD (mg/L)	Avg. Monthly 30	Avg. Weekly 45	Avg. Monthly 20	Avg. Weekly 30	Secondary effluent must at all times be oxidized to achieve Class A status.
TSS (mg/L)	Avg. Monthly 30	Avg. Weekly 45	Avg. Monthly 30	Avg. Weekly 45	Secondary effluent must be filtered to achieve Class A status.
Turbidity (NTU)	Avg. Monthly 2	Sample Max. 5	Avg. Monthly 2	Sample Max. 5	Secondary effluent must be filtered to achieve Class A status.
Total Nitrogen as N (mg/L)	See comment	See comment	Avg. Monthly 10	Sample Max. 15	Secondary effluent must be treated to a higher level to achieve Nitrogen removal for groundwater recharge.
Total Coliforms (#/100 ml)	7-d. Median 2.2	Sample Max. 23	7-d. Median 2.2	Sample Max. 23	Secondary effluent must be further disinfected to achieve Class A status.
pH	6-9	6-9	6-9	6-9	pH shall be between 6 and 9 standard units at all times.
DO	See comment	See comment	See comment	See comment	DO shall be measurably present at all times

[a] Values taken from State Reclaimed Water Permit 04-2002, available on Ecology website: http://www.ecy.wa.gov/programs/wq/reclaim/index.html

To facilitate regulatory review, Table 3-5 compares specific pertinent requirements of the Reuse Standards as they relate to the Plant design elements.

Table 3-5. Project Requirements Indicated by Washington State Standards for Water Reclamation and Reuse

Article/Section	Compliance Status
Definitions	The reclaimed water production process will begin with oxidized wastewater. The oxidized wastewater will be coagulated, filtered, and disinfected with a hypochlorite solution.
Article 1. Irrigation Section 1- Nonfood Crops Section 2- Land Treatment Systems Section 3- Food Crops Section 4- Landscape Irrigation	The proposed facilities are designed to produce Class A reclaimed water. Class A reclaimed water is suitable for use on all sites described in Article 1.
Article 2. Impoundments Section 1- Landscape Impoundments Section 2- Restricted Recreational Impoundments Section 3- Nonrestricted Recreational Impoundments Section 4-Constructed Beneficial Use and Constructed Treatment Wetlands	The proposed facilities are designed to produce Class A reclaimed water. Class A reclaimed water is suitable for use on all sites described in Article 2.
Article 3. Groundwater Recharge by Surface Percolation Section 1- Applicability Section 2- Treatment Requirements Section 3- Other Requirements Section 4-Evaluation	This article is not applicable to this facility. No groundwater recharge is proposed.
Article 4. Commercial and Industrial Uses Section 1- Fish Hatchery Basins Section 2- Decorative Fountains Section 3- Flushing of Sanitary Sewers Section 4- Street Cleaning Section 5- Washing of Yards, Lots, and Sidewalks Section 6- Dust Control Section 7- Dampening of Soil for Compaction Section 8- Water Jetting for Consolidation of Backfill Around Pipelines Section 9- Fire Fighting Section 10-Fire Protection Section 11- Toilet and Urinal Flushing Section 12- Ship Ballast Section 13- Washing Aggregate and Making Concrete Section 14- Industrial Boiler Feed Section 15- Industrial Cooling Section 16- Industrial Process Water	The proposed facilities are designed to produce Class A reclaimed water. Class A reclaimed water complies with state standards for reuse in all applications identified in Article 4. Additional treatment or blending with other water supplies may be necessary to satisfy more stringent water quality requirements associated with fish rearing.
Article 5. Other Uses of Reclaimed Water Section 1- Streamflow Augmentation Section 2- Other Uses of Reclaimed Water	The proposed facilities are designed to produce Class A reclaimed water. Class A reclaimed water is suitable for all uses described in Article 5.
Article 6. Other Methods of Treatment	This article is not applicable to this facility. The method of treatment used is included in the standards.

Article/Section	Compliance Status
Article 7. Sampling and Analysis Section 1. Protocols and Minimum Frequencies	
(a) BOD	(a) Oxidized wastewater samples are composited over 24 hours. Composite samples will be collected and BOD concentrations determined daily.
(b) TSS	(b) Oxidized wastewater samples are composited over 24 hours. Composite samples will be collected and TSS concentrations determined daily.
(c) Coliforms	(c) Grab samples for coliform analysis will be collected daily from Class A reclaimed water, at a time when the wastewater characteristics are most demanding.
(d) Turbidity	(d) Continuously recording turbidimeters will be used to monitor the turbidity of filtered wastewater. Turbidity shall be recorded at least every 4 hours.
(e) Dissolved Oxygen	(e) Grab samples for dissolved oxygen will be taken from Class A reclaimed water and measured daily at a time when the wastewater characteristics are the most demanding
(f) Laboratory Methods	(f) Approved laboratory methods will be used for analyses and analyses will be conducted at WDOE approved laboratories.
Article 8. Engineering Report Section 1. Scope and Minimum Requirements	This engineering report has been prepared to meet the scope and minimum requirements set forth by the State of Washington in Section 1, Article 8 of the Standards for Water Reclamation and Reuse.
Article 9. Operational Requirements	
Section 1. Personnel	The treatment plant has a sufficient number of qualified personnel to operate the reclaimed water facility.
Section 2. Maintenance	A preventative maintenance program will be prepared for the reclaimed water facility and incorporated into the treatment plant's maintenance program.
Section 3. Operating Records and Reports	Operating records and reports will be recorded and maintained according to WDOE requirements.
Section 4. Bypass	There will be no piping provisions in the design that could provide a means for untreated or partially treated wastewater to enter the reclaimed water distribution system. Inadequately treated reclaimed water is automatically discharged to a sanitary sewer.

Article/Section	Compliance Status
Section 5. Disinfection (a) Where chlorine is used as the disinfectant in the treatment process, a minimum chlorine residual of at least 1 mg/L after a contact time of at least 30 minutes is required.	(a) Sodium hypochlorite will be used as a disinfectant at a Ct value of 30 minmg/L will be maintained under all circumstances. Hypochlorite dosages will be increased to compensate for contact times less than 30 minutes to insure that Ct value of 30 minmg/L is maintained.
(c) A chlorine residual of at least 0.5 mg/L shall be maintained in the reclaimed water during conveyance from the reclamation plant to the use area unless waived by the Washington Departments of Health and Ecology.	(c) A chlorine residual of 0.5 mg/L will be maintained at all times in the farthest point of the distribution system. Provisions will be included to inject sodium hypochlorite solution at the reclaimed water facilities to maintain this residual.
Article 10. General Requirements of Design Section 1. Flexibility of Design	The proposed facilities will include process and piping flexibility to provide the highest degrees of treatment under varying circumstances. Included are standby filters and standby pumps to accomplish this. The water reclamation process flow is diverted to a sanitary sewer whenever reclaimed water quality conditions approach the maximum limits required for Class A reclaimed water.
Section 2. Alarms	Alarms will be installed to provide for warning of disinfection system failure (low chlorine residual) and coagulation system and filtration system failure (turbidity alarm). Failure of the existing plant's biological systems is presently alarmed by existing instrumentation systems. Alarms will be monitored continuously at these facilities.
Section 3. Power Supply	Water reclamation operations will cease as a result of power supply interruptions and will prevent partially treated water from entering the reclaimed water distribution system. Reclaimed water distribution pumps will be supplied with standby power to maintain the supply of reclaimed water (drawn from the reclaimed water storage tank) during power outages.
Section 4. Storage, Where No Approved Alternative Disposal System Exists	This section is not applicable since the existing treatment plant discharge to Budd Inlet is an approved alternative disposal system.

Article/Section	Compliance Status
Article 11. Alternative Reliability Requirements	
Section 1. Emergency Storage or Disposal	Since the existing wastewater treatment plant can discharge all of its secondary effluent to the receiving waters, there is no need to provide emergency disposal of reclaimed water. In the event of a failure of any of the reclaimed water treatment facilities, all treated plant effluent in the reclaimed water facilities will be discharged to the sanitary line leading to the headworks of the treatment plant.
Section 2. Biological Treatment	All provisions of this section are currently met by the existing treatment plant.
Section 3. Secondary Sedimentation	All provisions of this section are currently met by the existing treatment plant.
Section 4. Coagulation	The proposed facilities will include adequate polymer storage, supply, and metering capabilities. A polymer metering system will be provided.
	Provisions for automatically activated long term disposal meeting the requirements of Article 11, Section 1 will be provided.
Section 5. Filtration	Turbidity alarms will be provided to signal water quality failure in the filters. The alarm will automatically divert excessively turbid filtered plant effluent to the sanitary sewer as a long-term disposal option. Multiple filters will also be provided and capable of treating the entire flow with one unit out of service.
Section 6. Disinfection	Sodium hypochlorite will be used as the disinfectant. A dedicated standby metering pump will be provided to apply sodium hypochlorite downstream of the filters. Each metering pump will be alarmed for failure detection and non-disinfected filtered secondary effluent will be diverted to the sanitary sewer as a long-term disposal option.
Article 12. Use Area Requirements	All reclaimed water valves, lines, and storage facilities will be properly labeled according to State Standards for Water Reclamation and Reuse. Reclaimed water distribution and cross connection control will conform with State and City of Olympia standards. Setback distances shall be set according to State Standards for Water Reclamation and Reuse.

CHAPTER 4

PLANT DESCRIPTION

This chapter provides an overview of the Budd Inlet Treatment Plant. The Plant is made up of a number of constituent systems, each of which is discussed in terms of function, condition, and capacity. Design data are provided where applicable. Detention times for various components are provided in terms of peak monthly and peak hourly flows. Since the new NPDES permit does not define discharge flow limits, projected 2025 peak monthly and hourly flows of 32.6- and 86.4-MGD, respectively, will be used to calculate detention times.

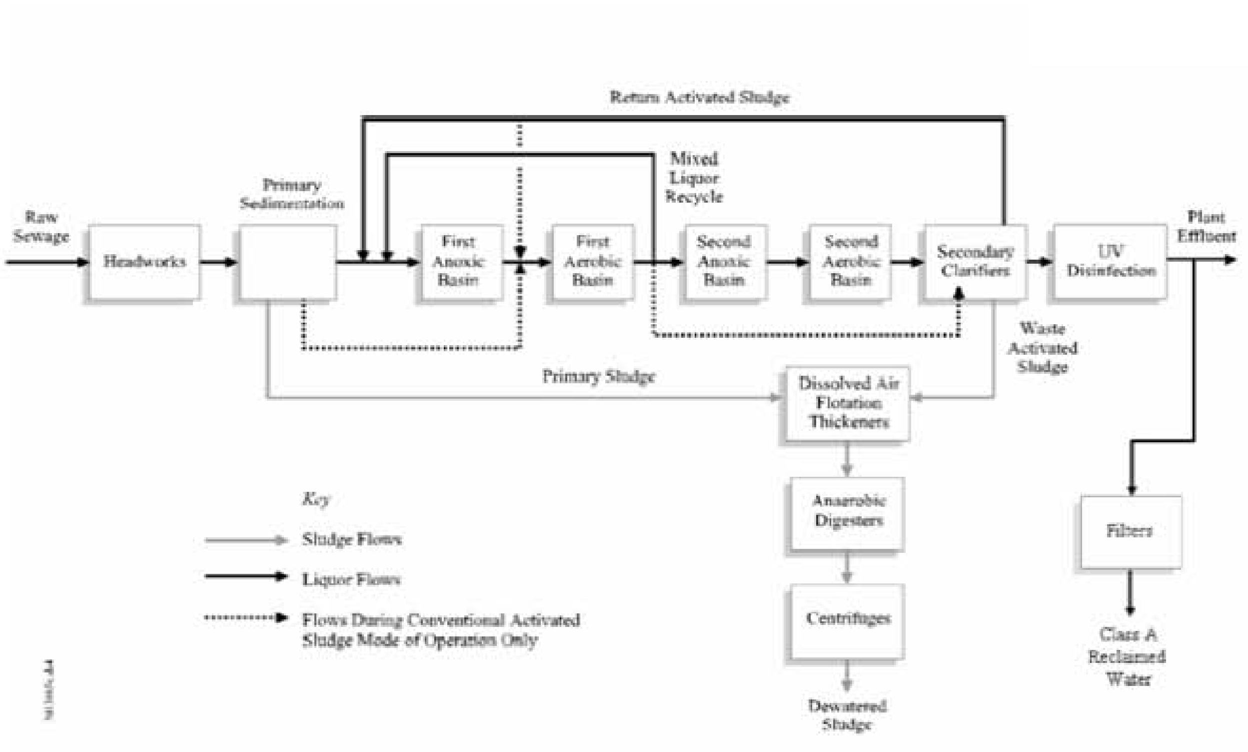

Figure 4-1. LOTT Treatment Plant Process Flow Schematic

LIQUID STREAM

Preliminary Treatment

The purpose of preliminary treatment is to remove large debris and easily settleable material from raw sewage.

Wastewater is directed through the headworks, which includes influent screens, grit removal tanks, flow equalization tanks, and influent pumps as shown on Figure 4-2. Table 4-1 contains design criteria for the preliminary treatment units.

Table 4-1. Preliminary Treatment Design Data

Process Element	Number of units	Design Value	Reference
Flow measurement			
Influent, accoustic doppler (ADFM), inches	1	60	(1)
Influent screening			
Mechanically-Cleaned Perforated Plate Escalator Screens	4		(3)
Perforated Screening Opening, inch		0.25	
Capacity (each), MGD		25	
Chopper Pumps, gpm	2	200	(3)
Screenings Compactors, ft^3/hr	2	45	(3)
Grit removal			
Aerated grit chambers	2		(2)
Length (ft)		55	
Width (ft)		20	
Average Depth (ft)		11.3	
Detention time @ PMF, min		10.8	
Detention time @ PHF, min		4.1	
Agitation air blowers	3		(2)
Grit pumps, recessed impeller, constant speed, gpm	10	150	(2)
Grit separator, cyclone, gpm	2	200	(2)
Grit washer, ton/yr	2	1.5	(2)
Influent pumps			
Large units, MGD (each)	4	18	(1)
Small unit, MGD	1	5	(2)
Flow equalization basins, MG (total)	5	2.5	(1)

(1). Discussion with Plant staff

(2). LOTT WRMP, 1998

(3). LOTT WWTP Bar Screen Replacement Engineering Report, CH2M Hill, 2002.

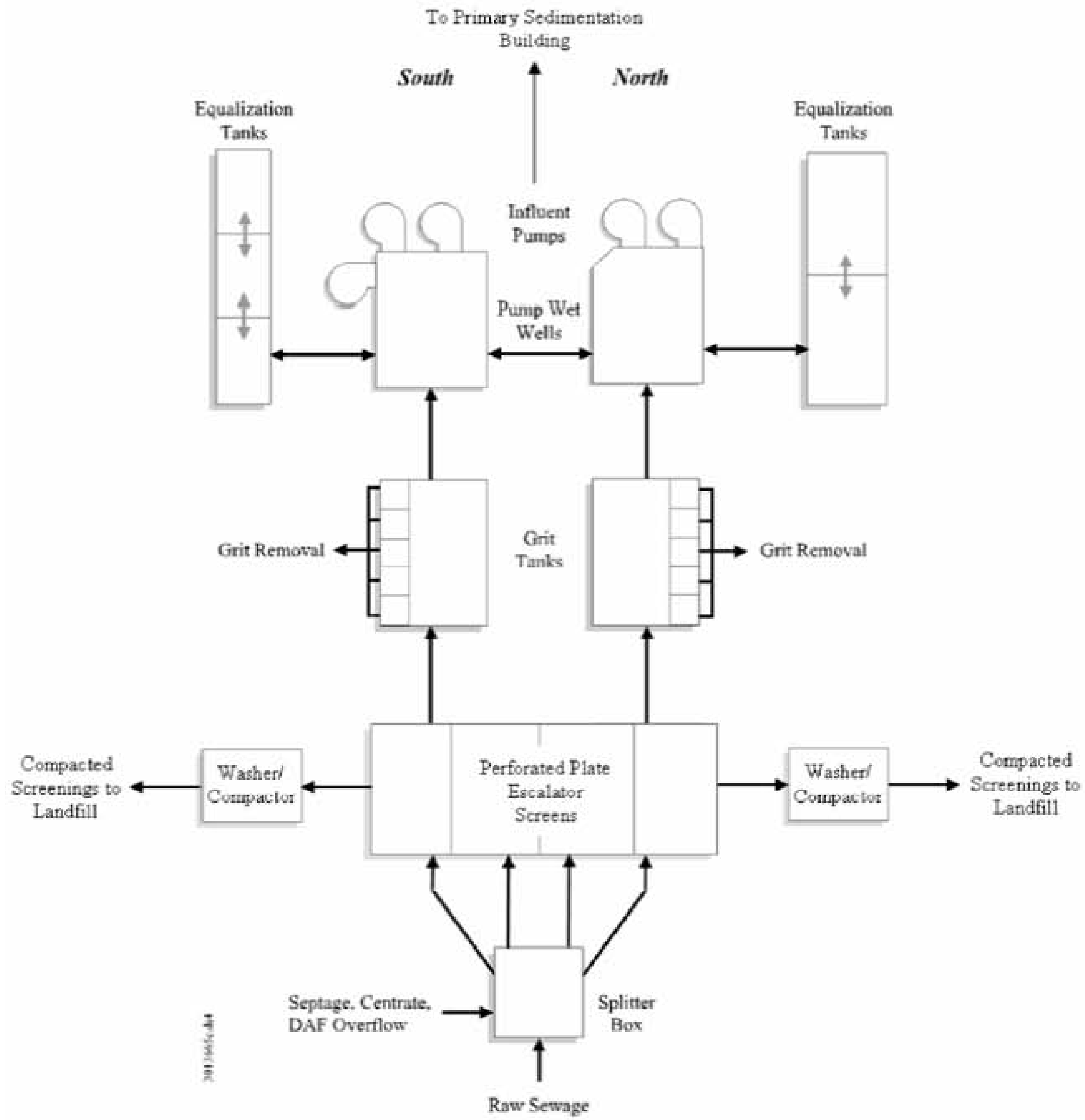

Figure 4-2. Preliminary Treatment Flow Schematic

Influent Flow Meter

LOTT has installed an Accoustic-pulse Doppler Frequency Modulating (ADFM) flow monitor in the 60-inch Plant influent pipe. The meter is tied into the Plant's control system, and allows for real-time control. The data logging script is currently programmed to report up to 100-MGD, but this value can be increased should the need arise.

Influent Screens

Raw sewage enters the treatment plant through the influent splitter box and four influent channels in the screening area. Motor-operated sluice gates at the head of each channel control influent raw sewage flow through the headworks. Four mechanically cleaned perforated plate escalator screens located in the channels remove large debris from the influent wastewater. Flow passes through a series of perforated plates which are continuously rotated along a circuit. As the circuit moves along, plates are brushed and screenings are conveyed to a pair of screenings pits. Macerating chopper pumps convey ground-up screenings to a washer/compactor unit, which dewaters the screenings to allow for landfill disposal. Each screen has a rated capacity of 33-MGD. Screenings are collected and hauled to the Thurston County landfill for disposal.

Grit Removal

After screening, wastewater enters two aerated grit removal tanks. Grit removal removes large inorganic and organic particles to protect downstream equipment from excessive wear and tear. Grit tanks have been designed for peak storm flow conditions.

According to the Department of Ecology's Criteria for Sewage Works Design (1998), also known as the Orange Book, aerated grit chambers should be designed for a peak flow detention time of 3 to 5 minutes. A 4-minute detention time corresponds to a peak flow of 87.9-MGD with both tanks online. This limit is just above the anticipated peak hourly storm flows through 2025 (Chapter 6), and substantially higher than the firm capacity of the influent pumps (54 MGD). Single tank firm capacity at 4-minute detention time is 43.9-MGD.

The detention time in the tanks is high enough for the tanks to serve as preaeration tanks under average flow conditions. Alternately, for flows up to 35-MGD (5-minute detention time for a single grit tank), one grit tank may be taken out of service to reduce energy consumption. Design criteria for the grit removal units are presented in Table 4-1.

The bottom of each grit tank is steeply sloped to accumulate grit into five collection hoppers on the side of the tank where it is removed and pumped for further processing. An air sparger at the bottom of each hopper keeps separated grit from becoming compacted. Three agitation air blowers supply air to the grit separation tanks. However, operations staff have found that only one blower is necessary for grit removal.

During draining and cleaning of the anaerobic digesters, grit and accumulated debris are directed through the north grit tank. During this procedure, the influent wastewater flow is diverted to the south grit tank.

Grit accumulated in the hoppers is removed through ten recessed impeller grit pumps and conveyed to the grit screening/handling room. The grit is then processed through a cyclone separator and a grit washer/classifier to remove fecal matter, excess water, and other highly biodegradable material. The settled grit is then screw conveyed to storage hoppers for disposal. Liquid supernatant from the separator and classifier are recycled to the plant influent splitter box.

Influent Pumping/Flow Equalization

The purpose of the influent pumping system is to lift and convey the degritted raw sewage to the primary sedimentation tanks through two 30-inch diameter force mains. Degritted sewage overflows from the west side of the two grit tanks to two influent wet wells (see Figure 4-2). A normally open, motor-operated sluice gate can be used to combine/separate influent wastewater streams or isolate pumps. Four variable-speed, 200-hp centrifugal pumps located on the west side of the wet wells and one variable-speed, 50-hp centrifugal pump located on the south side of the south wet well provide influent pumping capacity. The large pumps each have a capacity of 18-MGD. The small pump, with a capacity of 5-MGD, is used during low flow conditions and for trimming capacity on the larger pumps.

Scum and grease balls accumulate on the liquid surface on the influent wet wells but are eventually drawn down into the influent pump suction and removed in the primary sedimentation tanks. A more positive method of scum removal is needed for higher flows and loadings.

Equalization tanks provide up to 2.5 million gallons of storage in five tanks. Three equalization tanks are south of the south wet well beneath the employee parking lot. The tanks fill in series with the flow controlled by internal weirs. The two north equalization tanks are underneath the anaerobic digesters. All equalization tanks gravity-drain back to the wet wells. Prior to the 1993 plant upgrade, the flow equalization system provided temporary storage of wastewater during peak flow conditions. Hydraulic capacity was installed during 1993 that allowed direct treatment of influent peak-hour flows up to 64-MGD (firm capacity.) The combination of the flow equalization tanks and added hydraulic capacity reduces the probability of a Combined Sewer Overflow (CSO) event. Flow equalization can be used to minimize carbon loading fluctuations to the biological treatment process.

Primary Treatment

Primary treatment is used to remove easily settleable material from the raw wastewater. Primary treatment at the LOTT Plant includes flow measurement, seven rectangular primary sedimentation tanks with tipping trough scum collectors, surface return flight sludge collectors, and dedicated sludge pumps. Design data for the primary treatment process is shown in Table 4-2.

Table 4-2. Primary Treatment Design Data

Process Element	Number of units	Design Value	Reference
Primary Flow Measurement			
Influent, Parshall Flume, MGD	1	55	(1)
Primary Sedimentation			
Primary Sedimentation Tanks	7		(1)
Length (ft)		125	
Width (ft)		14	
Depth (ft)		8	
Detention time @ PMF, min		32.4	
Detention time @ PHF, min		12.2	
Sludge Pumps			(1)
Progressive cavity, gpm	1	200	
ODS positive displacement, gpm	4	100	

(1). LOTT WRMP, 1998.

Primary Influent Flow Measurement

The flow rate of raw, degritted sewage entering primary treatment is measured by a 60-inch throat-width Parshall flume located in the primary sedimentation tank influent channel. The discharge of the flume is several feet upstream of a 90-degree bend, which directs wastewater into the primary influent channel. The 90-degree bend is not desirable since it does not provide hydraulically smooth flow conditions for the flume discharge and it disproportionately loads individual sedimentation tanks. However, the resulting turbulent conditions downstream of the flume have not impaired flume calibration, according to Plant staff. This flow measurement is used by the plant computer to control influent gates and the pump speed for influent pumping, return activated sludge, waste activated sludge, and internal mixed liquor recycle pumping. The new Plant influent flow monitor, installed in 2003, currently acts as a backup system.

Primary Sedimentation Tanks

Seven identical and covered rectangular primary sedimentation tanks remove floatable materials and easily settleable solids from influent degritted sewage. The west tank is operated independently, whereas the remaining six tanks are hydraulically connected and operated in pairs. Wastewater is distributed to the primary sedimentation tanks from the distribution channel. Effluent from the primary sedimentation tanks overflows into weirs at the end of each tank. Removal rates average 60 to 70 percent for solids, and 20 to 40 percent for BOD. Sluice gates can direct primary effluent to the first anoxic basin or to an intermediate pump station wet well, depending on the biological treatment system mode of operation (see below) and flow levels. High level alarms in the intermediate pump station wet well can cause primary effluent to be bypassed to ultraviolet (UV) disinfection.

Chain and flight collectors run along the bottom of each tank to push the settled solids to collection hoppers at the upstream end of each sedimentation tank. The bottom longitudinal collectors convey settled solids to the hopper, and cross collectors transfer sludge from the hopper to the sludge pump sump. The upper return flight of the longitudinal collector moves floating materials to tilting scum skimmers at the downstream end of the tank. Floating material (scum liquor) flows by gravity to the scum holding tank located in the headworks building.

Primary sludge is removed from the primary sedimentation tanks and pumped to the dissolved air flotation thickeners. The plant staff has the option of using a set of four ODS diaphragm pumps (one dedicated to each pair of tanks) or through a single, positive displacement, progressing cavity (Moyno) pump. Plant staff prefer the progressing cavity pumps because a steady flow to the DAF is preferred for solids loading. Sludge flow is measured using a magnetic flow meter.

The primary sedimentation tanks perform well but are near the end of their useful life. The primary sedimentation tanks are the sole remnants of the original treatment plant constructed in the 1940s. Historically, LOTT has repaired these tanks for leaks and retrofitted them for process optimization and odor control. However, the condition of the subgrade structure will require these facilities to be replaced within the next few years.

Scum Handling

The scum handling system provides a single means of concentrating, storing, and disposing of scum collected from the primary sedimentation tanks and the influent wet wells. Scum from other sources, such as the secondary clarifiers and aeration and anoxic tanks, is routed directly to the influent splitter box through the septage and sanitary drain piping systems. An overhead spray system in each wet well can direct scum to a scum sump located between the two wet wells. Flow into the sump can be controlled by periodic opening and closing of two sluice gates. This scum collection system is not used because plant staff found it difficult to optimize the overhead spray system.

Scum collected from the primary sedimentation tanks is conveyed to the scum holding tank in the blower room of the headworks building. The Plant has recently instituted a biological scum digestion process which relies on the addition of specialized bacteria. These bacteria, stored in powder form, are activated by mixing with warm water. The warm water suspension is added to the primary sedimentation basins just upstream of the scum collection troughs. Scum plus the added bacteria flow to the scum holding tank. The scum holding tank has been modified to allow for oxygen addition via a flexible plastic bubbler, as well as a caustic drip to control pH. Plant staff can control the hydraulic retention time in the tank by adjusting the frequency and depth of pumpdowns. Currently, a detention time of 2.5 days has been implemented. The digested contents of the scum tank are pumped back to the Plant headworks. Since this process has been implemented, the Plant has been able to discontinue use of the scum concentrator, and eliminate the need for landfill disposal.

Foul air is exhausted from the primary sedimentation tank building through a mixed media odor control system housed inside the building.

Secondary Treatment Process

The secondary treatment process enables LOTT to meet its NPDES permit limits. Primary effluent is conveyed to the secondary treatment process for additional removal of organic carbon and, depending upon the time of year, nitrogen. The LOTT permit contain seasonal nitrogen limits for both summer and the spring/autumn shoulder period. In response to permit conditions, the secondary treatment process can be operated in two separate modes: 1) conventional activated sludge - carbon removal in winter; and 2) biological nutrient removal (BNR) - carbon and nitrogen removal during summer. With implementation of Class A Reclaimed Water production, the Plant is shifting to year-round BNR treatment to maintain the required low effluent nutrient levels. A process flow schematic for the secondary treatment system is shown on Figure 4-3. Biological nutrient removal uses all secondary treatment tanks, whereas conventional activated sludge relies on the first aeration basins to provide most of the treatment.

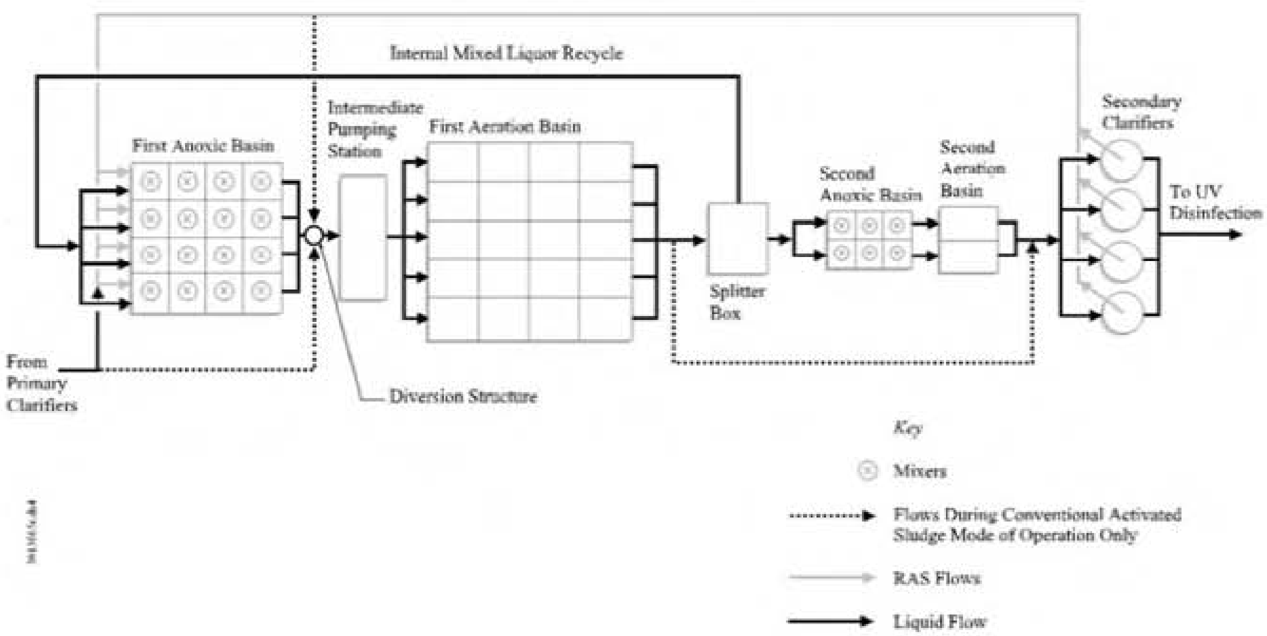

Figure 4-3. Secondary Process Flow Schematic

Flow through the secondary treatment system is controlled by the intermediate pump station and the splitter box. Other important components of the secondary treatment system include the process aeration blowers, channel aeration blowers, return activated sludge (RAS) pumps, methanol feed system, secondary clarifiers, and the soda ash feed system. Design data for the secondary treatment process is shown in Table 4-3.

Table 4-3. Secondary Treatment Design Data

Process Element	Number of units	Design Value	Reference
First Anoxic Tank (stage)	16		(1)
Length (ft)		42	
Width (ft)		42	
Depth (ft)		8	
Mixers, vertical propeller, hp	1	10	
Recycle Ratio, max		4:1	
Detention time @ PMF, hr		1.2	
Detention time @ PHF, hr		0.5	
First Aeration Basin (train)	5		(1)
Length (ft)		240	
Width (ft)		50	
Depth (ft)		24	
Aerators, fine bubble	Full bottom		
Mixers, vertical propeller, hp	1	25	
Detention time @ PMF, hr		7.9	
Detention time @ PHF, hr		3.0	
Second Anoxic Tank (stage)	6		(1)
Length (ft)		39	
Width (ft)		39	
Depth (ft)		24	
Mixers, vertical propeller, hp	1	15	
Detention time @ PMF, hr		1.2	
Detention time @ PHF, hr		0.5	
Second Aeration Basin (train)	2		(1)
Length (ft)		39	
Width (ft)		39	
Depth (ft)		24	
Aerators, fine bubble	Full bottom		
Detention time @ PMF, hr		0.4	
Detention time @ PHF, hr		0.2	
Process Aeration			(1)
Single stage centrifugal	4		
Power, hp		500	
Capacity, icfm		7,400	
Intermediate Pump Station			(1)
Vertical wet pit variable speed			
75-hp, MGD (each)	2	17	
150-hp, MGD (each)	4	33	

Secondary Clarifiers	4		(1)
Diameter (ft)		120	
Depth (ft)		14.5	
SOR @ PMF, gal/sf/day		721	
SOR @ PHF, gal/sf/day		1,920	
RAS Pumps	8		(1)
Power, hp		20	
Capacity, gpm		2,000	
WAS pumps	4		(1)
Power, hp		10	
Capacity, gpm		300	

(1). LOTT WRMP, 1998

Under the LOTT NPDES permit, the Plant can be operated to optimize biochemical oxygen demand (BOD5) removal without a total inorganic nitrogen (TIN) restriction. In this operating mode the first anoxic basins are bypassed and primary effluent is sent directly to the first aeration basins (via the intermediate pump station) for BOD5 removal.

The first aeration basin consists of five separate trains, each containing four cells (20 cells total). Return activated sludge is pumped from the secondary clarifiers to the distribution box at the southeast corner of the first aeration basin, where flow is proportioned to each operating train. Primary effluent may enter any or all of the first three cells. This feature allows the first aeration tank to be operated in plug flow, step feed, or reaeration schemes. The influent channel is equipped with channel aeration diffusers and foam suppression sprays.

Mixed liquor flows from the first aeration basin to the secondary clarifiers as shown in Figure 4-3. During conventional activated sludge operation, flow is directed to the clarifiers via a gate at the south end of the discharge channel. The discharge channel is equipped with aerators. The discharge channel is also equipped with floating scum skimmers at each end to collect and remove scum to the headworks.

Biological Nutrient Removal System

The LOTT Biological nutrient removal system operates a four-stage Bardenpho™ process to optimize total inorganic nitrogen removal from the plant effluent. The four-step process consists of: 1) first anoxic basin, 2) a first aeration basin, 3) second anoxic basin, and 4) second aeration basin. Nitrogen is selectively removed biologically by exposing the sewage through controlled alternating anoxic and aerobic environments to allow nitrification and denitrification to occur sequentially.

Organic nitrogen and ammonia are oxidized to nitrite and nitrate (nitrification) by nitrifying organisms in the first aeration basin. A large fraction of the nitrified mixed liquor is recycled to the first anoxic basin, where denitrifying organisms reduce the nitrate to nitrogen gas utilizing the primary effluent as a carbon substrate to achieve denitrification. Any residual nitrate not recycled to the first anoxic basin is denitrified in the second anoxic basin. The denitrified mixed liquor is reaerated in the second aeration basin prior to proceeding to the secondary clarifiers. While some nitrogen, as ammonia, is utilized in cell synthesis, the majority of the influent nitrogen is removed from the wastewater as nitrogen gas.

Biological nitrogen removal is sensitive to temperature and solids retention time (SRT) and require an adequate supply of readily biodegradable carbon, measured as BOD or chemical oxygen demand (COD) in the influent wastewater. Until early 1996, the LOTT plant influent contained sufficient BOD to achieve the desired level of denitrification. Irregular discharges from the Olympia Brewery Company caused a depletion of the readily biodegradable portion of organic carbon substrate when the brewery was not in production. Enforcement of a pretreatment program also substantially reduced the supply of readily biodegradable carbon.

Methanol supplementation of the influent carbon substrate immediately upstream of the second anoxic basin was successfully implemented to sustain denitrification in the face of decreasing brewery flows during the late 1990s to the brewery closure in 2003.

When the biological nitrogen removal process is not in operation (November 1 through March 31), the first and second anoxic basins and the second aeration basin are bypassed via the diversion structure as shown on Figure 4-3. Under this operating mode, primary effluent flows to the intermediate pump station and then is pumped to the first aeration basin. Return activated sludge is added with the primary effluent.

First Anoxic Basin

The purpose of the first anoxic basin is to denitrify combined RAS, mixed liquor recycle, and primary effluent when operating in nutrient removal mode. Prior to the 1994 expansion, the first anoxic basin was a high purity oxygen activated sludge basin. During the expansion, the structure was modified to provide four parallel trains of four anoxic cells (16 total cells). Each cell is stirred using a 10 hp vertical mixer. Originally, these mixers were surface aerators that were retrofitted with motors, shafts and propellers for mixing to minimize air entrainment. The mixers are controlled by dissolved oxygen concentration measured in the first cell of each train.

Primary effluent enters the east end of the anoxic basin through control gates in the first cell of each train. The return activated sludge flow is distributed using weirs upstream of the first cell of each train. Internal mixed liquor recycle is discharged to the bottom of the first cell of each train through a dedicated pipe from the splitter box. Denitrified mixed liquor is conveyed to the intermediate pump station for further processing.

Since the first anoxic and first aeration tanks are physically separated, operational flexibility is compromised and nutrient removal performance reduced because staff cannot finely adjust the anoxic tank volume in response to changes in the influent loadings. In order to function optimally, readily biodegradable substrates should be consumed in the anoxic basins, and should not be available to the aerobic basin. This requires a careful balance between the anoxic and aerobic basin volumens, which currently can only be achieved by bringing entire treatment trains in- and out-of-service.

Plant operating staff has not reported any mechanical operational problems in the first anoxic basin. However, the rotational speed of the mixers has resulted in some process problems associated with air entrainment. The presence of air in the anoxic tank can provide a selective advantage against preferred organisms, which also reduces denitrification process effectiveness. The first anoxic basin is bypassed when operating in the conventional activated sludge mode.

Intermediate Pump Station

The purpose of the intermediate pump station is to lift and transfer primary effluent, denitrified mixed liquor, plus RAS and recycle flows to the first aeration basin as shown on Figure 4-3. The Intermediate Pump Station contains two wet wells. Each wet well houses two 30-inch, 150-hp and one 24-inch, 75-hp vertical pumps with variable frequency drives.

The intermediate pump station raises the mixed liquor and primary effluent flow by about 10 feet to allow mixed liquor to flow by gravity through the remaining elements of the secondary treatment process and UV disinfection. Since the primary effluent plus RAS and recycle flows are pumped, there is a substantial operating cost penalty. This penalty will increase proportionally with energy costs.

First Aeration Basin

The purpose of the first aeration basin is to provide air for carbonaceous oxidation and nitrification. This basin was constructed during the 1994 expansion. Since the basin is physically separated from the other secondary treatment basins, it contributes to the operational complexities and operational costs.

The first aeration basin consists of five separate trains, each containing four cells (20 cells total). Under the conventional mode of operation, return activated sludge is pumped from the secondary clarifiers to the distribution box at the southeast corner of the first aeration basin, where flow is proportioned to each operating train. Primary effluent may enter any or all of the first three cells. This feature allows the first aeration tank to be operated in plug flow, step feed, or reaeration schemes. The influent channel is equipped with channel aeration diffusers and foam suppression sprays. Under the BNR mode of operation, return activated sludge is pumped back to the first anoxic basin.

Mixed liquor proceeds from the first aeration basin to the splitter box (Figure 4-3). During BNR operation, a gate in the north end of the discharge channel opens, directing flow to the splitter box. Aerators in the first aeration basin discharge channel are turned off to limit dissolved oxygen entering the anoxic basins. As in the conventional activated sludge mode, floating scum skimmers in the discharge channel collect and remove scum to the headworks.

Process air is provided to the first aeration basins through a network of fine-bubble, membrane diffusers located in a fixed grid at the bottom of each tank. Diffusers are 9-inch diameter, membrane type. The aerator grid is arranged to facilitate air delivery and operational flexibility. The diffusers are arranged more densely in the upstream end of each tank to allow more air to be introduced where oxygen demand is greatest. Each cell contains a number of blank diffuser holders equal to approximately 10 percent of the total diffusers in the cell to allow for additional diffusers if necessary. In the fourth cell of each train, diffusers have been placed in three rows around the cell perimeter. This enables the mixed liquor dissolved oxygen concentration to decrease to less than 0.5 mg/L prior to transfer to the first or second anoxic basins. High dissolved oxygen concentration in the anoxic basins disrupts the denitrification process. A 25-hp mechanical mixer located in the fourth (final) cell of each train keeps the mixed liquor solids suspended.

The diffused aeration system uses compressed air from blowers located adjacent to the first anoxic basin. The main aeration header, which supplies process air, runs across the east end of the first aeration basin to two separate headers branching off for each train. One header serves the first three cells of each train and the second leg delivers air to the fourth cell only. For maintenance purposes, each train can be isolated with a manual butterfly valve.

For process air control between basins, each header is equipped with motorized, modulating butterfly valves. The position of each valve is controlled by dissolved oxygen concentration. Manual butterfly valves on the drop leg to each cell allow air flows to be balanced between cells in a train. Hot wire anemometers upstream of each motorized valve continuously measure airflow. Also, portable airflow monitors may be placed in each drop leg for airflow balancing between cells.

In 1997, Plant staff reported widespread deterioration and failure of the diffuser membrane material. This resulted in larger air bubbles and reduced the oxygen transfer efficiency. The diffuser manufacturer (Sanitaire) supplied two alternative membrane designs which have been installed without further problem.

Splitter Box

The splitter box is a hydraulic control structure used to distribute recycle and finish flows between the first and second anoxic basins in the nutrient removal mode. The structure is located immediately upstream of the second anoxic basin. Modulating pneumatic plug valves control the flow of nitrified mixed liquor from the first aeration tank to the first anoxic basin for denitrification based upon a manually set recycle ratio. Modulating hydraulic slide gates are used to equally split the flow of mixed liquor to two trains in the second anoxic basin. The flow rate through the second anoxic basin is equal to the sum of the plant influent and RAS flow rates. The splitter box is not used during conventional activated sludge mode operation.

The splitter box influent flow rate is measured with a 60-inch magnetic flow meter. Four 25-inch diameter pipes are used to convey flow from the splitter box to the first anoxic basin. Each pipe is equipped with a magnetic flow meter and a pneumatic plug control valve.

Second Anoxic/Second Aeration Basin

The second anoxic and second aeration basins provide the final biological denitrification and nitrification steps prior to settling and disinfection. This basin was installed during the 1994 plant expansion and consists of two trains each with four cells (eight total cells) (see Figure 4-3). The first three cells of each train serve as the second anoxic zone and the fourth cell as the second aeration zone. This basin is in service only during nutrient removal mode. Mixed liquor from the splitter box is proportioned into the first two cells of each train. The first cell of each train can also be isolated from the downstream cells. This allows operation of three, four, or six anoxic cells to optimize final denitrification. Mixed liquor from the anoxic cells flows to the final two aerated cells. During warm weather, the plant may with one second anoxic/second aeration basin train in operation. Both trains are used during cool weather conditions because of the slower reaction rates.

Air is supplied to the second aeration basin similarly to the first aeration basin. Mixed liquor from the second aeration zone flows to the diversion structure and on to the secondary clarifiers.

Process Aeration Blowers

Process air is supplied to the first and second aeration basins using four constant speed, single-stage centrifugal blowers. The blowers, manufactured by Roots are rated at 7,400 cubic feet per minute (icfm) and equipped with 500-hp motors. The blowers operate under a cascade control system.

Secondary Clarifiers

The purpose of the secondary clarifiers is to separate mixed liquor solids from liquid effluent for disinfection. The four Dorr-Oliver secondary clarifiers, installed in 1976, have a 120 feet diameter and a 15-foot sidewater depth. Designed as center feed and peripheral overflow units, they are equipped with inboard launders and weirs. During 2003 several of the launders failed and LOTT replaced the fiberglass units with a concrete launder and weir attached to the exterior wall. The result of this project was a reduction in the overall weir length however, the launder also created a baffle to deflect short circuiting eddies back into the sludge blanket. The net effect of these improvements on the capacity had not been assessed at the time of this report. Settled sludge is drawn from each clarifier through dedicated return activated sludge (RAS) pumps from an intake manifold located on the collector rake arms.

Each clarifier is equipped with two RAS and one WAS pump. The eight RAS pumps are vertical, mixed-flow, wet pit type pumps with variable speed drives. A magnetic flow meter is used to measure the flow from each pair of pumps. In conventional activated sludge mode, two pumps withdraw RAS from each clarifier and recycle it to the first aeration basin. In nutrient removal mode, RAS is recycled to the first anoxic basin.

Waste activated sludge (WAS) is withdrawn from each RAS wet well and directed to the dissolved air flotation thickeners for solids processing. The four Stromag WAS pumps are equipped with variable speed drives. The WAS pumps are used to maintain the solids retention time (SRT) for the secondary treatment process. The WAS pumps are operated continuously to even out the load to the dissolved air flotation thickeners.

Generally, the secondary clarifiers perform very well, producing effluent with suspended solids concentration below 10 mg/L when mixed liquor settling performance is unimpaired by filamentous organisms.

Methanol Feed System

The purpose of the methanol feed system is to supply readily biodegradable carbon when the carbon to nitrogen (C:N) ratio in sections of the biological treatment system falls below operating limits required for adequate nutrient removal. These conditions have become more common since the shutdown of the brewery. Methanol can be pumped to the primary sedimentation tank effluent channel or the influent channel of the second anoxic basin depending upon biological treatment process objectives. Methanol is stored in a 7,000-gallon, above-ground tank adjacent to the UV disinfection building. The methanol delivery system is computer controlled.

Soda Ash Feed System

Although this system has never been used, the soda ash feed system could provide additional alkalinity when nitrification lowers the existing alkalinity too much. The system consists of a storage silo, a volumetric feeder, a solution tank mixer, two slurry pumps, and a bin vibrator. This system delivers a soda ash or lime slurry at the diversion structure adjacent to the second anoxic basin.

Ultraviolet Disinfection

The ultraviolet (UV) disinfection system is the final liquid stream processing step. Its purpose is to disinfect the secondary effluent to maintain fecal coliform concentrations below 200 MPN/100 mL on a monthly average basis and 400 MPN/100 mL on a weekly average basis to satisfy NPDES permit requirements. The ultraviolet disinfection system consists of seven channels, each 5 feet wide and 25 feet long. Six channels are equipped with Trojan 4000 UV disinfection equipment, while the seventh is vacant for future expansion. A UV disinfection system relies upon UV light exposure time from the lamps. To optimize exposure to UV light, water depth in each channel is maintained at 2 feet to ensure complete submergence of the lamps. Each channel can disinfect between 3 and 11 MGD of secondary effluent.

Individual UV lamps are 58 inches long and arranged in modules across the width of a channel. A module contains eight vertically stacked lamps spaced three inches apart. A group of 20 modules are installed across the width of each channel forming a bank of lamps. Each channel contains two banks of lamps. The spacing of the lamps provides sufficient UV radiation to ensure destruction of pathogenic microorganisms during the hydraulic residence time in the channel. The performance of the UV disinfection system is contingent on the successful performance of the secondary clarifiers, since high suspended solids will block the UV radiation and reduce the amount available for disinfection.

The operational manual recommends rotation of the channels on a periodic basis. However, this resulted in an elevated rate of lamp failure (lower mean time to failure). Also, infrequent wetting of channels led to the proliferation of flies in the UV building. Consequently, the plant staff changed the operations to maintain flow through at least two channels for long periods of time. This has reduced the frequency of lamp failures and minimized the occurrence of flies by keeping active channels full of water.

Current operational practice is to shutdown the UV disinfection system in the event of a plant power outage. Once switched to emergency power, all six channels may be operated, depending on power usage throughout the Plant. The UV lamps and influent gates to these two channels must be manually started before primary effluent can be processed under these circumstances. Up to 33-MGD can be treated under emergency power operations.

Effluent Pump Station

UV-disinfected secondary effluent flows to the effluent pump station for discharge from the Plant to Budd Inlet or sent to the reclaimed water filters. The pump station is equipped with seven (7) pumps and (3) three wet wells (A, B, and C), connected by motor-operated sluice gates. There are five pumps in Wet Well A discharging to the North Outfall. Plant staff report an operational pumping limitation of 50-MGD (total effluent flow) due to pressure in the outfall pipeline. One pump in each of wet wells B and C route discharges to the Fiddlehead outfall; they are used only for pumping overflows from the equalization basins and disinfected final effluent under emergency conditions. Plant staff estimate pump capacity at approximately 15-MGD per pump. The normal mode of operation is to have all the gates open except a bypass gate. This provides a larger working volume and simplifies maintenance of a wet well level set point.

Wet well A also contains three 50-hp vertical turbine pumps. These pumps (1,100 gpm at 128 feet total head) are used primarily to feed the Plant's Reclaimed Water Facility with secondary effluent passed through a self-cleaning strainer. A portion of this flow is diverted upstream of the strainer to provide unscreened fill water for the thickeners. A portion of the strained secondary effluent is directed to the low temperature heat loop system which supplies cooling water to heat exchangers in the blower building. This system is also used to fill the first aeration and the second anoxic/second aeration basins.

Reclaimed Water Facility

The Plant's Reclaimed Water Facility, completed in 2004, uses a sand filter and sodium hypochlorite disinfection to bring secondary effluent up to Class A Reclaimed Water Standards. The Facility is capable of treating up to 1.5-MGD of flow on a continuous basis.

Secondary effluent is conveyed to the filters from effluent Wet Well A via a low-pressure force main. The force main is routed near the chemical metering building to allow for injection of coagulants and sodium hypochlorite solution for disinfection, prior to discharge at the filters. A two stage static mixer installed in the force main downstream of the chemical injection points provides flash mixing of coagulants and disinfectants in the oxidized wastewater stream upstream of the filters.

Coagulated plant effluent is filtered and then discharged to the contact basins for disinfection. Filtration rates are adjusted by varying the speed of the filter feed system pumps. The sand media in each filter is circulated and backwashed via a pair of sand circulating/ backwashing units. Aside from the sand media, these filters do not have moving parts. The airlift pump mechanism in each sand circulator/backwash unit is driven by an air supply furnished from the plant's existing service air system. Although these filters are often capable of unit filtration rates in excess of five gpm per square foot of filter bed (area of a horizontal section through the filter bed), the filters for this unit are based on a maximum design unit filtration rate of 3.5 gpm/sf.

The State of Washington's Standards for Water Reclamation and Reuse require a 0.5 mg/L total chlorine residual in the transmission lines. This cannot be accomplished with a UV system. For these reasons, sodium hypochlorite solution is used as a disinfectant. State guidelines for Class A reclaimed water also require a one mg/L chlorine residual at the end of a 30-minute contact time for chlorine disinfection. A contact basin downstream of the sand filter ensures that the appropriate contact time with the disinfectant is achieved. A chlorine residual analyzer provides a feed back control system for the initial bleach additions. A second chlorine residual analyzer verifies that free chlorine residual is at least one mg/L at the outlet from the collection channel for the contact basins.

This water is filtered and disinfected to Class A standards, and a portion is stored in a 140,000 gallon capacity clear well. Three vertical turbine pumps draw water from the clear well to be distributed through the plant for equalization basin washdown, scum and foam suppression spray systems, cooling makeup water, and in the grit washers and pump seal water systems.

Reclaimed water distribution and pumping is accomplished via three variable speed vertical turbine pumps, each located in a sump adjacent to the storage tank. The system is designed so that two pumps will be capable of providing a reclaimed water distribution pumping capacity of approximately 2100 gpm at a minimum pressure of 65 psi. The third pump is a standby pumping unit. A variety of specialty valves have been included in the pumping system to relieve pressure surges in the force main, air trapped in the line, and potential vacuum conditions. A hydropneumatic tank maintains system pressure and flow during pump starts, minimizes pump cycling, and dampens pressure surges in the distribution system. Since there is no elevated storage available in the distribution system, the hydropneumatic tank provides the only water storage in the distribution system piping. The hydropneumatic tank also acts as a large pulsation dampener and attenuates pressure fluctuations in the line.

The Reclaimed Water Distribution Pumping System is not currently connected to the Plant's emergency power system, and is shut down during power outages.

Transmission piping consists of 12-inch ductile iron pipe. The transmission line alignment follows Adams Street and then heads west on Olympia Avenue to Heritage Park. The force main ultimately routes to the Capitol Lake Pump Station. From this location, Class A Reclaimed Water can be supplied to number of users, including local parks, commercial and industrial users, and to sites for groundwater recharge, if desired. Distribution discharge pressure is set at 65 psi.

Budd Inlet Outfall

The LOTT Plant has two 48-inch outfalls. Figure 4-4 shows the location of both outfalls with the mixing and acute dilution zones identified. Treated effluent is discharged to Budd Inlet out of the North Outfall that extends 953 feet off of the shoreline near the northern terminus of North Washington Street. The final 250 feet of the outfall contains the 48-inch diffuser section, with an invert of approximately 19 feet below mean lower low water (MLLW). The mixing zone extends 213.5 feet from the last discharge port at both ends of the diffuser section and 215 feet from the centerline of the diffuser section. The acute zone extends 21.4 feet from the ends of the diffuser and 21.5 feet from the centerline of the diffuser pipe.

The North Outfall is used for all Plant flows up to 64.0 mgd at mean higher high water (MHHW) and approximately 85 mgd at MLLW. Peak flows in excess the North Outfall capacity may be discharged through the Fiddlehead Outfall only in the case of an emergency. The Fiddlehead Outfall no longer has a diffuser section and may be exposed at lower tide elevations. Consequently, it effectively does not have a mixing zone and it cannot be relied upon as a discharge. In the case of an emergency, the Plant must notify the Department of Ecology before diverting flow to this pipe.

The North Outfall was upgraded from 30- to 48-inch diameter in 1997. A portion of the pipeline runs through a State-regulated dangerous waste site formerly used by the Cascade Pole Company. The challenges involved in working within the regulated site forced the LOTT Alliance to leave this section of pipe in place, using an in-situ forming process to correct the deteriorating pipeline condition. As a result, approximately 1,200 feet of the North Outfall run remains at 30-inch diameter, creating a flow bottleneck. Approximately 700 feet of the 30-inch pipe is located within the bentonite cut-off wall which defines the dangerous waste site.

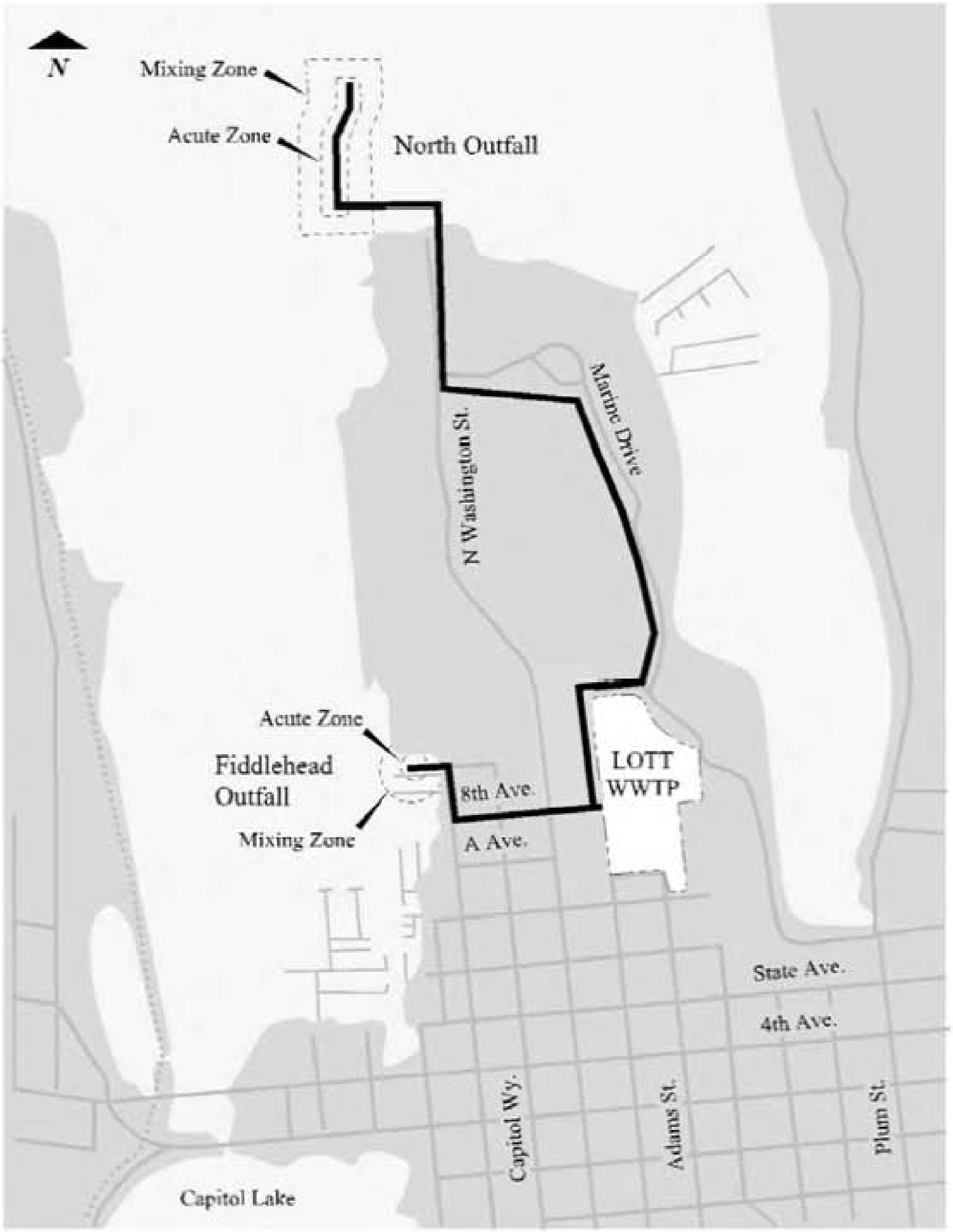

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Figure 4-4. LOTT Outfalls and Mixing Zone Locations

Table 4-4. Solids Treatment Design Data

Process Element	Number of units	Design Value	Reference
Thickening			
Dissolved air flotation tanks	4		(1)
Length (ft)		43	
Width (ft)		14	
Depth (ft)		12	
Sludge withdrawal pumps, gpm	4	100	(1)
Digestion			
Anaerobic digesters	4		(1)
Diameter (ft)		70	
Depth (ft)		30	
Sludge transfer pumps	3		(1)
Power, hp		10	
Capacity, gpm		250	
Sludge recirculation pumps	5		(1)
Power, hp		10	
Capacity, gpm		310	
Gas circulating compressors	5		(1)
Power, hp		20	
Pressure, psig		25	
Capacity, scfm		180	
Dewatering Centrifuge			
Low capacity units, lb/hr	2	1,500	(2)
High capacity unit, lb/hr	1	2,500	(2)

(1). LOTT WRMP, 1998

(2). Discussion with Plant staff

Solids Stream Unit Processes

The purpose of the solids handling unit processes is to reduce the quantity and moisture content of the sludge produced in liquid stream processes. The existing LOTT plant uses dissolved air flotation (DAF) for thickening, anaerobic mesophilic digestion for solids stabilization, and centrifuge dewatering for final moisture reduction, as shown on Figure 4-1. Design data for the solids treatment system is contained in Table 4-4.

Combined primary and waste activated sludge from the liquid stream is measured by a magnetic flow meter prior to thickening. Process biosolids (term used to describe stabilized and dewatered sludges from municipal wastewater treatment plants) are hauled from the Plant for reuse at several land disposal sites on a contract basis.

Sludge Thickening

The purpose of sludge thickening is to remove excess water from combined primary and waste activated sludge (mixed sludge) prior to anaerobic digestion. The sludge thickening system contains four rectangular 600 sf Rexnord dissolved air flotation (DAF) units. Piping exists for separate thickening of WAS and primary sludge, however, the plant does not operate in this mode since primary sludge thickening results in excessive wear and tear on mechanical equipment. Historically, the DAF units have produced a thickened sludge with 5 to 6 percent solids content with polymer addition.

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 DAF effluent is recycled to the pressurization tank, and the pressure is elevated to 40 psig using the plant's high-pressure service air. Pressurized flow from the tank is passed through a pressure release valve, where it combines with the sludge feed to the DAF thickener. Thickened sludge floats to the surface where surface skimmers collect it to hoppers for transfer to the anaerobic digesters. Operation of the pressurization tanks at pressures greater than 40 psig has resulted in generation of large bubbles, which break up the sludge blanket.

Sludge which falls to the bottom of the DAF unit, is conveyed to bottom hoppers with bottom flight collectors and directed to the thickened sludge pumps. Clarified effluent (supernatant) drains to the headworks for processing with the liquid stream. Polymers are used to enhance sludge thickening and performance of the DAF thickeners. Liquid polymer may be added in the sludge feed line or to the pressurized flow.

The plant measures all the sludge flows to and from the DAF. Suspended solids probes, originally installed to measure the total suspended solids of the WAS, the thickened (float) sludge, and the bottom sludge have been removed from service since they proved to be unreliable.

Although each DAF unit was originally designed for a maximum loading of 600 lb/hr (24 lb/sf/d) solids, these units often receive loadings in excess of 800 lb/hr (32 lb/sf/d). Plant operating experience has demonstrated consistent performance levels up to these increased loading rates.

Anaerobic Digestion

The purpose of the anaerobic digesters is to biologically stabilize thickened sludge by converting easily degradable portions to carbon dioxide, methane, and water. Total volatile solids reduction ranges from 30 to 60 percent. Following anaerobic digestion, the residual material (referred to as biosolids) is suitable for land application. Anaerobic sludge digestion facilities at the LOTT plant include four 70-ft diameter, 30-ft deep, concrete tanks with floating covers. Digesters may be operated in single-stage (parallel) or two-stage (series) modes. Normal practice is to operate two digesters in parallel as primary digesters, feeding a third digester which acts as a secondary digester. The fouth digester is held is reserve. Normally, combined thickened sludge is fed to the anaerobic digesters. However, the digesters are also configured to receive primary sludge directly from the primary sedimentation tanks and thickened WAS from the DAF units. Design data for the anaerobic digesters is listed in Table 4-4.

The anaerobic digester equipment building contains all process mechanical equipment needed to efficiently operate the digestion process. Thickened sludge is fed to the bottom of the digesters through the circulating sludge system in the center of the tank. Circulating sludge is withdrawn from four separate locations around the perimeter of each digester and pumped to the sludge heat exchangers before being returned to the digesters to assist in keeping them completely mixed. The heat exchangers are used to maintain mesophilic conditions (normally at 95° F) in the digester. By-product digester gas is the principal fuel for the high temperature heat loop system. Hot water from the heat loop system is pumped and recycled through the sludge heat exchangers.

Digested sludge is withdrawn from the bottom of the digester and pumped to solids dewatering centrifuges to remove excess water. 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 (this is used particularly in two-stage operations). Digesters may be drained by gravity to the aerated grit chambers.

Each digester is equipped with floating gasholder-type covers which are supported by digester gas pressure. The gas pressure is maintained at approximately 13-inch water column. 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 recirculates digester gas through twelve coarse cone diffusers located on the bottom of each digester. The gas mixing system provides the primary mixing energy to keep the digester sludge homogenous. However, gas mixing has been blamed for causing foaming problems around the cover of the digester (foaming can result in nuisance and odor problems). LOTT staff has attempted to adjust the gas recirculation rates and alternating recirculation periods but this has not reduced foaming. Microthrix, a foam inducing bacterium, has been found in the digesters.

Foul air from the anaerobic digester equipment building is collected and treated in the odor control system prior to release to the atmosphere. The odor control system is discussed later in this section.

Solids Dewatering

The purpose of solids dewatering is to remove excess moisture from anaerobically digested sludge (biosolids) and to reduce land application hauling costs. Solids dewatering equipment consist of three (3) centrifuges (two (2) low capacity and one (1) high capacity units), dewatered sludge conveyance equipment, and loading facilities for sludge hauling trucks. All solids dewatering equipment is contained in the solids handling building. Foul air from the centrifuges and solids handling building is exhausted to the odor control system.

Centrifuges remove excess water from the biosolids by mechanically enhancing the effects of gravity. Digested biosolids are 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: increasing bowl speed to increase the settling velocity and final cake solids concentrations; increasing scroll speed to reduce the solids residence time 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.

The two (2) low capacity centrifuges were installed in the 1980 plant expansion and the high capacity unit was added in 1999. The two older units each have a design solids loading rate of 1,500 lb/hr, while the high capacity unit has a design solids loading rate of 2,500 lb/hr. Current solids loads enable the plant to operate using only the high capacity unit. The two (2) low capacity units serve as backup. While all three units could be operated simultaneously, a lack of real-time control and limitations in polymer supply have limited the practicality of this option.

The sludge transfer pumps in the digester equipment building convey anaerobically digested biosolids (approximately 2 to 3 percent solids) to the centrifuges. The flow rate and solids concentration of the feed solids are continuously measured.

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

Dewatered biosolids at a solids concentration of approximately 21-23 percent 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 shut down for up to eight minutes, which allows time for repositioning trucks under the hopper.

Centrate from the centrifuges is monitored for suspended solids. High suspended solids readings in the centrate results in an alarm. 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 the primary sedimentation building, which is considerably closer than the centrate storage basin. When needed, one of the spare primary sedimentation basins is used as a centrate storage basin. Since centrate contains substantial ammonia it poses a substantial aeration loading in the biological treatment system. Consequently, the storage basin is used to control centrate return flows when in nutrient removal mode.

Polymer Feed Systems

Polymer systems are used to enhance solids thickening and dewatering operations. The LOTT plant contains three independent polymer systems in the solids handling building. Three dry polymer systems and two automatic mixing and dilution liquid polymer systems (installed during the 1982 expansion) can supply polymer to the sludge thickeners and can provide polymer to the secondary clarifiers. A packaged polymer dilution and feed system, which provides polymer solely to the dewatering process, was installed between the 1982 and 1994 plant expansions. Either dry or concentrated liquid polymer can be mixed automatically and fed to the secondary clarifiers, DAF units, or centrifuges. Dry polymer feed is preferred because of cost.

Biosolids Recycling

One 37 foot end-dump trailer is used to transport dewatered biosolids to contracted land application sites or a composting facility. The trailer has a capacity of 26 tons. The trailer is equipped with a heavy-duty tarping system and a watertight tailgate to reduce odors and eliminate spillage. An average of one truckload of biosolids is delivered for land application or composting every other day.

Foam Reduction Processes

Periodic foaming has created a number of problems at the Plant. Foaming has been noted in both the digesters as well as in the aeration basins. Some of the problems related to foaming include reduced digester active volume, sludge recirculation pump gas entrainment, ineffective digester temperature control, housekeeping and maintenance upkeep, digester cover insulation damage, solids transfer hold up, and water requirements associated with spray downs, flushing, and foam washdown. In 2006, the Plant adopted new methods for dealing with foam, including Polyaluminum Chloride dosing in the aeration basins to combat the growth of Microthrix bacteria, and the reduction of aeration basin solids retention time (SRT) to 7-8 days during BNR operation.

ANCILLARY PLANT SYSTEMS

Ancillary systems are used to support the wastewater processes needed to achieve permit conditions. Several of the ancillary systems are critical to plant operation including, air and water supply. The following is a summary of the ancillary systems at the LOTT plant.

Air Systems

The LOTT treatment plant contains two air systems, service air and instrument air, to satisfy utility needs throughout the facility. Each system contains a designated set of compressors and a pipe network for distribution. The service air system provides high pressure air for utility purposes, such as the operation of pneumatic tools and valve positioners. Two rotary screw compressors with 350 cfm capacity were installed in 2004.

The instrument air system provides a source of clean, dry, oil-free, high pressure air to operate devices such as pneumatic valve controls and pneumatic instruments. Two instrument air compressors, each rated at 100 scfm at 100 psig, are located in the headworks building.

Service Water System

The service water system includes water from different sources for several different applications, including potable water, potable hot water, non-potable water, seal water, reclaimed water, and screened reclaimed water.

Hot and cold potable and non-potable water originate from the city water supply. An 8-inch main brings city water into the plant from North Franklin Street to the headworks building where it is distributed through the plant. A 3-inch main conveys city water into the administration building from North Adams Street. It supplies potable water and potable hot water to the administration building and to other areas of the plant.

Non-potable water is taken from the 8-inch potable supply in the headworks building. In most cases, non-potable water meets potable standards. However, since the piping is downstream of the backflow preventer, it is subject to potential contamination and considered non-potable. Non-potable water is conveyed through the plant in an 8-inch pipe network. Branches supply water for irrigation, yard hydrants, utility stations, fire hydrants, and the seal water system.

Seal water is used to cool mechanical equipment and seal rotating equipment. The seal water system branches from the non-potable water system at two locations; headworks building and solids handling building. In each case, an air break tank, dual pumps, and a hydropneumatic tank are provided. The pumps in the headworks area deliver 190 gpm of seal water at 65 psi. The pumps in the solids handling building are rated for 15 gpm at 85 psi and supply water for seal protection on pumps in the solids handling and digester equipment buildings.

Cleaning and Housekeeping

A portable hot water pressure washer is used to provide cleaning throughout the Plant.

Site Sanitary Sewer and Storm Water Collection Systems

Wastewater from within the LOTT treatment plant is collected and conveyed to the headworks. Plant wastewater includes domestic wastes from washrooms, laboratory drainage, tank drainage, scum, foam, septage, thickener underflow and centrifuge centrate. In addition, virtually all the stormwater drainage from within the Plant boundary discharges to the Headworks. The exceptions are the visitor parking area and two remote drainage grates, which discharge to the municipal stormwater collection system and are conveyed to the east bay of Budd Inlet.

Odor Control Systems

Odor control was incorporated in the first enlargement of the Budd Inlet Treatment Plant in 1979. During the last major expansion completed in 1994, almost all wastewater treatment unit process areas were enclosed and foul air treated. As of 1998, there were four separate foul air treatment systems at the Plant. Three were chemical wet scrubbers installed in the 1979 expansion and the fourth, an activated carbon scrubber, was installed in 1994 for the biological nitrogen removal facilities. Performance of the existing odor scrubbers at the Plant was assessed as part of an odor control study in performed in 1997-1998 (LOTT Odor Control Study Final Report, December 1998).

The largest odor control system consists of two 10-ft. diameter, activated carbon bed scrubbers located west of the second anoxic/second aeration basin. It was designed to remove odors from the first aeration basin, first and second anoxic basins, second aeration basin, and the centrate storage tank.

South Odor Scrubber

The 1998 Odor Control Study called for replacing the South Odor Scrubber. A new scrubber was needed for two reasons: 1) the below-grade room housing the South Odor Scrubber was planned to be converted to a reclaimed water storage tank, and 2) poor performance of the South Odor Scrubber. This replacement project was completed in 2003.

The new South Odor Scrubber includes a packed bed scrubber tower, exhaust fan, stack, associated ductwork, and chemical feed and storage facilities. Caustic soda is added to raise the pH of the scrubber liquid, which facilitates absorption of hydrogen sulfide, with sodium hypochlorite added to oxidize the absorbed hydrogen sulfide and other odor causing compounds.

The South Odor Scrubber treats foul air collected primarily from the Headworks Building and the headspace of equalization basins. A portion of the foul air collected in the Digester Building is also routed to the South Odor Scrubber.

North Odor Scrubber

The 1998 Odor Control Study recommended the replacement of the North Odor Scrubber as well as the South and Primary Odor Scrubbers based on the number of odor inquiries received. The North Odor Scrubber is a liquid-chemical scrubber. Although all liquid chemical scrubbers were noted to have the same problems in the 1998 Odor Study (lack of caustic addition, suboptimal performance), the North Odor Scrubber was found to have significantly less of an impact on surrounding odors. The North Odor Scrubber is designed to treat foul air from the future truck loading bay enclosure. Consequently, the North Odor Scrubber replacement will be coordinated with these future activities or increased odor inquiries.

Primary Odor Scrubber

A pair of liquid-chemical scrubbers operating in parallel provides odor control for the Primary Sedimentation Building. Although the 1998 Odor Control Study called for the replacement of this system, the project will be coordinated with the design and construction of a new primary sedimentation system.

Septage Receiving

A septage receiving station was installed at the LOTT treatment plant to provide a local facility to collect septage and RV waste dumping. The septage receiving station is located west of the effluent pump building. Permitted septage haulers discharge their truck contents into a manhole that flows to the headworks building. A vehicle carrying potentially hazardous waste discharges septage to a separate, large underground holding tank. Waste samples are routinely taken and analyzed. Non-hazardous septage waste can be released from the holding tank to the influent sewer. Septage volumes are highly variable depending upon cost and seasonal factors.

Fluid Power System

The fluid power system provides high pressure hydraulic fluid to modulate gates at the splitter box and operate the UV disinfection basin, the first aeration basin, and at the second anoxic/second aeration basin sluice gates. The system consists of two-3 hp hydraulic gear pumps, high-pressure hydraulic fluid, solenoid valves and emergency accumulators. It is normally powered through the plant electrical power, supplemented by an uninterruptible power supply (UPS). The emergency UPS is capable of providing up to 100V for operation of local control panels and solenoid valves. The pumps are powered by the larger plant emergency power system during power failures.

Low Temperature Heat Loop

The low temperature heat loop (LHL) recovers low-grade waste heat for heating and cooling uses at the plant. The main heat demand is the plant heating, ventilation, and cooling (HVAC) system. The LHL is the heat source and heat sink for all HVAC equipment. Cooling equipment transfers heat into the loop, whereas heating equipment extracts heat from the loop. Cooling of plant equipment is a secondary function of the LHL.

Three heat exchangers are used to thermally balance the system. Two heat exchangers transfer heat to the reclaimed water circuit when there is excess heat. The third exchanger draws heat from the high temperature heat loop.

The LHL operates at a temperature of 80°F and collects waste heat from methane compressors, lube oil coolers, and sludge centrifuges. Typically, the exit water temperature is 90°F, which is considered a marginal supply temperature for standard HVAC coils and air handling units. The LHL was originally designed to remove heat from ozone generators and oxygen compressors, neither of which are in service today. Consequently, much of the heat required in this loop must be transferred from the high heat loop.

High Temperature Heat Loop and Digester Gas System

Sludge heating is the primary purpose of this combined system. Other purposes include generation of low cost electricity, reduction of utility electrical demand charges, delivery of heat to the LHL (as needed), and disposal of excess digester gas. The primary heat sources for the high temperature heat loop (HHL) are the boilers, and the secondary source is the methane engine generator. Water from the HTHL is pumped to the sludge heat exchangers in the digester building to maintain sludge temperatures at 95°F. When the heat supply is greater than the demand and there is no other use for this energy, the HHL water is directed to a heat exchanger and cooled with strained reclaimed water.

Purified digester gas, collected from the floating covers, is used to satisfy immediate demands for gas at the engine generator and boilers. When more gas than needed is available, high-pressure compressors transfer gas to the methane storage tank for later use. When demand for digester gas is greater than supply, natural gas is provided as an auxiliary fuel.

CHAPTER 5

WASTEWATER CHARACTERIZATION

This chapter provides a description of the wastewater entering the treatment plant. It includes a summary of recent flows, wastewater characteristics recorded as a part of the treatment plant's daily historical record, and wastewater characteristics determined during an intensive two-week study performed in December 2003 as part of this project.

CURRENT FLOWS AND LOADING

Table 5-1 provides a summary of the wastewater flows from 1998 to 2003. Flows from the brewery have been excluded.

Table 5-1. Raw Wastewater Flows (MGD) for the Period 1998 to 2003 (Brewery Flows Excluded)

Year	Average Annual	Average Dry Weather[1]	Average Wet Weather[2]	Summer[3]	Shoulder[4]	Peak Month	Peak Day	Annual Rainfall (in)[5]	Annual Rainfall Percentile[6]
1998	11.50	9.10	13.76	8.62	9.70	17.61	37.56	54.99	72%
1999	12.82	9.79	17.49	9.07	10.67	22.68	40.80	64.57	96%
2000	10.26	9.43	13.35	9.13	9.78	13.48	23.27	41.49	14%
2001	9.88	8.74	9.46	8.50	9.06	15.76	42.96	51.53	57%
2002	10.20	8.98	13.57	8.51	9.62	15.37	32.11	41.05	13%
2003	10.75	9.55	11.46	8.64	10.77	13.17	34.67	52.07	59%

1. Average dry weather defined as April though October.
2. Average wet weather defined as November through March. For example, in 2001, average wet weather is defined as flow from November, 2000 through March, 2001.
3. Summer defined as June, July, and August (LOTT NPDES Permit).
4. Shoulder defined as April, May, October (LOTT NPDES Permit).
5. Rainfall recorded at the Olympia Airport.
6. Rainfall records compared with historical rainfall record, 1956-2003. For example, the 64.57 inches of rainfall in 1999 was in the 96th percentile, meaning only 4 years out of 100 would be expected to experience higher rainfall totals.

Due to physical limitations at the Plant's Parshall flume (maximum capacity of 55-MGD) and the use of the equalization (EQ) basins, flow records are not representative of actual peak hourly flows. Plant staff estimates peak hourly flows in the range of 70 to 80-MGD based on influent pump capacity.

A summary of Plant loadings over the period 2001-2003 is provided in Table 5-2 (brewery loadings have been excluded from this analysis).

Table 5-2. Raw Wastewater Flows and Loadings for the Period 2001 to 2003

Parameter	2001	2002	2003	Average
BOD				
Annual Average Raw BOD Load, lb/d	18,830	19,677	20,644	19,717
Annual Average Raw BOD Conc., mg/L	241	242	239	241
Peak Month BOD Load, lb/d	23,745	22,404	21,800	22,649
Raw BOD Conc. @ Peak Month BOD Load, mg/L	347	287	214	283
Peak Month BOD Load, month	July	Nov	Jan	
Peak Day BOD Load, lb/d	38,584	71,094	54,779	54,819
Peak Day/Peak Month BOD Load ratio	1.62	3.17	2.51	2.44
TSS				
Annual Average Raw TSS Load, lb/d	23,697	21,656	22,568	22,640
Annual Average Raw TSS Conc., mg/L	304	266	260	277
Peak Month TSS Load, lb/d	28,718	24,990	27,246	26,985
Raw TSS Conc. @ Peak Month TSS Load, mg/L	420	292	264	325
Peak Month TSS Load, month	July	Dec	Jan	
Peak Day TSS Load, lb/d	43,909	103,192	69,270	72,124
Peak Day/Peak Month TSS Load ratio	1.53	4.13	2.54	2.73
TKN				
Annual Average Raw TKN Load, lb/d	3,905	2,993	3,348	3,415
Annual Average Raw TKN Conc., mg/L	50.6	37.0	39.8	42.5
Peak Month TKN Load, lb/d	5,978	3,269	4,679	4,642
Raw TKN Conc. @ Peak Month TKN Load, mg/L	75.8	39.3	62.5	59.2
Peak Month TKN Load, month	Jan	Dec	June	
Peak Day TKN Load, lb/d	8,821	3,738	9,622	7,394
Peak Month/Annual Average TKN load ratio	1.53	1.09	1.40	1.34
Peak Day/Peak Month TKN Load ratio	1.48	1.14	2.06	1.56
Annual Average TKN/BOD Load ratio	0.21	0.15	0.16	0.17
Mixed Liquor Temperature				
Minimum Month Mixed Liquor Temp, deg C	14.5	14.1	14.9	14.5
Minimum Month Mixed Liquor Temp, month	Dec	Jan	Dec	
Peak Month Mixed Liquor Temp, deg C	21.7	22.0	22.0	21.9
Peak Month Mixed Liquor Temp, month	Sep	Aug	Sep	

BOD: Biochemical oxygen demand
TSS: Total suspended solids
TKN: Total Kjehldahl Nitrogen

On average, the brewery contributed a flow of about 500,000 gallons per day, 6,000 lb/day of BOD, 2,000 lb/day of TSS, and 150 lb/day of TKN. In terms of BOD, this amounted to approximately 25 percent of total Plant loadings.

WASTEWATER CHARACTERIZATION

A special wastewater characterization program was carried out to determine the current wastewater characteristics and to collect sufficiently detailed data to calibrate the BioWin biological process simulator. The characterization and calibration were previously performed as part of the 1997 WRMP. However, it was decided that the intensive sampling program should be repeated and the simulator re-calibrated since the influent wastewater characteristics may have changed over the past seven years, particularly in light of the brewery closure in 2003.

The sampling program consisted of 14 consecutive days of 24-hour composite samples from selected process streams between December 10 and 23, 2003, and one day of grab sampling on December 12, 2003. The samples were analyzed for a range of characteristics. A summary is provided in Table 5-3. The full spectrum of sampling data is included in **Appendix B**.

Table 5-3. Summary of Wastewater Characterization Data, December 2003

	Raw Sewage	Primary Effluent	Secondary Effluent	Mixed Liquor	RAS	WAS
Flow	12.27	12.30	12.10	16.90	4.41	0.20
Solids Fractions						
TSS (mg/L)	225	88.8	10.7	883	NA	5,704
VSS (mg/L)	202	76.8	9.2	799	NA	5,012
VSS/TSS	0.90	0.86	0.86	0.91	NA	0.88
COD Components						
COD (mg/L)	497	258	53.2	NA	NA	7,772
sCOD (mg/L)	NA	104	35.5	NA	NA	NA
ffCOD (mg/L)	NA	68.9	26.3	NA	NA	NA
BOD Components						
BOD5 (mg/L)	216	104	10.0	NA	NA	NA
sBOD5 (mg/L)	NA	37.7	NA	NA	NA	NA
cBOD5 (mg/L)	NA	NA	5.5	NA	NA	NA
COD/BOD5	2.3	2.5	5.3	NA	NA	NA
Nitrogen Components						
TKN (mg/L)	NA	32.6	5.4	NA	NA	487
sTKN (mg/L)	NA	24.9	4.1	NA	NA	NA
NH3-N (mg/L)	NA	24.3	3.0	NA	NA	NA
NO3-N (mg/L)	NA	1.8	15.6	NA	NA	NA
Phosphate						
PO4-P (mg/L)	NA	2.8	2.7	NA	NA	NA

NA: Not measured.
RAS: Return Activated Sludge
WAS: Waste Activated Sludge
VSS: Volatile Suspended Solids
COD: Chemical Oxygen Demand
sCOD: Soluble COD
ffCOD: Filtered and Flocculated COD
BOD5: 5-Day Biochemical Oxygen Demand
sBOD5: Soluble BOD5
sTKN: Soluble TKN
NH3-N: Ammonia as Nitrogen
NO3-N: Nitrate as Nitrogen
PO4-P: Phosphate as Phosphorous

A number of variations from the data collected in 1997 (January 30 through February 12) are worth mentioning. Influent solids have increased by approximately 30 percent (from 174 to 225 mg/L). However, influent COD and BOD have experienced only about 10 percent increase during the same period. Two opposing forces appear to be at work. On one hand, increased population and service connections are expected to generate increased flows and loadings. However, the shutdown of the brewery disproportionately lowered the BOD and COD loadings. This would explain why the increase in COD and BOD is only one-third that observed for solids loadings. The mixed liquor solids values appear quite low (about 75 percent the MLSS concentration reported in 1997). However, an operational change during the sampling period (turning mixed liquor channel coarse bubble diffuser mixers off to combat foaming) is likely to have resulted in inaccurate mixed liquor samples. Further discussion of this effect is provided in Chapter 6. Waste sludge is more concentrated than before, reflecting a decreased wastage rate (0.3 to 0.2 MGD). The quality of the final effluent has deteriorated somewhat, with effluent solids more than double the 1997 concentration (5.0 to 10.7 mg/L), and effluent COD increased by 89 percent (28.2 to 53.4 mg/L). Readably biodegradable substrates in the primary effluent, the energy source for phosphate-removing, and floc-forming organisms, has decreased by 27 percent (58.6 to 43.0 mg/L), reflecting brewery shutdown.

While the Plant was operating in conventional mode during both characterizations periods, a considerable amount of phosphate removal was occurring during the 1997 study (decrease from 3.4 to 0.5 mg/L between primary effluent and final effluent). Phosphate removal, which acts to increase the amount of inert solids in the system, would help explain some of the difference in mixed liquor VSS/TSS ratio.

CHAPTER 6

FLOW AND LOADING PROJECTIONS

Accurate flow and loading projections are essential to any assessment of treatment plant capacity. These projections will help to demonstrate when, over the twenty-year planning cycle, various elements within the treatment plant will reach their operational capacities. Flow and loadings projections are built upon three key elements:

- Analysis of historical flows and loadings recorded at the treatment plant.
- Projections of population and/or commercial growth within the service area.
- Analysis of environmental factors, such as precipitation, which may contribute to wastewater flow.

This chapter discusses how each of these elements was used to generate a set of projections covering the span of this project.

WASTEWATER GENERATION RATE PROFILES

By assigning per capita wastewater generation rates to a population, flows and loadings can be projected by combining population projections with estimates of future sewering areas. Wastewater generation rates reflect the wastewater generated by individuals on a daily basis, and does not include any allowance for rainfall, stormwater, groundwater, or other sources. These rates represent a base flow, independent of season or climate, yet following a clear diurnal and weekly pattern tied to community characteristics.

A set of wastewater generation rate profiles were generated using information from the 1998 WRMP, based upon an analysis of drinking water use, and observed flows at the treatment plant and monitors located throughout the LOTT system. These rates are calibrated on a yearly basis as part of LOTT's Capital Improvements Program (CIP). For the 2003 CIP, results of a system-wide flow reductions program were integrated into the profile. Since then, the profiles have been further calibrated based upon flows observed at the treatment plant. A summary of the results is provided in Table 6-1.

Table 6-1. Summary of LOTT Wastewater Generation Rate Profiles, 1997-2003 (gallons per capita day, gpcd)

	Lacey	Olympia	Tumwater	Employment
1995-2002 CIP	66.0	85.3	72.8	40.0
2003 CIP	64.0	81.0	69.0	39.4
2003 Drinking Water Analysis	63.6	59.0	66.4	29.3

Profiles derived from the 2003 drinking water analysis vary from the other profiles, particularly for the City of Olympia. Unable to explain what caused the reduction, a conservative approach using the 2003 CIP values was favored. The rate profiles were calibrated against flows observed at the treatment plant, with some allowance given to the drinking water study, and the following set of profiles were used to conduct the Plant assessment (Table 6-2).

Table 6-2 Current LOTT Wastewater Generation Rate Profiles

Lacey gpcd	Olympia gpcd	Tumwater gpcd	Employment g/employee/d
64	75	69	35

POPULATION AND SERVICE AREA PROJECTIONS

When the generation rate profiles in Table 6-2 are combined with population estimates and estimates of service area, they can be used to calculate base sanitary flow. Population projections are published by the Thurston County Regional Planning Council (TRPC) for 5-year intervals. These are updated regularly in conjunction with regional municipal governments. LOTT service area maps are updated annually by staff from Olympia, Lacey, and Tumwater as part of LOTT's CIP effort. Spatial representation of the population projections and service area are provided on Figures 6-1 through 6-4.

The timing for expansion of the service area within the Urban Growth Management Area (UGMA) is based on local Health Department criteria for maximum density of on-site treatment. Population and employment projections for the entire service area are presented in Table 6-3. Employment projections are generated by the State Office of Financial Management (OFM) and submitted to the TRPC for distribution in the County in accordance with local Comprehensive General Plans.

While population and employment forecasts are useful in determining the base sanitary flow, historical flow data plus precipitation records are required to predict wastewater flows at the treatment plant. Average annual, peak month, and various seasonal flow projections depend upon an accurate model of system inflow and infiltration (I&I).

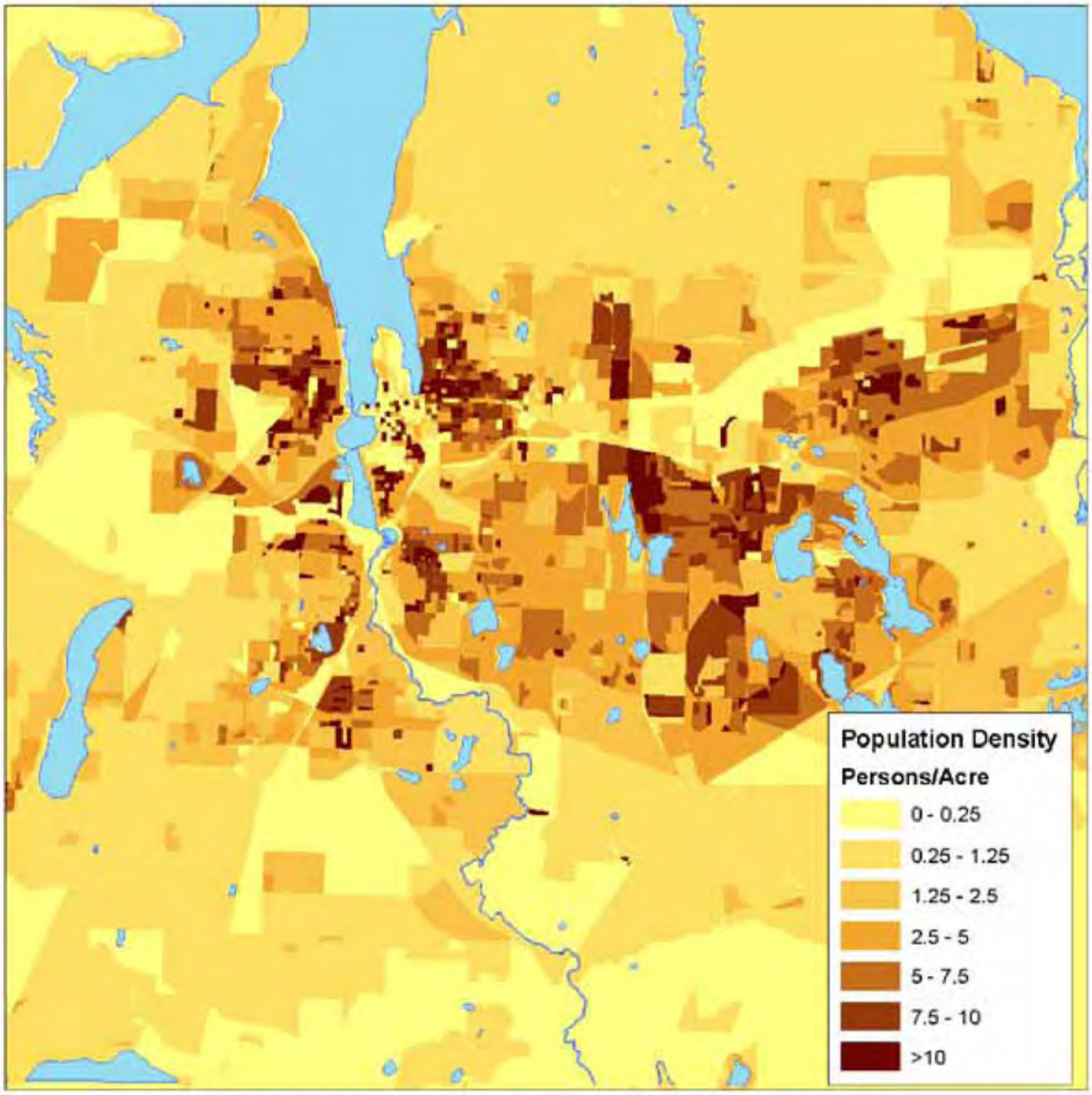


Figure 6-1. LOTT System Population Density, 2005

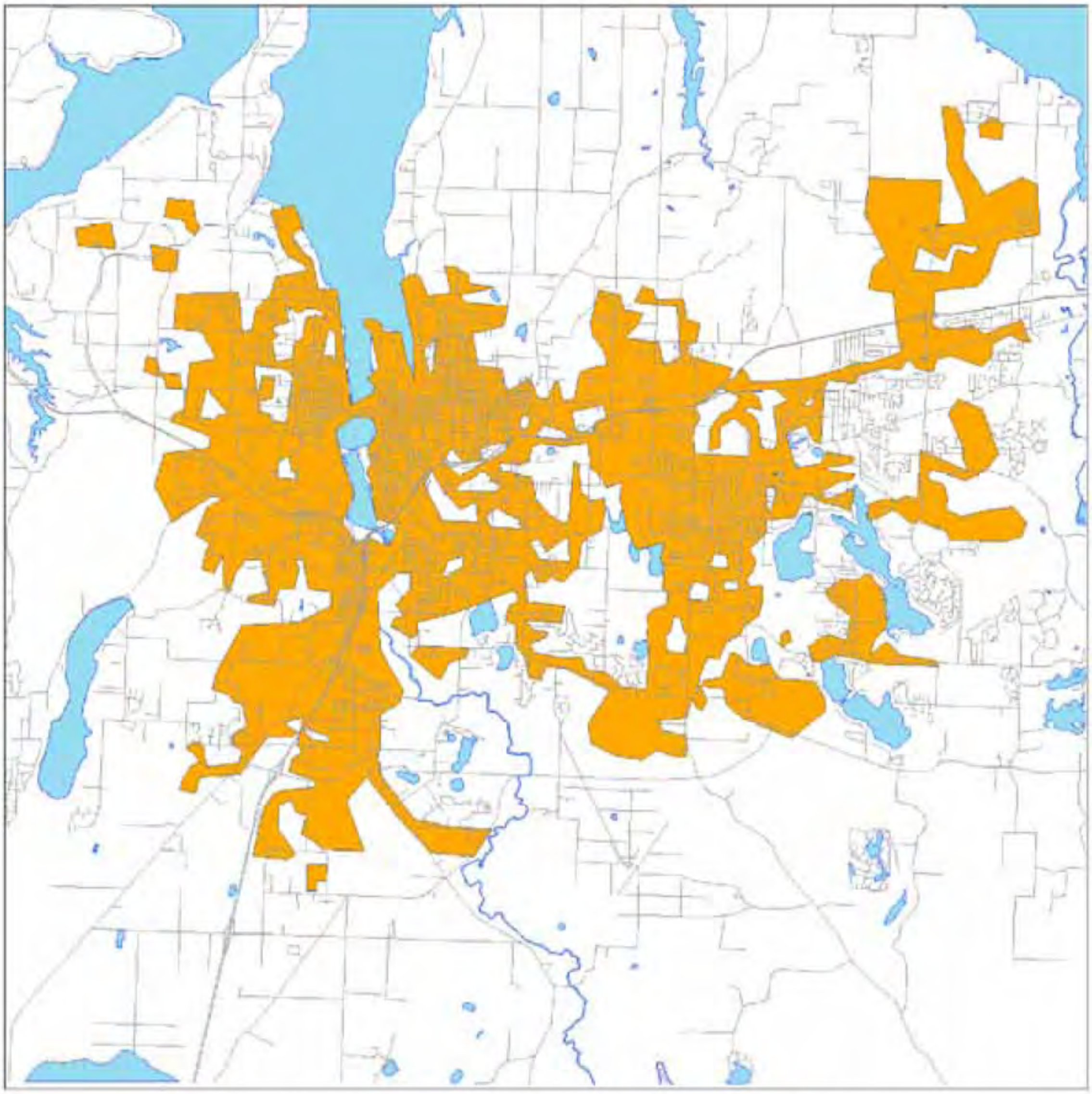


Figure 6-2. LOTT Existing Service Area, 2004

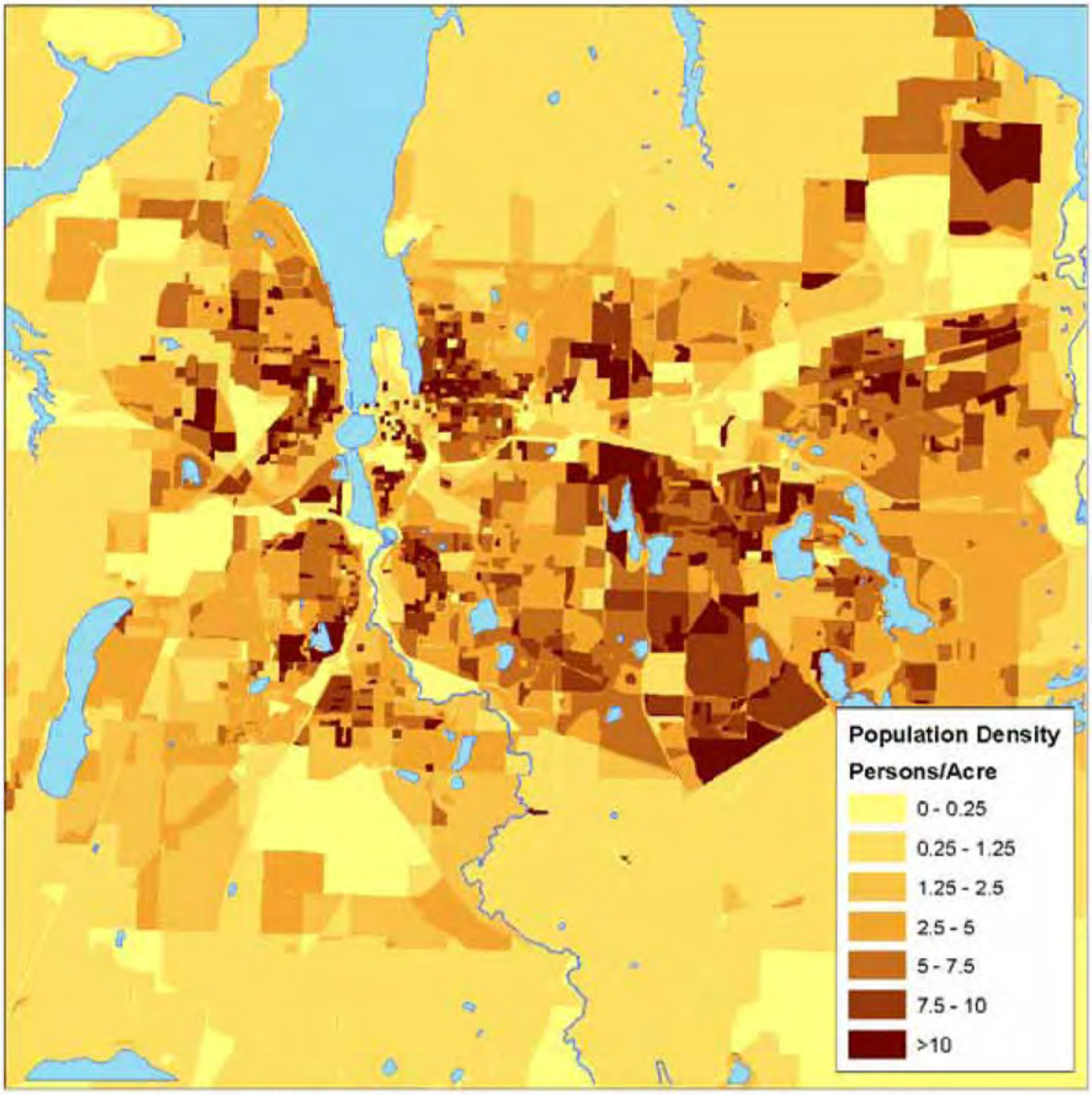


Figure 6-3. LOTT System Projected Population Density, 2025

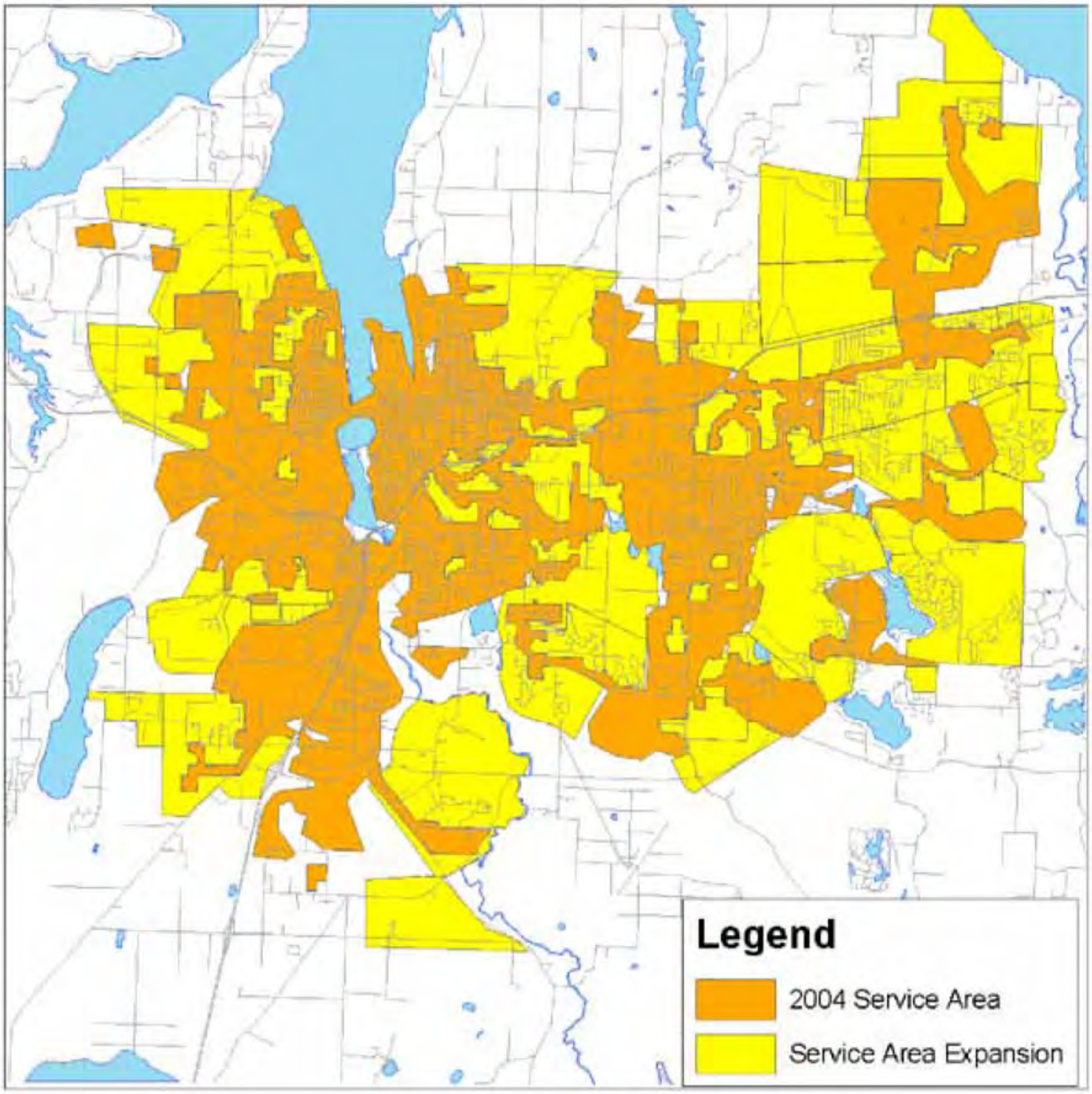


Figure 6-4. LOTT Projected Service Area, 2025

Table 6-3. LOTT Residential Population and Employment Projections

Year	Residential Population	Sewered Residential Population	Employees	Sewered Employees
2004	143,141	86,269	101,191	80,765
2005	145,789	91,413	102,865	82,858
2006	150,828	96,647	104,534	84,840
2007	155,868	103,286	106,203	87,072
2008	160,908	111,446	107,872	89,497
2009	165,961	119,539	109,546	91,812
2010	171,002	127,265	111,215	93,564
2011	174,435	131,700	112,884	95,490
2012	177,867	136,049	114,554	97,417
2013	181,309	142,087	116,227	99,697
2014	184,742	147,706	117,896	101,983
2015	188,175	154,179	119,566	105,300
2016	191,378	162,142	121,235	109,021
2017	194,588	167,689	122,908	111,314
2018	197,790	172,906	124,577	113,519
2019	200,992	177,711	126,247	115,691
2020	204,194	180,866	127,916	117,561
2021	207,260	183,540	129,589	119,414
2022	210,318	186,219	131,259	121,271
2023	213,376	188,912	132,928	123,137
2024	216,434	191,617	134,597	125,010
2025	219,501	194,344	136,270	126,897

Based upon 2003 population density projections provided by the Thurston Regional Planning Council (TRPC) and estimates of sewered area expansion submitted by the Cities of Olympia, Lacey, and Tumwater.

INFLOW AND INFILTRATION

In 1994, an I&I Study evaluated infiltration and inflow in the LOTT service area by dividing the area into discrete sewage drainage basins (sewer basins) and quantifying the I&I from each basin. The 1994 I&I Study, along with analyses performed during the 1998 WRMP, served as the basis of I&I projections throughout the service area. From this work, an I&I model has been developed to anticipate changes in I&I over time and relating to precipitation events. Starting in 2003, LOTT implemented a 7-year infiltration and inflow program to continually monitor infiltration and inflow in each of the 63 basins in the LOTT service area (Figure 6-5). Data from the first year of this effort have been imported into the existing model, and all flow and loading projections in this document reflect the new data.

Figure 6-5. LOTT Sewer Basins

The I&I model consists of two parts. The first part reflects the current extents of the LOTT service area. Analysis of historical flows to the Plant along with precipitation records are used to estimate the system's response to rainfall events. Once the model is calibrated, long-term precipitation records are used to generate risk-based I&I projections. If a moderate storm during the period of record produced a certain amount of I&I, the model can project what a much larger storm, perhaps a storm that occurs just once in one-hundred years, would generate.

The second part of the I&I model is I&I generated in areas to be sewered. In general, new pipes are expected to contribute much less I&I to a system than older pipes. For this reason, new pipe I&I allocations are generally much lower than those derived from the existing system. Based on previous efforts an I&I rate of 0.042 gallons/inch-diameter-miles (idm) per new customer is assumed for new sewered areas. A summary of I&I values, corresponding to a number of different averaging periods, is provided in Table 6-4.

Table 6-4. Summary of LOTT System I&I

Period	Existing Sewered Area I&I (MGD)	New Sewered Area I&I (gal/day/idm)[1]
Average Annual	3.0	240
Average Dry Weather[2]	1.3	140
Average Wet Weather[3]	5.0	340
10-Year[4] Peak Month	12.0	600
10-Year[4] Peak Day	35.0	1,693
10-Year[4] Peak Hour	52.0	3,600
Summer[5]	0.9	60
Shoulder[6]	1.9	140
10-Year[4] Peak Summer Month	2.3	160
10-Year[4] Peak Shoulder Month	4.6	330

1. IDM = inch-diameter-miles. This refers to the amount of sewer pipes in the system, calculated by multiplying the length of the pipe in miles by the diameter of pipe in inches.
2. April through October.
3. November through March.
4. 10-year return period. Refers to 10 percent chance of this much I&I within any given year.
5. June through September.
6. April, May, October.

ENTITLEMENTS

By agreement, there are two large users who have had preferential access to system capacity (entitlement). These include the former Olympia Brewery and The Evergreen State College (TESC). The brewery ceased operations in 2003, and included a provision in its settlement that no future occupant may use the site as a brewery. With the closure of the brewery, the flow entitlement has been removed, and any future occupant would be required to pay annual wastewater fees like any other customer. However, the LOTT Alliance has agreed that any future occupant of the site would not have to pay initial connection fees up to 1-mgd. The TESC entitlement remains active, with current flow amounting to approximately 175,000 gallons per day, a fraction of its total entitlement of 1.167 mgd.

FLOW PROJECTIONS

Using the generation rate profiles in Table 6-2, the service population projections in Table 6-3, and the estimates of I&I in Table 6-4, flow projections were determined for the LOTT system. Table 6-5 contains the complete set of flow projections, including those associated with common statistical return frequencies and with return frequencies commensurate with the existing and proposed NPDES permit conditions.

Table 6-5. LOTT System Flow Projections, 2004-2025 (MGD)

Year	Base Sanitary Flow	Average Annual	10-Year[1] Peak Month	10-Year[1] Peak Day	10-Year[1] Peak Hour	Average Dry Weather[2]	Average Wet Weather[3]	Summer[4] Average	Summer 10-Year[1] Peak
2004	9.16	12.16	21.16	44.16	61.16	10.46	14.16	9.74	11.16
2005	9.57	12.63	21.71	44.95	62.38	10.91	14.65	10.06	11.49
2006	9.99	13.09	22.25	45.74	63.59	11.35	15.14	10.49	11.93
2007	10.50	13.67	22.94	46.73	65.12	11.90	15.75	10.91	12.37
2008	11.12	14.38	23.76	47.94	66.99	12.57	16.48	11.44	12.92
2009	11.73	15.07	24.58	49.13	68.84	13.23	17.21	12.08	13.59
2010	12.29	15.71	25.34	50.25	70.59	13.83	17.88	12.71	14.25
2011	12.64	16.11	25.81	50.93	71.63	14.22	18.30	13.29	14.86
2012	13.00	16.51	26.27	51.59	72.65	14.59	18.72	13.66	15.24
2013	13.47	17.04	26.90	52.50	74.04	15.10	19.28	14.02	15.62
2014	13.91	17.54	27.49	53.35	75.35	15.58	19.80	14.51	16.13
2015	14.45	18.15	28.19	54.36	76.88	16.16	20.44	14.97	16.61
2016	15.11	18.88	29.04	55.57	78.73	16.86	21.20	15.53	17.18
2017	15.55	19.38	29.63	56.41	80.02	17.33	21.72	16.20	17.88
2018	15.96	19.85	30.17	57.20	81.23	17.78	22.22	16.65	18.36
2019	16.35	20.29	30.69	57.94	82.35	18.20	22.68	17.08	18.80
2020	16.63	20.59	31.04	58.44	83.10	18.49	22.99	17.48	19.22
2021	16.87	20.86	31.35	58.87	83.75	18.75	23.28	17.77	19.51
2022	17.11	21.13	31.66	59.30	84.40	19.01	23.56	18.02	19.77
2023	17.36	21.40	31.97	59.74	85.05	19.27	23.84	18.26	20.03
2024	17.60	21.68	32.29	60.18	85.71	19.53	24.12	18.52	20.29
2025	17.85	21.95	32.60	60.62	86.37	19.79	24.41	18.77	20.55

1. Base Sanitary Flow = base wastewater generation, excludes any inflow or infiltration.
2. Average Annual = average flow over the entire year.
3. 10-Year Peak Month = there is a 10 percent chance that a monthly average flow of this level or higher would occur in the given year.
4. 10-Year Peak Day = there is a 10 percent chance that a daily average flow of this level or higher would occur in the given year.
5. 10-Year Peak Hour = there is a 10 percent chance that an hourly average flow of this level or higher would occur in the given year.
6. Average Dry Weather = average flow over the period from April through October.
7. Average Wet Weather = average flow over the period from November through March.
8. Summer = average flow over the period from June through September.
9. Summer 10-Year Peak = there is a 10 percent chance that the summer (June through September) average flow would at this level or highe
10. Shoulder = average flow for April, May, and October
11. Shoulder 10-Year Peak = there is a 10 percent chance that the shoulder (April, May, October) average flow would at this level or higher

LOAD PROJECTIONS

Loading projections are developed similarly to flow projections using generation rate profiles for loadings. Per-capita BOD and TSS production profiles were calibrated against loadings measured at the treatment plant over the period 2002-2003 (Table 6-6). Plant loadings were adjusted to account for the removal of the brewery (Table 6-7).

Table 6-6. LOTT Wastewater Loading Profiles (lb per capita/employee day)

Residential lb/capita/day		Employment lb/employee/day	
BOD	TSS	BOD	TSS
0.140	0.150	0.120	0.130

Using the population, employment, and service area expansion estimates and the profiles in Table 6-6, the following set of loading estimates was prepared.

Table 6-7. Projected Loadings (Annual Average), LOTT System, 2004-2025

Year	BOD (lb/day)	TSS (lb/day)
2004	21,215	22,872
2005	21,993	23,709
2006	22,971	24,761
2007	23,951	25,815
2008	25,157	27,112
2009	26,600	28,663
2010	28,020	30,189
2011	29,322	31,586
2012	30,183	32,513
2013	31,032	33,427
2014	32,161	34,641
2015	33,231	35,792
2016	34,545	37,205
2017	36,115	38,895
2018	37,176	40,036
2019	38,181	41,117
2020	39,123	42,131
2021	39,799	42,858
2022	40,405	43,512
2023	41,012	44,166
2024	41,622	44,824
2025	42,235	45,484

Based on review of historical records, the Plant loadings do not follow a clear seasonal pattern, and peak loadings may occur at any time throughout the year (Figure 6-6). The monthly variability in the observed average loading approached 40 percent and often ranged from 3 to 15 percent. For the capacity assessment, it is important to not underestimate the Plant loadings in the model. The load projections model outputs annual average loadings, which must be adjusted using a "maximum month" correction. Since maximum month BOD and TSS loads are equally likely to occur in summer, winter, or spring the maximum month correction will be applied for all model conditions.

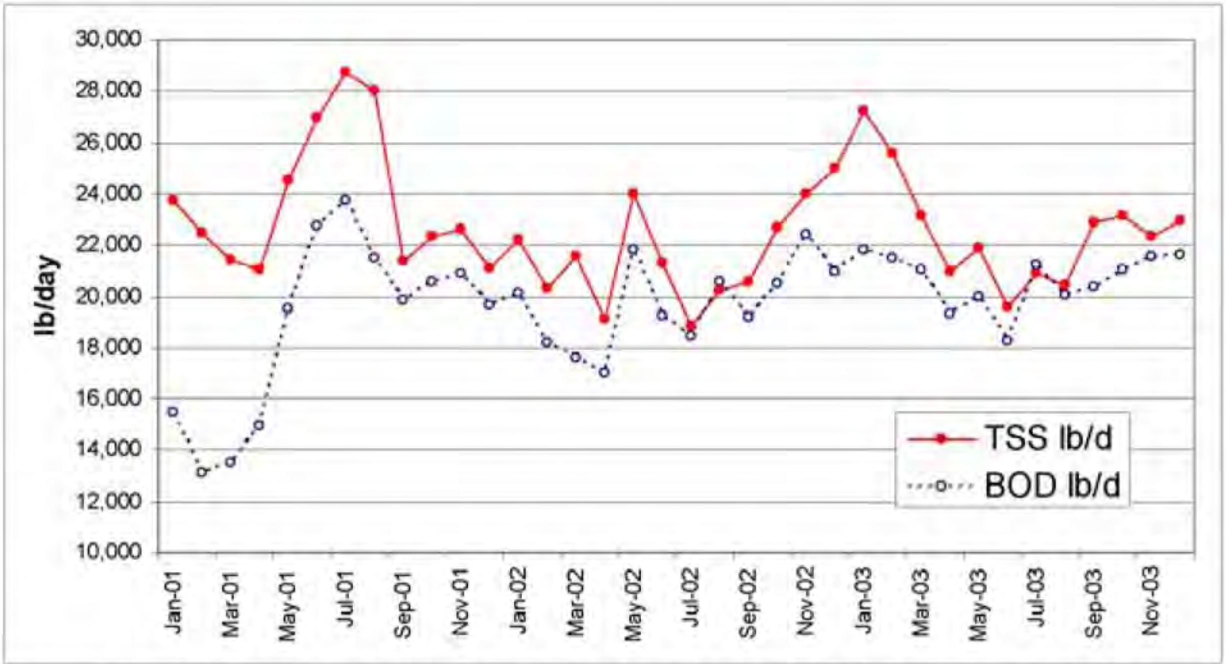


Figure 6-6. Monthly Average Loadings Recorded at LOTT Plant, 2001-2003 (Brewery Loads Excluded)

Peak month multipliers for BOD and TSS loads based on the 2001 to 2003 data are presented in Table 6-8. Based on this data, a fixed multiplier of 1.20 is applied to BOD and TSS loads for all modeling scenarios.

Table 6-8. Peak Monthly Loadings, 2001-2003, Comparison with Average Annual Values (Brewery Loads Excluded)

Year	Month	BOD (lb/d)	Multiplier[1]	Month	TSS (lb/d)	Multiplier[1]
2001	July	23,745	1.261	July	28,718	1.212
2002	November	22,404	1.139	December	24,990	1.154
2003	January	21,800	1.056	January	27,246	1.207
Average			1.152			1.191

1. Peak month divided by average annual

CHAPTER 7

PRIMARY SEDIMENTATION TANK EVALUATION

The objective of the analysis was to evaluate the performance of the primary sedimentation tanks at the LOTT plant and determine their capacity. Settling tests were conducted in the field during the period February 4-6, 2004, and during a simulated moderate storm event on February 26, 2004. An analysis of historical plant data over the period 2001-2003 was used to develop a sedimentation tank model.

The Budd Inlet Treatment Plant has a total of seven primary sedimentation tanks. These are rectangular-covered basins with chain and flight collectors running along the bottom of each tank. Each basin is 8.0-ft in depth, 14-ft wide, and 125-ft long. The sedimentation tanks were constructed in 1952, and expanded in 1983. In 1997, LOTT staff replaced the flights, scrapers, and chains, and upgraded the system drivers.

SETTLING AND FLOCCULATION TESTS

Settling and flocculation tests were conducted in February 2004, to assess non-settleable solids and settling potential, and also to verify flow distribution across the active trains. These tests demonstrated that under normal wet weather conditions the sedimentation tanks removal rate was close to ideal settling, and flow was evenly distributed between the active trains. These tests also demonstrated a potential for increased efficiency via mechanical flocculation. The results of these settling and flocculation tests are provided in Table 7-1.

Table 7-1. Settling and Flocculation Tests Conducted at LOTT Plant Primary Sedimentation Tanks February 2004

	4-Feb	5-Feb	6-Feb	Mean
Primary Influent TSS (mg/l)	234.1	184.4	375.8	264.8
Primary Effluent TSS (mg/l)	59.3	61.4	115.1	78.6
Primary Influent TSS (mg/l) after 30 min. Ideal Settling	86.8	63.2	80.8	76.9
Primary Influent TSS (mg/l) after 30 min. Flocculation + 30 min. Settling	39.0	46.0	41.7	42.2
Percent Removal, Primary Sedimentation Tanks	74.7	66.7	69.4	70.2
Percent Removal, Settling only	62.9	65.8	78.5	71.0
Percent Removal, Flocculation + Settling	83.3	75.1	88.9	84.1
Primary Influent Flow Rate (MGD)	16.0	12.6	13.2	13.9
Surface Overflow Rate (gpd/ft2)	1524	1197	1255	1325

A storm event was simulated on February 26, 2004, to evaluate surface overflow rate (SOR) limitations. Flow was sequestered in the Plant equalization basins, and then released through the primaries over the course of two hours. Although Plant flow was nearly doubled from its baseline (to a value of 24-MGD, with an SOR of 2,300 gpd/ft^2), no significant SOR limitation was observed. Solids removal during the simulated event was 78 percent (raw influent TSS was 446 mg/l).

ANALYSIS OF PLANT HISTORICAL DATA

To establish a relationship between influent solids concentration and removal efficiency, three years of primary influent and effluent data were plotted. A curve-fit to these data produced the following result:

$$E = E_o \exp[(-b/TSS_{in}) - c*SOR)]$$

Where

E	=	Solids removal efficiency
E_o	=	Maximum removal efficiency = 0.960
b	=	102.76 mg/L
c	=	$2.66e^{-5}$ ft^2/gpd
TSS_{in}	=	Primary influent TSS (mg/L)
SOR	=	Surface overflow rate (gpd/ft^2)

This relationship, along with the Plant data, is plotted on Figure 7-1.

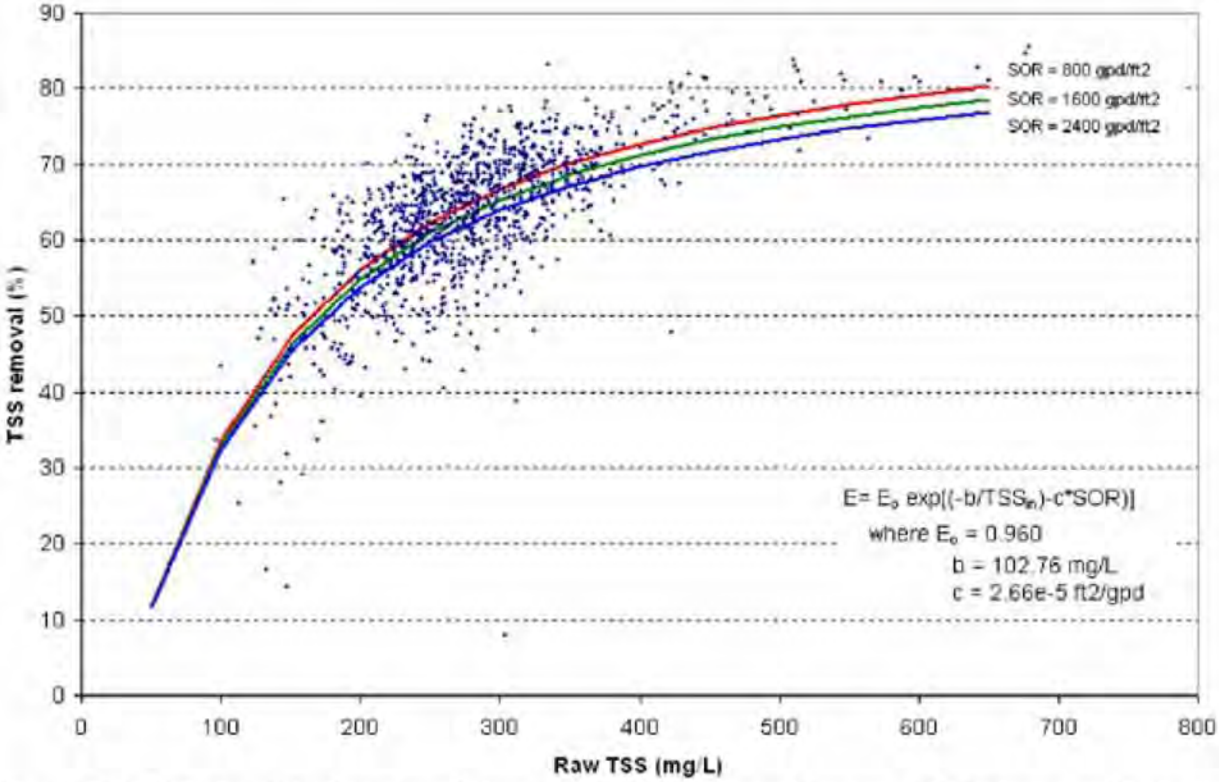


Figure 7-1. Relationship Between Primary Influent TSS and Removal Efficiency at Various Surface Overflow Rates, LOTT Plant, 2001-2003.

The relationship plotted in Figure 7-1 indicates that primary sedimentation tank efficiency is more dependent upon solids concentration than upon flow. Tripling the surface overflow rate from 800 to 2400 gpd/ft^2 has very little impact on the removal efficiency. This was reflected in the simulated storm event data, where excellent removal (78 percent) was observed in the face of relatively high flow (surface overflow rate of 2286 gpd/ft^2) and high influent TSS concentration.

PHYSICAL ASSESSMENT OF PRIMARY SEDIMENTATION SYSTEM

The primary sedimentation basins were constructed in 1952. Over a 50-year time period, the corrosive environment inside the Primary Sedimentation Building has systematically degraded the integrity of the structure and mechanical elements therein. Many structural elements have been in regular service for over 50 years. The risk of catastrophic failure of some or all of these elements is suggested to be within 5 to 10 years and many of the structures no longer meet local seismic code. Concrete in several areas has deteriorated exposing rebar (which has corroded) and spalling concrete/exposed aggregate can be observed at the effluent launders, tank walls, pipe gallery, and the building enclosure. In addition much of the mechanical equipment is no longer manufactured and requires the maintenance staff to machine their own replacement parts. Several mechanical elements must be serviced or maintained frequently to remain in service. The chain and flight units have failed and require replacement. The odor control can no longer be operated effectively. Several tanks are cracked and leak primary effluent to the plant storm drain (this can be visually observed as surface boils at high flows) and could result in an overflow event if it were to fail.

The flow pattern within the Primary Sedimentation Building presents a challenge. Flow enters the building and immediately is passed through a Parshall Flume. The Parshall Flume discharges into a 90 degree bend feeding the basins. The bend downstream of the Parshall Flume limits the accuracy of flow measurement in the flume above approximately 55 MGD and creates an unstable hydraulic flow pattern. At times, Plant staff are required to sandbag and counterweight the channel sections to assure the wastewater does not overtop the channel. This also results in improper distribution to the individual sedimentation tanks and limits treatment effectiveness.

In terms of hydraulics, the primary sedimentation basins are exposed to extremely high surface overflow rates during storm events. The current peak hour flow projection (62 MGD, from Chapter 6) equates to an SOR over 5,000 gpd/ft^2 with all 7 primary basins in service. By 2025, peak SORs are projected in the 6,000 to 7,000 gpd/ft^2 range, depending on the amount of flow diverted to satellite treatment plants. Hydraulic modeling of the treatment plant has pointed to the primary sedimentation tanks as the key hydraulic bottleneck, with flooding modeled at flows higher than 72 MGD.

Finally, the MCC is located in a classified space and does not meet current electrical code. In addition, the MCC is below the maximum water surface elevation in the building and could potentially flood since it is near the distribution channel mentioned above.

The primary clarifiers serve as a critical treatment step in the process, particularly with respect to the Highly Managed Plan and with the addition of satellite treatment plants to the system. The return solids from the satellite plants will have high fractions of particulate BOD which are best removed in the primaries. Consequently, failure of this process element can be catastrophic to the LOTT Alliance. The existing units also lack flexibility should the LOTT Alliance elect to enhance primary sedimentation, for example, through chemical addition.

CHAPTER 8

BIOLOGICAL PROCESS MODEL CALIBRATION

BACKGROUND

A biological process model is necessary to test the performance of the treatment plant and assess the risks of different operating schemes. A numerical model enables LOTT to simulate operating conditions without creating a failure condition. However, prior to using any simulation model, it must be calibrated to assure it represents the actual system response.

The four-stage nitrogen removal process at the LOTT plant was simulated using the BioWin simulator, developed by EnviroSim Associates of Flamborough, Ontario, Canada. BioWin is based upon International Water Association Activated Sludge Model No. 1 modified for biological phosphorus removal. It is a PC-based simulator that uses a series of mechanistic and empirical models to represent material transformations and pollutant removal in both the liquid and solid streams of a wastewater treatment facility. It enables the user to simulate carbonaceous oxidation, nitrification, denitrification, and enhanced biological phosphorus removal.

The BioWin model, first constructed as part of the 1998 LOTT WRMP, was re-calibrated for the current Plant operation using the December 2003 sampling data discussed in Chapter 5. During the sampling period, the secondary system was operating in activated sludge (non-nutrient removal) mode. Under this mode of operation, primary effluent is routed directly to the First Aeration Basin, from which the mixed liquor then flows straight to the secondary clarifiers. The First Anoxic Basin, Second Anoxic Basin and Final Aeration Basins were not in service, and there was no internal mixed liquor return. The LOTT Plant was designed to operate in activated sludge mode during the wet weather periods, when nitrogen removal was not required. However, the Plant has at times continued to operate in nitrogen removal mode during the wet weather period with a lower internal mixed liquor recycle rate to more easily transition to nutrient removal.

APPROACH

As the first step of the calibration process, an inert suspended solids (ISS) mass balance was performed around both the secondary system and the secondary clarifiers. ISS is the difference between total suspended solids (TSS) and volatile suspended solids (VSS). It is used as the reference parameter in solids balances for biological systems as it remains unchanged through the process (unless biological phosphorus removal is practiced). A TSS or VSS mass balance can be performed around the secondary clarifiers if no biological reaction takes place inside the clarifiers that would result in destruction or generation of solids. LOTT operations confirmed both conditions were met. ISS mass balances are used to verify plant measurements in terms of both flows and solids concentrations.

Comparing the average daily data for the sampling period, an ISS mass balance for the whole secondary system achieved a closure of 106 percent, that is, the mass loading of primary effluent ISS exceeded the sum of the mass loadings of secondary effluent and WAS ISS by only 6 percent. Given uncertainties in solids flow measurements and sample analysis, a closure error of 6 percent for this mass balance is considered a satisfactory result. Mass balance closure around the secondary clarifiers, however, was not achieved. Based on the sampling data, there was more than twice as much ISS leaving the secondary clarifiers in the effluent and the underflow than there was ISS entering in the mixed liquor. This suggests a potential error in the plant measurements. Because ISS mass balance closure was achieved around the secondary system, which includes data for secondary effluent and WAS, the source of error was likely associated with either the mixed liquor or RAS or both. The mixed liquor concentrations, at an average of 883 mg/L for TSS and 799 mg/L for VSS during the sampling period, seemed unusually low. During investigation it was discovered that air was manually cycled on and off in the mixed liquor channel to suppress foaming. It is possible that the air was turned off and some of the mixed liquor had settled during the time when the automatic sampler was drawing samples. Consequently, the composite samples would not provide a representative characterization of the mixed liquor. Therefore, for the purpose of the simulator calibration, the mixed liquor solids concentrations were back-calculated from the solids mass balances and then compared with predictions by BioWin. Based on mass balances around the secondary clarifiers, the average MLSS and MLVSS concentrations would be 1581 and 1389 mg/L, respectively. These concentrations compare closely with the concentrations measured earlier in December and November 2003 and in January 2004, when the agitation air remained on continuously in the mixed liquor channel.

Results of the BioWin calibration are summarized in Table 8-1. The calibration was performed first by running steady-state simulations based on average values during the sampling period. The steady-state simulation allows a check of the predicted mixed liquor and WAS concentrations, carbonaceous BOD removal, and clarifier solids removal. Dynamic simulations were then performed using normalized diurnal patterns established by the two-hour grab samples. Dynamic simulations allow a check of the predicted effluent ammonia and nitrate concentrations, as nitrification is generally more sensitive to changes in flows and loadings. The BioWin results in Table 8-1 are average values from the dynamic simulation. Plots of simulator predictions and observed values based on the daily composite samples are provided in **Appendix C**. Also listed in Table 8-1 are the primary effluent COD and TKN fractions, as well as some of the kinetic parameters used in the winter and summer calibration in 1997.

Comparing the values for the three calibrations, it can be seen that the fraction of readily biodegradable COD (F_{bs}) is considerably lower in the recent calibration, which can be attributed to the loss of the brewery discharge into the collection system. As a result of the lower F_{bs}, as well as higher unbiodegradable soluble COD fraction (F_{us}), the overall COD to BOD ratio is higher in the recent calibration. The kinetic coefficients for the nitrifier growth rate ($\mu_{max,n}$) and decay rate (b_a) in the recent calibration were based on results of a WERF (Water Environment Research Foundation) project described in the manual *Methods for Wastewater Characterization in Activated Sludge Modeling (2003)*. The WERF project concluded that $\mu_{max,n}$ at 20 deg C generally lies in the range of 0.9 to 0.95 day^{-1}, while b_a at 20 deg C is 0.17 day^{-1}. In the Budd Inlet calibration, $\mu_{max,n}$ was adjusted to 0.80 in order to better match the measured effluent ammonia and nitrate concentrations. It should be noted that because the air was turned on and off in the mixed liquor channel during the sampling period, some denitrification might have occurred in the channel. This phenomenon was not simulated as part of the calibration as it was not considered a normal operating practice.

Table 8-1. BioWin Calibration Summary

Parameter	Winter calibration (12/10-12/23/03)			Winter calibration (1/30 – 2/12/97)	Summer calibration (7/16-7/29/97)
	Observed	Assumed	Predicted	Obs'd/assumed	Assumed
Primary Effluent fractions [1]					
F_{bs}	0.16	-	-	0.21	0.34
F_{us}	0.14	0.13	-	0.08	0.04
F_{up}	-	0.22	-	0.20	0.24
F_{xsp}	-	0.76	-	0.85	0.56
F_{ac}	-	0.15	-	0.10	0.025
F_{na}	0.74	-	-	0.64	0.66
F_{nox}	0.84	-	-	0.56	0.70
PE ISS (mg/L)	12.0	-	-	12.3	11.8
COD/BOD	2.48	2.55	-	2.45	2.10
SRT (day)	5.1	-	5.8	-	-
WAS flow (MGD)	0.200	0.185	-	-	-
RAS flow (%Q)	36	30	-	-	-
AB- Stage 4 [2]					
MLSS (mg/L)	1581	-	1388	-	-
MLVSS/MLSS	0.88	-	0.87	-	-
Kinetic Coefficient [3]					
$\mu_{max,n}$ (d^{-1})	-	0.80	-	1.09	1.09
Temp correction	-	1.072	-	1.029	1.029
b_a (d^{-1})	-	0.17	-	0.04	0.04
Temp correction	-	1.029	-	1.029	1.029
Secondary Effluent					
COD (mgL)	53	-	46	-	-
sCOD (mg/L)	36	-	35	-	-
CBOD (mg/L)	5.5	-	3.8	-	-
TSS (mg/L)	10.7	-	8.8	-	-
TKN (mg/L)	5.4	-	6.4	-	-
NH_3-N (mg/L)	3.0	-	4.3	-	-
NO_3-N (mg/L)	16	-	18	-	-
Alkalinity (mmol/L)	1.2	-	1.1	-	-

Notes:

1. F_{bs} = fraction of readily biodegradable COD
   F_{us} = fraction of unbiodegradable soluble COD
   F_{up} = fraction of unbiodegradable particulate COD
   F_{xsp} = fraction of slowly biodegradable COD that is particulate
   F_{ac} = fraction of readily biodegradable COD that is VFAs
   F_{na} = fraction of TKN that is ammonia
   F_{nox} = fraction of biodegradable organic nitrogen that is particulate
2. Observed MLSS and MLVSS/MLSS are values back-calculated from solids mass balance.
3. $\mu_{max,n}$ = maximum specific nitrifier growth rate
   b_a = nitrifier decay rate

CHAPTER 9

SOLIDS STREAM MODELING

BACKGROUND

The solids-stream treatment processes were evaluated using an analysis of historical data. The historical data analysis provided performance values that were subsequently used in the plant-wide solids mass balance model, MABLE, as part of the plant capacity assessment. Separate stress testing of the solids-stream processes, including the dissolved air flotation thickener (DAFT) system, anaerobic digesters and centrifuges was not conducted during this study.

Solids removed in the primary and secondary clarifiers are thickened in four rectangular DAFT units. Historically, the DAFT units have produced sludge of about 5.6 percent total solids. This process has not exhibited a great deal of seasonal variation over the past three years of operation. Anaerobic digestion is used to stabilize thickened sludge by converting it 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 suitable for land application. At the LOTT plant, two primary sludge digesters operate in parallel and feed into a secondary digester. A fourth digester is held in reserve. An average of 52 percent volatile solids (VS) reduction has been observed over the past three years at the Plant, well above a benchmark of 38 percent required by 40 CFR Part 503 of the EPA's framework for Class B Biosolids. This value of 52 percent VS reduction, which includes any reduction in the primary as well as secondary digesters, may be somewhat lower than what the digestion system can normally achieve, as there was a seventeen-month period between 2001 and 2003 when the secondary digester had been taken off-line due to construction. During periods in which all digesters were in operation, the volatile solids reduction averaged approximately 55 percent.

The digested sludge is sent to the centrifuges for dewatering. Normally, only one centrifuge (the newer, higher capacity unit) is in service, concentrating the sludge to levels of approximately 22 percent solids. The two older, lower capacity units serve as backup. An overview of solids stream process performance is provided in Table 9-1.

APPROACH

As the BioWin model is focused solely on the secondary biological processes, MABLE is used to model the Plant solids treatment processes, including Headworks, Primary Clarifiers, DAFT, Digesters, and Dewatering. Calibration of MABLE was limited to use of standard performance parameters extracted from previous work (1998 LOTT WRMP), or evaluated based upon Plant data collected between 2001 and 2003. The values in Table 9-1 provide the backbone of the mass balance structure. A DAFT solids capture rate of 99.85 percent and centrifuge solids capture rate of 95 percent were assumed. The former is based on mass balance modeling work performed in 1999 and corresponds to the 1998 annual average value. The latter was estimated to approximately match Plant data. Other MABLE parameters, such as yield, were evaluated based on concurrent

BioWin modeling. Results from the MABLE modeling are incorporated into the capacity charts presented in Chapter 12.

Table 9-1. Solids Stream Process Performance at the LOTT Plant 2001-2003

	Primary Sludge Solids	Thickened Sludge Solids	Volatile Solids Reduction [1]	Digester Solids	Dewatered Sludge Solids
Average	1.8%	5.6%	51.7%	2.9%	21.8%
April	2.0%	5.5%	55.9%	2.8%	23.7%
Summer [2]	1.8%	5.6%	52.9%	2.9%	21.7%
Winter [3]	1.7%	5.6%	50.0%	2.8%	21.9%

1 From February 2002 – June 2003 secondary digester was offline due to construction.
2 Summer defined as April through October.
3 Winter defined as November through March.

CHAPTER 10

CONTROLLING OPERATING CRITERIA

A wastewater treatment plant contains a series of unit processes, each of which is subject to a capacity limitation. This chapter describes the controlling parameters for each unit process using a combination of modeling results, physical testing and regulatory factors (as shown in Table 10-1) to define capacity. These limits have been developed in collaboration with LOTT staff based upon an acceptable level of operating risk. The basis and assumptions used in deriving these limits are described subsequently. Note that in accordance with Ecology requirements, the rated capacity is typically the sum of all dedicated units with the largest unit removed from service. The units assumed to be out of service are indicated in Table 10-1.

Table 10-1. Controlling Operating Criteria

Unit	Capacity
Headworks Bar Screens, Peak Flow (MGD)	
3 Screens, 1 out of service	99
Grit Tanks	
Peak Flow with 4-Minute HRT[1] (MGD)	
1 Tank in Service	43.9
2 Tanks in Service	87.9
Influent Pumps, Peak Flow (MGD)	
3 Large units, 1 out of service	54
Aeration Basins	
Diffuser System Air Supply[2] (scfm)	
First Aeration	
Stage 1	11,960
Stage 2	6,080
Stage 3	4,560
Stage 4	3,380
Final Aeration	960
Blower Air Supply (icfm)	
3 units, 1 out of service	22,200
Intermediate Pump Station, Peak Flow (MGD)	
3 Large units, 2 small units (1 large unit out of service)	133
RAS Pumps, Peak Flow (MGD)	
7 units, 1 out of service	20.2
WAS Pumps, Peak Flow (MGD)	
3 units, 1 out of service	1.3

Secondary Clarifiers	
Solids Loading	Varies[3]
Hydraulic Loading[4] (MGD)	
4 units	80
UV Disinfection, Peak Flow (MGD)	
6 channels	66
Effluent Pumps, Peak Flow (MGD)	
North Outfall: 4 large pumps, 1 large pump out of service	50
Fiddlehead Outfall: 2 pumps	30
Outfall Capacity[5] (MGD)	
North Outfall	64
Fiddlehead Outfall (Emergency Only)	41
System Hydraulic Limit (MGD)	
Primary Sedimentation Collection Channel and Tanks Overflow	72
Sludge Thickening	
Maximum DAFT Loading Rate (lb/d)	
3 tanks, 1 out of service	53,015
Thickened Sludge Transfer Piping, Peak Flow (gpm)	60
Sludge Digestion, Minimum HRT (days)	25
Sludge Dewatering, Maximum Solids Loading (lb/hr)	
1 Large unit, 56 hr/wk operation	2,500

1. Ecology Orange Book criteria for grit tanks specific 3-5 minute HRT.
2. See Tables 10-2 through 10-4 for max oxygen uptake rate limits for each seasonal condition.
3. Varies depending on flow, MLSS, no. of clarifiers on-line, and sludge settling characteristics
   For dry weather period, sludge volume index (SVI) = 286 mL/g assumed
   For wet weather period, SVI = 234 mL/g assumed
4. Based on maximum surface overflow rate of 1,768 gpd/ft^2.
5. At mean higher high water (MHHW). At mean sea level (MSL), limits are 68- and 63-MGD for North and Fiddlehead outfalls, respectively. Note the Fiddlehead Outfall may only be used in emergencies, and requires prior notification of Ecology.

LIQUID STREAM UNIT PROCESSES

The following sections summarize the controlling operating criteria for liquid stream processes at the Budd Inlet Plant.

Headworks

The 2004 bar screen replacement project has resulted in 4 sets of step screens, each set with a capacity of 33-MGD (firm capacity 99-MGD).

Grit Tanks

There are two aerated grit chambers at the LOTT plant. At the high water surface level, the liquid volume is 244,040 gallons. The Criteria for Sewage Works Design (1998) by Ecology, also known as the Orange Book, recommends that aerated grit chambers be designed for a minimum detention time of 3 to 5 minutes at peak design flow to sustain removal efficiencies. Assuming a 4-minute detention time under peak hour flow conditions with both chambers on-line, the maximum capacity for the aerated grit chambers would be 87.9 MGD. The flow rate exceeds the projected peak hour flow for all permit scenarios through 2025. With one tank out of service, however, grit tank capacity is only 43.9-MGD, which is less than the current peak hourly and peak daily flows observed at the Plant. By 2025, peak hourly flows of 86-MGD would result in a detention time of 2.0 minutes. While the Orange Book does not have a reliability classification requirement for a backup grit tank, having capacity to deal with peak hourly flows in the grit tanks can be advantageous. Grit removal is linked to detention time in the grit tanks. Once the detention time falls below the minimum recommended value of 3 minutes, there is a higher probability of grit passing through the system and affecting downstream Plant elements. Grit can cause wear and tear, particularly affecting the influent pumps. Excessive grit entering the primary sedimentation tanks will ultimately reach the digester as primary sludge. This grit can cause wear and tear of sludge processing equipment, as well as increase inorganic digester loads.

Influent Pumping Capacity

The influent pumps lift the degritted wastewater (called raw degritted sewage (RDS) in the Plant) from the influent wet wells to the primary sedimentation tanks. There are a total of five pumps, four of which are rated at 18 MGD at the design head of 46 feet and the fifth pump rated at 5 MGD at the design head of 36.6 feet. The small pump is used primarily for low influent flow conditions. The firm capacity of the influent pump station, with one of the four larger pumps out of service, is 54 MGD. With all four of the larger pumps in service, the pump station has a total capacity of about 72 MGD.

The Ecology Orange Book requires that the capacity of influent pumps shall be such that, with the largest pump out of service, the remaining pumps will have the capacity to handle the peak flow. However, the Plant has some flexibility stemming from the availability of equalization basin capacity. The Plant can store approximately 2.5-MGD of flow in its five equalization basins. At the influent pump station firm capacity (54-MGD), this would allow the Plant to operate for 1.9 hours at the projected 2025 peak hourly flow (86.4-MGD), or approximately 9.1 hours at the projected 2025 peak daily flow (60.6-MGD) before filling the equalization basins. Given a typical storm hydrograph (Figure 10-1 is derived from a storm observed in January, 2002), the Plant could deal with up to 67.5 MGD of peak hourly flow before filling the equalization tanks. Flow projections indicate this level of peak hourly flow to occur in 2009 and beyond.

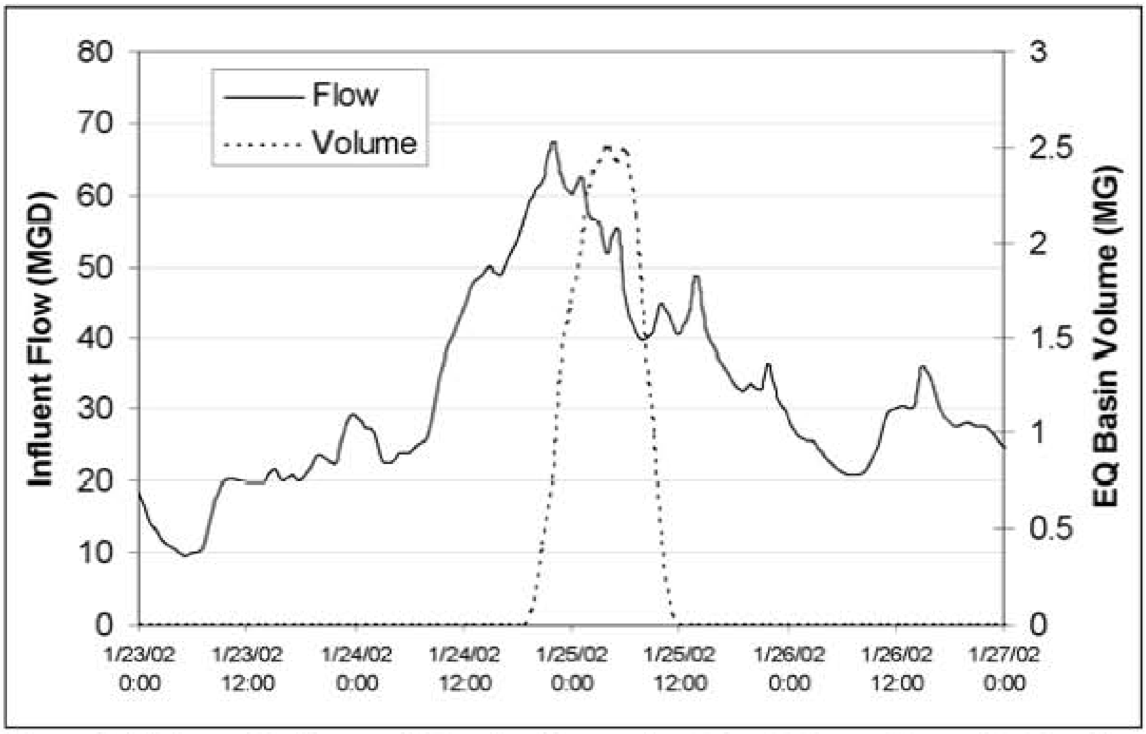


Figure 10-1. Storm Hydrograph Used to Determine Plant Influent Pump Station Firm Capacity with Equalization Tanks

Primary Sedimentation

The primary sedimentation Parshall flume flow meter has a capacity of 55-MGD. Because of this limitation, the interpretation of historical peak flow data has been incomplete. With the installation of the new Plant influent flow meter, the plant can now obtain accurate information on peak flows.

Primary sedimentation tank efficiency depends upon a number of variables, including influent flow and solids loading. The Ecology Orange Book recommends that primary sedimentation tanks be sized to accommodate an average overflow rate of 800 to 1,200 gal/ft^2/day and a peak overflow rate of 2,000 to 3,000 gal/ft^2/day. Given tank dimensions, this corresponds to an average flow of up to 12.6-MGD, and a peak flow of up to 31.5-MGD (one tank out of service). Flow projections indicate that both of these limits are already being exceeded. However, Plant data and the results of the settling tests described in Chapter 7 suggest that the primary sedimentation tanks are still providing an adequate level of solids removal. The relationship between influent solids, flow, and primary sedimentation tank efficiency, developed in Chapter 7, is used in Chapter 12 to construct the Plant capacity charts.

Diffuser Air Supply Capacity

The limits for the diffuser air supply capacity represent the maximum rate at which air can be supplied by the fine pore diffusers in the aeration basins to satisfy the oxygen demand for both carbonaceous BOD oxidation and nitrification.

An analysis of diffuser air supply capacity must take into account the daily and hourly variation in organic loading. The BioWin process simulator, however, has been set up in this project to evaluate monthly average flows and loadings. Therefore, it is necessary to transform the diffuser and blower air flow limitations, expressed as peak hourly flows reflecting peak hourly oxygen uptake rates (OURs), to corresponding peak monthly OUR values. This can be done by applying standard peaking factors. In this analysis, peak hour to peak month OUR ratios of 2.0, 2.0, and 1.8 have been applied for summer, April, and winter conditions, respectively.

These OUR ratios are lower than those estimated from historical BOD loadings. Based on 2001 to 2003 Plant data, the average peak day to peak month BOD loading ratio was 2.44, while the peak hour to daily average BOD concentration ratio determined from the diurnal sampling in December 2003 was 1.30. Multiplying the two results provides an estimated peak hour to peak month BOD ratio of about 3.17. However, these conditions are not likely to occur simultaneously and the higher costs invoked by a factor of this magnitude are prohibitive. Oxygen demand does not vary in direct proportion to BOD loading under dynamic conditions. The response time of the microorganisms to sudden increases in BOD loading depends on the system solids retention time (SRT), and net accumulation or loss of COD in the secondary system may occur, thereby attenuating the impact of the short-lived peak loading conditions. For these reasons, the standard peak hour to peak month ratio of 2.0 has been applied. A lower ratio of 1.8 is used for the winter period, reflecting the lower oxygen demands by the Plant as it operates in conventional mode.

The estimated OUR limits for the three seasonal conditions are provided in Tables 10-2 through 10-4. During the capacity curve development, the model-predicted OUR for each aeration cell is compared against the estimated peak month OUR limits.

Table 10-2. Estimated Maximum Allowable Oxygen Uptake Rates in Aerated Cells for Summer Conditions (T = 22°C)

Aeration Stage	No. of diffusers[1]	Total air flow (scfm)[2]	αF[3]	Peak hour AOR (lb/d)[1]	Peak hour OUR (mg/L/hr)	Peak month OUR (mg/L/hr)[4]
First aeration – 1	2,990	11,960	0.44	34,110	59.8	29.9
First aeration – 2	1,520	6,080	0.59	22,990	40.3	20.2
First aeration – 3	1,140	4,560	0.68	19,950	35.0	17.5
First aeration – 4	845	3,380	0.74	18,230	40.6	20.3
Final aeration	240	960	0.74	4,230	39.2	19.6

1. Total number of diffusers and actual oxygen required (AORs) in all 5 first aeration basins and both final aeration basins based on data given in original diffuser specifications (On-site Facilities Improvements Contract 92-1, Project manual volume 2, Section 11373, Parametrics, Inc. 1991) and in chapter 4 of the Task 700 report (1997).
2. A peak air flow per diffuser of 4 scfm was assumed. It may be possible to increase air flow to 6 scfm per diffuser for peak hour loading condition, but pressure loss in the air piping will increase and the standard oxygen transfer efficiency (SOTE) will decrease. Note "scfm" = standard cubic feet per minute.
3. Alpha-f is a correction to account for differences between clean water and process water. A value of 1.0 indicates clean water. The values cited in this table are based on data given in the original diffuser specification, except for the value associated with stage 1 of the first aeration basin, which was increased from 0.38 to 0.44. This was adjusted to better match the estimated oxygen uptake rate (OUR) based on actual plant data. To accurately determine the actual αF values, off-gas testing needs to be performed.

4. Peak month OUR was estimated by dividing the peak hour OUR by the estimated ratio of peak hour to peak month OUR of 2.0.

Table 10-3. Estimated Maximum Allowable Oxygen Uptake Rates in Aerated Cells for Winter Conditions (T = 14.5°C)

Aeration Stage	No. of diffusers[1]	Total air flow (scfm)[2]	αF[3]	Peak hour AOR (lb/d)[4]	Peak hour OUR (mg/L/hr)	Peak month OUR (mg/L/hr)[5]
First aeration – 1	2,990	11,960	0.44	34,570	60.6	33.7
First aeration – 2	1,520	6,080	0.59	23,560	41.3	22.9
First aeration – 3	1,140	4,560	0.68	20,370	35.7	19.8
First aeration – 4	845	3,380	0.74	18,960	42.2	23.4

1. Total number of diffusers in all 5 first aeration basins and both final aeration basins based on data given in chapter 4 of the Task 700 report (1997).
2. A peak air flow per diffuser of 4 scfm was assumed. It may be possible to increase air flow to 6 scfm per diffuser for peak hour loading condition, but pressure loss in the air piping will increase and the SOTE will decrease.
3. Based on data given in original diffuser specification, except for the value associated with stage 1 of the first aeration basin, which was increased from 0.38 to 0.44. This was adjusted to better match the estimated OUR based on actual plant data. To accurately determine the actual αF values, off-gas testing needs to be performed.
4. AOR values estimated assuming the following: SOTE = 34.1%, diffuser submergence = 22 ft, system elevation = 100 ft, β = 0.95, equivalent depth = 0.33 of diffuser depth, and operating D.O. = 2 mg/L (0.5 mg/L for stage 4 of first aeration basin)
5. Peak month OUR was estimated by dividing the peak hour OUR by the estimated ratio of peak hour to peak month OUR of 1.8

Table 10-4. Estimated Maximum Allowable Oxygen Uptake Rates in Aerated Cells for April Conditions (T = 16°C)

Aeration Stage	No. of diffusers[1]	Total air flow (scfm)[2]	αF[3]	Peak hour AOR (lb/d)[4]	Peak hour OUR (mg/L/hr)	Peak month OUR (mg/L/hr)[5]
First aeration – 1	2,990	11,960	0.44	34,460	60.4	30.2
First aeration – 2	1,520	6,080	0.59	23,450	41.1	20.6
First aeration – 3	1,140	4,560	0.68	20,250	35.5	17.8
First aeration – 4	845	3,380	0.74	16,350	36.4	18.2
Final aeration	240	960	0.74	4,640	43.0	21.5

1. Total number of diffusers and AORs in all 5 first aeration basins and both final aeration basins based on data given in original diffuser specifications (On-site Facilities Improvements Contract 92-1, Project manual volume 2, Section 11373, Parametrics, Inc. 1991) and in chapter 4 of the Task 700 report (1997).
2. A peak air flow per diffuser of 4 scfm was assumed. It may be possible to increase air flow to 6 scfm per diffuser for peak hour loading condition, but pressure loss in the air piping will increase and the SOTE will decrease.
3. Based on data given in original diffuser specification, except for the value associated with stage 1 of the first aeration basin, which was increased from 0.38 to 0.44. This was adjusted to better match the estimated OUR based on actual plant data. To accurately determine the actual αF values, off-gas testing needs to be performed.
4. AOR values estimated assuming the following: SOTE = 34.1%, diffuser submergence = 22 ft, system elevation = 100 ft, β = 0.95, equivalent depth = 0.33 of diffuser depth, and operating D.O. = 2 mg/L (0.5 mg/L for stage 4 of first aeration basin)

5. Peak month OUR was estimated by dividing the peak hour OUR by the estimated ratio of peak hour to peak month OUR of 2.0.

Blower Air Supply Capacity

Currently, there are four 500-hp blowers, each rated at 7,400 icfm. The total aeration capacity is thus 29,600 icfm with all blowers in service, or 22,200 icfm with one blower out of service. The fourth blower could be used during times of peak aeration demand, but the air flow capacity would be limited because of increased piping friction losses. For this evaluation, peak hour aeration demand must be met with one blower out of service.

The blower air supply capacity was converted to air flow limits under standard conditions (20°C, 1 atm) by assuming blower inlet temperatures of 32°C in the summer, 15°C in the winter, and 20°C in April. Using the same peaking factors as for the OUR limits, the peak month blower air flow limits were then estimated, as summarized in Table 10-5.

Table 10-5. Blower Air Flow Limits for Different Seasonal Conditions (Assumes 3 Blowers in Service)

Season	Blower Inlet Temp (°C)	Peak Hour Air Flow (scfm)	Peak Month Air Flow (scfm)[1]
Summer	32	21,310	10,660
Winter	15	22,590	12,550
April	20	22,200	11,100

1. Peak month air flow was estimated by dividing the peak hour air flow by the estimated ratio of peak hour to peak month air flow of 2.0 for summer and April and 1.8 for winter conditions.

Secondary Clarifier Solids Loading Capacity

Because BioWin utilizes a one-dimensional layered model for simulating secondary clarifiers, it is inadequate for predicting clarifier performance, particularly under overloaded conditions, unless detailed calibration of the clarifier model is performed using field data. Therefore, the clarifier solids loading rate (SLR) limits were determined by state point analysis using the MLSS concentrations predicted by BioWin for each model run. As part of the original plant performance testing in 1997, settling tests were conducted to determine the batch settling curve unique to this plant (Fig. 10-2).

The following values were derived for the Vesilind settling parameters:

V_o = 172 m/d

k = 0.40 L/g

$$\text{where } V_s = V_0\, e^{-kX}$$

and:

V_s = Settling velocity (m/hr)
V_0 = Equation parameter (m/hr)
k = Equation parameter (L/g)
X = Solid concentration (g/L)

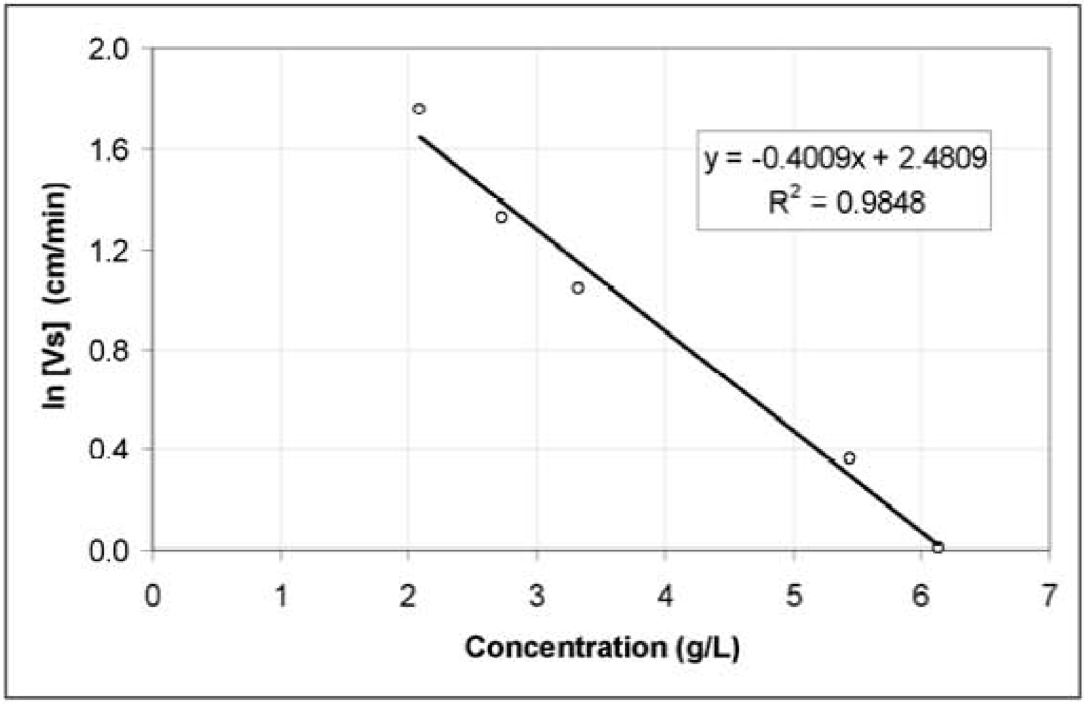


Figure 10-2. Log Transformed Settling Data and Linear Least Squares Fit (used in determining settling parameters, Vo and k).

Alternatively, state point analysis could be performed using measured sludge volume index (SVI) values to estimate clarifier capacity. Based on 2001 to 2003 Plant data, the 95th percentile SVI values (measured in a 2-L settlometer, stirred) were 286 and 234 mL/g during dry weather and wet weather periods, respectively. State point analysis indicated that the clarifier capacity based on the 95th percentile SVI values is less than that based on the Vesilind parameters. Because the SVI values are more conservative, and more representative of current plant operation, they were used in the capacity evaluation.

Note during the course of this evaluation the secondary clarifiers were being modified with new weirs and launders. Additionally, the collector mechanisms will be replaced in 2005. Following completion of this work, it is recommended the settling tests be performed again. The results of such testing will likely impact the ultimate timing of future improvements.

Secondary Clarifier Hydraulic Loading Capacity

Stress testing performed in 1997 determined a peak hydraulic capacity of 20 MGD per clarifier. At this flow rate, at least half of the effluent launder and weir became completely submerged. A 20-MGD flow per clarifier corresponds to a surface overflow rate (SOR) of 1,768 gpd/ft^2. This is higher than the Ecology criterion of 1,200 gpd/ft^2 for secondary clarifier peak hour SOR. The Ecology value is considered to be conservative and should be used in the absence of performance testing data. For this capacity evaluation, clarifier performance was assessed based on both the peak SOR limit of 1,768 gpd/ft^2 and results of the state point analysis. As Ecology does not require one unit out of service for capacity rating, the rated hydraulic capacity of the clarifiers is 80 MGD. As stated in the previous section, this should be recalculated after completion of secondary improvements in 2005.

UV Disinfection Capacity

The UV disinfection system consists of six channels, each sized to disinfect between 3 and 11 MGD of secondary effluent. A seventh channel, currently not fitted with UV disinfection equipment, serves as a spare to allow for future expansion of the system. The Department of Ecology does not require a unit to be held out of service for capacity rating purposes, so the rated capacity of the system is currently 66-MGD. Capacity would increase to 77-MGD with expansion into the seventh channel.

Effluent Pumping Capacity

The effluent pumping station was retrofitted in 1998. Currently there are four 200-hp pumps, each rated at approximately 16.7 MGD at high tide, and one 150-hp pump rated at 15 MGD at high tide. These five pumps pump disinfected effluent to the Budd Inlet outfall. The 150-hp can not be used in conjunction with the larger pumps, meaning that firm capacity of the system is rated with 3 of the larger pumps in service, at 50 MGD. Given the pressure in the pipeline, the capacity increase with a 4th pump in service is negligible. There are two additional pumps used to pump combined sewer overflows from the equalization basins and, under emergency conditions, disinfected final effluent from the UV Basin to the Fiddlehead outfall. These pumps can output a flow of approximately 15-MGD per pump.

Outfall Capacity

Hydraulic calculations through the outfall and diffuser system were performed in 1997 for two tidal conditions, mean sea level (MSL) and mean higher high water (MHHW), to determine the maximum capacity of the outfall. At MSL, the maximum amount of head available from the effluent pumping station to the diffuser section of the North outfall is approximately 25 feet. The maximum flow that can be conveyed via gravity through the North outfall and diffuser system is calculated to be 68 mgd at MSL. At MHHW, the maximum amount of head available to the system is approximately 18.43 feet, resulting in a maximum flow of 64 mgd. Flows above these maximum limits can only be diverted to the Fiddlehead Outfall in the case of an emergency.

System Hydraulic Limitations

Hydraulic limits are based on hydraulic bottlenecks in the liquid-stream treatment train. A hydraulic profile analysis was performed as part of the 1997 process evaluation. This evaluation was compared and verified against existing conditions and a series of critical hydraulic restrictions were identified.

The hydraulic analysis shows the mixed liquor distribution box weir becomes submerged at 57 MGD. This disrupts equal distribution of the mixed liquor flow among the secondary clarifiers, potentially causing premature overloading and thereby affecting overall clarifier performance. At 72 MGD, the primary sedimentation collection channel and tanks begin to overflow. The 57 MGD flow limit is considered less critical since the Plant can safely continue to operate (with flow blending up to a certain point depending upon mass settleability) when the mixed liquor flow is not distributed evenly. Furthermore, the mixed liquor distribution box and channel are scheduled to be renovated as part of the Plant's secondary clarifier equipment replacement project in 2007.

SOLIDS STREAM UNIT PROCESSES

The following sections summarize the controlling operating criteria for the solids stream unit processes at the Budd Inlet Plant.

Sludge Thickening Capacity

The capacity of the four existing DAFTs was expressed in terms of the highest solids loading rate observed for each unit. Based on Plant operating data and staff observations, the DAFTs can process up to 33 lb/ft^2-d of solids and still achieve 4 to 6 percent solids without excessive polymer use. Compared to the original solids loading rate of 0.5 to 1.0 lb/ft^2-hr (or 12 to 24 lb/ft^2-d), the sludge thickening capacity is almost 50 percent higher than the design valve. This is likely due to increased operating experience with the equipment and more effective use of polymer. Consequently, the original design criteria were considered too conservative. For this capacity evaluation, the maximum loading rate is decreased by a 10 percent de-rating factor (included as a safety factor) and one of the four DAFTs was assumed to be out of service. This results in a maximum solids loading rate of 53,015 lb/d. The solids loading rates to the DAFTs were estimated by a combination of BioWin simulations and solids mass balance calculations in MABLE. For each set of flow and BOD concentration conditions, sludge production rate in the secondary treatment system, as predicted by BioWin, was used as input to MABLE, which in turn computes the total solids load to the thickeners, the hydraulic load to the digesters, and solids load to the centrifuges. Because peak day loadings were not directly simulated as part of the capacity chart development, the predicted solids loading rates were compared against the limit of 53,015 lb/d, and peak day loading was assumed to be accommodated by placing the fourth DAFT in service.

Thickened Sludge Transfer Piping Capacity

The thickened sludge from each DAFT combines in a common manifold and is carried by a 4-inch line, which expands further downstream into a 6-inch line, to the sludge digestion system. The 4-

inch pipe has a maximum capacity of 60 gpm. Beyond this flow rate, excessive headloss in the piping may result in accumulation of solids in the pipe. Using a 10 percent decrease as a safety factor to account for peak day loading, the maximum capacity is then 54 gpm or 77,760 gpd.

Sludge Digestion Capacity

The capacity of the four anaerobic digesters is defined in terms of hydraulic retention time. The operating objective is to operate at a minimum hydraulic retention time (HRT) of 25 days to achieve the desired solids stabilization. However, the EPA biosolids guidelines require only a 15-day HRT to achieve Class B biosolids status (provided volatile solids (VS) destruction is at least 38 percent). Consequently the Plant has some operational flexibility that can be useful in the future. Currently, two digesters operate in parallel as primary digesters, followed by a third digester operating as a secondary digester. In the capacity evaluation, it was assumed that three digesters would operate as primary digesters, and the fourth one as secondary digester. The 25-day HRT limit applies to the primary digesters and average monthly loading conditions only.

Sludge Dewatering Capacity

The sludge dewatering system at the Plant consists of three centrifuges, two of which were installed in the 1980 plant expansion and the third one added in 1999. Based on operational and performance data developed during startup testing, the two older units each have a design solids loading rate of 1,500 lb/hr, while the newer unit has a design solids loading rate of 2,500 lb/hr. Prior to the dewatering system upgrade in 1999, only one centrifuge could operate at a time. After the upgrade, all three centrifuges can operate simultaneously, thereby resulting in a total maximum design load of 5,500 lb/hr. Currently, the plant typically operates with only the larger unit in service. The two older units serve as backup. In the capacity evaluation, it was assumed that only the newer unit is in operation, thus resulting in a maximum solids loading limit of 2,500 lb/hr. This limit is compared with the predicted solids loading rate under peak month loading conditions. The centrifuge was assumed to operate 7 days a week, 8 hours per load, and 1 load per day. Peak day solids loading is assumed to be accommodated by extended hours of operation.

CHAPTER 11

PLANT OPERATING SIMULATIONS AND ASSUMPTIONS

Influent flows and loads as well as effluent requirements vary seasonally. Typically a capacity chart is developed for dry weather, low flow, or summer operation, and another for wet weather, high flow, or winter operation. These seasonal variations represent the extremes of plant operating conditions. For the LOTT Plant, three different potentially-limiting seasonal conditions were considered for the capacity evaluation:

- Summer – Represents April through October influent wastewater characteristics (relatively higher BOD concentrations and summer temperatures) and the requirement to meet nitrogen removal limits.

- April – Represents April influent wastewater characteristics (relatively lower CBOD concentrations and lower temperatures) and the requirement to meet a nitrogen removal limit.

- Winter – Represents November through March influent wastewater characteristics (high flow, low BOD concentrations, and low temperatures) and the requirement to meet a BOD removal limit.

The biological process model draws its inputs and parameters from Plant historical data and the flow and loading projections (Chapters 5 and 6). The model defines the three seasonal conditions as follows. Summer conditions are based on the average of the characteristics measured during the period from April through October. Winter conditions based on the average of the characteristics measured during the period from November through March. Winter flows are defined as 10-year peak monthly flows. April conditions are drawn from Plant historical data for the month of April alone. April flows are defined as a 10-year peak dry weather month. This means there is a 10 percent chance of having flows this high during a single month during the dry weather period (April through October) for any given year. April flows were calculated by applying a standard multiplier to summer flows: over the period 1996-2003, the 10-year return ratio of peak dry weather month to average dry weather month was 1.27. Flows and loadings for the three model periods are summarized in Table 11-1.

SATELLITE RECLAMATION FACILITIES

The Highly Managed Alternative, discussed in the 1998 LOTT WRMP, envisioned the construction of a number of satellite treatment plants (SRPs) throughout the LOTT system. These plants draw off raw sewage at remote locations in the collection system and treat to Class A reclaimed water standards. Solids from the SRPs are returned to the collection system and treated at the LOTT plant. The satellite plants divert flows and loads from the LOTT Plant, help to satisfy NPDES discharge limits, and take advantage of the Plant's excess solids handling capabilities.

Table 11-1. Total System Flows and Loadings: Observed 2001-2003, and Projected 2005-2030 (Brewery Flows Excluded)

	Flow (MGD)			Concentration (mg/L)					
				Summer		Winter		April	
Year	Summer[1]	Winter[2]	April[3]	BOD	TSS	BOD	TSS	BOD	TSS
2001	8.74	15.76	9.31	281	341	183	251	183	273
2002	8.98	15.37	10.86	263	283	212	241	191	214
2003	9.55	13.17	11.37	256	275	215	240	204	222
2005	10.91	21.71	13.85	Variable[4]					
2010	13.83	25.34	17.57						
2015	16.16	28.19	20.52						
2020	18.49	31.04	23.48						
2025	19.79	32.60	25.13						

1. April through October.
2. November through March. Flow is representative of peak month (10-year peak month for projections).
3. Maximum dry weather month = peak month during the period April though October (10-year peak month for projections).
4. Loading projections vary depending on satellite plant activity (see below).

The first satellite plant is scheduled for completion in 2006. This Plant will have the capacity to treat 2-MGD of raw sewage, with expansion capacity to 5-MGD. The number of satellite plants to be constructed, and the treatment capacity installed at each site will vary depending on planning goals and available discharge capacity. At the time of modeling, three different satellite plant implementation scenarios were considered. The three scenarios foresaw 2025 satellite treatment capacity of:

- Low Rate of SRP Construction: 7-MGD
- Moderate Rate of SRP Construction: 10-MGD
- High Rate of SRP Construction: 13-MGD

Ecology is currently conducting a total maximum daily load (TMDL) determination for the Deschutes River / Budd Inlet Watershed (WRIA13) which may further restrict the summer capacity (see Chapter 3 regarding the NPDES permit). Consequently, the 2005 LOTT Capital Improvements Program includes increased production of Class A reclaimed water at the Budd Inlet Treatment Plant to provide additional flexibility. This may delay the construction of additional SRP capacity. In order to understand the effect of this upon Plant capacity, a fourth scenario was developed as described below:

- Budd Inlet Class A – Up to 12-MGD Class A reclaimed water production at Budd Inlet Plant, delay SRP construction.

A summary of the four scenarios is presented in Table 11-2.

Table 11-2. Satellite Reclamation Facility Capacity Scenarios (MGD)

	SRP Construction Rate			
	Low	Moderate	High	Budd Inlet Class A
2004	0	0	0	0
2005	0	0	0	0
2006	2	2	2	2
2007	2	2	4	2
2008	2	2	5	2
2009	2	2	5	2
2010	2	3	6	2
2011	3	3	6	2
2012	3	4	7	2
2013	3	4	7	2
2014	4	5	8	2
2015	4	6	9	2
2016	5	7	10	2
2017	5	7	10	3
2018	6	8	11	3
2019	6	8	11	3
2020	6	8	11	3
2021	7	9	12	3
2022	7	9	12	3
2023	7	9	12	3
2024	7	9	12	3
2025	7	10	13	3

Process modeling shows that the effect of adding satellite plants is observed mainly in the flow and organic loading. Satellite plants remove flow and BOD from the system, resulting in lower flows and BOD loads at the Budd Inlet Treatment Plant. The SRPs return solids to the system, meaning that the solids loading to the Budd Inlet Treatment Plant is relatively independent of satellite treatment. Figure 11-1 provides a comparison of summer period projected flows and loadings, under the low SRP construction rate scenario.

Figure 11-1. Projected Effect of SRPs on Budd Inlet Treatment Plant Flows and Average Daily Loadings Summer Conditions, Low SRP Construction Rate

EFFLUENT LIMITS

The proposed LOTT plant discharge permit, discussed in Chapter 3, includes a load-based TIN limit. To accommodate this, the model has been configured to produce effluent TIN concentrations of either 2 mg/L or 3 mg/L. A summary of the SRP and effluent limits used in the model scenarios is provided in Table 11-3.

Table 11-3 SRP Effluent Limits Scenarios

Scenario	Season	SRP Rate	Effluent Limits (mg/L)			
			TIN	BOD	TSS	NH3-N
1	Summer	High	2	5	10	--
2	Summer	High	3	5	10	--
3	Summer	Moderate	2	5	10	--
4	Summer	Moderate	3	5	10	--
5	Summer	Low	2	5	10	--
6	Summer	Low	3	5	10	--
7	April	High	2	5	10	--
8	April	High	3	5	10	--
9	April	Moderate	2	5	10	--
10	April	Moderate	3	5	10	--
11	April	Low	2	5	10	--
12	April	Low	3	5	10	--
13	Winter	High	--	30	30	26
14	Winter	Moderate		30	30	26
15	Winter	Low	--	30	30	26
16	Summer	Budd Inlet Class A	3	5	10	--
17	April	Budd Inlet Class A	3	5	10	--

In the following chapter, discussion will focus on the low rate of SRP construction case and the Budd Inlet Class A case. These are the two most likely satellite treatment scenarios. The moderate and high rate of SRP construction cases will demonstrate the effect of increasing amounts of satellite treatment on Budd Inlet Treatment Plant capacity. Taken together, these scenarios will guide LOTT in determining the most appropriate level of SRP construction.

CHAPTER 12

PLANT CAPACITY DISCUSSION

INTRODUCTION

The compilation of the capacity assessment is a series of capacity diagrams illustrating the capacity restrictions at the Plant with respect to flows and loads. These diagrams depict when components of the treatment plant are expected to reach their limitations. Separate charts have been generated for each set of scenarios identified in Chapter 11, (Table 11-3): summer, winter, April, varying SRP construction rate, and varying effluent TIN limits. The charts are constructed as follows:

- The x-axis represents the average monthly wastewater flow. These flows represent the total flows for the entire LOTT system, including flows treated at the potential satellite plants. For summer conditions, they represent the average dry weather flow; for April conditions, they represent the 10-year peak monthly average flows in April; and for winter conditions, they represent the 10-year peak monthly average flows.

- The y axis expresses raw influent BOD at the Plant.

- The loading curve, represented as a solid black line, demonstrates the change in plant influent BOD concentration with increasing total system flow. This line is used to identify when the capacity limits are reached. In this report, the line appears as a series of peaks and valleys. The variability of the loading curve represents changes in Plant flows and loads brought about by the installation of satellite treatment plants, and by large construction or connection projects in various parts of the tributary system. For example, diversion of 1-MGD flow to a satellite plant will show up on the loading curve as a "bump", as the satellite plants remove more flow than load. Large construction projects in newly developed areas will also show up on the loading curve as "bumps", as new developments tend to have highly efficient pipes, and lower inflow and infiltration. Barring the addition of satellite plants and new construction, the loading curve would be expected to be more or less horizontal.

- The colored lines represent capacity curves for each component of the treatment plant. The point where each of the colored curves crosses the black line represents the capacity limitation for each corresponding component.

- As a guide, a timeline based on the results of Chapter 6 has been added along the x-axis, to suggest when components are expected to reach capacity.

The curves on the chart are interpreted using the method of progressive disclosure. Simply stated, progression across the chart from left to right reveals the limit of each unit process, and when these limits will occur. When the curves representing all Plant unit processes are plotted simultaneously on the chart, they describe a ranking of overall Plant capacity limits. Interpretation of a specific curve is as follows:

- All combinations of influent BOD concentration and influent flow to the left of this curve are acceptable operating conditions.
- Influent BOD concentrations and flow combinations to the right of the curve are likely to cause the Plant to become unstable and not meet discharge criteria.

Note that these curves are generated for a certain set of conditions. As conditions change (i.e. permit requirements, wastewater characteristics, number of units in service, operating strategies, etc.) the curves will shift and may alter the capacity limitation. Consequently, the series of scenarios (Table 11-3) taken collectively will provide an indication of the sensitivity of the Plant to changing conditions.

A total of 17 scenarios were modeled, reflecting the four different satellite treatment scenarios discussed in Chapter 11. In order to simplify the capacity discussion, this chapter is divided into three sections:

- Low Rate of SRP Construction
- Increased Rates of SRP Construction
- Budd Inlet Class A Scenario

Discussion of the low rate of SRP construction case serves as a baseline, as this scenario represents the midpoint of the four satellite treatment scenarios, and the most likely of the three SRP-driven scenarios. Later in the chapter, the results of the low rate case will be compared with more aggressive satellite plant scenarios, in order to assess the effect of increasing satellite treatment on Budd Inlet Plant capacity. Finally, towards the end of the chapter, the Budd Inlet Class A scenario will be evaluated. This case represents the opposite end of the spectrum, with nearly all system flows being treated at the Budd Inlet Plant, and minimizing the effects of satellite treatment.

LOW SRP CONSTRUCTION RATE

The capacity charts for the cases representing the low rate of SRP construction are presented on Figures 12-1 through 12-4. This SRP construction rate was designed to limit average summer flows at the LOTT plant to 12-MGD.

Summer Conditions, Effluent TIN = 3 mg/L

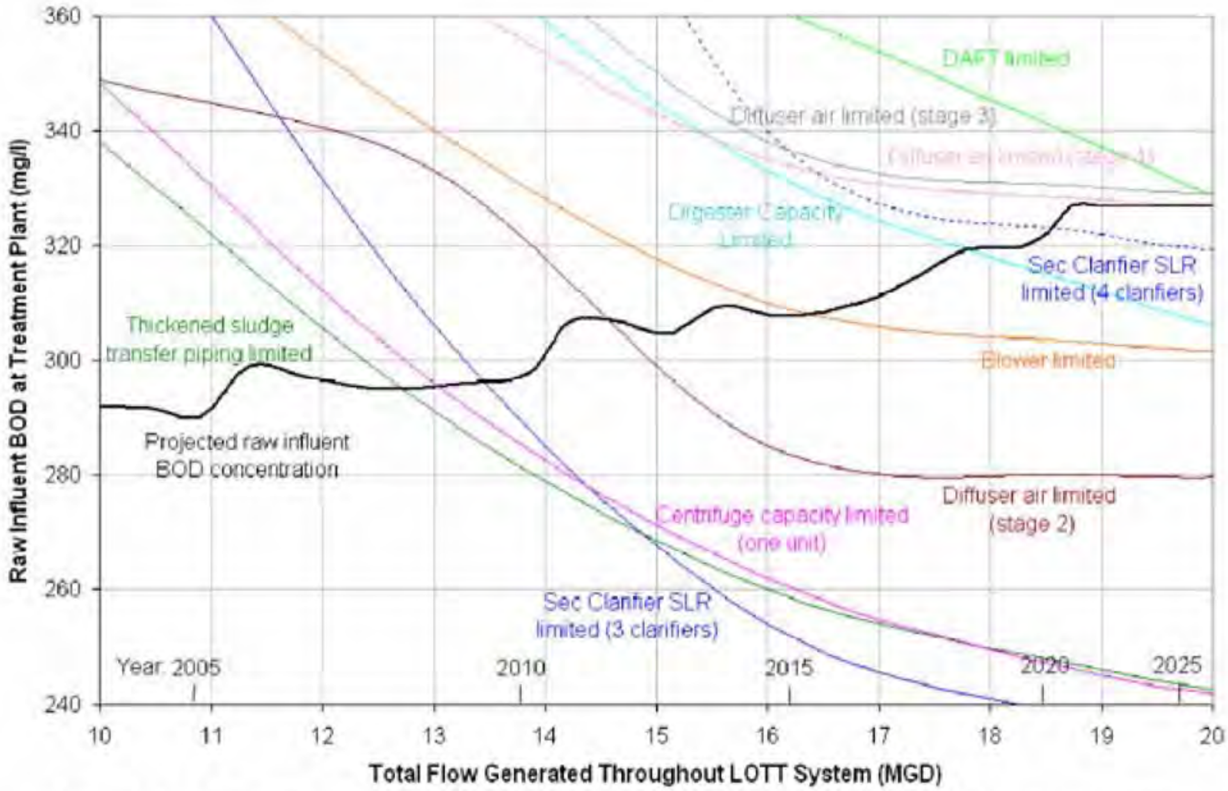


Figure 12-1. Capacity Curve for Summer Condition, Low Rate of SRP Construction, Effluent TIN = 3 mg/L

Under summer conditions with an effluent TIN limit of 3 mg/L, the most stringent constraint is shown on Figure 12-1 to be represented by the thickened sludge transfer piping at approximately 12.75-MGD of dry weather flow. At nearly 13.0-MGD, centrifuge capacity with one unit in service, operating 56 hours per week, is reached. These limitations are followed closely by the secondary clarifier solids loading rate limit, at a total system flow of 13.5 MGD. This corresponds to a circumstance with 3 clarifiers in service, 1 in reserve. With all 4 clarifiers in service, the SLR limitation is pushed back to 18.5 MGD. This report typically will list the capacity with 3 clarifiers in service in order to simulate a circumstance where one clarifier is down for repairs or otherwise limited. Note that this is more conservative than the Ecology Orange Book requirement, which does not require a clarifier be held out of service for capacity rating purposes.

Post-2010, at a system flow of 14.5-MGD, diffuser air supply capacity in stage 2 of the first aeration basin is reached. Blower air supply capacity is limiting at approximately 16.3-MGD. The digester capacity is reached towards 2017, at 17.8-MGD of total system flow. Finally, at the right end of the curve, near 20-MGD, diffuser air capacity in stages 1 and 3 of the first aeration basin becomes limiting.

Summer Conditions, Effluent TIN = 2 mg/L

Decreasing the effluent TIN limit to 2 mg/L has very little effect, under summer conditions. The capacity curve for this condition is plotted on Figure 12-2 for comparison with Figure 12-1.

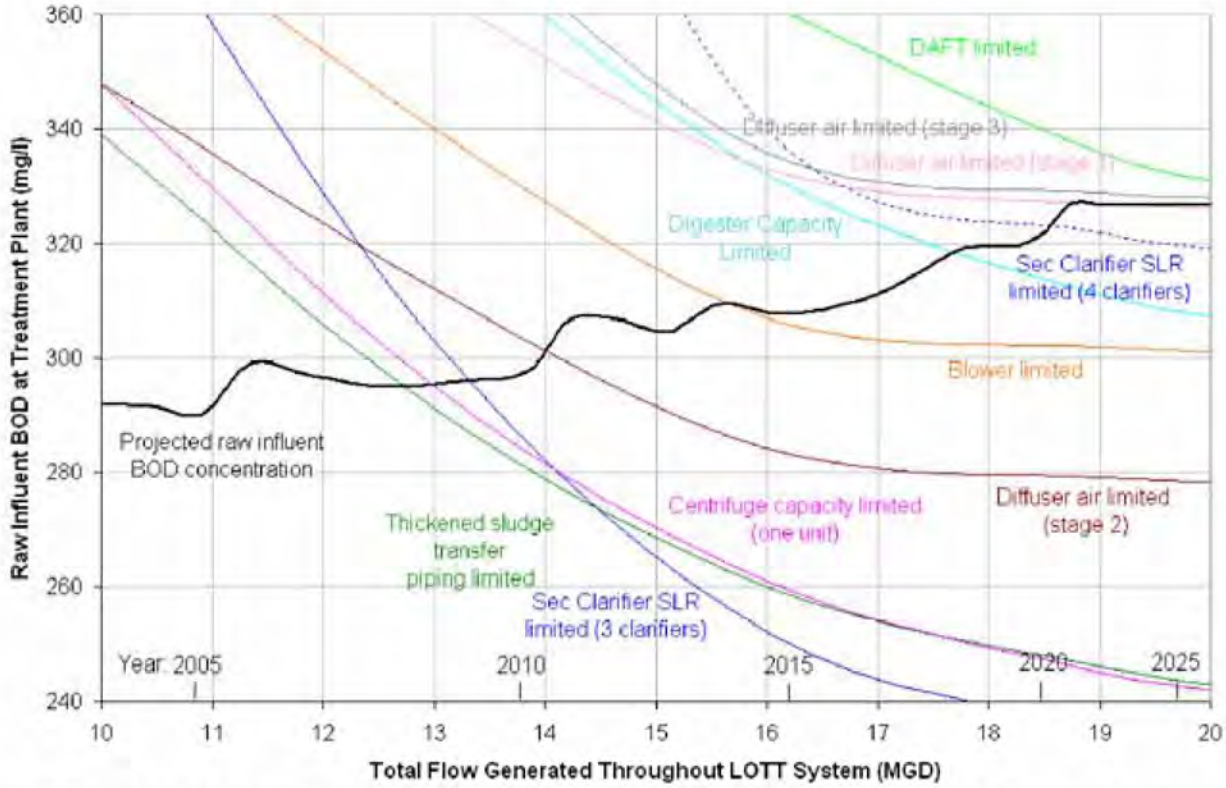


Figure 12-2. Capacity Curve for Summer Condition, Low Rate of SRP Construction, Effluent TIN = 2 mg/L

The only significant difference caused by the lower TIN limit is to move the stage 2 diffuser air limitation forward by approximately 0.5-MGD of total system flow.

April Conditions, Effluent TIN = 3 mg/L

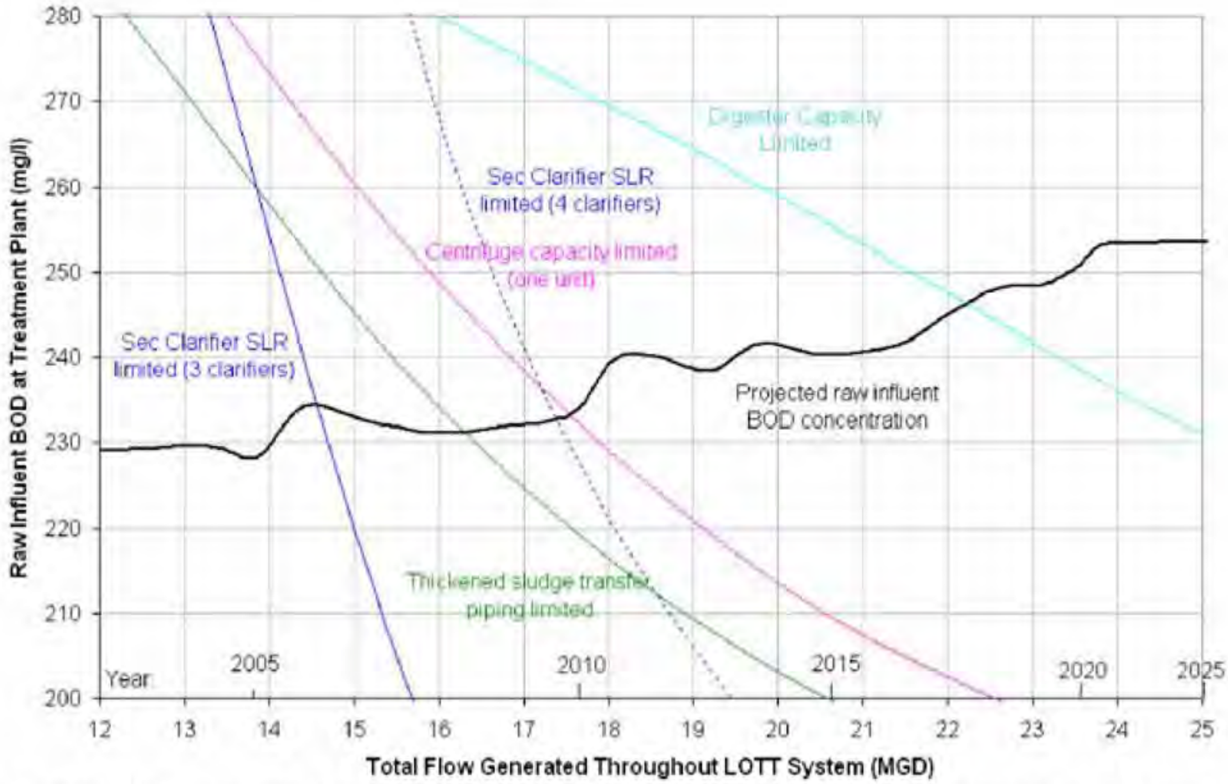


Figure 12-3. Capacity Curve for April Condition, Low Rate of SRP Construction, Effluent TIN = 3 mg/L

Under April conditions with an effluent TIN limit of 3 mg/L, the most stringent limitation is represented by the secondary clarifier SLR curve with 3 clarifiers in service, at a total system flow of about 14.6-MGD, as shown on Figure 12-3. With all 4 clarifiers in service, this limitation moves to 17.4-MGD. The next most stringent limitation is associated with the thickened sludge piping, at a flow of 16.25-MGD, followed by the centrifuge capacity limitation at 17.6-MGD. Further down the planning horizon, digester capacity is reached at 22.2-MGD (circa 2018). The secondary process tank constraints noted in the summer scenarios (diffuser air capacity, blower capacity) are not limiting for the April condition.

April Conditions, Effluent TIN = 2 mg/L

Imposing an effluent TIN limit of 2 mg/L primarily affects the secondary clarifiers. The secondary clarifier SLR limitation with 3 units in service is pushed off the chart to the left, as shown on Figure 12-4, indicating that the LOTT plant is already exceeding capacity for this condition. Even with 4 units in service, capacity would have been exceeded as of 2006. The lower TIN limit does not significantly affect the other April condition capacity limitations.

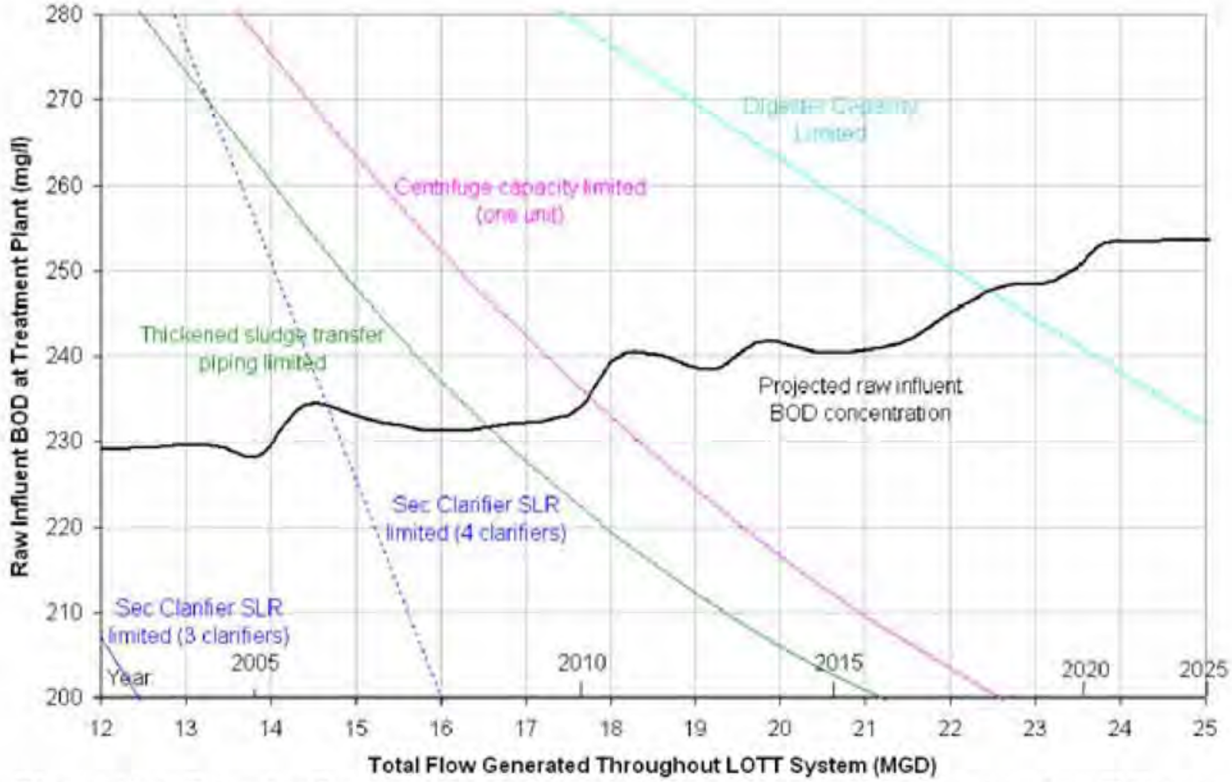


Figure 12-4. Capacity Curve for April Condition, Low Rate of SRP Construction, Effluent TIN = 2 mg/L

Winter Conditions

During the winter, the Plant hydraulic limitations become significant. Since winter flow is modeled as 10-year peak monthly flows, capacity limitations noted in this discussion represent a 10 percent risk level. In order to plot the hydraulic limitations (which are determined on a peak hourly flow basis) on the capacity curve (plotted on a peak monthly flow basis), the flow and loadings projections are used to match peak hourly flows to peak monthly flows.

A number of the Plant's hydraulic limitations are already exceeded, including:

- Effluent pump station to North Outfall (50-MGD)
- Influent pump station firm capacity (54-MGD, corresponding to a peak monthly flow of 18-MGD).
- Parshall flume primary influent flow meter (55-MGD, 18.4-MGD peak month).
- Grit tank firm capacity (1 tank in service, 43.9-MGD, 13.5-MGD peak month).
- Secondary clarifier overflow rate, 3 units (60-MGD, corresponding to a peak monthly flow of 20.7-MGD).

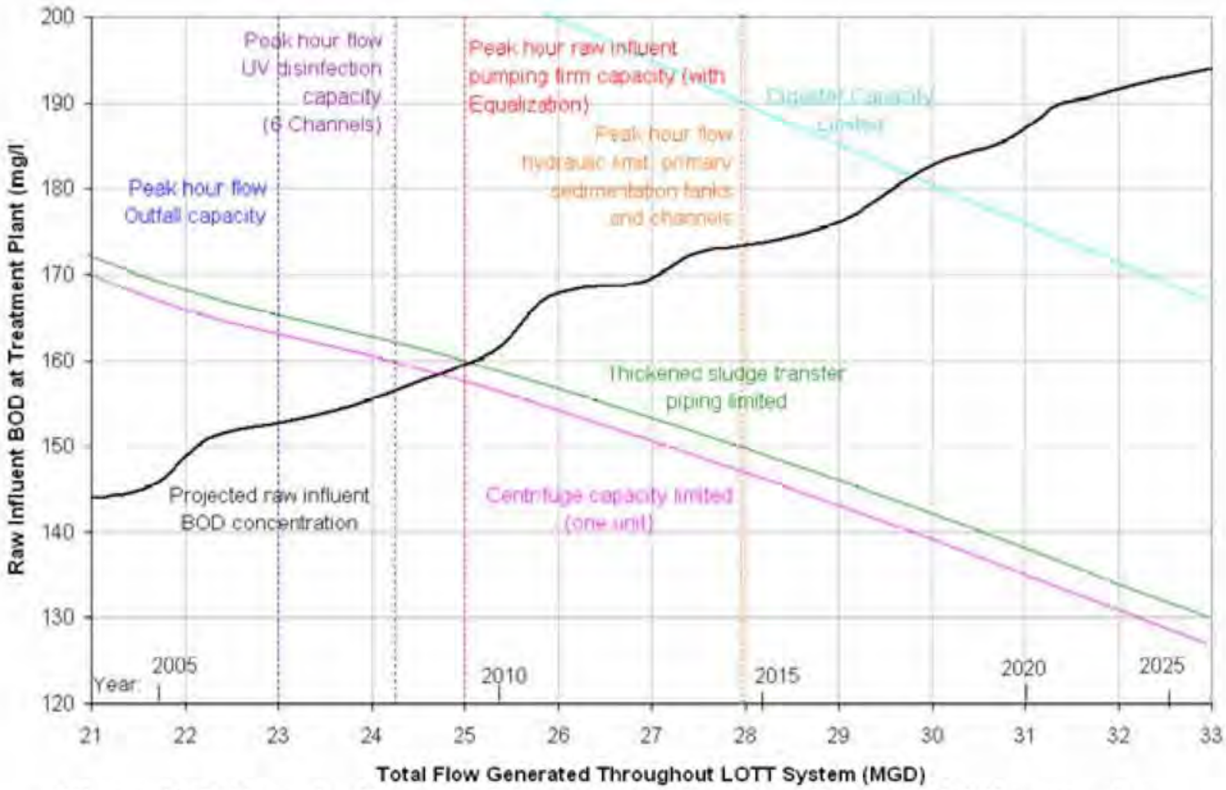


Figure 12-5. Capacity Curve for Winter Condition, Low Rate of SRP Construction

Of these, only the influent pump station capacity fails to meet the General Requirements for Reliability set forth in Ecology's Criteria for Sewage Works Design (Orange Book). The influent pumping capacity limitation is mitigated by the Plant's equalization capacity. As discussed in Chapter 10, the Plant can operate at flows greater than the influent pumping station's firm capacity (54-MGD) by diverting a portion of the flow to the equalization tanks. A typical storm hydrograph was used to determine a firm capacity, with equalization, of 67.5 MGD. This corresponds to a peak monthly flow of 25 MGD, occurring in 2009.

The Parshall Flume is not a critical component of the Plant, especially now that an influent flow meter has been installed in the 60" influent pipe.

The Plant has spare UV equipment, allowing for 6 channels to operate at all times. As Ecology does not require one unit out of service, the rated capacity of the system is 66 MGD. This limitation is projected to occur in 2008. A 7^{th} channel is ready for expansion when required. The expanded capacity of the system (77 MGD) would be sufficient through 2020 (31 MGD)

The Grit Tank is not a critical plant process, and can function hydraulically if the mechanical components fail. For this reason, the 2 tank limit of 87.9-MGD is the more critical limitation.

The secondary clarifier hydraulic capacity has been defined at 80-MGD, which is outside of the Plant's planning horizon for all but the Budd Inlet Class A treatment scenario.

The Plant outfall capacity, at 64-MGD (23-MGD peak hour) occurs around 2007. This represents effluent through the North Outfall. The Fiddlehead Outfall has an additional 41-MGD of capacity, which may be used in emergency situations (typically during storm events, where much of the flow would be stormwater). Capacity of the North Outfall could be increased by removing the 30-inch section of pipe in the vicinity of the State-operated dangerous waste site formerly used by the Cascade Pole Company. At least 500-feet of the 1,200-foot run of 30-inch pipe is located outside of the sealed-off portion of the site, meaning that it could be replaced without requireing excessive permitting or safety measures. Increasing the pipe diameter from 30-inches to 48-inches would allow over twice as much flow to pass through the bottlenecked section, relieving the capacity limitation and decreasing the frequency with which the Fiddlehead Outfall must be used.

Both of the outfall capacities are in excess of what the pumps in the effluent pump station can currently output. Output to the North Outfall is limited to 50-MGD due to pressure in the pipeline. Part of this limitation is caused by the 1,200 foot 30-inch bottleneck, which generates over 10-psi of pressure at 50-MGD, with in-pipe flow velocity in excess of 15 ft per second. The emergency pumping capacity to the Fiddlehead Outfall is limited to 30-MGD due to the size of the pumps. Combined effluent pumping capacity of approximately 80-MGD is sufficient throughout the planning period for all but the Budd Inlet Class A scenario, in which effluent pumping limitations would be exceeded in 2020.

Centrifuge capacity and thickened sludge transfer piping limitations are reached at 24.6- and 25.0-MGD respectively. The Plant's overall hydraulic capacity, represented by primary sedimentation tanks and channels, is reached at 72.0-MGD, corresponding to a peak monthly flow of 28.0-MGD. Digester capacity and effluent pump station capacity both reach their limits at a peak monthly flow of 30-MGD.

EFFECT OF INCREASED SRP FLOWS

Two other SRP construction schedules were modeled, both of which divert additional flows to potential satellite plants. The effect of diverting flow to the satellite plants is complicated, as both flows and organic loadings to the Budd Inlet Plant are decreased, but solids loads remain nearly constant. The decreasing flows lead to more highly concentrated loadings, which can impact primary sedimentation performance, as well as diffuser air capacity.

The effect of adding satellite plants is most pronounced in the summer. Since the satellite plants are designed to treat a constant flow, regardless of season, the fraction of flow treated at satellite plants is highest during the summer. Figures 12-6 and 12-7 depict capacity curves for the summer condition for the moderate and high SRP conditions. As effluent TIN has little impact on capacity for the summer condition, only scenarios with an effluent limit of 3 mg/L are shown.

Addition of satellite plants causes the element capacity curves, as well as the loading curve, to ebb and flow, complicating interpretation of the charts. As a whole, the addition of satellite plants relieves Plant capacity limitations, particularly with respect to the secondary clarifier SLR and the aeration basin diffuser air capacity. This is tied to both flow and loading. In the most aggressive case, the high rate of diversion leaves only 7- to 8-MGD of dry weather flow to be treated at the Budd Inlet Plant. Even though influent concentrations are high, the Plant has ample capacity to treat due to the decreased organic loadings. A number of limitations observed in the least aggressive SRP case (Figure 12-1), do not show up in either of the more aggressive cases. These limits include blower capacity, diffuser capacity in first aeration basin stages 1 and 3, Digester capacity and DAFT capacity. Even though the overall solids loading to the Plant remains high (as a result of satellite plants returning solids to the system), the addition of satellite plants relieves solids handling capacity at the Plant. This is mostly due to the lower BOD as well as TKN loadings sent to the secondary system. With less biological solids being generated in the treatment process, there is more room to deal with the solids entering the system. Centrifuge and transfer piping limits are the only constants across all scenarios. The transfer piping is a known bottleneck, not likely to change much from one scenario to the next, and the centrifuge limit reflects a highly conservative control system (only one unit in service, 56 hours per week).

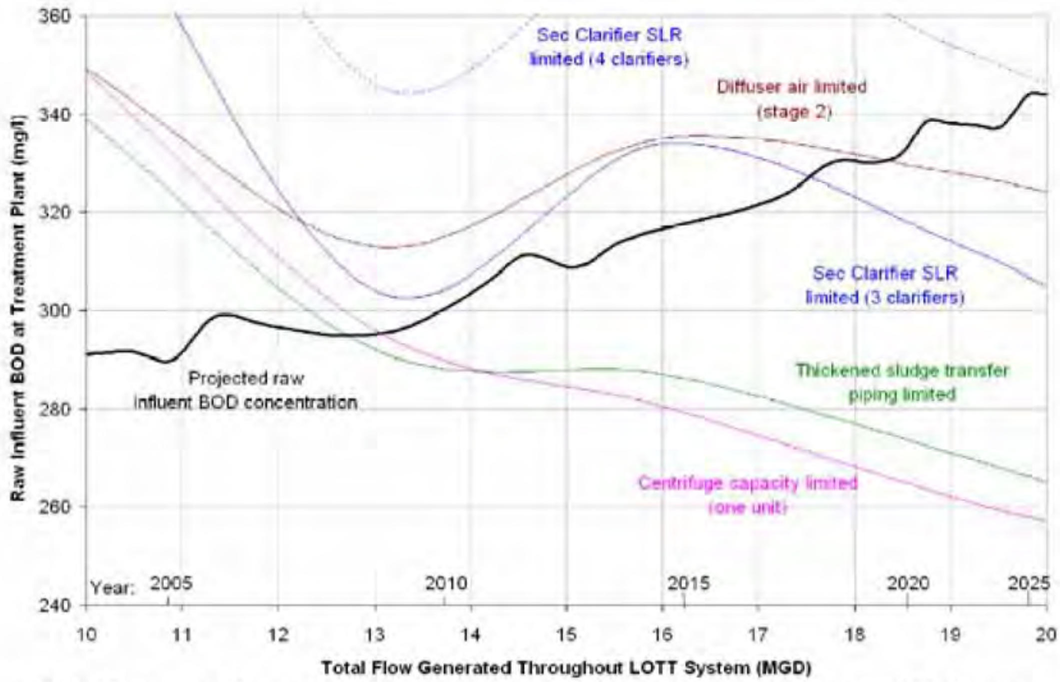


Figure 12-6. Capacity Curve for Summer Condition, Moderate Rate of SRP Construction, Effluent TIN = 3 mg/L

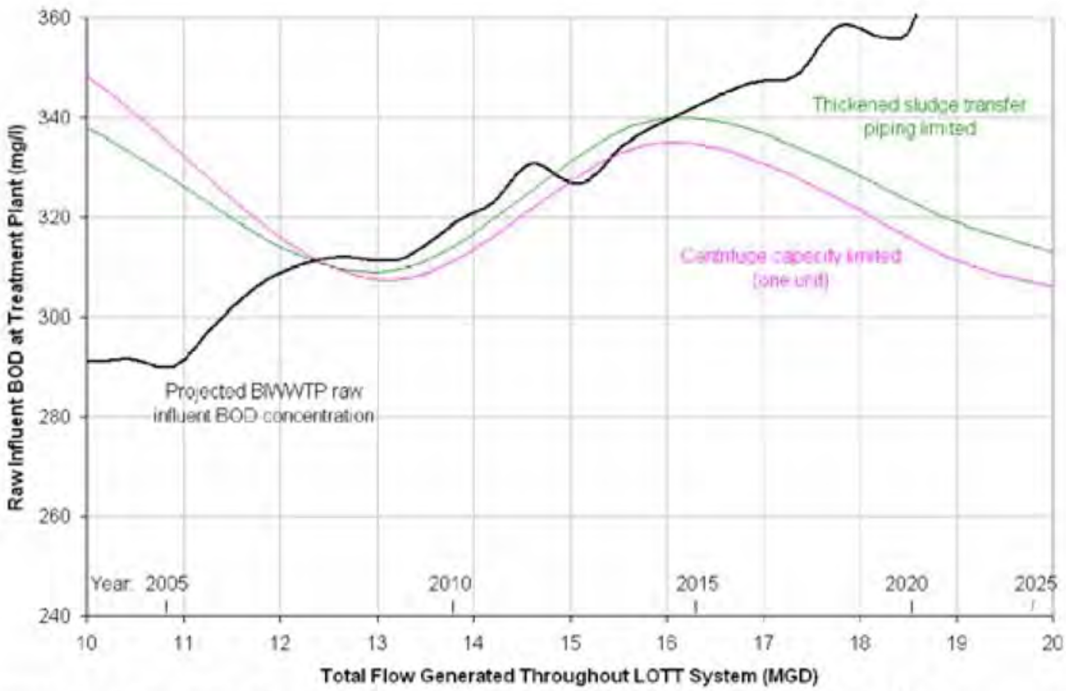


Figure 12-7. Capacity Curve for Summer Condition, High Rate of SRP Construction, Effluent TIN = 3 mg/L

In April, the addition of satellite plants has a more complicated result, related to the effluent TIN limit. Plots for the most aggressive SRP schedule are provided on Figures 12-8 and 12-9 reflecting the two effluent TIN scenarios.

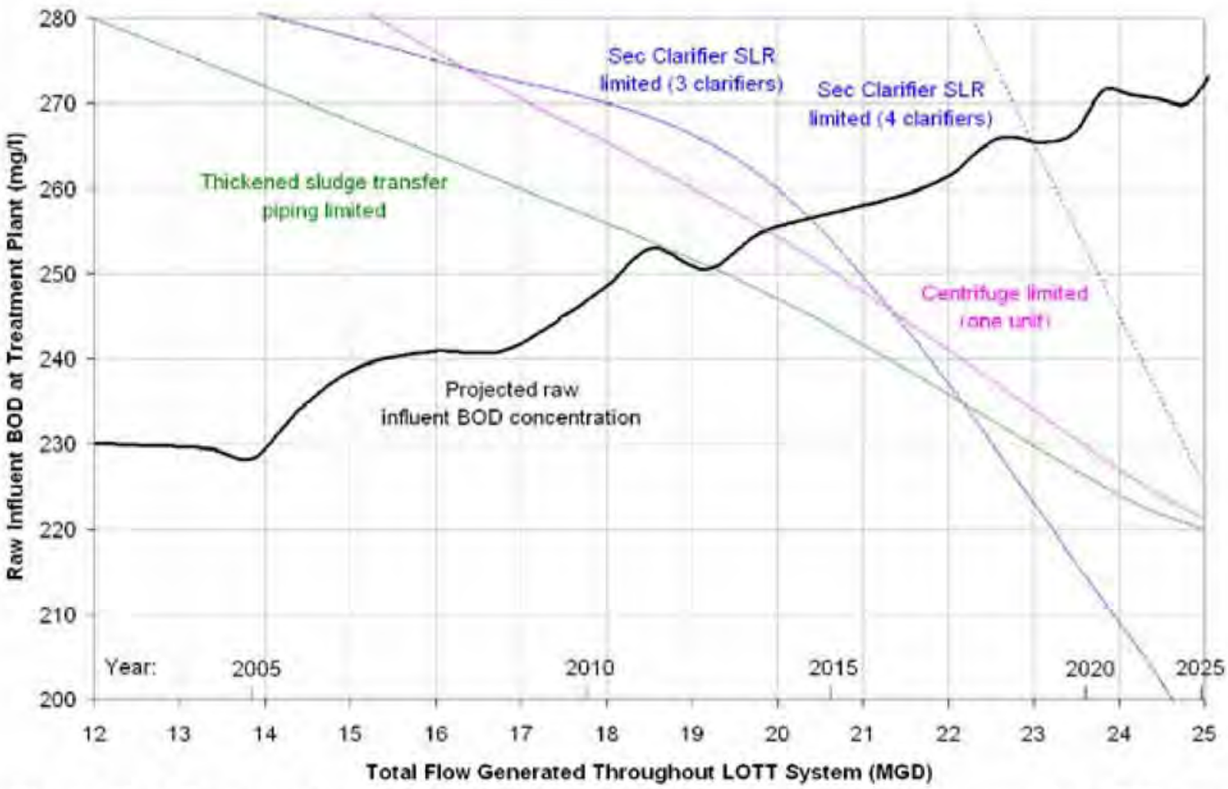


Figure 12-8. Capacity Curve for April Condition, High Rate of SRP Construction, Effluent TIN = 3 mg/L

Compared to the least aggressive case (Figures 12-3 and 12-4), the digester limitation disappears, and there is some relief in the transfer piping and centrifuge limitations. However, the secondary clarifier SLR limitations follow the same pattern observed for summer conditions. At the higher effluent TIN limit, the increased satellite diversion relieves capacity, allowing for an additional 5 or 6 years before the clarifier limitation sets in. At the effluent TIN limit of 2 mg/L, however, the clarifier remains limited even given current Plant conditions. The inability to effectively deal with the low TIN limit without constricting clarifier performance in April is independent of satellite flow. The low temperatures, high flows, and the slow conversion from conventional to BNR mode make this a vulnerable period. The low effluent TIN limit is dealt with by increasing the SRT and methanol addition, which leads to higher solids concentration in the aeration basins, stressing the clarifiers.

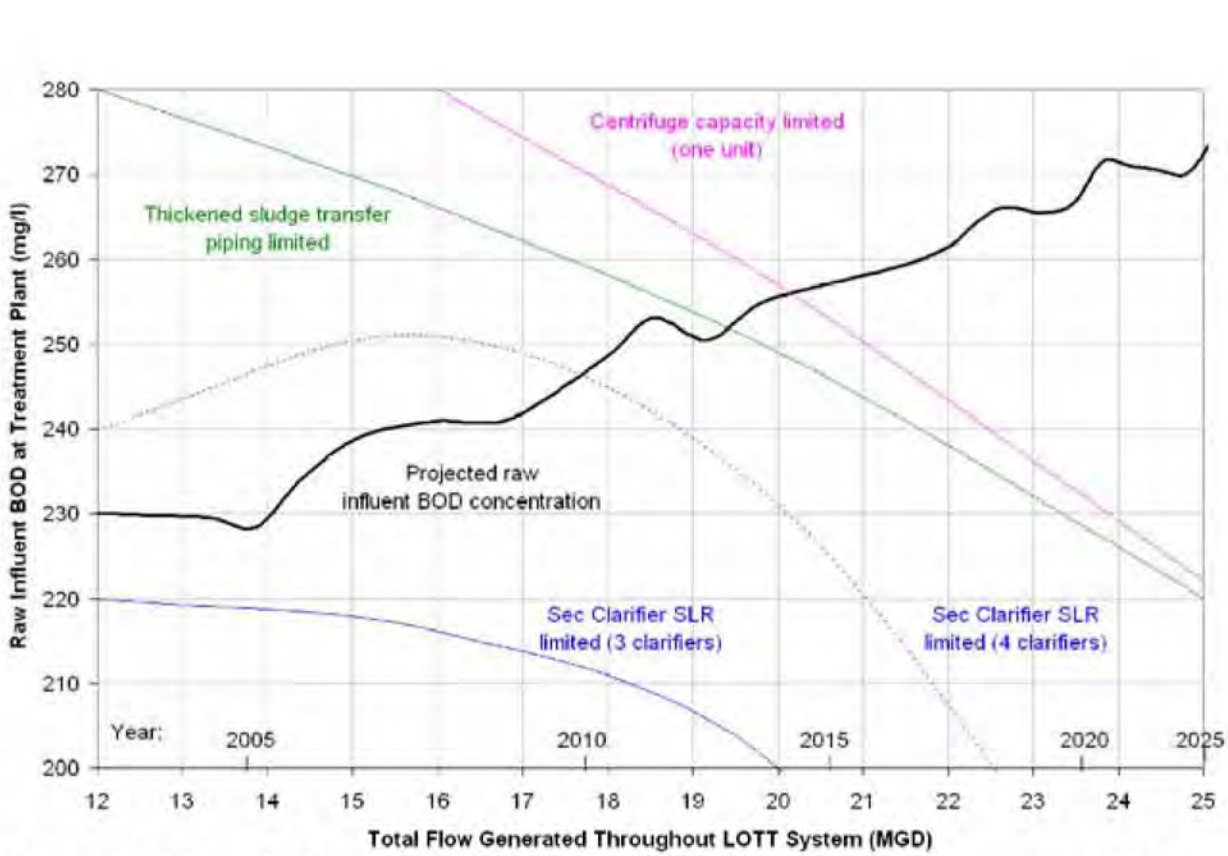


Figure 12-9. Capacity Curve for April Condition, High Rate of SRP Construction, Effluent TIN = 2 mg/L

Satellite flows have much less of an impact on winter capacity limitations. This is because the satellite plants treat a constant flow, so any additional storm flows get passed on directly to the Budd Inlet Plant. Even in the most aggressive case, at least 60 percent of total system flow in winter is routed to the Budd Inlet Plant. For the corresponding case in summer, only 30 percent of total system flow gets to the Budd Inlet Plant. The result of this is to dampen the effect of SRP addition on Budd Inlet Plant capacity limitations.

Plant hydraulic limitations are directly related to the amount of flow at the Budd Inlet Plant. The effect of the satellite treatment scenarios on these hydraulic limits is presented in Table 12-1.

Table 12-1. Plant Hydraulic Limitations, Sorted by Satellite Treatment Options

Hydraulic Limit	Capacity MGD[1]	Equivalent Peak Month Flow Capacity (MGD), by SRP Scenario: BIA[2]	Low[3]	Medium[4]	High[5]	Approximate Time Capacity is Reached, by SRP Scenario: BIA	Low	Medium	High
Grit Tanks (1 tank)	43.9	13.5	13.5	13.5	13.5	Over	Over	Over	Over
Effluent Pump Station to North Outfall (Firm)[6]	50	16.0	16.0	16.0	16.0	Over	Over	Over	Over
Influent Pump Station (Firm)[7]	54	18.0	18.0	18.0	18.0	Over	Over	Over	Over
Parshall Flume	55	18.4	18.4	18.4	18.4	Over	Over	Over	Over
North Outfall[8]	64	23.0	23.0	23.0	25.0	2007	2007	2007	2009
UV Disinfection (6 channels)[9]	66	24.0	24.0	24.0	26.5	2008	2008	2008	2012
Influent Pump Station (Firm, with equalization)[10]	67.5	25.0	25.0	25.0	27.5	2009	2009	2010	2014
Plant Hydraulic Limitation (Primary Sedimentation Tanks)	72	27.0	28.0	29.5	31.0	2013	2014	2016	2020
Influent Pump Station (Full)[11]	72	27.0	28.0	29.5	31.0	2013	2014	2016	2020
UV Disinfection (7 channels)[12]	77	29.6	31.0	--	--	2017	2020	>2025	>2025
Secondary Clarifier SOR[13]	80	31.0	--	--	--	2020	>2025	>2025	>2025
Effluent Pump Station, both outfalls[14]	80	31.0	--	--	--	2020	>2025	>2025	>2025
Grit Tanks (2 Tanks)[15]	87.9	--	--	--	--	>2025	>2025	>2025	>2025
Headworks Bar Screens	99	--	--	--	--	>2025	>2025	>2025	>2025
Outfall Capacity	105	--	--	--	--	>2025	>2025	>2025	>2025
Intermediate Pump Station	133	--	--	--	--	>2025	>2025	>2025	>2025

1. Hydraulic limitation is expressed as peak hourly flow.
2. Budd Inlet Class A scenario.
3. Low rate of SRP construction.
4. Moderate rate of SRP construction.
5. High rate of SRP construction.
6. 3 large pumps in service, 1 in reserve.
7. 3 large pumps in service, 1 in reserve (firm capacity).
8. At the tidal mean higher high water (MHHW) condition, the North Outfall is limited to 64-MGD. Flows in excess of 64-MGD will be routed to the Fiddlehead Outfall. The combined Outfall capacity is well in excess of projected peak flows over the planning period.
9. Absolute treatment limit, all 6 channels in service.
10. 3 large pumps in service, 1 in reserve (firm capacity), with equalization tanks.
11. 4 large pumps in service, no reserve.
12. With expansion into the 7th channel.
13. 4 clarifiers in service.
14. 50-MGD to North Outfall, 30-MGD to Fiddlehead Outfall
15. Both tanks in service, none in reserve.

BUDD INLET CLASS A SCENARIO

In this scenario, only a minimal amount of flow is diverted to satellite treatment plants. The scenario mirrors the low rate of SRP construction scenario through 2010. From that point, however, the Budd Inlet Class A scenario allows only one additional MGD of satellite treatment, scheduled to come online in 2017, providing a total of 3-MGD satellite treatment through 2025.

Comparing the Budd Inlet Class A scenario with the low rate of SRP construction scenario, the key differences are flow and organic loading, both of which are increased by 25 to 30 percent for the Budd Inlet Class A scenario (Table 12-2).

Table 12-2. Flow (MGD) and Loadings (lb/d) Comparison at the Budd Inlet Treatment Plant, Low Rate of SRP Construction versus Budd Inlet Class A Scenario

	Low Rate of SRP Construction				Budd Inlet Class A Scenario			
Year	Flow	BOD	TSS	TKN	Flow	BOD	TSS	TKN
2005	10.91	26,391	28,450	5,429	10.91	26,391	28,450	5,429
2010	11.88	29,495	34,718	6,230	11.88	29,495	34,718	6,230
2015	12.25	31,471	39,777	6,799	14.21	35,674	41,364	7,501
2020	12.63	33,910	45,339	7,463	15.56	40,429	47,948	8,560
2025	12.95	35,318	48,327	7,834	16.86	44,098	51,901	9,315

	Percent Difference			
Year	Flow	BOD	TSS	TKN
2005	0%	0%	0%	0%
2010	0%	0%	0%	0%
2015	16%	13%	4%	10%
2020	23%	19%	6%	15%
2025	30%	25%	7%	19%

Although there is only a slight difference in solids loading (7 percent by 2025), the increase in BOD and nitrogen load will have the effect of increasing solids production in the secondary process. As the MLSS concentration rises with increased organic and TKN loadings, the solids load to the clarifiers and downstream solids handling elements will increase correspondingly. Similarly, the higher organic and TKN loadings also lead to higher aeration demand in the aeration basins, thus causing the aeration system to reach its capacity limit at an earlier date. A capacity chart for the summer condition, with an effluent TIN limit of 3 mg/L was developed for the Budd Inlet Class A case (Figure 12-10).

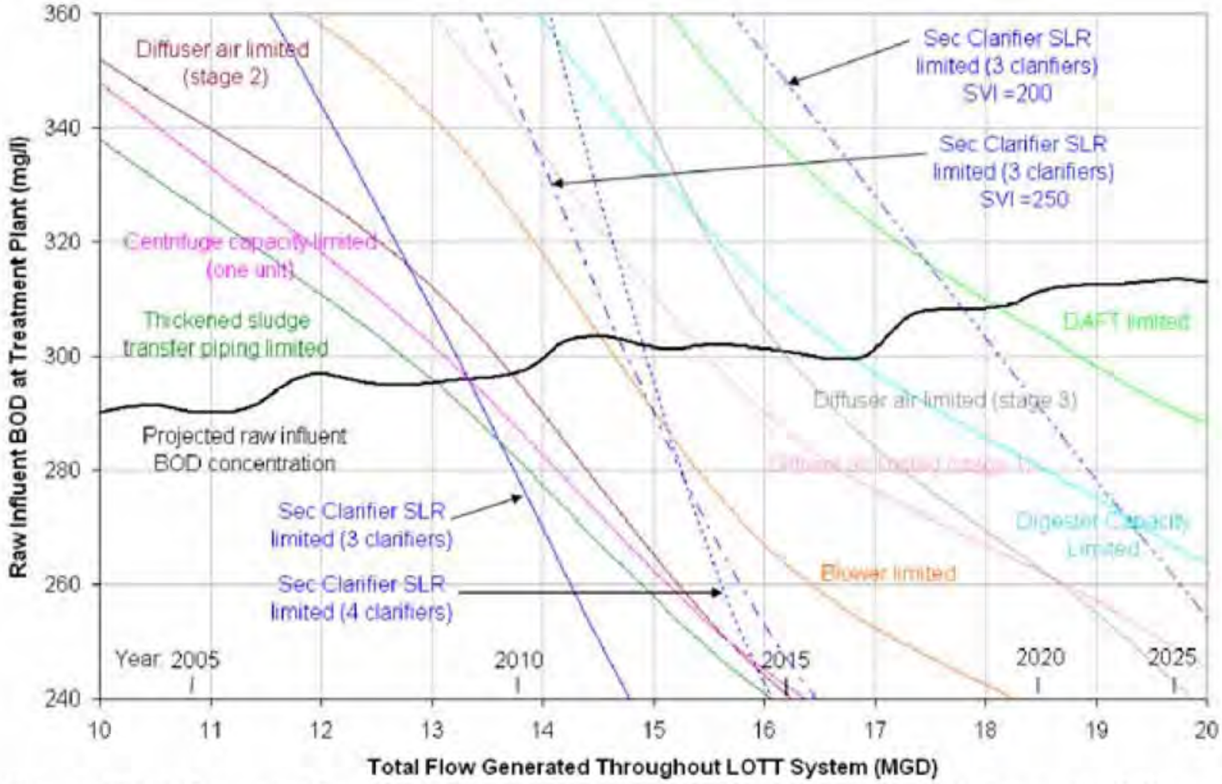


Figure 12-10. Capacity Curve for Summer Condition, Budd Inlet Class A Scenario, Effluent TIN = 3 mg/L

The shape of the loading curve (solid black line) reflects the addition of 2-MGD satellite treatment in 2006 and 1-MGD satellite treatment in 2017. The small increase in concentration around 2011 is caused by the completion of a large number of development projects in Lacey. The capacity chart is similar to the chart presented on Figure 12-2 through 2010. For this reason, thickened sludge transfer piping, centrifuge and secondary clarifier SLR limits remain virtually unchanged. From this point, however, the increased flows and loadings at the treatment plant begin to drive the element capacity curves down. Nearly all aspects of the treatment plant are affected. Diffuser air flow in the first three stages of the first aeration basin become limited at 15.4-, 13.8-, and 16.2-MGD respectively (compared with 20.0-, 14.5- and 20.0-MGD with the low SRP scenario). Blower capacity, which is tied in with diffuser capacity, is reached approximately 3 years earlier, at peak monthly flows of 14.5-MGD (compared with 16.3-MGD in the low SRP case). Digester and DAFT limitations, related to the increased rate of biological solids production, appear at peak monthly flows of 16.8- and 18.1-MGD (moving up from 17.8- and 20.0-MGD in the low SRP case). A similar curve for April is presented on Figure 12-11.

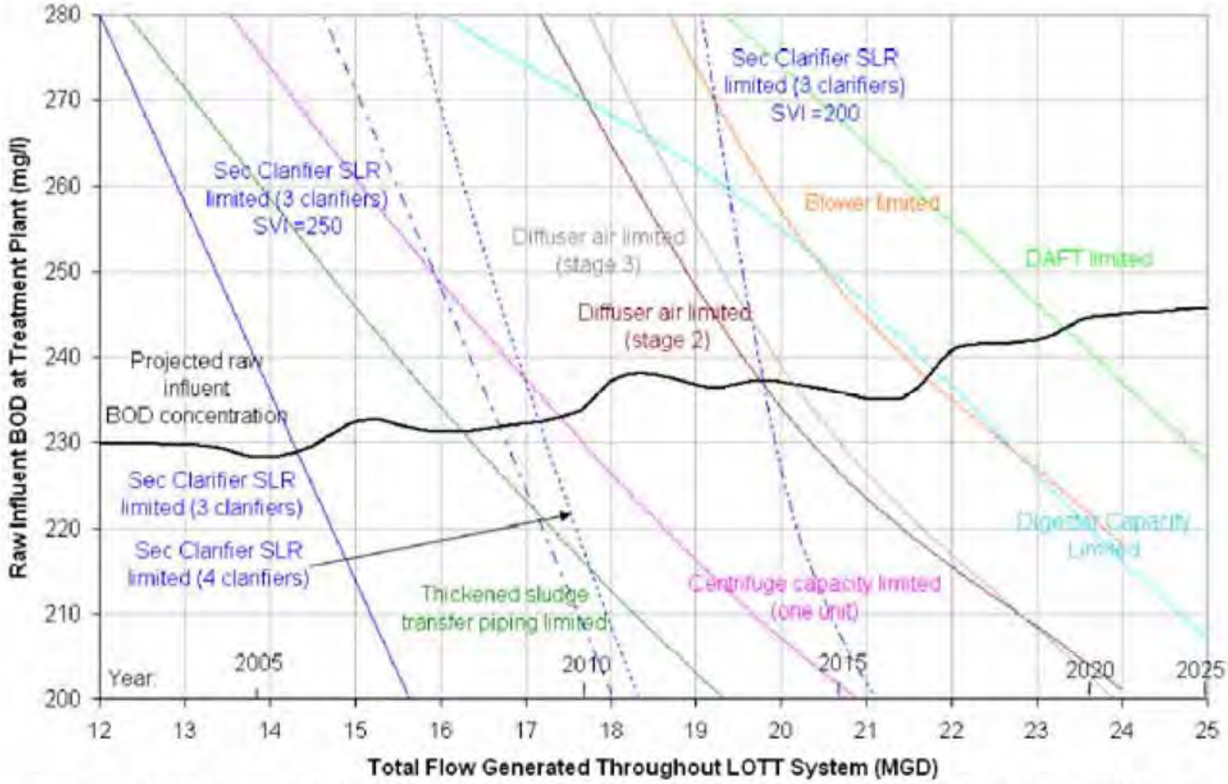
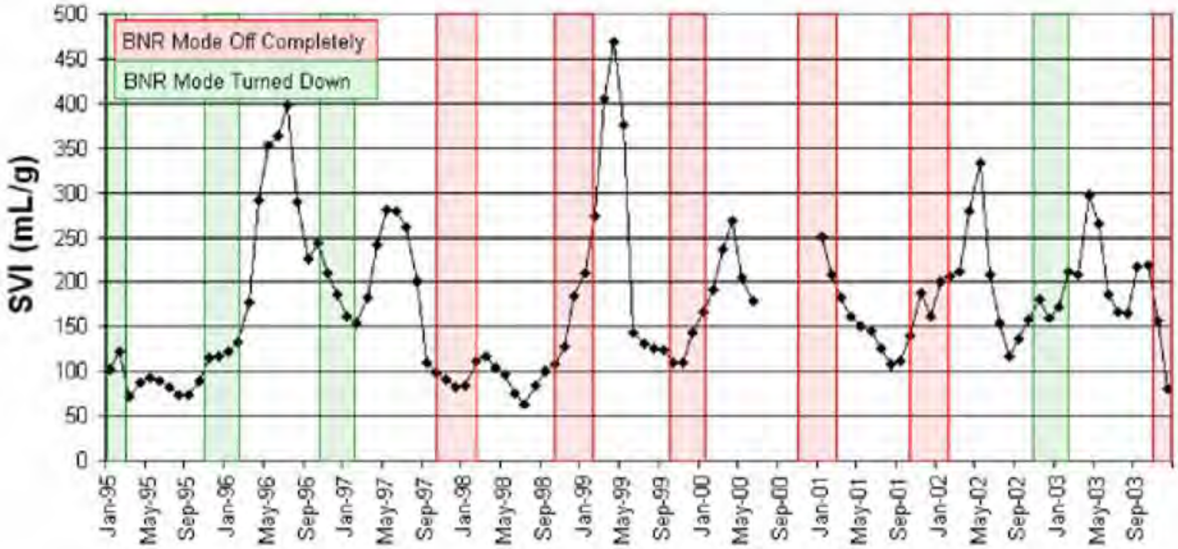


Figure 12-11. Capacity Curve for April Condition, Budd Inlet Class A Scenario, Effluent TIN = 3 mg/L

In this case, increased flows and loads to the treatment plant result in the appearance of several limitations not observed in any of the satellite plant cases. The curve is nearly identical to that of the low rate SRP construction (Figure 12-3) through 2010. However, by 2014 diffuser air flow limitations in stage 2 (19.8-MGD) and stage 3 (20.1-MGD) are reached. Blower capacity is reached at 21.8-MGD, along with Digester capacity (21.9-MGD). Finally, DAFT capacity is reached near 2020, at 23.3-MGD. The main difference from the low rate SRP case (Figure 12-3) is the appearance of diffuser and blower limitations. This reflects the increased aeration demands caused by the increased BOD and TKN loads to the treatment plant.

SECONDARY CLARIFIER SOLIDS LOADING RATE

One consistent feature noted in nearly all the capacity charts is the early limitation caused by secondary clarifier solids loading rate. In the summer, in both the Budd Inlet Class A and low rate of SRP construction cases, this limitation occurs around 2010. In April, this limitation is highly dependent upon the effluent TIN. At effluent TIN of 3 mg/L, the limitation occurs near 2006 for the low rate of SRP construction case, and near 2015 for the high rate of SRP construction case. When the effluent TIN limit is 2 mg/L, Plant capacity is already exceeded in both cases. This limitation, however, is highly dependent upon sludge settling quality. Sludge settling quality is typically tracked by measuring the sludge volume index (SVI). Lower SVI values correspond to better-settling sludges. For this capacity assessment, SVI was set at 286 mL/g. This represents the 95th percentile of SVI values recorded at the treatment plant during the dry weather months over the period 2001-2003 (Figure 12-12). An SVI of 286 mL/g is a very high value, about double of what might typically be seen as a target level.



Unshaded areas reflect the Plant operating in full BNR mode.
Areas shaded in green reflect partial BNR operation (Plant configured for BNR with internal mixed liquor recycle rate at ¼ to ½ the normal rate).

Figure 12-12. Monthly Average SVI Values Recorded at the Budd Inlet Treatment Plant, 1995-2003

The SVI tends to follow an annual pattern of increasing in the spring (March through May). This timing corresponds with the traditional shift from conventional to BNR mode of operation, which may result in a disruption in the microbial population. Typical practice is to begin the changeover in February or March by opening up the anoxic basins, and gradually increasing the internal mixed liquor return rate and increasing the SRT. As the SRT increases, there is a tendency to grow bulking and/or foaming filamentous organisms, particularly when the mixed liquor temperature is too cool to promote optimal nitrifier growth. While postponing the switchover to later in the spring may prevent or at least minimize the duration of this effect, this may not be practical given the Plant is faced with a winter (November through March) effluent ammonia limit of 26 mg/L and a spring (April and May) effluent TIN limit.

Operating the Plant in year-round BNR mode may promote a stable, nitrifying microbial community, and would tie in with the Plant's development of Class A Reclaimed Water production. Maintaining the nitrifying community in the face of high wet weather flows and storm events could be accomplished by storing the sludge inventory in the first anoxic tank (implementing a temporary bypass). In the past, attempts at operating the Plant in at least partial BNR mode during the winter have not eliminated the spring SVI peak (Figure 12-12). However, proposed modifications to the process tanks (Chapter 13) may allow for a greater level of control, facilitating SVI control in the face of effluent nutrient limitations and the dynamic seasonal conditions experienced in the spring.

Figure 12-13. Effect of SVI on Secondary Clarifier SLR Capacity, April Conditions, Effluent TIN Limit of 3 mg/L, Low rate of SRP Construction (3 Clarifiers in Service)

If the Plant could lower the SVI even by a moderate amount (from 286 to 250 mL/g), it would have a considerable impact on clarifier capacity. Figure 12-13 demonstrates the effect of lowering the SVI during April conditions, an effluent TIN of 3 mg/L, and a low rate of SRP construction. Lowering SVI to 250 mL/g would provide an additional 2 to 3 years of capacity. A more robust decrease to 200 mL/g would provide approximately 10 years of additional capacity. Similar trends are observed for the Budd Inlet Class A scenarios (Figure 12-10 and 12-11). A summary of SVI effects is provided in Table 12-3.

Table 12-3. Effect of SVI on Secondary Clarifier Solids Loading Rate Capacity Limitations, Three Clarifiers in Service[1]

SVI	Budd Inlet Class A Scenario				Low Rate SRP Construction	
	Summer		April		April	
(mL/g)	Limit (MGD)	Year	Limit (MGD)	Year	Limit (MGD)	Year
286	13.3	2009	14.2	2006	14.5	2006
250	14.8	2012	16.8	2009	17.1	2009
200	17.8	2018	19.8	2013	22.6	2018

1. Effluent TIN limit = 3 mg/L in all cases.

Given the effect of SVI on clarifier capacity, it is recommended that the Plant evaluate options of SVI control. These include:

- Year round BNR operation
- Decreasing SRT
- Enhanced flocculation (alum, polyaluminum chloride)
- RAS chlorination
- RAS polymer addition (polyaluminum chloride)

When the Class A Reclaimed Water facility is brought on line, the Plant will migrate towards year-round BNR operation. Maintenance of a stable microbial community may prevent or reduce the occurrence of spring SVI peaks. The Plant could also operate at low SRT values to induce washout of filaments, add chemical coagulants (alum or polyaluminum chloride) upstream of the secondary clarifiers to improve mixed liquor flocculation, or add chemicals further upstream in the aeration tanks to induce the incorporation of the bulking (and foaming) filaments into the mixed liquor causing them to be lost from the system in the WAS. Addition of chemicals to the RAS has also been observed to control Plant SVI and facilitate final settling.

A decrease in SVI with the corresponding extension of clarifier capacity would give the Plant time to delay capacity improvements in this area. Judging from historical SVI values plotted on Figure 12-12, it is not at all unreasonable to expect the Plant to maintain an SVI of less than 200 mL/g, absent the springtime peaks.

Finally, peak hourly flows at the Plant are currently above the mixed liquor distribution box hydraulic limit of 57-MGD. The result of this condition can be modeled by taking a clarifier off-line, to simulate a worst-case maldistribution of solids. This report has focused on the case with 3 clarifiers in service, which takes into account this limitation, or a condition in which one clarifier is taken down for maintenance.

SUMMARY

Overviews of the capacity limitations identified in this chapter are presented on Figures 12-14 through 12-16. These figures express the anticipated timing of capacity limitations at the Budd Inlet Treatment Plant. Blue boxes indicate a winter capacity limitation, mainly having to do with hydraulic limitations. Red and orange boxes indicate summer capacity limitations for both the TIN less then 3 mg/L (red) and TIN less than 2 mg/L (orange) cases. Dark and light green boxes indicate April capacity limitations for both the TIN less then 3 mg/L (dark green) and TIN less than 2 mg/L (light green) cases. A bulleted list of items follows.

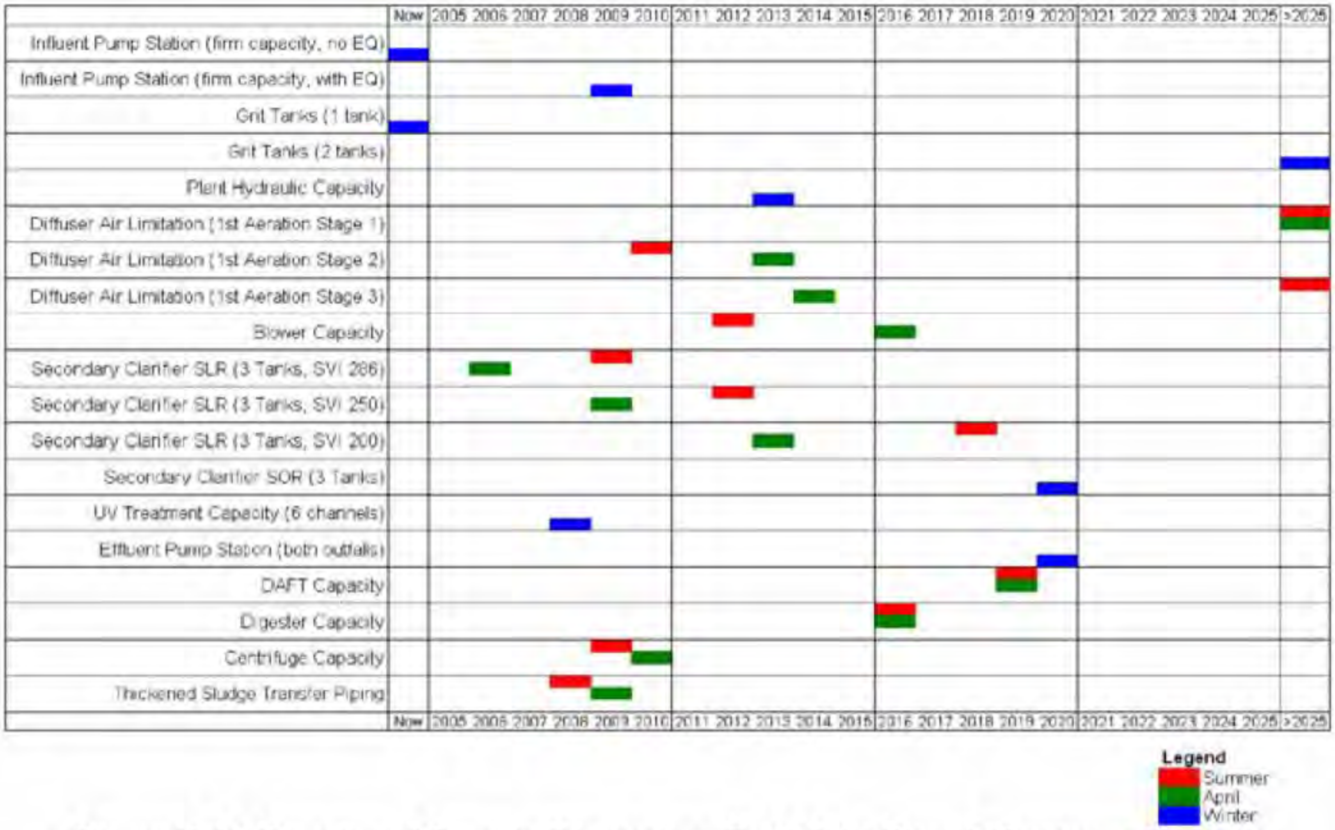


Figure 12-14. Overview of Capacity Limitations, Budd Inlet Class A Treatment Scenario

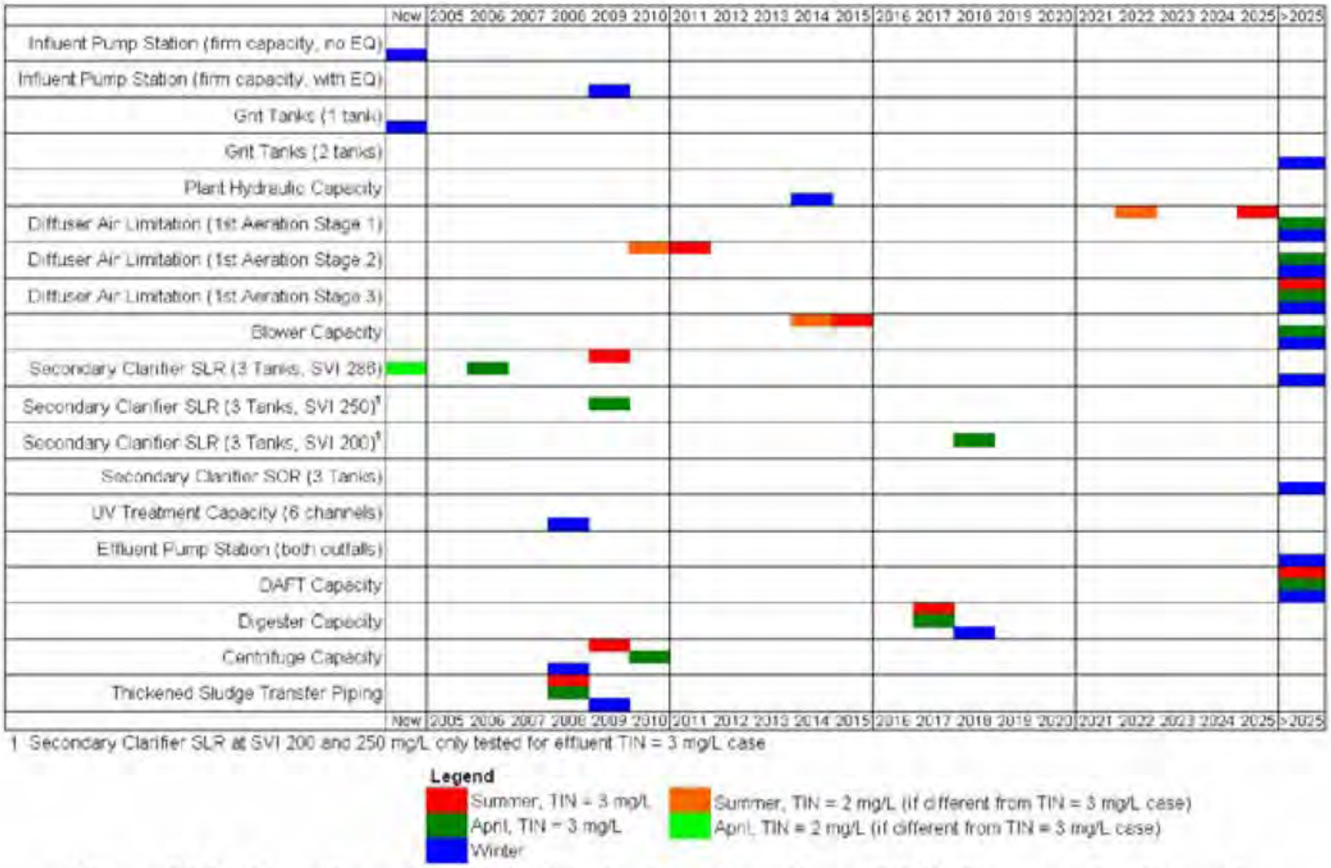


Figure 12-15. Overview of Capacity Limitations, Low Rate of SRP Construction Scenario

Figure 12-16. Overview of Capacity Limitations, High Rate of SRP Construction Scenario

- Thickened sludge transfer piping is a bottleneck, with capacity limitations occurring near 2007-2008 in nearly all modeled scenarios.
- Centrifuge operation with just one unit in service, 56 hours per week, is not sustainable beyond the 2007-2008 timeframe.
- UV treatment capacity with 6 channels in service will become limited in 2008. With expansion to 7 channels, capacity could be extended to 2017.
- Secondary clarifier SLR limitations are broken down as follows
  - Summer: capacity limitation in 2009-2010 for both the low rate of SRP construction and Budd Inlet Class A scenarios. The limitation is relieved with additional satellite plant diversion.
  - April: with an effluent TIN limit of 2 mg/L, capacity is already exceeded at the Plant. With an effluent TIN limit of 3 mg/L, capacity varies depending on the role of satellite treatment. For both the Budd Inlet Class A and the low rate of SRP construction scenarios, capacity is limited in 2006-2007.

  - Winter: SLR limitation at peak monthly flow is not observed.

  - In all cases, capacity could be extended by even a moderate improvement in sludge settleability.

  - Note that the clarifier assessment has allowed for one clarifier to be left out of service. This has been done to model hydraulic limitations in the mixing box, and to allow for maintenance of any given unit at any time. If all 4 clarifiers were modeled in service, this would add approximately 3 years of Plant capacity in most simulated cases.

- Aeration capacity is most limited in summer, when the Plant is operating in BNR mode. Stage 2 of the first aeration basin suffers from diffuser supply limitations between 2010 and 2013 in most scenarios. Stages 1 and 3 become limited later, around 2022 in the low rate of SRP construction scenario, and in 2014-2015 in the Budd Inlet Class A scenario. In the April condition, capacity limitations are observed in stages 2 and 3 in 2013-2014 for the Budd Inlet Class A case. All of these limitations are relieved with the addition at SRP treatment capacity.

- Blower capacity is linked to aeration capacity. For the low rate of SRP construction case, this becomes limited around 2015. For the Budd Inlet Class A case, the limit moves up to 2012.

- Digester capacity becomes limited in 2017-2018 for both summer and April conditions for the low rate of SRP construction case. More aggressive SRP scenarios relieve this capacity limitation. The Budd Inlet Class A case becomes limited in 2016.

- DAFT capacity is limited in the Budd Inlet Class A scenario in 2019, for both summer and April conditions.

- Plant hydraulic limitations include the following:

  - Effluent pumping capacity to the North Outfall is already limited to 50-MGD. Combined effluent pumping capacity, rated to 80-MGD, would become limited in 2020 for the Budd Inlet Class A Scenario. Capacity to the North Outfall is influenced by a 1,200-foot section of 30-inch pipe running through the State-operated dangerous waste site formerly owned by Cascade Pole Company.

  - Influent Pump Station firm capacity is already exceeded. With an allowance for diversion to equalization tanks, this capacity limit is pushed to 2009 (Budd Inlet Class A and low rate SRP construction cases).

  - The overall Plant hydraulic capacity, expressed as overflow capacity in the primary sedimentation basins and channels, will be reached in 2013 (Budd Inlet Class A

  - The hydraulic limitation in the mixed liquor distribution box is currently exceeded. The Plant is addressing this limitation as part of its Secondary Clarifier Improvements Project.

- Grit tank single unit capacity already exceeded. Capacity with both tanks in operation is sufficient throughout the planning period.

- Secondary clarifier overflow rate, with 4 units in service, can handle projected flows through 2020 (Budd Inlet Class A case) or beyond 2025 for all other scenarios.

CHAPTER 13

BUDD INLET PLANT CAPITAL STRATEGIES

A number of capacity limitations have been identified in Chapter 12. Based on the analyses presented in this report, LOTT must implement a number of upgrades and improvements to the Budd Inlet Plant to continue to provide expected levels of service. This chapter presents a variety of strategies to accomplish this goal and discusses the advantages and disadvantages. The alternative strategies are evaluated, and a list of comprehensive site alternatives is presented at the end of the chapter.

SUMMARY OF ALTERNATIVE TREATMENT PROCESSES

To address the capacity and reliability needs of the Plant, alternative treatment approaches were considered. The following sections summarize these considerations.

Primary Sedimentation

The primary sedimentation basins are over 50 years old, well beyond their intended service life. Spalling concrete, exposed rebar, and corrosion have begun to compromise the structural integrity. In addition, the configuration of electrical gear no longer meets electrical safety standards. The overall Plant hydraulic limitation in the primary sedimentation basins and channel overflow is projected to occur in 2013. Efficiency of the primary sedimentation basins will impact all downstream Plant elements, and is therefore of critical importance. For these reasons, replacement of the primary sedimentation building is the first major capacity augmentation project to evaluate. Completion of this project is recommended for 2008. Three alternatives were considered:

- Conventional Treatment: a new set of conventional primary sedimentation basins would be constructed. The size and footprint of new building would be similar to the existing building. Removal efficiencies would improve with optimized entry conditions and sludge removal strategies.

- Conventional Basins with Chemical Enhancement: a new set of conventional primary sedimentation basins similar to above with chemical addition facilities to augment sedimentation. With this option, removal efficiencies would improve, and decrease the solids load upon the secondary clarifiers. Preliminary modeling suggests chemical enhancement could extend the time of reaching secondary clarifier capacity by up to 8 years, assuming 85 percent TSS and 75 percent BOD removal, on average. Additional O&M costs involved with chemical addition would be accrued, as would the need for a chemical storage space.

- High Rate Primary Sedimentation: two new treatment technologies exist-- one which uses sand and the other which uses coagulant and recycled solids to promote nucleation and improve sedimentation. Both of these technologies offer extremely high removal efficiencies in a fraction of the space required for a conventional system. Installation of a high rate primary sedimentation system would relieve capacity limitations in the secondary clarifiers, and could even be used to thicken solids to an extent that DAFT would not be necessary. Annual O&M costs, however, would be considerably higher than those for conventional treatment, both in terms of energy consumption and chemical addition.

Aeration Basins

Diffuser air supply and blower capacity are projected to be limited in 2010 and 2012, respectively under the Budd Inlet Class A treatment scenario (later for the more aggressive satellite treatment scenarios). Treatment processes currently lack flexibility, and the shifts from conventional treatment to BNR mode play a key role in secondary clarifier capacity limitations, as evidenced by annual peaks in SVI during switchover periods. Plant staff have expressed a desire to have more control over secondary processes, and the elimination of an awkward flow routing (from first aeration, across the street to anoxic tanks and second aeration, then back across the street to the clarifiers) would reduce costs associated with the Intermediate Pump Station. For these reasons, an alternative involving conversion to a folded tank design has been proposed. The folded tank allows for better control of the nutrient removal processes. It allows the operator to vary the size of aerobic and anoxic tanks based upon seasonal nutrient removal requirements and process measurements performed on a daily basis without placing an entire tank in or out of service. This would allow a better balance of aerated and anoxic volumes to optimize nitrification and denitrification, thus reducing the need for methanol supplementation and solids production. As a result, the secondary clarifier capacity limit could be extended. During cooler months, anoxic tank volume could be optimized to meet varying permit demands between winter and shoulder season periods. Tank volume and methanol feed optimization would reduce the aeration demand, thus extending the time at which the capacity of either the diffusers or the blowers becomes limiting.

The ability to optimize anoxic and aerated volumes, plus the savings generated from decreased Intermediate Pump Station costs would allow for year-round nutrient removal. The elimination of the process change, which currently takes place in April and October, may eliminate or attenuate the peaks in SVI associated with microbial population shifts. Without the springtime SVI peaks, the historical record suggests the Plant could operate at SVI values between 200-250 mL/g throughout the year. The net effect of this would be to extend secondary clarifier capacity, as discussed in the previous chapter. Implementation of a folded tank would require the demolition of the existing first anoxic tank, with an additional treatment train constructed onto the south side of the existing first aeration basin. Recommended completion time: 2012. Blower capacity should be reevaluated alongside any changes to the process tanks.

Secondary Clarifiers

Secondary clarifier limitations are, along with the primary sedimentation basins, the most critical capacity limitation facing the Plant. The capacity analysis projects SLR limitations arising from 2006 through 2010 for April and summer conditions, respectively.

The SLR limitation is highly dependent upon SVI. Capacity modeling has indicated that limitations could be postponed by 5-10 years given moderate reductions in SVI. In order to extend the capacity rating of the clarification system, the Plant will have to prove that long term operation at lower SVI is possible.

If extending clarifier capacity through SVI does not prove possible, the Plant will have to investigate means of constructing new capacity. Two options for dealing with clarifier limitations are proposed.

- Construction of New Clarifiers: space could potentially be found at the Budd Inlet site for two more secondary clarifiers, identical to the four in existence. This space could be located either by selecting one of the high rate primary sedimentation options, or via a land-swap arrangement with the Port of Olympia. Selection of the folded tank process option would also free up space for new clarifiers. Note that clarifier solids loading rate capacity is not a linear function of clarifier area. That is, doubling the number of clarifiers does not necessarily double the loading capacity. Capacity is a function of how the clarifiers are operated (in terms of RAS pumping rate) and relates to actual solids loading, rather than flow. In general, the more clarifiers are added to the system, the less "return" one gets in terms of proportional capacity.

- Membrane Filtration of Mixed Liquor: an alternative to the construction of new clarifiers is to filter mixed liquor. A portion of the mixed liquor from the aeration basins would be sent to new membrane tanks, instead of to the secondary clarifiers, for solids separation. The filtrate would be treated to Class A reclaimed water standards, with solids pumped to the DAFTs. Depending on how much capacity is built into the membrane system, clarifier capacity could be extended throughout the planning period. A key advantage of this option would be the production of Class A reclaimed water, which could be sold for a variety of industrial or commercial uses, or recharged into the groundwater, thus limiting discharge into Budd Inlet.

Timing of the required capacity improvements are outlined in Table 13-1. Please refer to Figures 12-1, 12-3 and 12-13 for the low rate SRP case, and Figures 12-10 and 12-11 for the Budd Inlet Class A case. Table 13-1 is adjusted to account for SRP flow. Timing of improvements should be adjusted following secondary clarifier upgrades, to be completed in 2006-7.

Table 13-1. Secondary Clarifier Capacity Limitations (MGD) and Required Improvements (Budd Inlet Class A Treatment Scenario)

	SVI = 286 mL/g		SVI = 250 mL/g		SVI = 200 mL/g	
	Summer[1]	April[2]	Summer[1]	April[2]	Summer[1]	April[2]
Capacity Limit[3,4]	11.40	12.20	12.80	14.80	14.90	17.80
Projected Capacity Limitation	**2009**	**2006**	**2012**	**2009**	**2018**	**2013**
2025 Projected Flow[5]	16.79	22.13	16.79	22.13	16.79	22.13
Required Capacity	5.39	9.93	3.99	7.33	1.89	4.33
Projected Capacity with 4 Clarifiers[6]	12.80	15.20	15.00	17.00	ND	ND
Projected Capacity Limitation	**2012**	**2009**	**2018**	**2012**		
Projected Capacty with 5 Clarifiers[6]	14.30	16.50	16.80	19.00	ND	ND
Projected Capacity Limitation	**2015**	**2012**	**2024**	**2015**		
Projected Capacity with 3 Clarifiers + 6 MGD Filtration	17.40	18.20	18.80	20.80	20.90	23.80
Projected Capacity Limitation	**>2025**	**2014**	**>2025**	**2021**	**>2025**	**>2025**
Projected Capacity with 3 Clarifiers + 12 MGD Filtration	23.40	24.20	24.80	26.80	26.90	29.80
Projected Capacity Limitation	**>2025**	**>2025**	**>2025**	**>2025**	**>2025**	**>2025**

1. Assumes effluent TIN limit of 3 mg/L.
2. Assumes effluent TIN limit of 3 mg/L.
3. 2-MGD of SRP flow subtracted starting in 2006, 1-MGD SRP flow subtracted starting 2017.
4. Assumes 3 clarifiers in service. Note that these capacity limitations may change following secondary clarifier upgrades scheduled for 2006-7.
5. See Chapter 6, total 3-MGD SRP flow has been subtracted from system-wide totals.
6. The case with 3 clarifiers in service has been modeled with a total Plant RAS return rate of 40 percent influent flow. For the cases with 4 and 5 clarifiers, the total Plant RAS rate has been increased proportionally to account for the added clarifiers (53 percent for the case with 4 clarifiers, 67 percent for the case with 5 clarifiers). Note that the increased RAS flows will influence MLSS concentrations, and may increase demand on aeration basin diffusers and blowers.

ND = Not determined. Cases not modeled.

The main recommendation with respect to the secondary clarifiers is to improve the Plant SVI. Judging from the historical data, a typical SVI in the range of 200 to 250 mL/g would not be unreasonable, and would actually be considered a high value compared with most municipal wastewater treatment plants. In Chapter 12, a number of potential means of SVI control were proposed, including the use of flocculation aids, RAS chlorination or polymer addition, tighter SRT control, and year round BNR operation. The Plant will need to demonstrate consistent SVI control in order to effectively rerate the clarifiers (the rating is currently based upon the 95th percentile of SVI values recorded over the period 2001-2003 (286 mL/g for the summer and april periods).

Assuming a conservative case where only moderate SVI control is achieved, the following recommendations are in order. If two new secondary clarifiers are to be built, the recommended time frame would be by 2012 for both units. In order to maximize the capacity increase from the new clarifiers, the Plant would need to operate at a higher total RAS return rate, resulting in higher mixed liquor solids concentrations. This mode of operation may accelorate capacity limitations in the aeration tank diffusers and blowers. If membrane filtration of mixed liquor will be used to deal with clarifier capacity limitations, it is recommended to add one 6-MGD unit in 2012, with the possibility for an expansion near the end of the planning period.

Note that the Plant will undertake an upgrade of its secondary clarifier mechanisms in 2006-7. This upgrade may significantly impact clarifier solids loading rate capacity. Once this upgrade is complete, the clarifiers should be stress tested to reestablish capacity limits, and the analysis of clarifier capacity presented in this document should be updated.

Disinfection

The UV systems at the Plant are rated to a total capacity of 66-MGD with all six channels in service. This peak hour limitation will be reached in 2008. A seventh channel has been constructed, and could be brought online by adding the appropriate UV equipment. The Plant should plan to bring the seventh channel online in 2008. Capacity of the seven-channel system would be sufficient through at least 2017, depending on the amount of flow diverted to satellite plants. If the Plant constructs a membrane filtration system, or any reclaimed water system which includes chlorine as a means of disinfection, these flows would not require UV disinfection, and it is likely that the seven channel system would have sufficient capacity to extend through the planning period.

Solids Handling

Aside from the relatively minor and easily correctable capacity limitations noted in the thickened sludge transfer piping and centrifuge loading, digester capacity is projected to become a problem in 2016 (2017 for the low rate of SRP construction case), and DAFT capacity is projected to become limiting in 2019 (post-2025 for the low rate of SRP construction case). A number of upgrade projects have been identified to help relieve some of these issues. In order to position the Plant in line with current permitting trends, two options for producing Class A biosolids will be explored. Class A biosolids are suitable for land application as fertilizers, and could potentially serve the LOTT Alliance as a marketable commodity.

- Dryer Facility: a Class A dryer facility would accept solids from the digesters and use heat to convert them into a range of potential products including specialty fertilizer products. Energy costs would be significant. The existing digesters would still require expansion to meet the projected capacity limitation.

- Batch Reactors: a Class A cake could be produced by converting the existing digesters, plus an additional four new units, into a series of thermophilic and mesophilic batch reactors. The Class A cake would be suitable for land application and agricultural use. Energy and O&M costs would be considerably lower than the dryer facility.

The Class A solids additions are independent of the Plant capacity issues brought up in the previous chapter. The recommended time frame for this conversion will be linked to the permitting environment, and the availability of funding. Digester and DAFT capacity limitations are linked to improvements in other areas of the treatment plant. As a worst-case, upgrades to these units should be completed by 2016. It is recommended that Digester and DAFT capacity limitations be re-evaluated after improvements to the primary sedimentation basins, secondary process tanks, and secondary clarifiers / mixed liquor filters have been completed.

Land/Space at the Budd Inlet Treatment Plant

The Budd Inlet Treatment Plant has limited room for expansion. Currently, nearly all the available space is occupied (Figure 13-1).

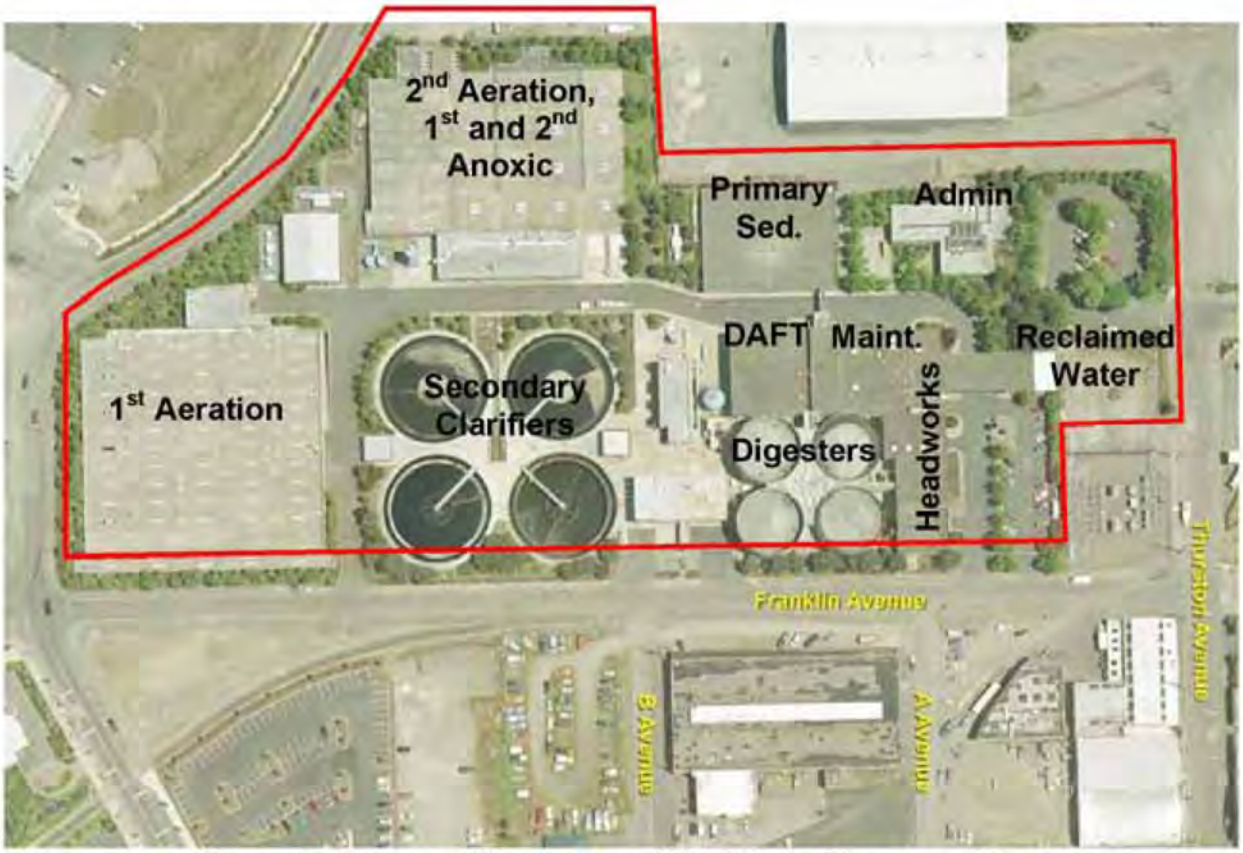


Figure 13-1. Current Site Layout of Budd Inlet Treatment Plant

While some of the options discussed in this chapter will relieve the Plant space limitation (folded tanks, high rate primary sedimentation), others will require space (new secondary clarifiers, membrane filtration of mixed liquor, Class A biosolids). In some cases (primary sedimentation replacement), the construction of new facilities must take place at a location other than the existing location in order to preserve treatment during construction. Long-term capital facilities needs requiring additional space at the Budd Inlet Treatment Plant site include:

- Area for two additional secondary clarifiers to control the total solids loading rates. Note that satellite plant construction does not relieve solids loading at the Budd Inlet Treatment Plant, and solids removed at the satellite plants are routed to the Budd Inlet Treatment Plant for final disposition.

- Area Class A biosolids production and temporary product storage to meet anticipated future regulatory criteria

- Property setback from essential process facilities for safety, security, and aesthetic (visual screening) purposes.

- All LOTT staff and services are planned to be located at the Plant. In addition, visitors, vendors, and contractors will often frequent the Plant as they assist LOTT with activities in the service area. LOTT may require up to 70 parking spaces to accommodate these uses. In addition, LOTT will require secure spaces for maintenance and specialty vehicles and overnight shift staff.

Property acquisition would bring some additional benefits, including providing a convenient construction staging area for large capital projects, and providing a larger odor buffer, which may result in decreased chemical consumption needs. LOTT has identified an area of approximately 2 acres immediately east of the Plant site as the best location for these activities. This area is currently owned by the Port of Olympia. This area is highlighted in Figures 13-2 through 13-6.

The primary sedimentation replacement project brought to light an opportunity to replace the Plant administration building. The current administration building is only large enough to house treatment plant administration. LOTT administration is currently located in a leased space a few blocks off-site. The laboratory section of the administration building is somewhat out-of-date, and would require extensive renovation to bring up to the current standard. One way to create a considerable upgrade of administration facilities, while presenting a favorable primary sedimentation construction schedule is to demolish the existing administration building and construct the new primary sedimentation structure on top of it. A new administration building could then be constructed in the area currently occupied by the parking lot, or two other locations on the north end of the Plant. The administration building options and other architectural considerations are discussed in Chapter 14.

Satellite Treatment and Reclaimed Water

The degree of flow diversion to satellite reclamation facilities will have a tremendous impact on capacity limitations at the Budd Inlet Treatment Plant. Increased flows to the SRPs will relieve Plant capacity limitations, particularly in the aeration basins, digesters, DAFTs, and, to some extent, the secondary clarifiers. However, available discharge and treatment capacity may impact LOTT's capital strategy. The satellite treatment facilities were originally conceived to meet anticipated discharge limits into Budd Inlet and produce Class A reclaimed water near the potential uses. Expanding reclaimed water production at the Budd Inlet Treatment Plant may better capitalize on available discharge and treatment capacity. This could be accomplished by expanding the existing Dynasand filters from their present-day capacity of 1.5-MGD to an in-place build out capacity of 6-MGD. It could also be accomplished by mixed liquor membrane filtration, as discussed above. Reclaimed water produced at the Plant could then be sold to industrial or commercial users, or piped to groundwater recharge facilities located throughout the service area.

The timing of reclaimed water production will be tied into the performance-based NPDES discharge permit and TMDL. The more the Plant can limit seasonal discharge, the easier the effluent TIN limit will be to meet (see Chapter 3 for permit discussion). In terms of the April, or "shoulder" condition under the proposed permit, the effluent TIN limit plays a significant role in the timing of the secondary clarifier SLR limitation. When the TIN limit approaches 2 mg/L, it becomes very difficult to meet the limit without exceeding clarifier capacity. To keep the effluent TIN limit around 3 mg/L, April flows would need to be limited to 13.5-MGD. Referring back to Chapter 6, and accounting for 2-MGD of satellite treatment and 1.5-MGD of existing Dynasand capacity at the Budd Inlet Plant, the shoulder condition will reach 13.5-MGD between 2010-2011 (10 year peak shoulder month). Since the effluent flow limit is not fixed, and some flexibility exists in terms of the TIN limit, expansion of reclaimed water production at the Plant (to a total of 6-MGD) can be planned for 2012, to coincide with the alternative timing of the mixed liquor membrane filtration discussed above.

While generation of Class A reclaimed water at the treatment plant will relieve discharges to Budd Inlet (discharge capacity), it will not affect Plant loadings. The satellite plants, in addition to removing flow from the system, would remove large quantities of BOD and nitrogen. In a Budd Inlet Class A scenario, these constituents would have to be treated, along with increased flow, at the Budd Inlet Plant. Even though solids load would remain relatively constant, the increased organic loads would stress the aeration basins and generate a larger amount of solids, thus stressing secondary clarifiers and downstream solids handling elements. The ability of the Plant to deal with these loads will depend upon the combination of alternatives selected from the preceding discussion.

ALTERNATIVE CAPITAL STRATEGIES

Given the variety of options presented above, and the inter-related nature of many of the treatment processes, a set of five comprehensive site alternatives were prepared to demonstrate the trade-offs between strategies. Cost estimates for each of the alternatives will be presented at the end of this section.

Alternative 1: Conventional

Alternative 1 selects the most conventional option for most of the processes being upgraded. A conventional primary sedimentation basin would be constructed on the site of the existing administration building. The new administration building would be split, with the administration portion taking up part of the existing parking lot, and a new laboratory being built at a location currently occupied by a maintenance facility. Two new secondary clarifiers would be constructed on a strip of land to be purchased from the Port of Olympia. The secondary process tanks would remain in their current configuration, with a diffuser and blower upgrade required to meet capacity limitations projected in Chapter 12. Class A biosolids would be achieved with a dryer system, with an upgrade of both digesters and DAFTs to help meet capacity limitations in those systems. Discharge limits would be met by increasing the capacity of on-site Dynasand units, rather than by increasing satellite treatment beyond that laid out in the Budd Inlet Class A treatment scenario.

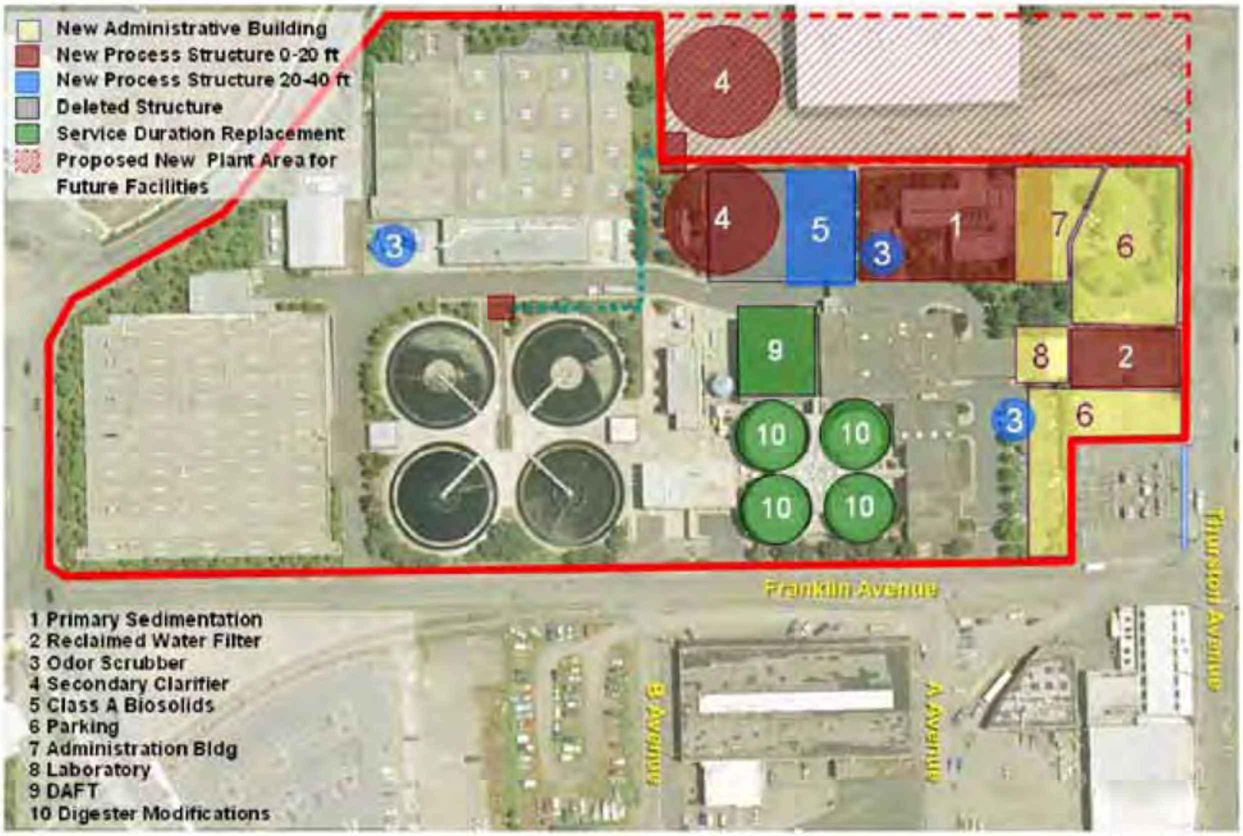


Figure 13-2. Alternative 1 Site Plan

Alternative 2: Conventional Primary with Membrane Filtration of Mixed Liquor

Alternative 2 mirrors Alternative 1 with respect to the administration building and primary clarifiers, with the exception that Alternative 2 calls for chemically enhanced primary sedimentation. The chemical enhancement is an option which could spare several years of secondary clarifier capacity. The main difference between Alternatives 1 and 2 is the provision of 6-MGD mixed liquor filtration, in place of two new secondary clarifiers. 6-MGD of flow from the mixed liquor distribution box would be routed to a membrane tank located on the vacant site left by the demolished primary sedimentation building. Solids would be pumped directly to the DAFT system, while filtered effluent would be routed to a newly constructed chlorine contact tank. Disinfected effluent would be Class A reclaimed water. The production of Class A reclaimed water in this manner would eliminate the need to expand the Dynasand filter plant beyond its current 1.5-MGD capacity. The membrane filtration option could take place with or without the chemically enhanced primaries, but chemical enhancement would delay the need for the filtration system by up to eight years. Since this alternative will not require the addition of any new secondary clarifiers, there would be no need to obtain any new land from the Port. Class A solids and DAFT improvements would be identical to those outlined in Alternative 1. SRP flows would be limited to the Budd Inlet Class A scenario. The main differentiating feature of this alternative would be relief of the secondary clarifier SLR limitation. This would decrease the Plant's dependence on maintaining a low SVI, and could hold off construction of mixed liquor filtration for several years, if necessary.

Figure 13-3. Alternative 2 Site Plan

Alternative 3: High Rate Primary Sedimentation

Alternative 3 demolishes the existing primary sedimentation building, and replaces it with a high rate sedimentation system. Construction scheduling and pacing of the administration building replacement and primary sedimentation replacement would be same as in the previous two alternatives. In this case, however, the relatively small size of the new primary sedimentation system would allow for a new administration building / laboratory to be constructed on the same site as the existing building. The degree of removal possible with a high rate primary sedimentation system would relieve the secondary clarifier loading to the extent that no new clarifiers would need to be built, and no membrane filtration of mixed liquor would be required. The secondary clarifiers would essentially stay as they are presently, with upgraded mechanisms. In order to comply with discharge limitations, the Dynasand filters would be expanded from 1.5- to 6-MGD. SRP treatment capacity would be as in the previous alternatives. Class A solids and DAFT improvements would be identical to those discusses in Alternatives 1 and 2. This alternative would require no land acquisition from the Port, and would leave a sizable swath of land in the to-be-vacated location of the existing primary sedimentation basins available for future contingencies.

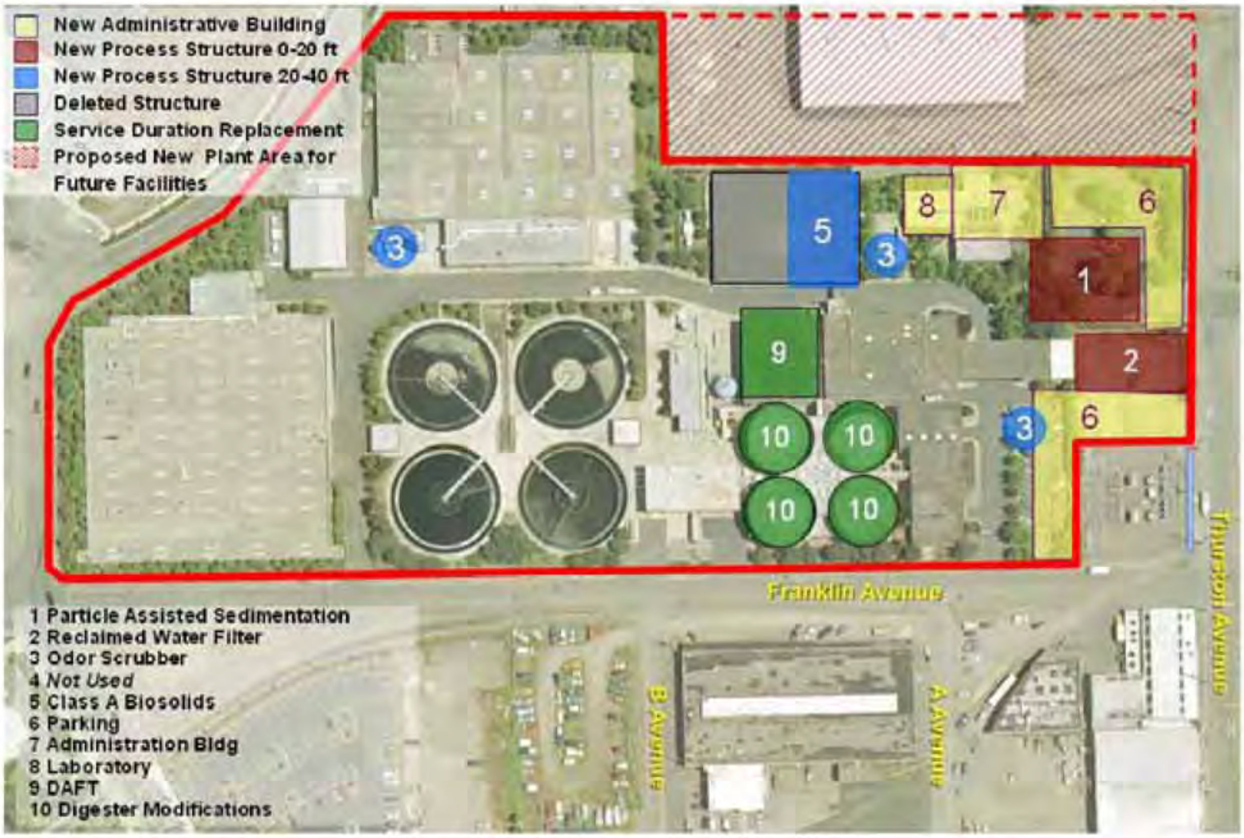


Figure 13-4. Alternative 3 Site Plan

Alternative 4: Folded Tank with Two New Secondary Clarifiers

Alternative 4 would install a new conventional primary sedimentation system on the site of the existing administration building. As in Alternatives 1 and 2, the new administration building would be separated from the new laboratory, and built partially on the site of the existing parking lot. The main differentiating feature of Alternative 4 is the conversion of the secondary process tanks to a folded tank design. The folded tank option frees up the space left by the demolished first anoxic basin, and also has the potential to extend secondary clarifier capacity, both by decreasing process solids production and allowing for a possible improvement in SVI by facilitating year-round BNR operation. Ultimately, however, Alternative 4 allows for the construction of two new secondary clarifiers. The first could be built on the to-be-vacated site of the existing primary sedimentation building. The second could be located either on land acquired from the Port directly east of the first new clarifier, or in the space vacated by the demolished first anoxic tank, in which case no land acquisition would be required. To comply with discharge limitations, the Dynasand filtration system would be expanded to 6-MGD. SRP flows, Class A solids and DAFT improvements would follow per the previous alternatives.

Figure 13-5. Alternative 4 Site Plan

Alternative 5: Folded Tank with Membrane Filtration of Mixed Liquor

Alternative 5 combines some of the features from Alternatives 2 and 4. In terms of primary sedimentation and administration, this Alternative is no different from Alternative 4 (conventional primary sedimentation, split administration and lab buildings). As with Alternative 4, Alternative 5 converts the secondary process tanks to a folded tank design. The alternatives differ, however, in that Alternative 5 uses the space vacated by the demolished first anoxic tank to install 6-MGD of mixed liquor filtration system. The membrane system, tied to a new chlorine contact tank, would produce Class A reclaimed water, eliminating the need for expansion of the Dynasand filtration plant. The membrane system also eliminates the need for further construction of secondary clarifiers, which eliminates any need for land acquisition. Construction on the site of the demolished first anoxic tank also allows for some Plant space to be left vacant to meet with future contingencies. SRP flows, Class A solids and DAFT upgrades would follow per the other 4 alternatives.

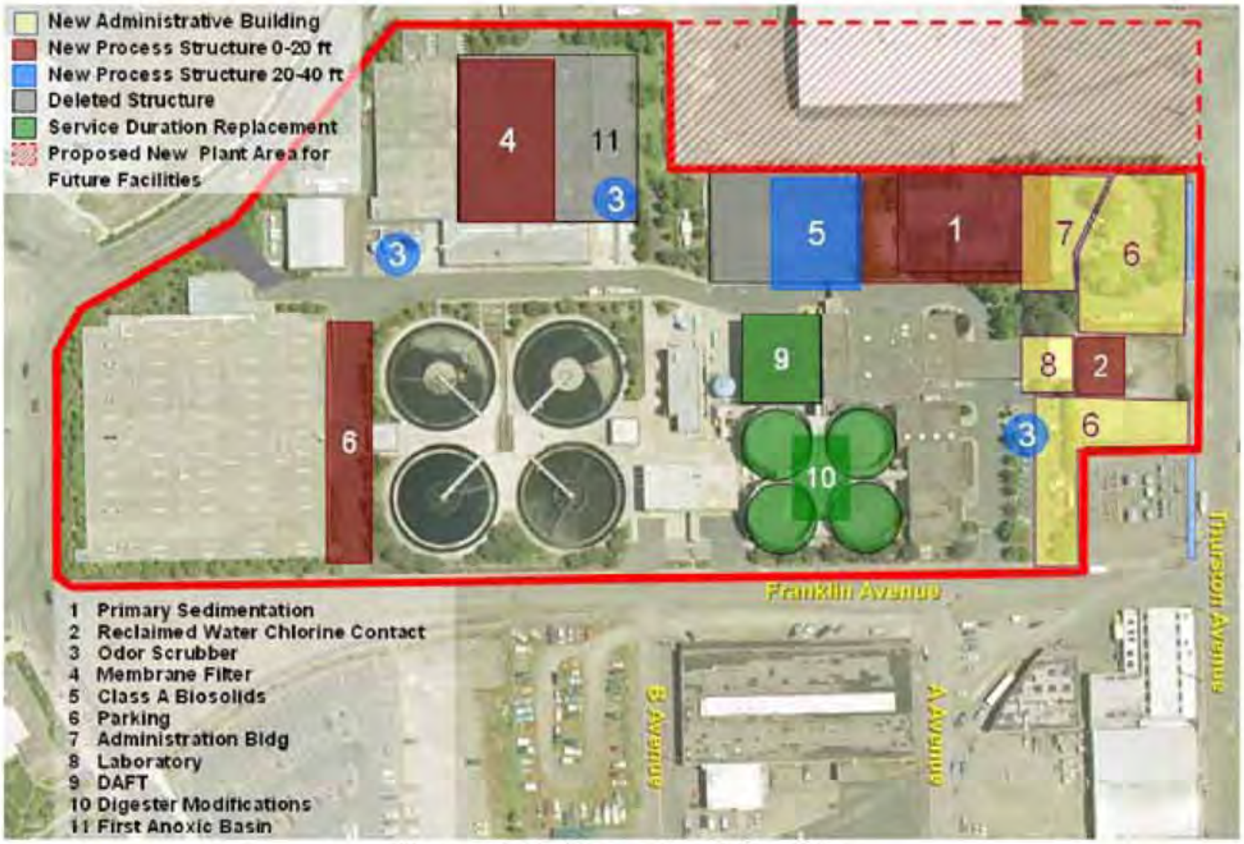


Figure 13-6. Alternative 5 Site Plan

Alternatives Summary and Cost Breakdown

A summary of the differentiating features of each Alternative, along with costs and sequencing, is presented in Table 13-2. A number of smaller projects, common to all five alternatives and present in the LOTT CIP, have been excluded for clarity. Overall cost summaries are provided in Table 13-3. This table reflects planning as of 2005, and all figures are in 2004 dollars.

Table 13-2. Alternatives Cost Breakdown[1]

Description	Alternative (year on line)					Construction Cost	Annual Operating Cost	Allied Cost
	1	2	3	4	5	($)	($/yr)	($)
Administration Building / Laboratory								
Stand Alone			2007			$4,709,205		$1,648,222
Partially Above PST, Laboratory Separate	2007	2007		2007	2007	$4,709,205		$1,648,222
Existing Building/Lab Demolition	2006	2006	2006	2006	2006	$548,805		$192,082
Primary Sedimentation Tank								
Conventional	2008			2008	2008	$12,961,573		$4,536,551

Description	Alternative (year on line)					Construction Cost	Annual Operating Cost	Allied Cost
	1	2	3	4	5	($)	($/yr)	($)
Chemically Enhanced		2008				$13,741,105	$791,297	$4,809,387
High Rate			2008			$12,236,238	$786,617	$4,282,683
Existing Tank Demolition	2008	2008	2008	2008	2008	$528,183		$184,864
Aeration Basins								
Folded Tank				2012	2012	$7,760,000		$2,716,000
Demolish First Anoxic				2012	2012	$550,000		$192,500
Secondary Clarifiers[2]								
Replace Existing Mechanisms, other Upgrades	2007	2007	2007	2007	2007	$3,852,399		$1,348,339
1 New Clarifier	2012			2012		$7,103,018		$2,486,056
2nd New Clarifier	2012			2012		$4,735,346		$1,657,371
Disinfection								
Chlorine contact channel		2012			2012	$1,039,650	$27,743	$363,878
UV equipment for 7th channel	2008	2008	2008	2008	2008	$100,000		$142,000
Reclaimed Water Filters								
Expand Dynasand units to 6 mgd (4.5 mgd new)	2012		2012	2012		$12,703,000		$4,446,050
Expand Dynasand units to 12 mgd (10.5 mgd new)						$29,600,000		$10,360,000
New Membrane Tanks (6 mgd)		2012				$15,774,000		$5,520,900
New Membrane Tanks in Place of 1st Anoxic (6 mgd)					2012	$14,300,000		$5,005,000
Thickening								
DAFT Mechanical Replacement and Building Enclosure	2015	2015	2015	2015	2015	$793,000		$277,550
Digestion								
Anaerobic Digester Cover Coating Replacement	2006	2006	2006	2006	2006	$240,000		$84,000
Anaerobic Digester Cover Fix in Place	2015	2015	2015	2015	2015	$3,172,000		$1,110,200
Class A Solids								
10 DT/d Class A Dryer	2015	2015	2015	2015	2015	$11,160,000		$3,906,000
Odor Control								
Primary Sedimentation Area	2007	2007	2007	2007	2007	$2,840,000		$994,000
Aeration Basin / Membrane		2012			2012	$1,039,812		$363,934
DAFT Enclosure	2015	2015	2015	2015	2015	$2,840,000		$994,000

1. All costs are 2004 $.
2. Secondary clarification projects should be re-evaluated following secondary clarifier mechanism upgrades, to be completed in 2006-7.

Table 13-3. Alternatives Cost Summary[1]

	Total Capital Cost	Annual Operating Cost
Alternative 1	$92,193,814	--
Alternative 2	$84,217,515	$819,040
Alternative 3	$75,232,820	$786,617
Alternative 4	$103,412,314	--
Alternative 5	$92,393,747	$27,743

1. Only includes items listed in Table 13-2. All costs are 2004 $.

CHAPTER 14

LAB AND ADMINISTRATION BUILDING ALTERNATIVES

As part of the Budd Inlet Master Plan process, the LOTT Alliance investigated options for the replacement of its lab and administration building. The existing laboratory, installed during the 1983 Plant expansion, has been awaiting an upgrade for several years. The lab lacks space, features a number of outdated analytical elements and no longer complies with health and safety codes. The administration area is also quite small, housing just a fraction of Plant staff, with several employees operating out of makeshift offices spread throughout the treatment Plant. The building lacks sufficient training space, as well as community outreach elements such as an interpretive center.

The LOTT Alliance currently leases approximately 4000sft of office space near the treatment plant. A combined office and administrative building will enable LOTT to optimize operations, facilitate staff collaboratively and reduce costs across all departments. Because there are space limitations in the downtown Olympia area surrounding the plant, as well as planned improvements to a number of Plant processes (Chapter 13), LOTT also conducted a Space Utilization Analysis to maximize to use of space at the Budd Inlet Treatment Plant. One of the principle considerations for this effort was logical placement of process and non-process staff and facilities. The conceptual design development was performed by Michael Willis Architects for the new Lab and Administrative Building.

LAB AND ADMINISTRATION BUILDING

A number of factors were evaluated to select a preferred design for the Lab and Administrative Buildings, these included:

- Site access
- Proximity to the Budd Inlet Plant
- Staff parking
- Bus parking
- Sustainability
- Capital and operational cost

The preferred design would include a conference room, a LOTT Board room, interpretive center, approximately 10-12 offices and 10-12 workstations, and the Plant Main Control Center. The Laboratory would be a separate building, allowing it to be constructed before the existing Administration and Lab Building was demolished and ensure availability of continuous laboratory services. Three sites were evaluated for the Lab and Administration Buildings as shown on Figure 14-1.

The LOTT Alliance investigated opportunities to develop a joint use facility with the Port of Olympia and City of Olympia. However, these did not prove feasible because of the schedule coordination issues, comgined parking requirements, site access, and the added space costs.

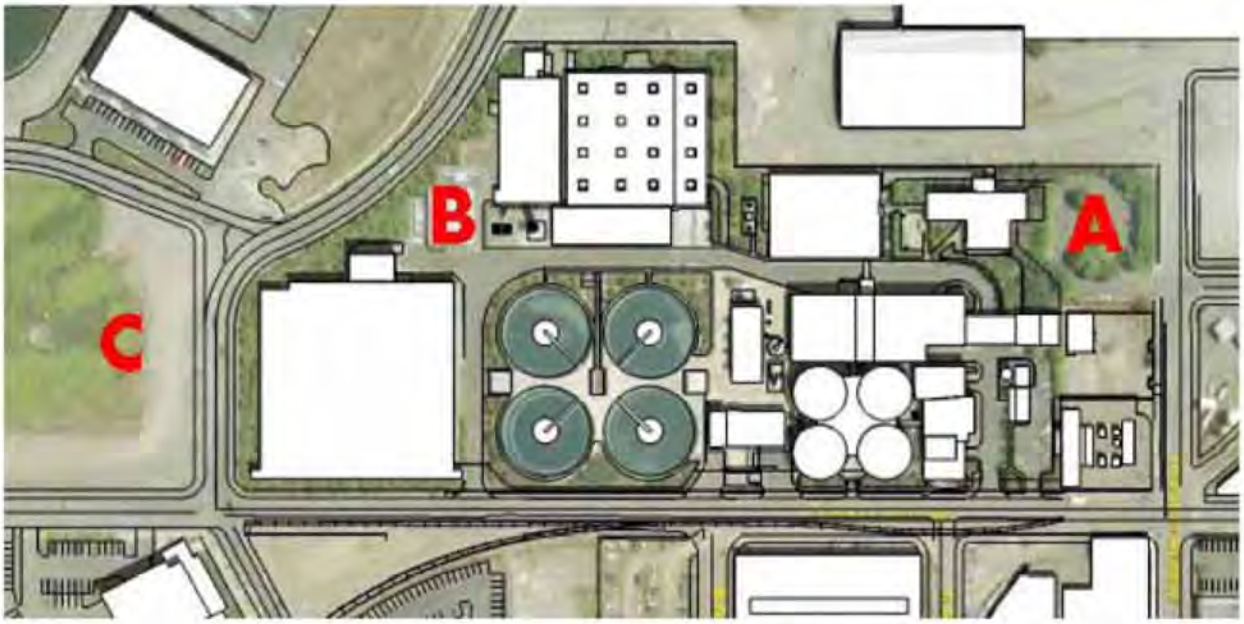


Figure 14-1. Lab and Administration Building Site Alternatives

Site A was selected as the preferred site, because it's located within the existing Plant boundaries, efficient access to the Plant, variety of parking options, and the opportunity to incorporate building construction into plans for a Primary Sedimentation Building replacement project. After discussions with LOTT, it was determined the Lab Building could be located in one of the two general areas on "Site A" as noted on Figure 14-1 or adjacent to the Recycled Water facility (south or west). The complete alternatives analysis can be found in Appendices D and E.

SPACE UTILIZATION ANALYSIS

The first priority for the Space Utilization Analysis was to identify the most appropriate location to relocate the Plant Main Control Center. The second priority was to identify possible locations where the water quality lab could be relocated and constructed before the existing administration building is demolished. The third priority was to identify locations where the contents of the existing warehouse and the substations in the existing Administration Building could be relocated.

The following summarizes the conclusions and recommendations from the Space Utilization Analysis (See Appendix F for a full discussion of the details).

<u>Areas to be decommissioned and made available for other uses</u>

- Odor Control and Soda Ash Storage
- Centrate Storage
- Solids Handling, Polymer Tank area
- Area between Solids and UV basins
- Area between Solids and Effluent Pump Storage
- Area west of the Recycled Water facility

Areas requiring minor remodeling or modification

- Blower Building office and lab areas
- Effluent Building office and storage areas

Areas that do not have allowable uses beyond their current use

- Blower Building spare room
- Headworks Vestibule
- Maintenance Building walkways
- Effluent Building Electrical Room

Areas may require upgrade to accommodate ADA requirements

- Locker Rooms in Maintenance Building
- Break Room in Maintenance Building

Additional Recommendations

The foundations of Centrate Storage are sufficient to support another structure and the location is central to many functions in the plant. For this reason, a new, 1-story, light weight building could be economically constructed over the existing tanks and consolidate the storage needs for the Plant. By removing the internal walls and piping and adding a stair and lift, the existing tank below grade could be used for much of the plant storage needs, such as the contents of the Storage Warehouse and Electrical Supply. The building above grade can be used to store archives and contents from Inventory.

If the area currently used for Inventory is converted back to its original use for vehicle maintenance, the contents of this area could be located in a central storage area, such as a new structure at Centrate Storage or elsewhere.

The contents of the existing warehouse building located on "Site B" (Figure 14-1) can be partially disposed of and partially relocated to several locations within the plant, including the high-bay space in the Blower Building, a new space over Centrate Storage or in smaller groups in Electrical Supply, Maintenance Building and the polymer tank area in Solids Handling.

Budd Inlet Wastewater Treatment Plant Master Plan
Public Workshop #1

Summary of Participant Comments

February, 2004

The LOTT Wastewater Alliance held its first Public Workshop for the Budd Inlet Wastewater Treatment Plant Master Plan on Monday, December 1, 2003. The purpose of this meeting was to gain general feedback and direction from community stakeholders before moving into the technical planning phase of the Master Plan.

The questions and issues raised by Workshop #1 participants are summarized below.

- Do you plan to expand beyond your existing footprint? Is that footprint limited?
- I would like to see you remain within your existing land allocation unless you are going beyond in order to create shared administrative space with peer entities.
- If you do expand the facility, will you be building up (increased building height)?
- Building higher structures within the plant may obstruct views, create eyesores.
- Building higher structures near or around the plant may generate new concerns pertaining to odor and unsightliness.
- What is water reclamation?
- Does increased production of reclaimed water equate to decreased volumes of treated wastewater discharged to Budd Inlet?
- How will reclaimed water be used, and by whom?
- Will there be storage space for reclaimed water?
- Is it possible that reclaimed (Class A Standard) water could be used to reduce expense and facilitate development of a community swimming pool?
- Why is treated wastewater effluent pumped into Budd Inlet as opposed to the Nisqually?

- We assume you'll use the best science.
- What are you doing to preserve or enhance area habitat and environmental quality?
- Improvement of water quality is a priority.
- What are the specific concerns we've been hearing about with regard to future discharge limitations in Budd Inlet (as mandated by EPA)?
- Has LOTT considered working in collaboration with partner jurisdictions (Port, County, City of Olympia) to create environmentally beneficial development standards and/or programs?
- Do you plan to develop and incorporate performance standards to provide empirical measurement of environmental costs and benefits related to LOTT's planned actions/activities?
- Can you do more at the "front end" of the waste cycle to reduce discharge?
- What incentives do you provide customers to reduce discharge?
- Will we (community) be given options to consider as this process moves forward?
- It seems the best way to proceed is for you to "run the numbers," create options, and then ask us (the community) to identify our preferences / provide guidance.
- Please be progressive with your plan. Try to ensure future decisions at the Plant benefit the downtown area, the environment and the community as a whole.
- Show people this project is at least as important as the Port's East Bay Master Plan. What happens here will have a major impact on the local area and the environment. It's not just about the "science of treating wastewater."
- Challenge will be conveying the story. Need to help people recognize this is an everyday people issue.
- Consider holding informational sessions with Neighborhood Associations.
- Informational materials about LOTT's planning should be provided at the Marina office for people who live on their boats (about 10% of the boats are live-aboards.)
- Does the Budd Inlet Wastewater Treatment Plant treat stormwater?
- How are carbons and runoff from the consolidated area treated?

- Will the Treatment Plant handle stormwater generated from the adjacent 17-acre "East Bay" Port property?
- Would LOTT not benefit from treating that stormwater / reducing nitrates on-site?
- How much nitrogen is removed from wastewater before discharge?
- What happens to solids generated during treatment process?
- How is treatment affected without undigested sugars once generated by Miller Brewery?
- Is LOTT interested in coordinating with Fish Tale Brewery on this matter?
- Where does LOTT discharge treated water?
- Does any of that water get discharged into the East Bay waterway?

Budd Inlet Wastewater Treatment Plant Master Plan
Public Workshop #2
Summary of Participant Comments

March, 2004

The LOTT Wastewater Alliance held its second Public Workshop for the Budd Inlet Wastewater Treatment Plant Master Plan on Thursday, February 26, 2004. The purpose of this meeting was to solicit feedback from community stakeholders on preliminary structural and landscape design concepts.

The questions and issues raised by Workshop #2 participants are summarized below.

- How does water treated at the Treatment plant compare to untreated water or a normal Puget Sound sample in terms of water quality?
- Why does LOTT need a new administrative building?
- Is LOTT committed to working within LEAD architectural standards?
- Has LOTT considered using "urban" vs. "suburban" design concepts?
- Can LOTT set an architectural "standard" that will set the community ahead as a whole?
- What are height restrictions in the Treatment Plant vicinity, and is it possible to build "up" vs. "out?"
- Would it be possible to build a parking garage on top of one of the Plant's clarifiers? It seems such a structure would require a solid foundation, and such a scenario provides one. Is the Port looking at developing parking space as well?
- My preference is that you construct any future clarifier, if necessary, on the west side of the existing Treatment Plant.
- Can parking and administration spaces be moved off the Plant site?

- Have you been coordinating with the City of Olympia or Timberland Library with regard to shared administration space?

- If you do move the administration building off-site, consider locating in the blocks between Intercity Transit and the Treatment Plant.

- Minimize traffic impacts to the extent feasible.

- Is it possible that future regulations could preclude any discharge to Budd Inlet all together?

- How much room does the Treatment Plant have before it reaches capacity?

- What type of water conservation education and activities does LOTT conduct now?

LOTT Wastewater Alliance

Budd Inlet Wastewater Treatment Plant Master Plan
Public Workshop #3

Summary of Participant Comments

November, 2004

The LOTT Wastewater Alliance held a third and final Public Workshop to discuss its Budd Inlet Wastewater Treatment Plant Master Plan on Monday, November 29, 2004. After providing an overview of the master plan purpose and process, LOTT asked community stakeholders to provide feedback on a preferred master plan alternative. Resulting questions and comments are summarized below.

- Is there a risk someone could sabotage the treatment plant? Are wastewater treatment facilities very high-up on the terror target list?
- Will reclaimed water be tested periodically to ensure no chemicals are infiltrating ground water? If so, will LOTT or Ecology do the testing?
- Make sure you build an administration building of sufficient size to accommodate staff increases well into the future. At a minimum, design the building so that an additional floor can be added at a future date.
- How will you keep the existing laboratory in operation while building the new one?
- Will you be replacing the metal fence on the east side of the plant?
- Can you market Class A biosolids? Is there a significant odor issue associated with the product?
- Will the purple pipe carrying reclaimed water from the Budd Inlet Plant to its final destination south of Tumwater pass along the Deschutes River? If so, is there a risk of contamination should the pipe break or leak?
- Will the Port be using reclaimed water and, if so, has it installed purple pipe yet?
- Are you going to stay out of the lagoon in Budd Inlet adjacent to the Capitol Lake Dam? I heard there was agreement among Squaxin Tribe and various public agencies to avoid impacting that area. If you conduct habitat improvements in association with this project, where will you do so?

APPENDIX B – WASTEWATER CHARACTERIZATION DATA

LEGEND:

TSS	Total suspended solids
VSS	Volatile suspended solids
COD	Total COD
sCOD	Soluble COD (filtered thru 0.45 micron membrane filter)
ffCOD	"Floc" COD as per test protocol
BOD5	Total 5-day BOD
CBOD5	Carbonaceous 5-day BOD
sBOD5	Soluble 5-day BOD (filtered thru 0.45 micron membrane filter)
TKN	Total Kjeldahl Nitrogen
sTKN	Soluble TKN (filtered thru 0.45 micron membrane filter)
NH3-N	Ammonia nitrogen
NO3-N	Nitrate nitrogen
NO2-N	Nitrite nitrogen
TON	Total oxidized nitrogen (nitrite and nitrate nitrogen)
TP	Total phosphorus
PO4-P	Soluble orthophosphate P (filtered thru 0.45 micron filter)
VFA	Short-chain volatile fatty acids (acetic, butyric, propionic)
Alk	Alkalinity as CaCO3

Daily Samples

	Raw Influent				
Day	Flow	TSS	VSS	COD	BOD5
12/10/03	13.20	241	215	486	223
12/11/03	12.92	263	247	478	203
12/12/03	13.61	207	178	491	216
12/13/03	14.79	179	159	391	193
12/14/03	14.46	176	155	383	153
12/15/03	12.62	227	197	555	244
12/16/03	12.30	203	191	507	180
12/17/03	11.79	216	190	484	203
12/18/03	11.68	224	203	481	236
12/19/03	11.50	227	197	490	213
12/20/03	10.98	231	211	582	237
12/21/03	10.49	249	228	508	238
12/22/03	10.72	285	262	606	231
12/23/03	10.77	222	197	516	247
Average	12.27	225	202	497	216

	Primary Effluent													
Day	Flow	TSS	VSS	COD	sCOD	ffCOD	BOD5	sBOD5	TKN	sTKN	NH3-N	NO3-N	TON	TP
12/10/03	13.20	77.3	63.6	245	89.5	52.7	98.3	29.4	26.3	20.3	17.3	2.09	2.29	4.07
12/11/03	12.92	79.1	65.1	247	95.1	62.7	97.4	35.1	34.3	26.2	24.7	2.13	2.38	5.12
12/12/03	13.91	76.9	69.2	234	98.1	63.3	94.9	31.8	31.3	23.9	22.2	1.57	1.82	4.89
12/13/03	14.79	72.3	61.7	209	101.0	51.2	87.8	30.8	22.5	16.0	13.7	1.73	1.90	3.49
12/14/03	14.46	69.0	54.8	216	99.1	56.4	90.5	26.2	28.2	21.6	19.9	1.94	2.15	4.36
12/15/03	12.62	78.0	68.3	252	105.0	71.9	106.0	43.8	33.1	25.5	24.1	2.11	2.37	5.14
12/16/03	12.30	86.7	75.6	244	96.4	58.2	100.0	33.2	27.2	22.1	20.2	1.75	1.95	4.58
12/17/03	11.79	79.1	65.1	242	86.1	60.9	85.0	28.7	39.3	28.1	30.6	2.07	2.44	5.71
12/18/03	11.68	79.5	68.0	274	97.7	73.0	102.0	31.7	36.7	28.1	27.8	2.30	2.69	5.87
12/19/03	11.50	88.4	81.4	313	148.0	118.0	133.0	63.7	36.9		28.4	1.92	2.31	5.90
12/20/03	10.98	95.3	86.0	281	95.3	66.3	112.0	35.9	33.3	24.2	23.8	1.45	1.75	5.36
12/21/03	10.49	84.4	73.3	276	112.0	80.1	118.0	44.6	31.4	25.5	25.2	1.24	1.50	5.25
12/22/03	10.72	87.8	75.6	280	119.0	74.2	116.0	45.1	38.2	30.7	30.4	1.24	1.55	5.98
12/23/03	10.77	189.0	167.0	302	111.0	76.0	119.0	47.3	37.8	31.4	32.2	1.39	1.65	5.98
Average	12.30	88.8	76.8	258	103.8	68.9	104.3	37.7	32.6	24.9	24.3	1.78	2.05	5.12

	Final Effluent													
Day	**Flow**	**TSS**	**VSS**	**COD**	**sCOD**	**ffCOD**	**BOD5**	**CBOD5**	**TKN**	**sTKN**	**NH3-N**	**NO3-N**	**TON**	**TP**
12/10/03	12.99	9.11	8.00	40.5	28.8	23.9	8.00	4.44	3.59	2.51	1.61	18.49	18.86	3.24
12/11/03	12.71	9.40	7.80	69.2	31.5	19.6	8.35	4.83	4.56	3.35	2.49	17.14	17.64	3.10
12/12/03	13.70	9.00	8.25	45.3	32.0	23.8	9.21	4.36	5.13	4.07	3.00	16.10	16.70	3.28
12/13/03	14.58	9.60	8.40	47.2	33.4	21.2	8.71	4.14	3.77	2.60	1.65	15.76	16.25	2.95
12/14/03	14.25	9.33	8.00	38.2	26.8	20.9	7.40	4.52	5.37	3.13	2.28	13.59	14.15	2.52
12/15/03	12.41	9.56	8.44	43.7	28.3	22.5	8.55	5.24	4.54	3.42	2.19	14.82	15.60	2.96
12/16/03	12.09	10.20	8.44	42.1	29.1	24.9	8.54	5.09	4.53	3.28	2.40	15.32	16.20	3.41
12/17/03	11.59	9.43	8.00	43.5	28.9	23.0	8.96	5.13	4.55	3.31	2.19	15.02	15.90	3.21
12/18/03	11.49	12.25	10.00	76.2	61.4	36.1	11.60	5.95	6.02	4.85	3.88	17.72	19.00	3.92
12/19/03	11.31	12.25	10.25	64.1	45.8	40.9	14.10	9.07	5.82	3.95	3.04	18.48	19.90	4.25
12/20/03	10.79	11.80	10.25	73.4	44.6	28.3	9.19	5.02	7.25	5.82	4.55	14.78	15.90	3.48
12/21/03	10.30	11.00	9.50	48.8	32.0	22.9	11.48	5.15	5.47	4.02	2.68	14.08	15.00	3.58
12/22/03	10.54	12.50	10.50	53.4	33.4	26.8	12.50	6.85	7.50	6.53	5.41	12.53	13.50	3.73
12/23/03	10.60	14.50	12.50	59.7	41.1	33.0	13.00	6.95	7.52	6.26	5.15	14.28	15.30	4.07
Average	12.10	10.71	9.17	53.2	35.5	26.3	9.97	5.48	5.40	4.08	3.04	15.58	16.42	3.41

	Mixed Liquor				RAS	WAS				
Day	Flow	TSS	VSS	Temp	Flow	Flow	TSS	VSS	COD	TKN
12/10/03	18.07	1,160	1,030	15.9	4.65	0.22	6,300	5,400	8,000	520
12/11/03	17.74	1,070	940	15.5	4.60	0.22	6,100	5,100	8,060	509
12/12/03	18.95	1,110	1,000	14.9	4.83	0.21	6,400	5,500	8,000	512
12/13/03	20.21	950	880	15.3	5.20	0.22	6,050	5,300	9,040	508
12/14/03	19.75	960	850	14.5	5.07	0.22	6,000	5,150	7,760	491
12/15/03	17.32	890	820	15.0	4.48	0.22	5,950	5,200	7,640	502
12/16/03	16.90	860	770	15.3	4.39	0.21	5,900	4,950	7,940	499
12/17/03	16.25	790	720	14.9	4.26	0.20	5,350	4,950	7,180	508
12/18/03	16.09	780	710	15.6	4.22	0.19	5,050	4,750	7,480	463
12/19/03	15.86	830	750	15.7	4.17	0.19				
12/20/03	15.19	790	730	15.6	4.02	0.19	5,400	4,850	8,520	484
12/21/03	14.55	850	760	15.7	3.87	0.19	4,900	4,350	6,860	437
12/22/03	14.84	780	710	15.7	3.94	0.18	5,300	4,650	7,100	422
12/23/03	14.91	540	520	15.8	3.97	0.17	5,450	5,000	7,460	478
Average	16.90	883	799	15.4	4.41	0.20	5,704	5,012	7,772	487

Diurnal Samples (Collected on 12/12/2003)

	Primary Effluent									
Time	Flow	TSS	VSS	COD	ffCOD	TKN	sTKN	NH3-N	TP	PO4-P
0000	13.76	100.0	83.3	268	78.5	24.8	18.1	15.55	4.02	2.10
0200	10.72	68.8	59.4	250	79.2	26.0	18.8	16.13	4.07	2.37
0400	9.78	50.0	40.6	174	56.4	20.5	14.5	12.31	4.11	2.33
0600	8.25	57.1	44.9	139	34.6	20.3	12.9	11.38	3.50	2.25
0800	19.50	41.8	33.0	146	50.9	19.1	14.0	11.74	2.93	1.87
1000	17.16	52.2	44.6	199	58.6	23.8	17.7	14.79	3.36	1.99
1200	16.94	66.7	53.8	266	85.7	43.0	31.0	29.74	5.48	3.05
1400	13.48	77.6	63.3	285	96.1	46.7	37.0	33.40	6.20	3.69
1600	13.80	100.0	85.2	343	108.0	50.8	36.3	35.60	7.16	4.04
1800	14.14	76.3	63.8	301	99.5	49.6	38.4	36.00	6.59	4.38
2000	13.50	67.5	57.5	324	106.0	49.4	40.4	36.80	6.58	4.17
2200	12.86	101.0	84.0	340	113.0	38.9	27.7	22.98	5.97	2.91
Average	13.66	71.6	59.5	253	80.5	34.4	25.6	23.04	5.00	2.93

	Final Effluent												
Time	Flow	TSS	VSS	COD	sCOD	ffCOD	CBOD5	TKN	NH3-N	NO3-N	TON	PO4-P	NO2
0000	13.55	9.8	8.8	61.3	44.2	29.5	4.86	12.0	9.36	16.81	17.78	3.42	0.98
0200	10.72	9.8	8.5	51.8	40.0	24.4	4.89	11.2	8.20	15.49	16.45	2.91	0.96
0400	9.78	9.5	7.8	53.4	31.9	26.4	4.50	7.5	5.87	17.37	18.27	2.74	0.90
0600	8.04	5.6	4.6	45.0	28.0	25.1	4.02	6.0	4.13	15.45	16.21	2.47	0.75
0800	19.50	9.8	8.0	44.5	31.0	24.7	4.90	4.2	2.45	16.13	16.64	2.67	0.51
1000	17.16	8.3	7.8	39.9	28.3	21.5	3.72	2.6	0.84	16.01	16.29	2.47	0.27
1200	16.73	5.8	4.8	53.0	26.9	19.9	2.87	1.8	0.25	15.22	15.36	2.37	0.14
1400	13.48	5.6	4.8	55.1	25.6	21.6	2.67	1.5	0.18	15.06	15.13	2.09	0.07
1600	13.80	6.0	5.2	31.5	22.5	17.0	2.40	1.6	0.44	15.46	15.77	2.29	0.31
1800	13.93	8.2	7.4	37.2	27.4	23.2	2.96	3.7	2.14	15.86	16.55	2.51	0.69
2000	13.50	10.2	9.0	40.2	31.6	24.3	4.23	6.0	4.19	15.75	16.66	2.73	0.92
2200	12.86	10.6	9.0	47.1	34.5	25.9	5.05	7.5	6.02	16.39	16.98	3.05	0.59
Average	13.59	8.3	7.1	46.7	31.0	23.6	3.92	5.5	3.67	15.92	16.51	2.64	0.59

	Mixed Liquor			WAS		
Time	TSS	VSS	Temp	Flow	TSS	VSS
0000	1,130	940		0.215	5,100	4,550
0200						
0400						
0600			14.9	0.215	5,200	4,550
0800						
1000						
1200				0.215	5,050	4,500
1400						
1600						
1800				0.215	5,550	4,950
2000						
2200						
Average	1,130	940	14.9	0.215	5,225	4,638

APPENDIX C – BIOWIN PROCESS MODELING RESULTS

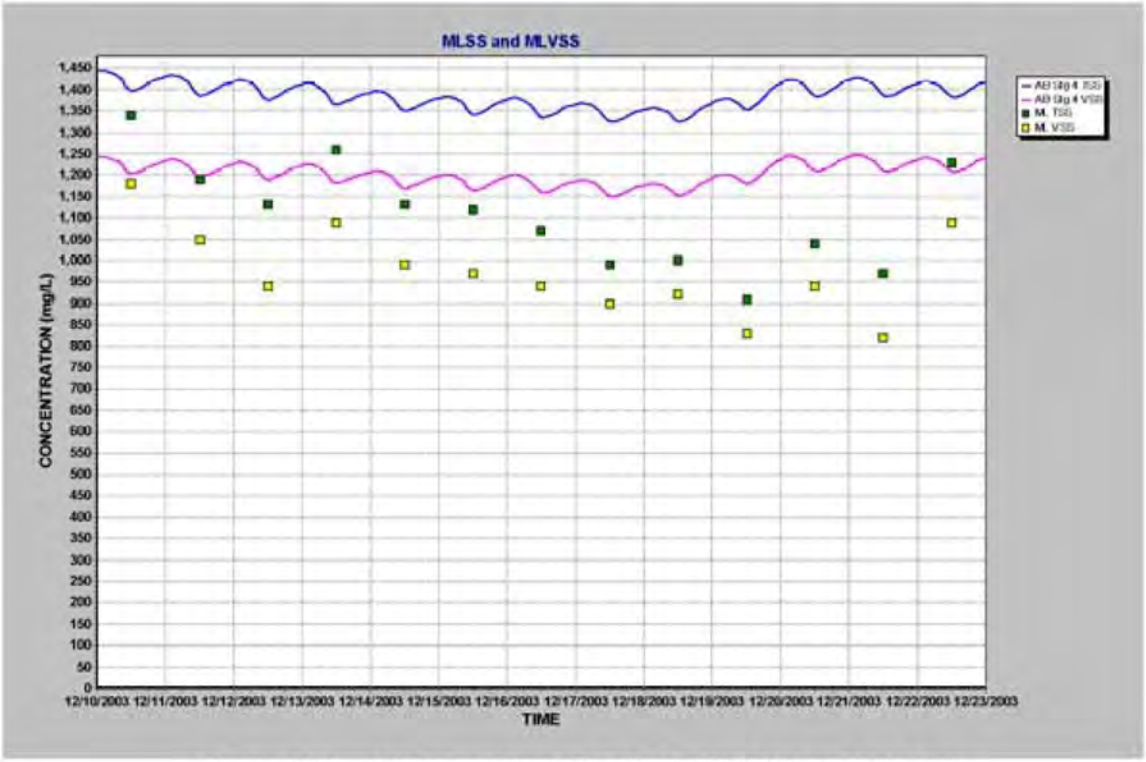


Figure C-1. Measured and Predicted MLSS and MLVSS

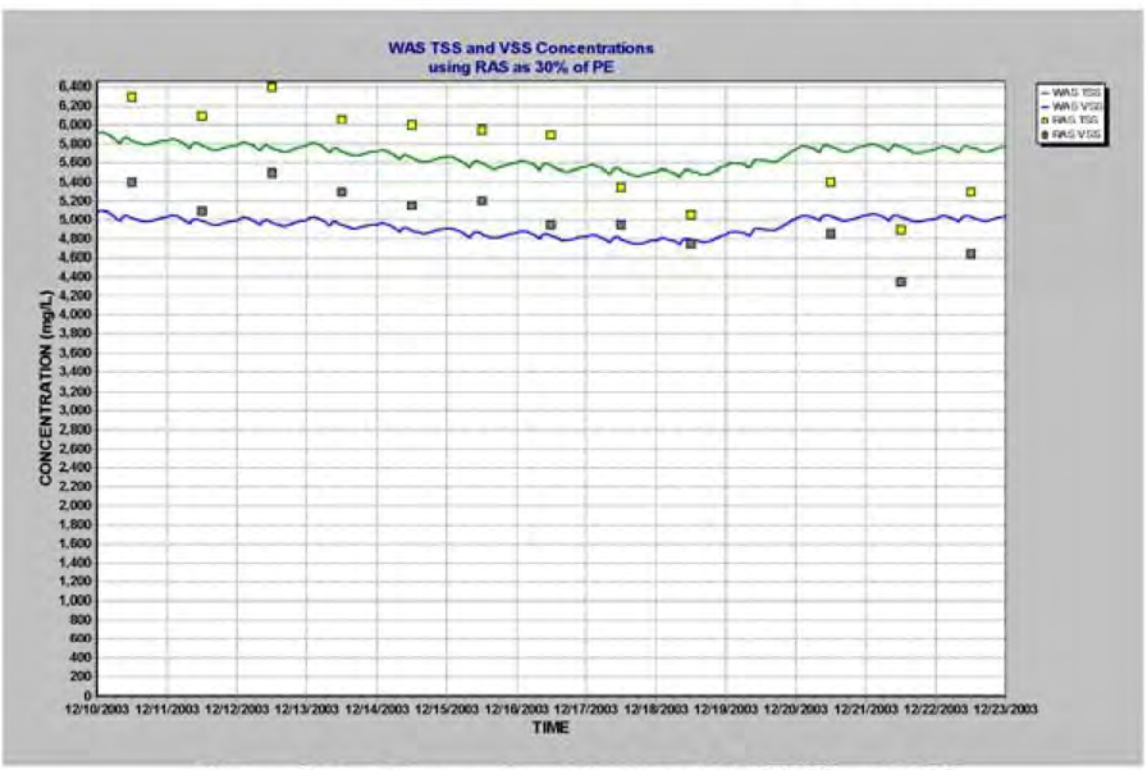


Figure C-2. Measured and Predicted RAS TSS and VSS

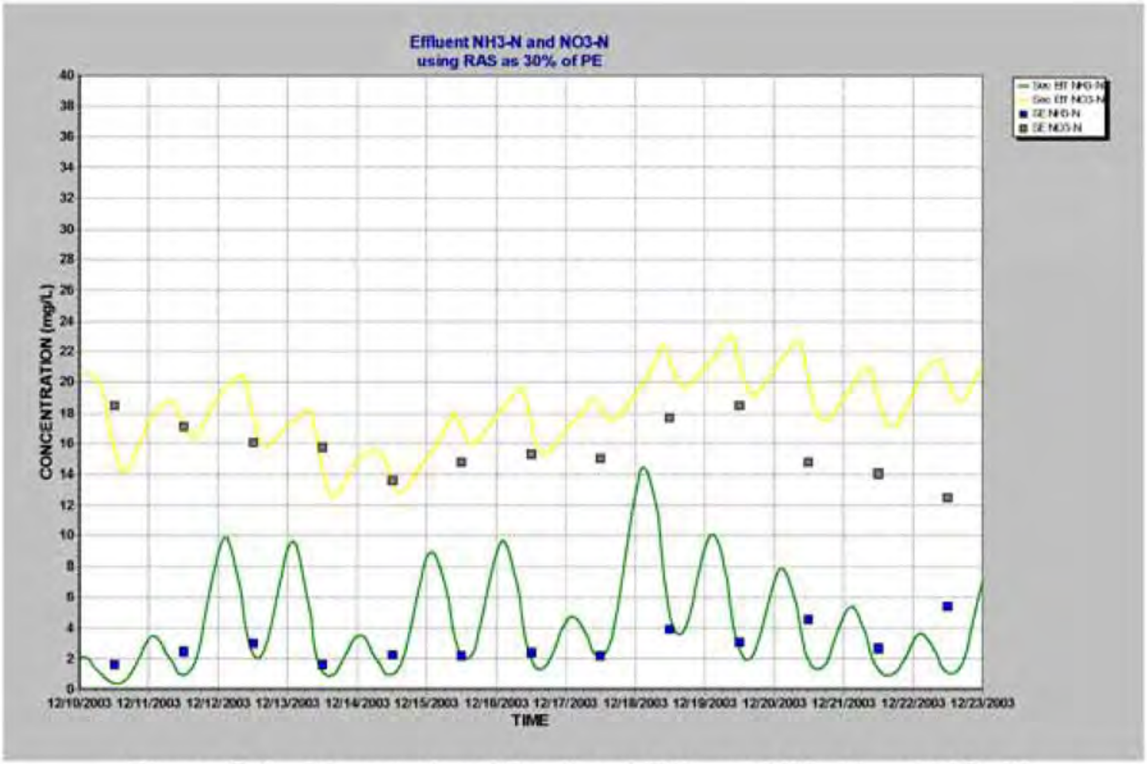


Figure C-3. Measured and Predicted Effluent NH_3-N and NO_3-N

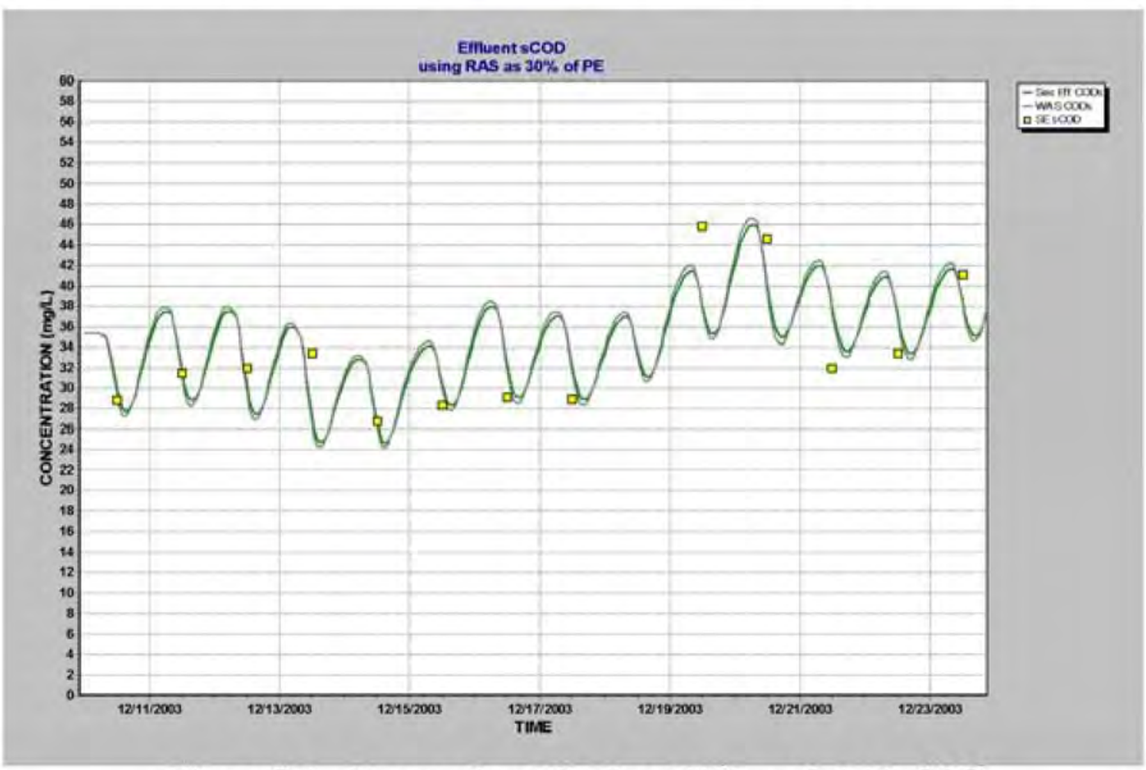


Figure C-4. Measured and Predicted Effluent Soluble COD

LAB and ADMINISTRATION BUILDING ALTERNATIVES

For the LOTT Alliance/Budd Inlet Wastewater Plant Master Plan, the architectural approach was to support and enhance the engineering effort. Several buildings will need to be replaced, renovated or expanded based on the modifications needed in the treatment facilities. Michael Willis Architects is working with LOTT and Brown & Caldwell to understand the requirements of each of the process options and to provide architectural and planning feedback. WMA also provided programming and planning services to assess the needs to the laboratory, plant management staff and LOTT's administration needs. Finally, MWA compiled information gained in these exercises to assist B&C and the LOTT Alliance to develop and analyze options for a new Water Quality Laboratory and Administration Buildings.

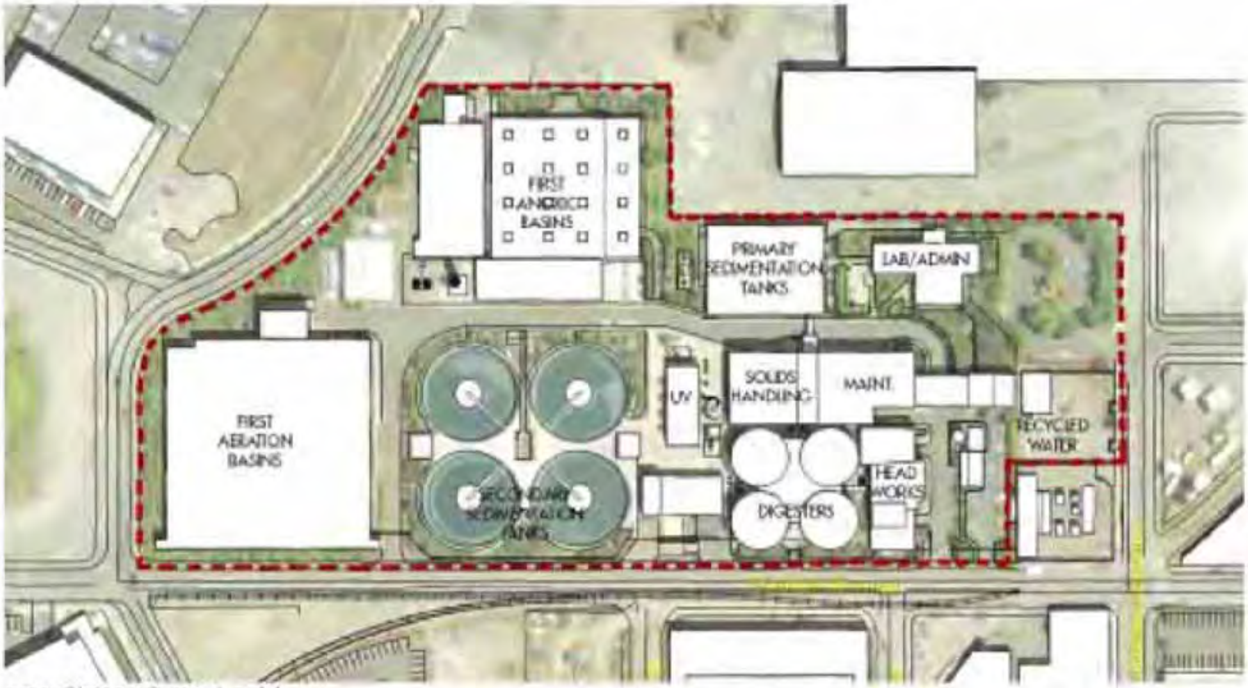
BACKGROUND

After an initial review of the existing plant and context, previous studies and master plan approach, MWA attended several meetings and a public workshop in which MWA presented architectural concepts to the public to supplement presentations by LOTT and B&C of Master Plan information. In further meetings, MWA met primarily with Chris Cleveland from Brown & Caldwell and with Mike Strub and Karla Fowler from LOTT Alliance to develop programming requirements and parameters based on the needs of the treatment facility.

The original focus of architectural work changed from developing a particular architectural design and style options for projected (new) process and non-process structures, to providing site analyses of several site options for new lab and administration buildings. Similarly, the initial programming study included only LOTT and plant requirements. With possible collaboration with the Port of Olympia, the focus changed to include the feasibility and efficiencies gained of a combination, joint-use office building. The resulting research is the programming and site analysis described in this chapter.

EXISTING SITE

The existing plant is located north of downtown Olympia, in an area that is gearing towards future commercial and residential development. In preparation for improvements to the surrounding neighborhood, LOTT has undertaken a series of strategies to make the plant a good neighbor in the community. By employing planting and berming along the west and north sides of the plant, LOTT has created an affective screened edge to the plant. LOTT has also made sidewalk improvements on the south, west and north sides of the plant. Areas to the east of the plant are somewhat unsightly and exposed to future developments in that area; however, expansion of the primary sedimentation basins will dovetail with other improvements along the plant edges. In addition to visual improvements, the plant has not only addressed, but continues to improve noise and odor issues in preparation for future housing and commercial growth.



EXISTING PLANT

FUTURE EXPANSION

Zoning and Code information: Areas within the plant are part of the City of Olympia's Downtown Business District. Adjacent properties owned by the Port are in the City of Olympia's Urban Waterfront Districts. The Port further distinguishes their property into the Market District to the west of the plant, Central District to the north, Boat Works District to the northeast and State Avenue District to the southeast. The Port of Olympia has conducted some master planning studies which were considered in this analysis and are included in the Appendix.

Zone ordinances will allow the following on all three sites considered:

- 100% development and building coverage
- No setbacks
- 65' maximum building height

Requirements are as follows:

- Parking: 3.5 spaces / 1000 sq. ft. of government office area
  3.3 spaces / 1000 sq. ft. of museum/exhibit area (6 stalls min. on site)
- Bicycle Parking: 2 stalls / 15 parking spaces for government offices (for class 1 & class 2)
  2 stalls / 20 parking spaces for museum / exhibit area (for class 1 & class 2)
- Loading: 1 berth / 20-50,000 sq. ft.

Additional zoning and code standards will need to be reviewed once a site is selected and building developed.

PROGRAMMING

As a result of meetings with Chris Cleveland of Brown & Caldwell, Mike Strub of LOTT, and other plant staff, MWA identified space requirements for a future water quality laboratory and administration building. In addition, LOTT and the Port of Olympia recognize that they can gain efficiencies by sharing public and common spaces such as lobby, reception, board rooms and training areas. MWA incorporated preliminary programming information provided by the Port to create a program for a LOTT + Port administration building. MWA used programming information to further establish a number of building options for each site under consideration.

Programming notes:

- **Conference & Board Room**: LOTT's existing board room is approximately 1000sf and is large enough for all functions that have been planned. The program calls for 1000sf for the Board Room and another 1000 sf for Training and Conference Rooms. The Board Room and Conference/Training Rooms may be located next to each other with a movable partition to create a multi-purpose room. If the Port is involved in the project, then the Board Room will need to grow to 1250 sf.
- **Interpretive center**: This will address educational information for the entire plant, including recycled water and waste water treatment. The firm of Lehrman Cameron has been working with LOTT to produce a document recommending interpretive signage and educational programming. If the Port is involved in the project, then a Maritime Museum may developed with the South Sound Maritime Heritage Association and be located in this facility.

LOTT Alliance
Budd Inlet WWTP

Michael
Willis
Architects

PROGRAM: LOTT / Plant

				Size - sf	# of staff	Notes	Comments
Plant / LOTT	Interpretive Center/ Education			2,085		not including "circulation"; 2500sf total with circulation	
		exhibit	1935				
		office	150				
	Admin offices			4,960			
		10-12 Offices + reception area	1,800		10-12	150 sf per office	
		10-12 work stations	1,200		10-12	100 sf per work station	
		(2) small Restrooms	160			80sf each	
		(2) Small conference rooms	400		2	200 sf each; w/ acoustic privacy	
		Document Production Area	400			copy area adjacent to offices	original program for 400sf; if share with Port, may locate 100sf for copy/work area with offices and remaining in shared areas.
		IT/ Server	150				
		Records	200			3 yrs on hand / archives accessible	
		File/ equip. storage	150			verify size, needs	
		Misc. Storage	300			verify size, needs	
	Sub-total			7,045			
	Circ @ 20%			1,409			
			Total	8,454	20-25		

COMMON/PUBLIC SPACES	Lobby/ reception			835		share with Port; not including "circulation"; 1000sf total incl. circ.	
	Public Restrooms			320		share with Port	
	Loading/ Receiving			200		share with Port	
	Board room / Meeting			1,000		share with Port	
	Training			1,000		share with Port	
	Lunch/Break			500		share with Port	
	Mechanical			500		share with Port	
	Electrical			500		share with Port	
	Sub-total			4,355			
--	Circ @ 20%			871			
			Total	5,226			
LOTT ADMINISTRATION BUILDING AREA:				13,680			

LOTT Alliance Budd
Inlet WWTP

Michael
Willis
Architects

PROGRAM: Port of Olympia

				Size - sf	# of staff	Notes	Comments
PORT OF OLYMPIA	Admin			5,760		not including circulation	total area given by Port was 6875sf, assume that included circulation; 5730 (20% circ. = 6912sf
		Offices	4200		28	150sf each, 28 offices per Port	
		Small Training	400			locate with shared areas, verify	
		Conference	400		2	200sf each, ?? per Port	
		Copy/work room	300		2	150sf each, 1 per floor, 2 floors, verify	
		(2) small restrooms	160		2	80sf each, 1 per floor, assume 2 floors	
		I.T./Server	150			verify size	
		File/ equip storage	150			verify size, needs	
	Maritime Museum			2,085		not including "circulation", 2500sf finished, circulation	
		Exhibit	1585			verify needs	
		Offices	150			per Port, verify size	
		Gift shop	150			per Port, verify size	
		Storage	200			verify size, needs	some exhibit storage can be off-site
	Port Sub-total			7,845	30-33		
	Circ @ 20%			1,569			
			Total	9,414			

ADDITION TO COMMON AREAS	Board			250		approx, share with LOTT	
	Lunch/Break			250		approx, share with LOTT	
	Mech/Elect.			250		approx, share with LOTT	
	Sub-total			750			
	Circ @ 20%			150			
			Total	900			

LOTT ADMINISTRATION BUILDING AREA:	13,680
LOTT+PORT BUILDING AREA	23,994

LOTT Alliance
Budd Inlet WWTP

Michael Willis Architects

PROGRAM: Plant Lab/Control

				Size : sf	# of staff	Notes	Comments
LOTT PLANT CONTROL CENTER	Control Center			600		Can be part of lab or separate	
		Control Room / Server w/ one workstation	400		1	Prefer central plant location Can downsize - usually only one operator present, verify size	
		UPS + Electrical	200				
		Mechanical	0			shared with lab; small area if separate	
LOTT WATER QUALITY LAB	Water Quality Lab	including wet/dry bench areas, analytical work areas, and library		1640		From lab staff based on existing areas, shown as minimum	
		Wet Chemistry	1000				
		Nutrient Room	160				
		Microbiology	240				
		Chemical Prep	100			alcove	
		Digestion Room	140				
		DI & Water System	-			closet; include in MEP area	
	Operator's Lab			140		verify	
	Sample receiving			150			
	Library			150			
	WAQ Offices			200		three work stations with ample files space	
	Storage Room			100			
	Restrooms w/ Lockers			300		verify, (2) at 150sf each	
	Break/ Conf. Rm			140		verify, can share if adjacent to Admin	
	Entry/ Security/ Lobby			200		verify	
	Bottled Gas Storage			80		verify	
	Lab services + Control Center MEP			450		including DI & Water	
	Sub-total			4,150			
	Circ @ 20%			830			
LAB/CONTROL TOTAL BUILDING AREA			Total	4,980			

Michael Willis Architects

LOTT Alliance
Budd Inlet WWTP

Program Summary

			Size - sf	# of staff
LOTT/PLANT ADMINISTRATION	Sub-total		7,045	
	Circ @ 20%		1,409	
		Total	8,454	20-25
COMMON/ PUBLIC SPACES	Sub-total		4,355	
	Circ @ 20%		871	
		Total	5,226	
LOTT ADMINISTRATION BUILDING AREA:			13,680	
PORT OF OLYMPIA OFFICES	Sub-total		7,845	50-55
	Circ @ 20%		1,569	
		Total	9,414	
ADDITION TO COMMON AREAS	Sub-total		750	
	Circ @ 20%		150	
		Total	900	
LOTT+PORT BUILDING AREA			23,994	

LOTT PLANT LAB/CONTROL	Sub-total		4,200	
	Circ @ 20%		840	
		Total	5,040	
LAB/CONTROL BUILDING AREA			5,040	

SITE ANALYSIS

The team reviewed several site options with LOTT and Brown & Caldwell. Three sites were selected as the most feasible for a future water quality lab and administration building.

SITE OPTIONS:

Site A is located at the south end of plant site. This site is the least preferred site because the Port would not likely be included in the building. LOTT considers this site the "fall back" if the other two site are not feasible. Construction for this site will need to tie into construction of the new Primary Sedimentation Basins. Locating the Administration building at the south end may eliminate the ability to separate a business entrance at the south from a public entrance at the north. Regardless of the location of the administration building, site A is the preferred location for the water quality lab. One administration building scheme for site A was developed including only LOTT program elements.

Site B is located at the north end of the plant site. This is the preferred site for LOTT if construction on this site is feasible. Site B is on the northern end of the LOTT property and so will potentially allow the Port to be involved in the building. Two plans were developed for each scheme. One plan includes only LOTT program elements, including interpretive center for the plant, Board Room and Training Rooms. A second plan will also include spaces for the Port, including the Maritime Museum and administrative spaces.

Location on this site will likely require relocation of two electrical substations. This is also the smallest area of the three locations. Relocation of the two substations will be expensive. The substations serve nearby buildings and should be located close to the areas they serve. Two possible locations to relocate the substations were identified by the team.

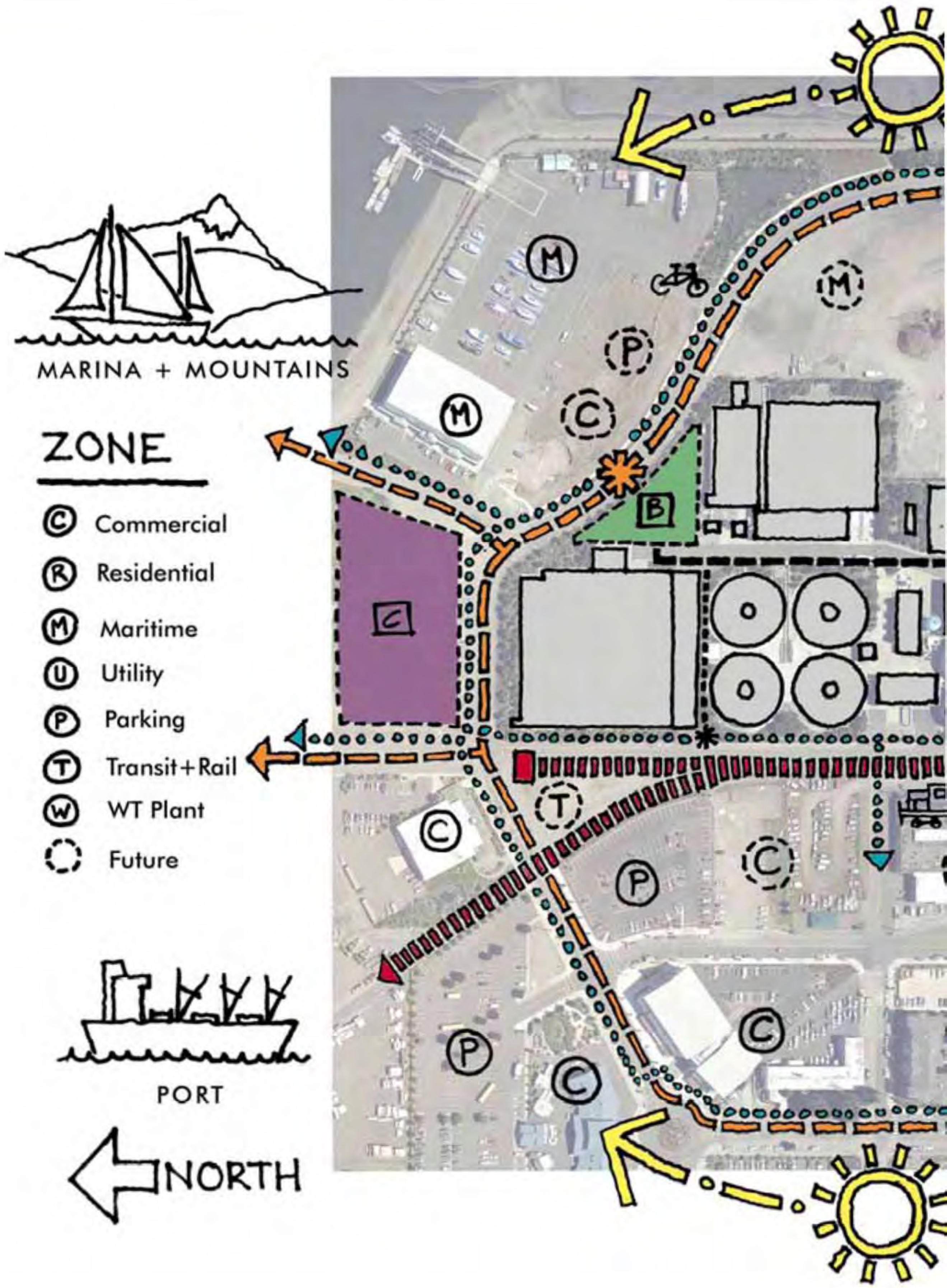
Parking will be an issue on this site. Disabled parking and a tour group drop-off need to be located on site at a minimum. Other visitor parking may be located across the street in an auxiliary parking lot if necessary.

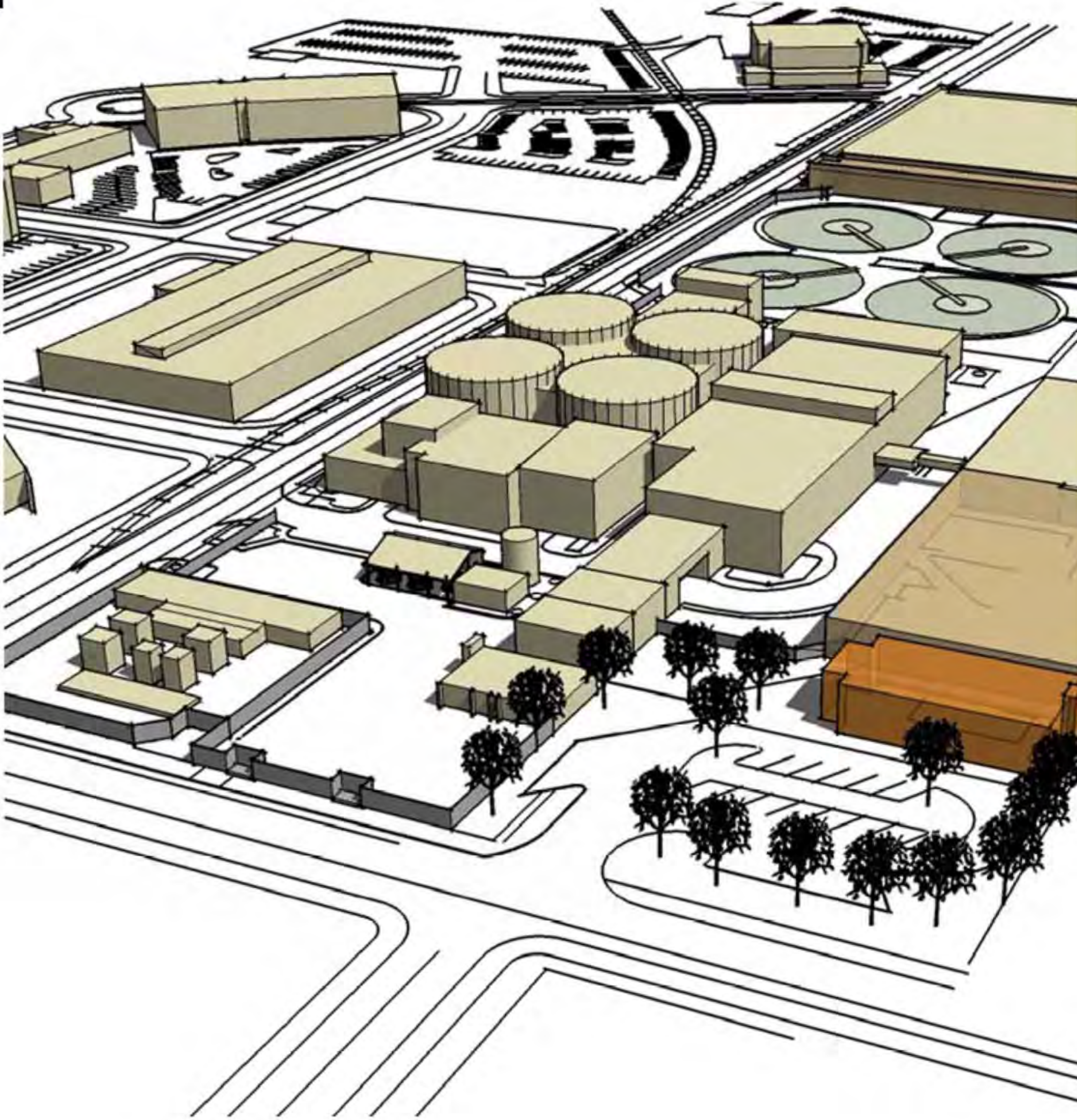
Site C is located on Port land north of the plant. This allows Port inclusion in the project and has adequate size for the program and parking. However, the land is limited to "water dependent" uses, which may preclude LOTT. The Port wrote a letter to the USACOE to determine if LOTT/Port use meets the threshold, but no decision was made at the time of this report. Due to soils conditions, this site will be difficult to build on.

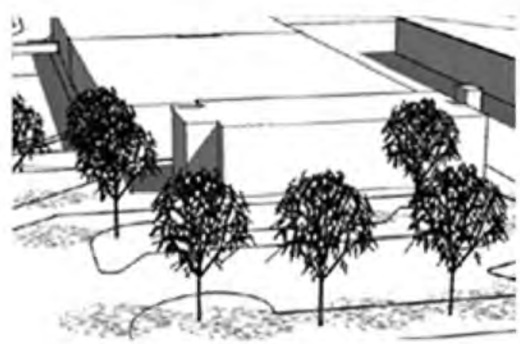
CRITERIA: The sites were evaluated using the following goals and criteria:

- **Site access**: LOTT hopes to create a public entrance to the north and turn the existing entrance at the north into a business entrance. This goal can be best met with an administration building on site B. This goal can be partly met with an administration building on site A.
- **Connection to plant**: The new administration building should allow for interaction between plant staff and LOTT administration and allow easy access for tours of the plant from the administration building. This goal is best met with an administration building on sites A and B. And existing "utilidor" may be able to be extended to site C under Marine Drive to create a connection between a building on the east side of site C and the plant.
- **Bus Parking**: Bus parking will be needed to accommodate tour buses. For sites A and B, bus parking can be inside the plant itself. For site C, bus parking will need to be provided on site.
- **Staff Parking**: Staff parking is already provided inside the plant and can remain in its current location if the administration building is constructed on sites A or B. Additional parking for Port staff will be needed for site B if the Port is involved in the project. Staff parking for LOTT and the Port will need to be provided on site C.
- **Sustainability:** The building should be able to utilize energy and water saving strategies. Solar and wind orientation should be considered.
- **Collaboration opportunities:** Efficiencies can be gained in a LOTT + Port administration building. The Port can participate in an administration building on Site B. The Port owns site C and so would also be involved in a building on that site.
- **Cost and Constructability**: The final criteria for selecting a site will be cost and constructability. The construction sequence planned for plant expansion that will affect the lab and administration building is as follows:

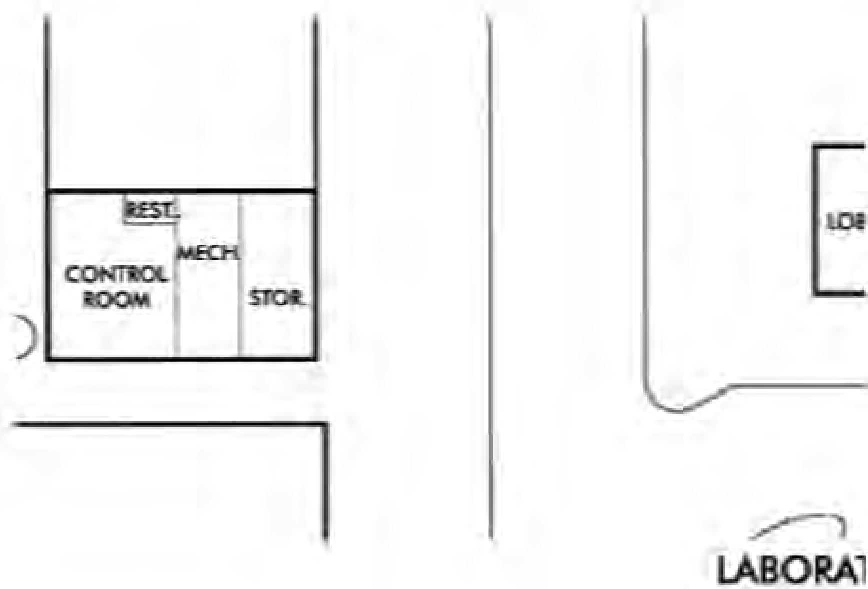
  1. Build new Lab/Control Building/Relocate UPS
  2. Demolish existing Admin/Lab Building
  3. Build Primary Sediment Basins
  4. Build new Administration Building


MARINA + MOUNTAINS
ZONE
C Commercial
R Residential
M Maritime
U Utility
P Parking
T Transit+Rail
W WT Plant
Future
PORT
NORTH
M
M
M
P
C
B
C
T
C
P
C
C
P
C

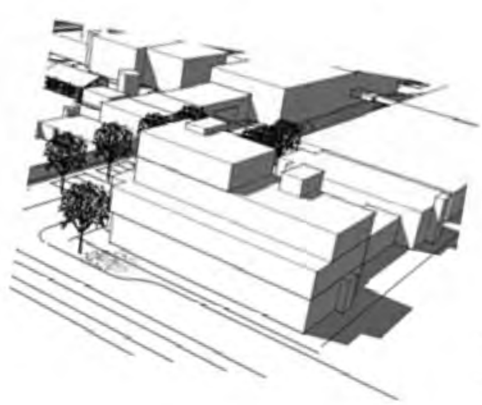


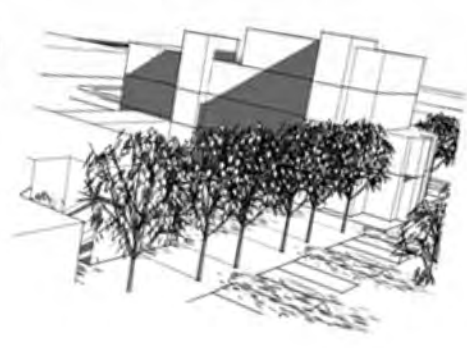


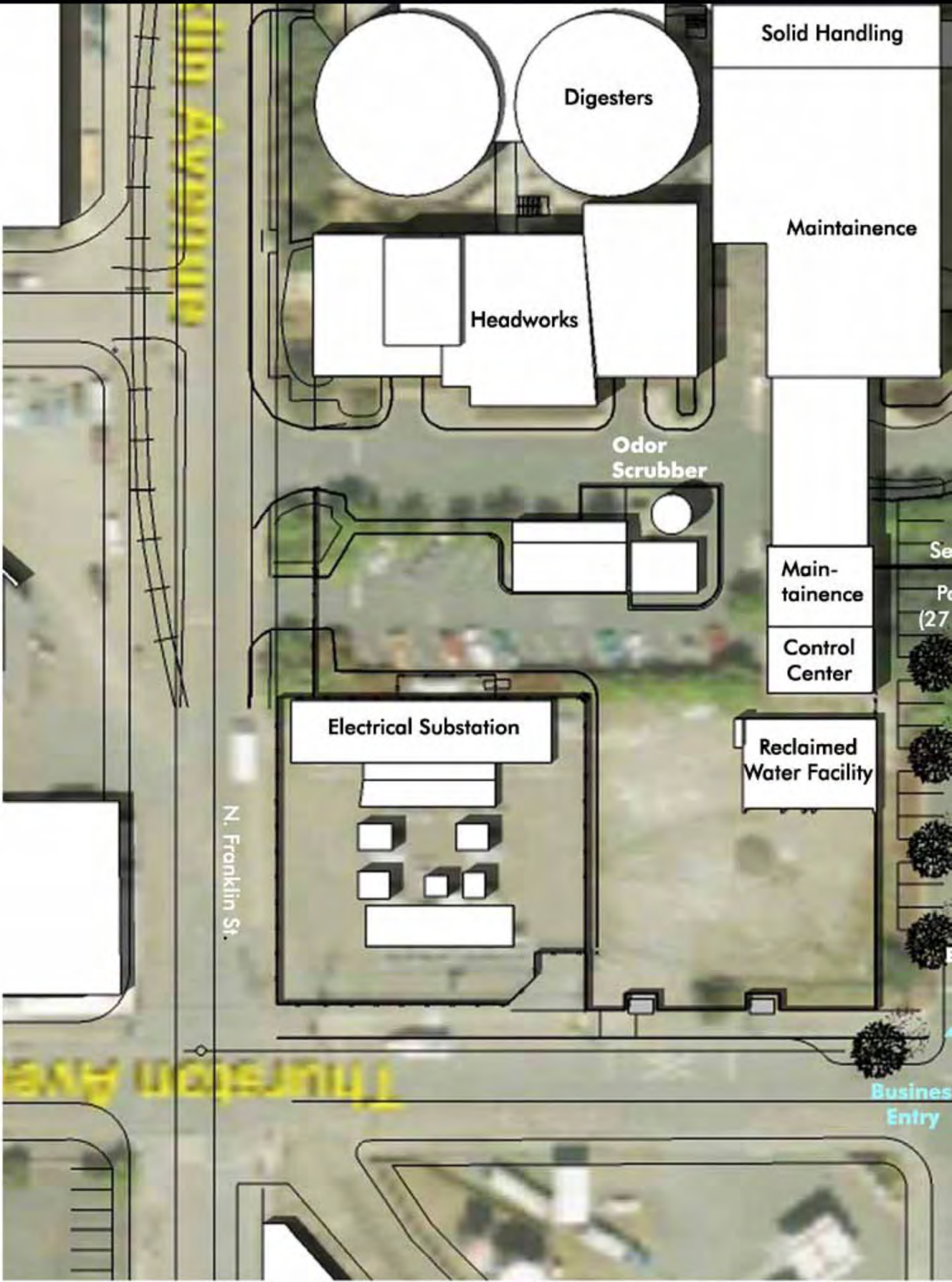

Solid Handling
Digesters
Maintainence
Headworks
Odor Scrubber
Control Center
Electrical Substation
Reclaimed Water Facility
N. Franklin St.
Thurston Ave



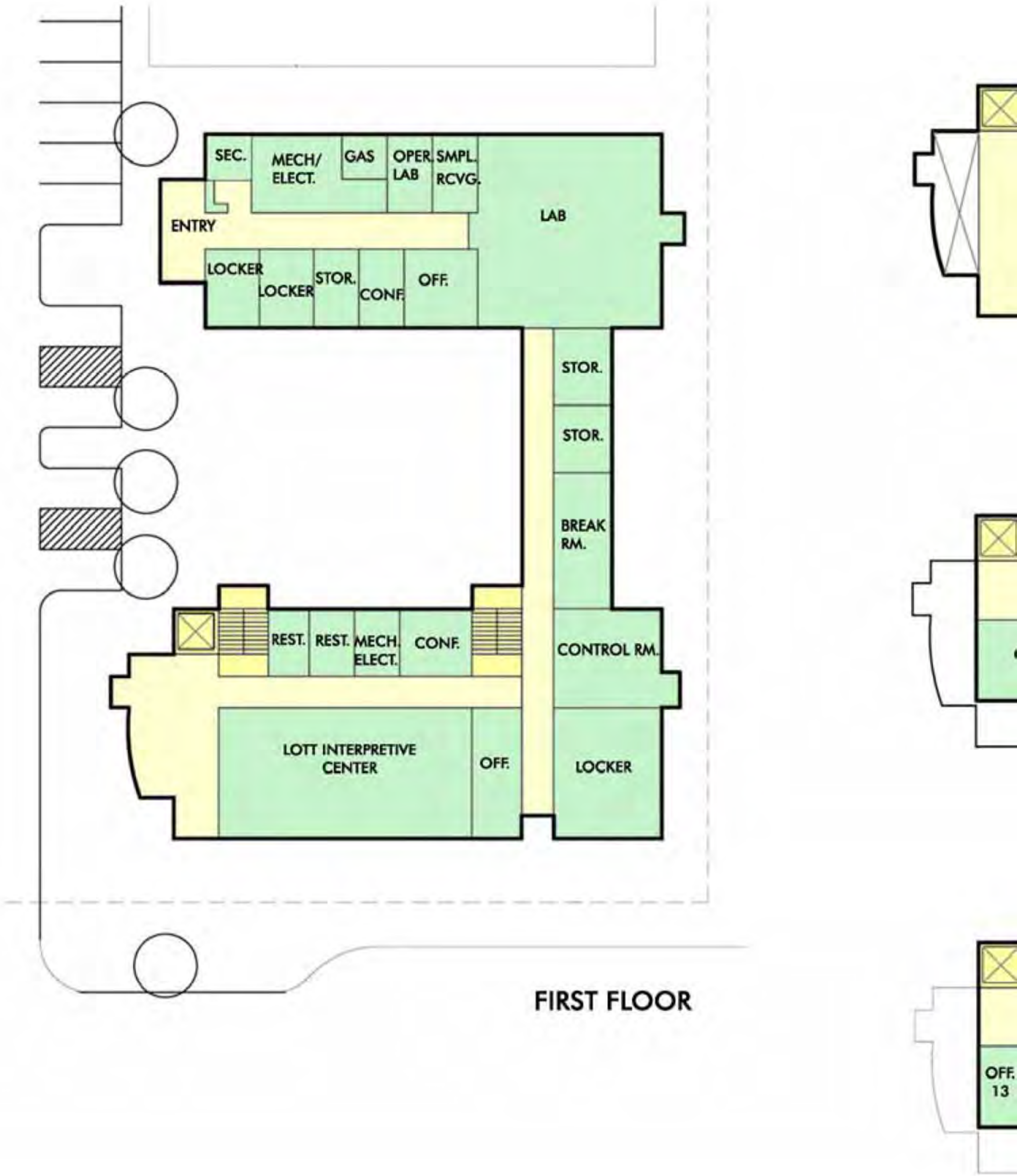
REST.
MECH.
CONTROL ROOM
STOR.
LABORAT



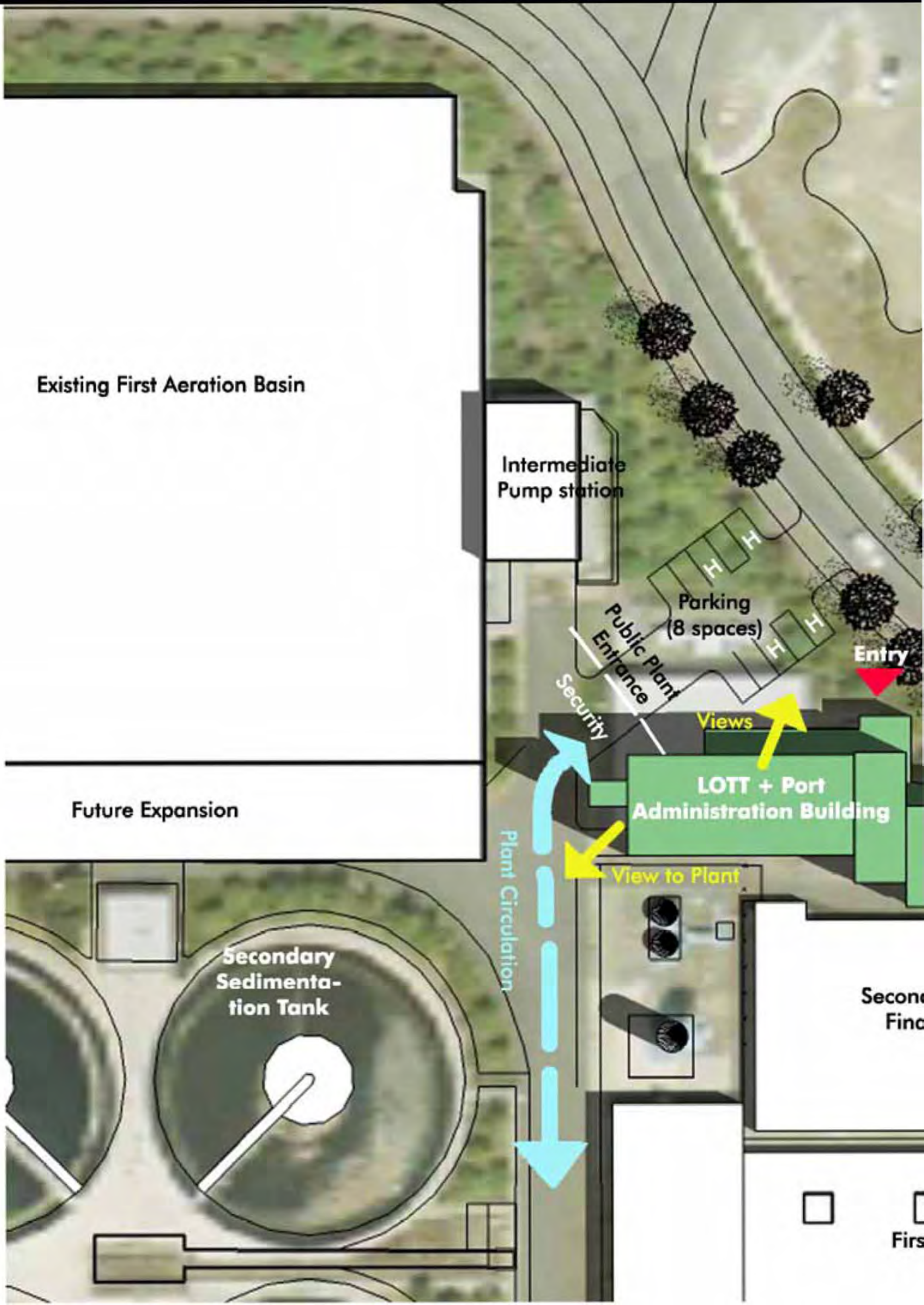


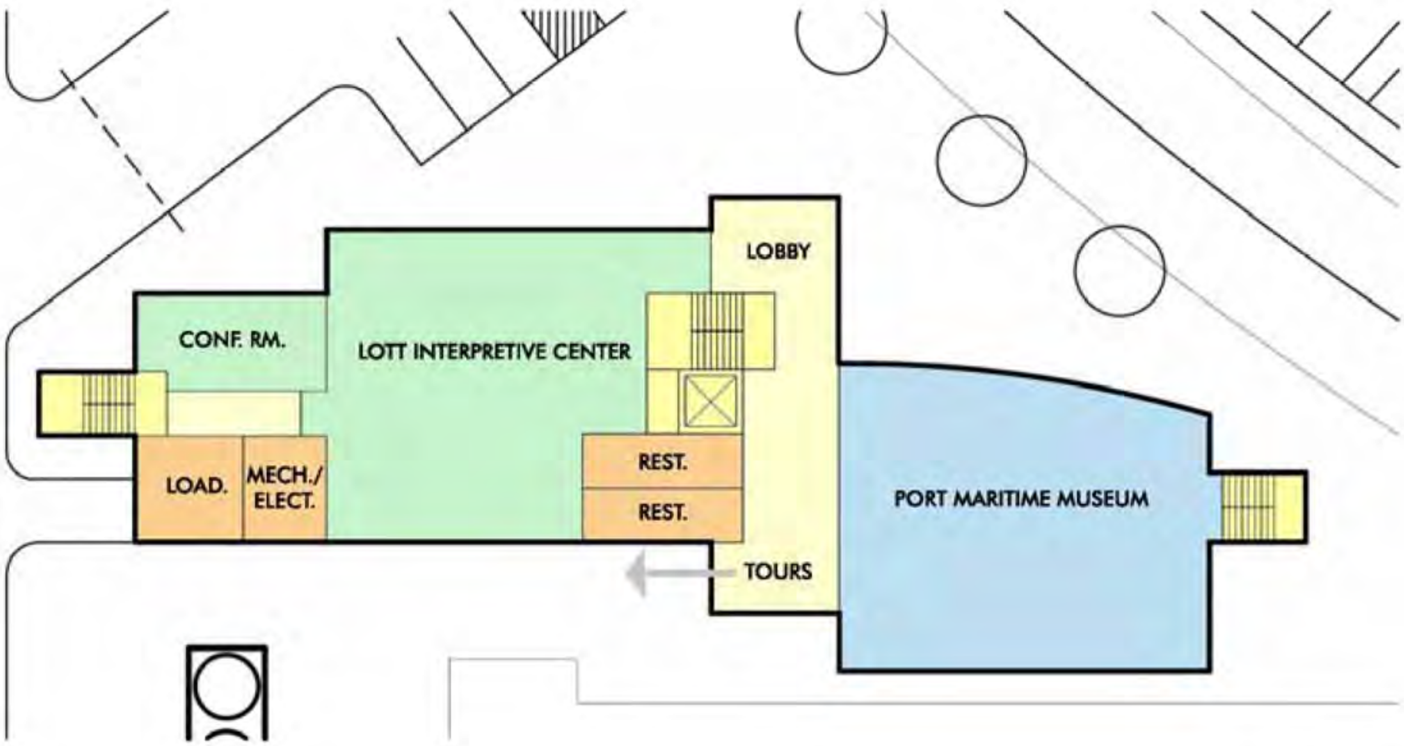


Solid Handling
Digesters
Maintainence
Headworks
Odor Scrubber
Main-tainence
Control Center
Electrical Substation
Reclaimed Water Facility
N. Franklin St.
Entry


SEC.
MECH/ ELECT.
GAS
OPER. LAB
SMPL. RCVG.
ENTRY
LAB
LOCKER
LOCKER
STOR.
CONF.
OFF.
STOR.
STOR.
BREAK RM.
REST.
REST.
MECH. ELECT.
CONF.
CONTROL RM.
LOTT INTERPRETIVE CENTER
OFF.
LOCKER
OFF. 13

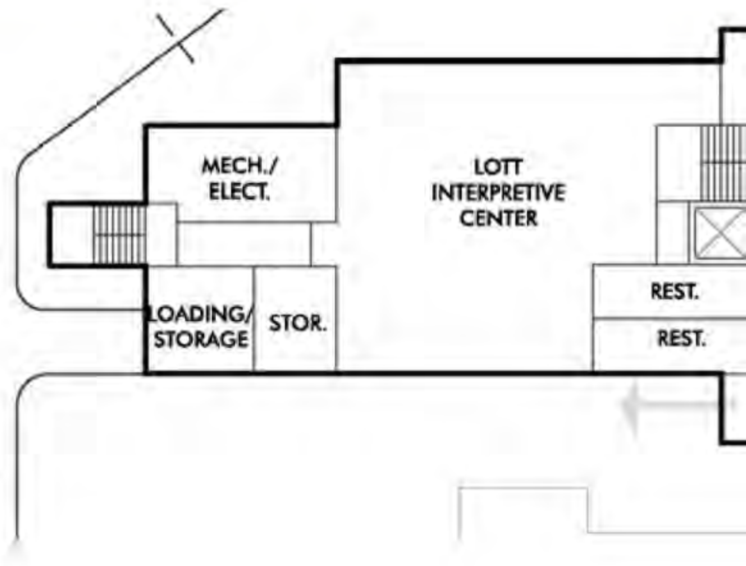
FIRST FLOOR

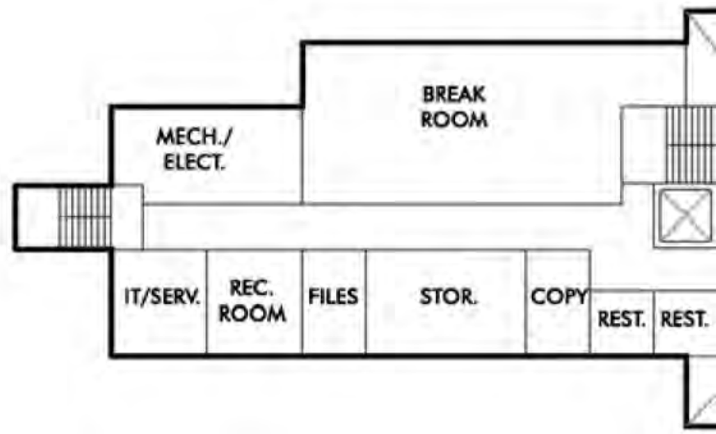

Existing First Aeration Basin
Intermediate Pump station
Parking (8 spaces)
Public Plant Entrance
Security
Entry
Views
LOTT + Port Administration Building
Future Expansion
View to Plant
Plant Circulation
Secondary Sedimentation Tank

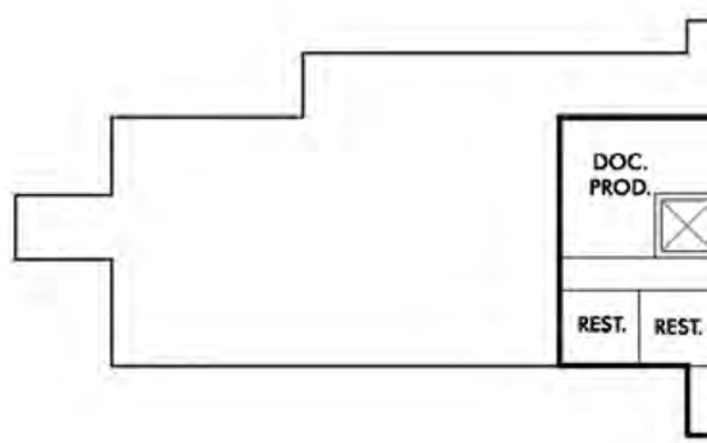

LOBBY
CONF. RM.
LOTT INTERPRETIVE CENTER
LOAD.
MECH./
ELECT.
REST.
REST.
TOURS
PORT MARITIME MUSEUM

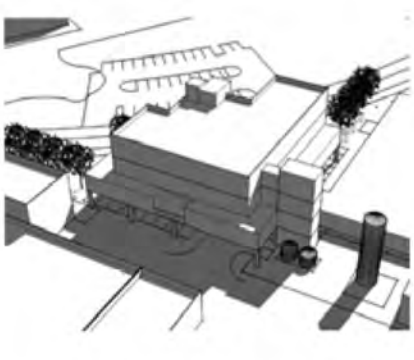
FIRST FLOOR

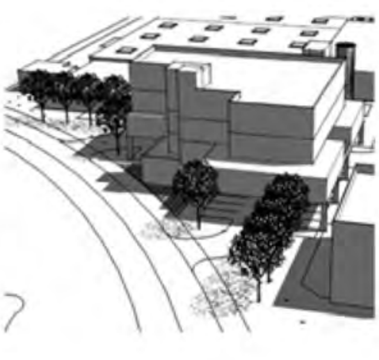

CIRCULATION
COMMON/
SHARED
LOTT
PORT

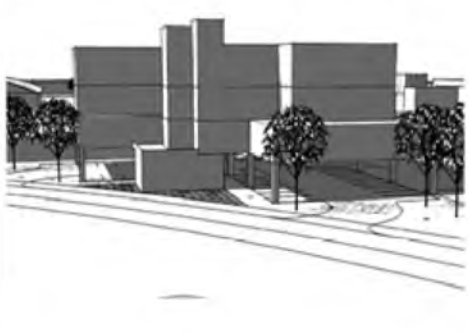

MECH./
ELECT.
LOTT
INTERPRETIVE
CENTER
REST.
REST.
LOADING/
STORAGE
STOR.

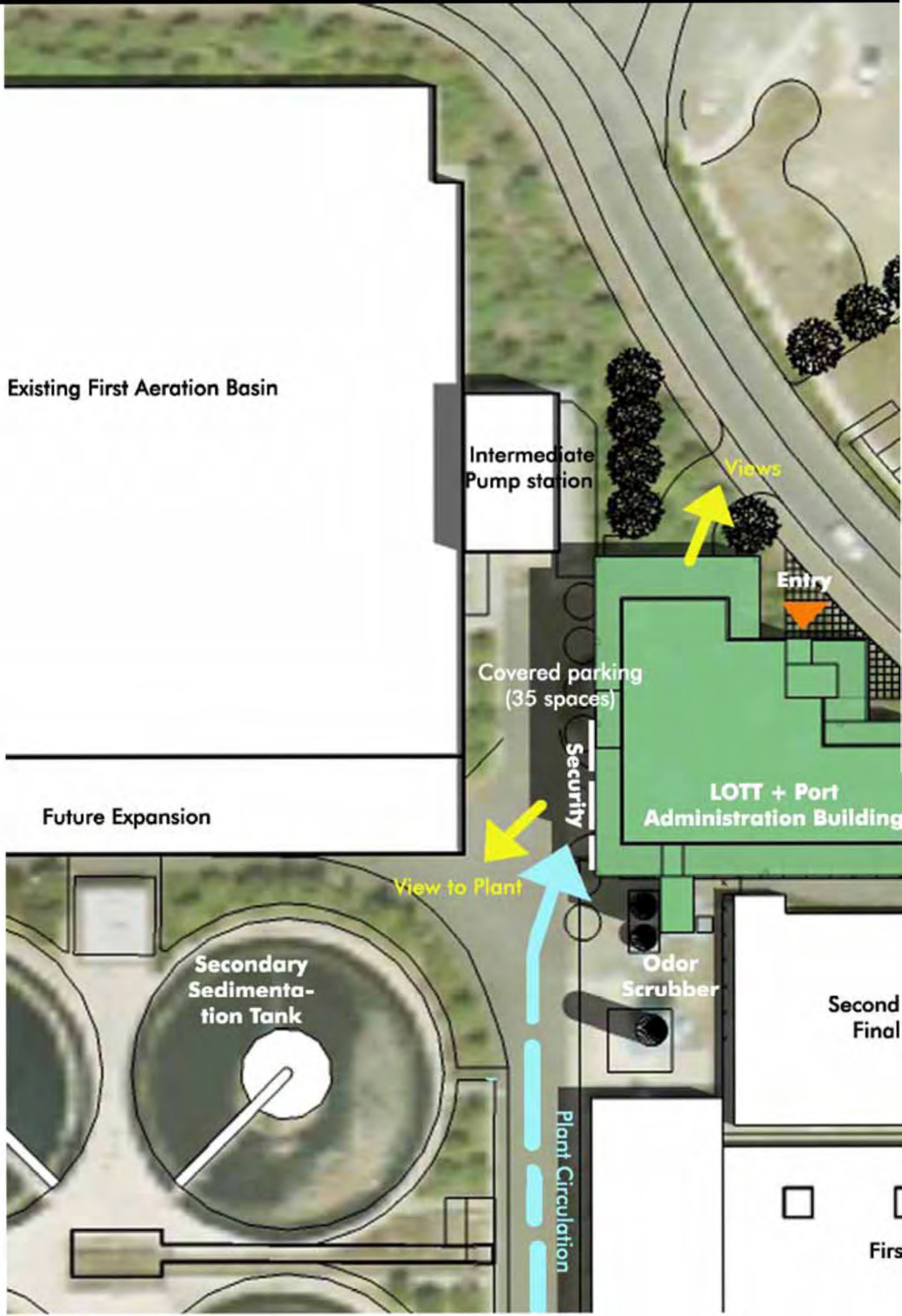

BREAK
ROOM
MECH./
ELECT.
IT/SERV.
REC.
ROOM
FILES
STOR.
COPY
REST.
REST.

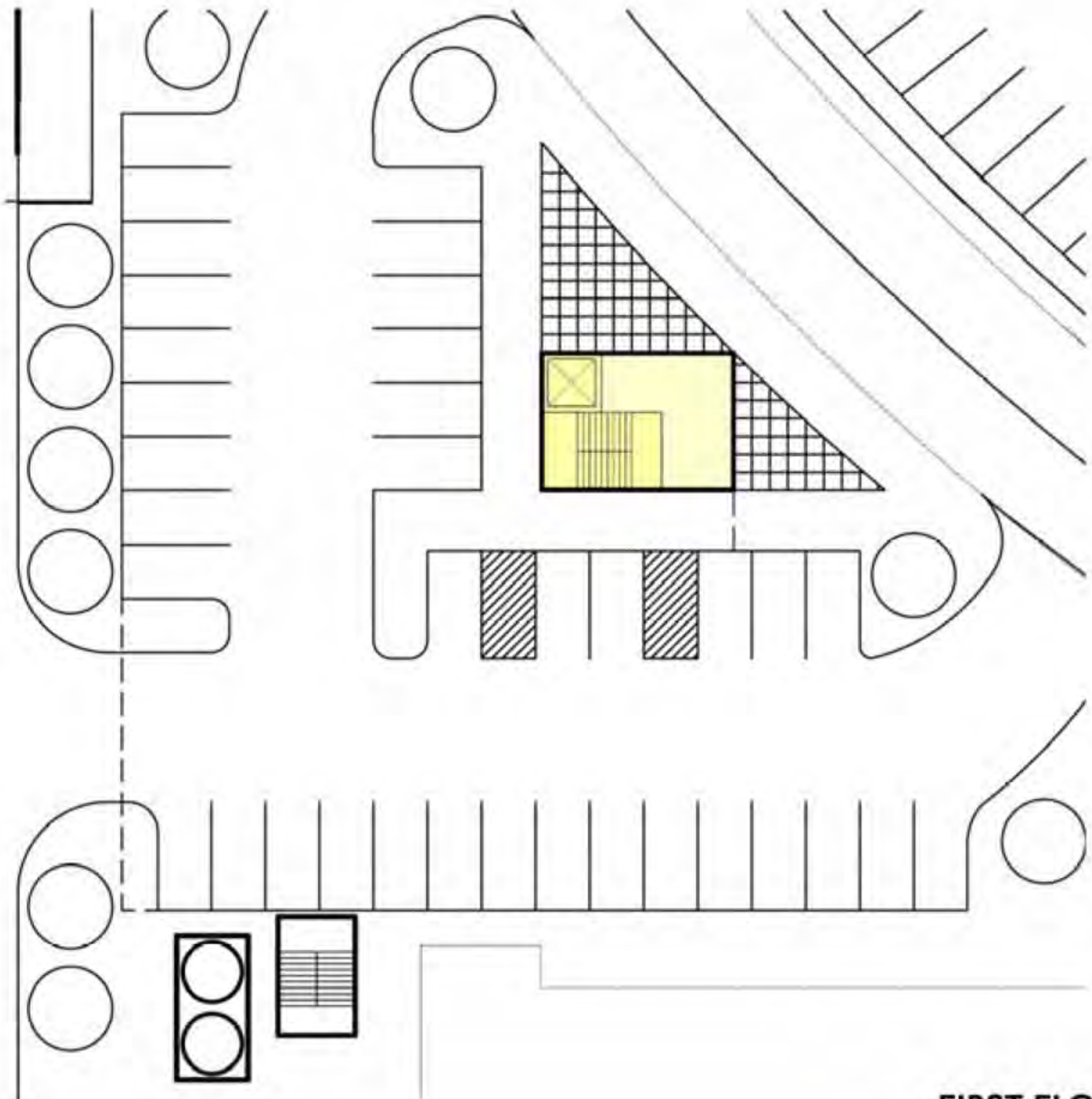

DOC.
PROD.
REST.
REST.



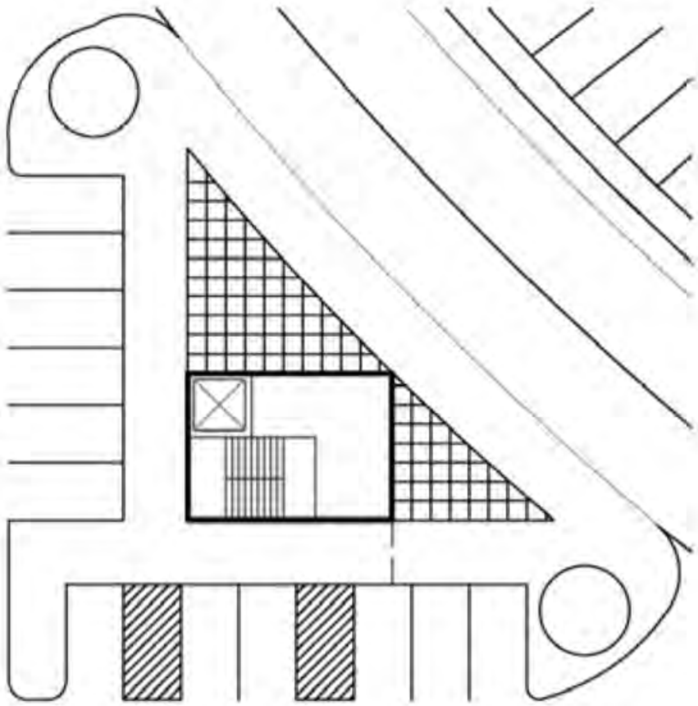




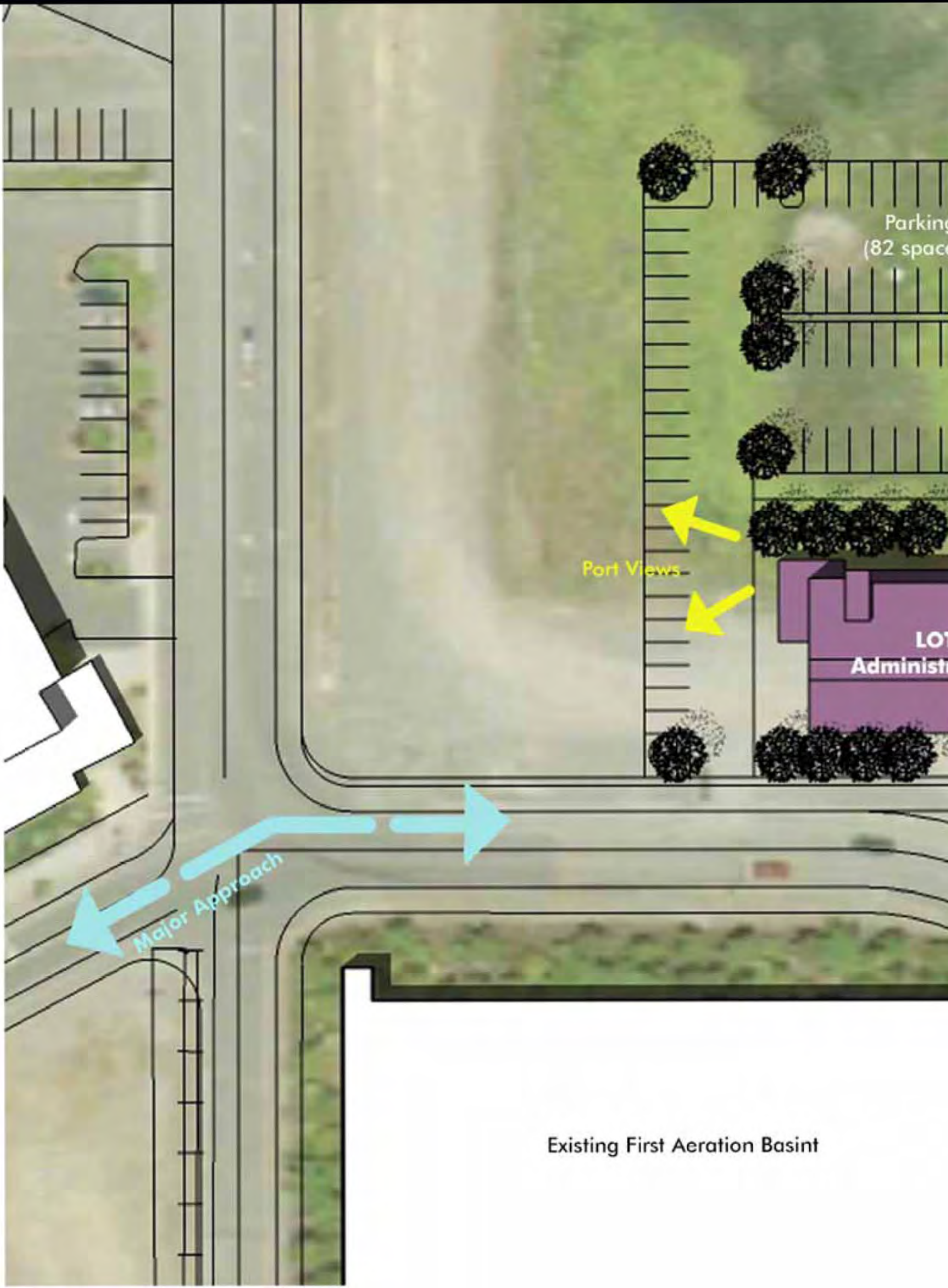

Existing First Aeration Basin
Intermediate Pump station
Views
Entry
Covered parking (35 spaces)
Security
LOTT + Port Administration Building
Future Expansion
View to Plant
Odor Scrubber
Secondary Sedimentation Tank
Plant Circulation



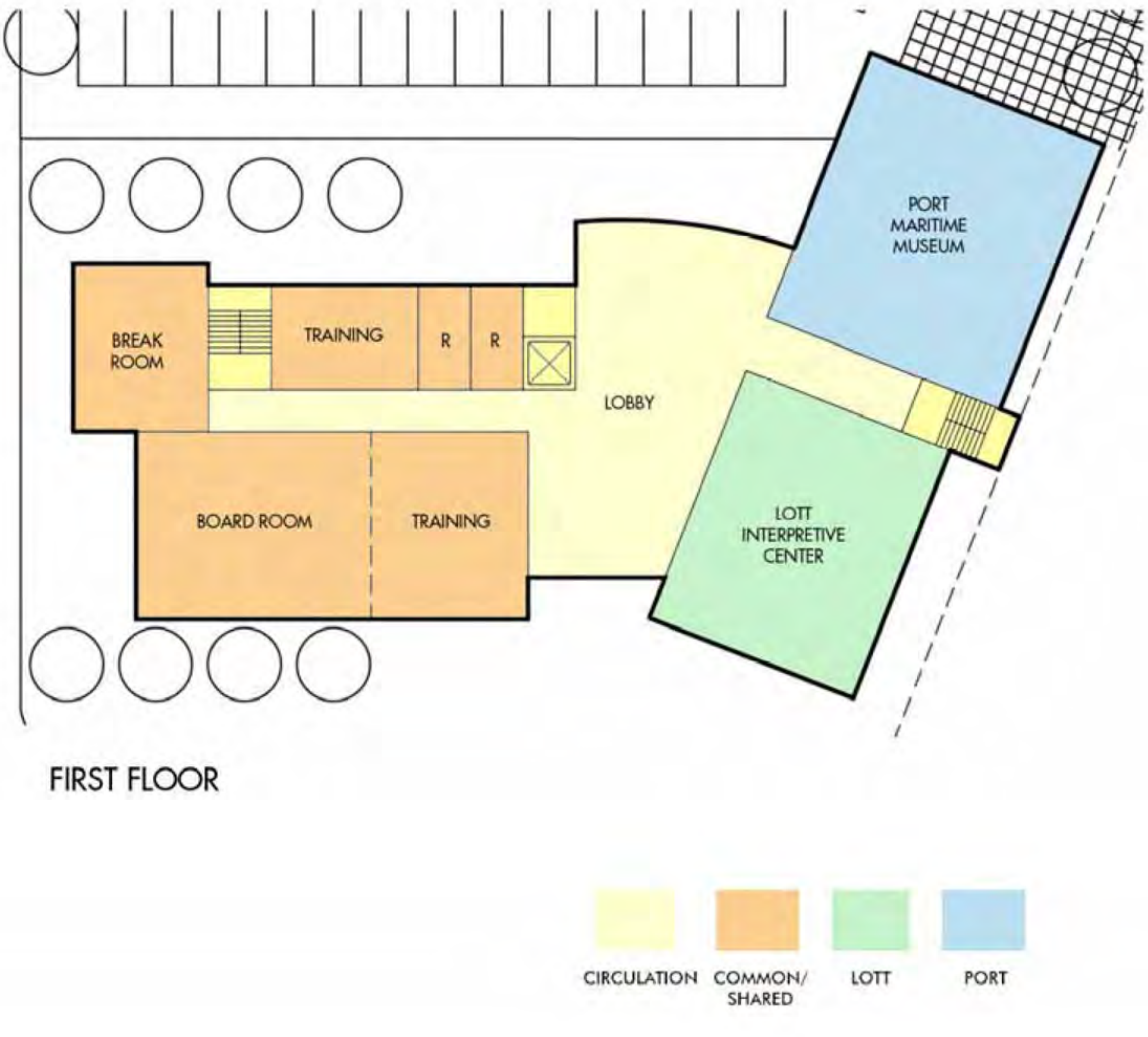
FIRST FLOOR

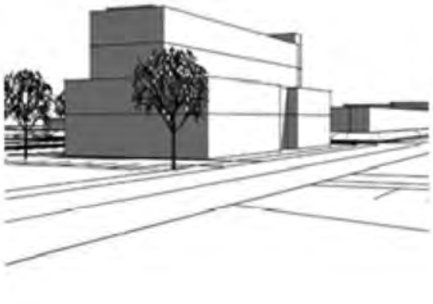


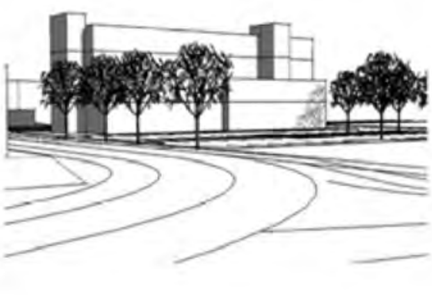
FIRST FLOOR

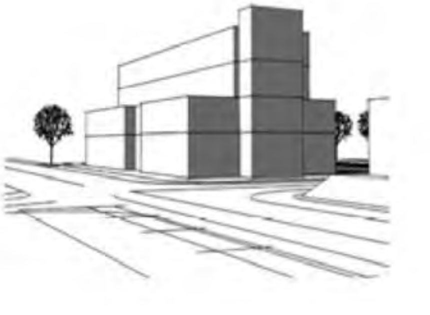


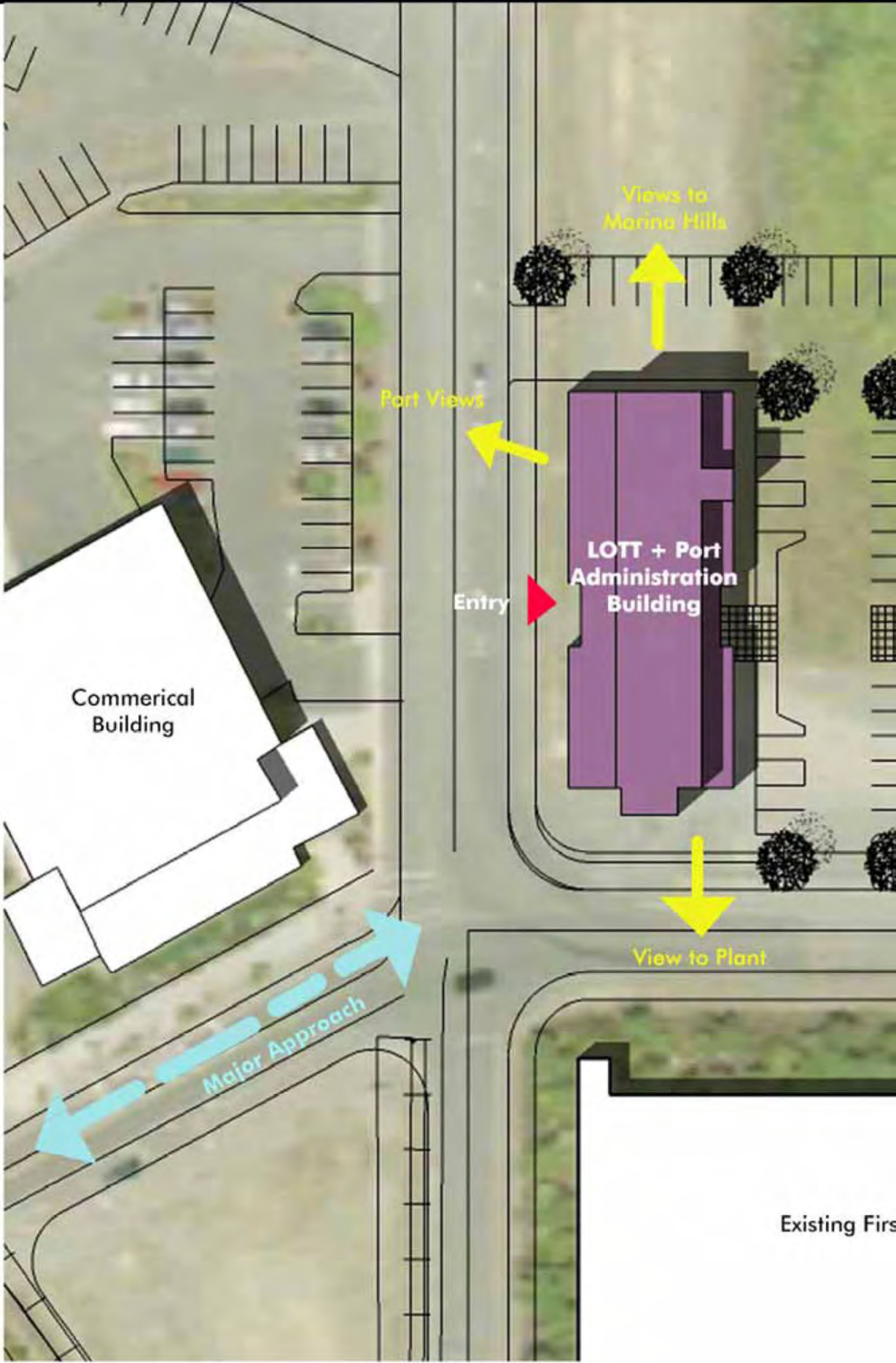
Parking
Port Views
Major Approach
Existing First Aeration Basint


PORT
MARITIME
MUSEUM
BREAK
ROOM
TRAINING
R
R
LOBBY
BOARD ROOM
TRAINING
LOTT
INTERPRETIVE
CENTER
FIRST FLOOR
CIRCULATION
COMMON/
SHARED
LOTT
PORT

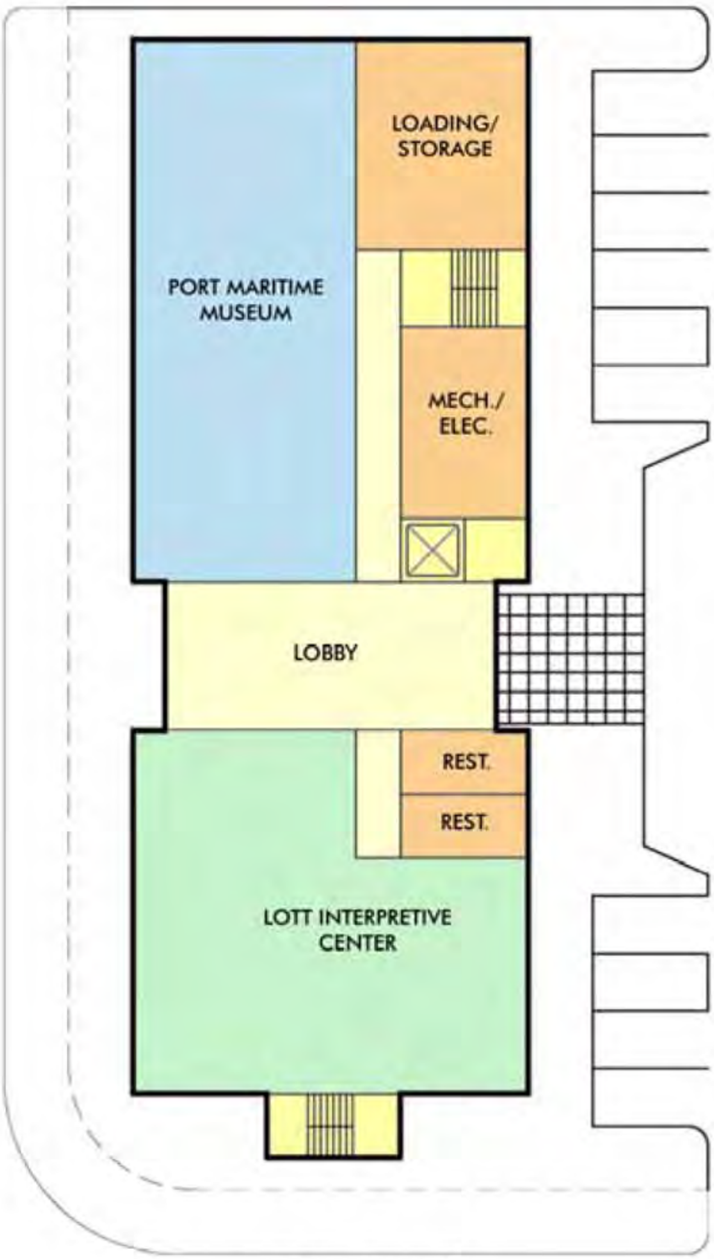




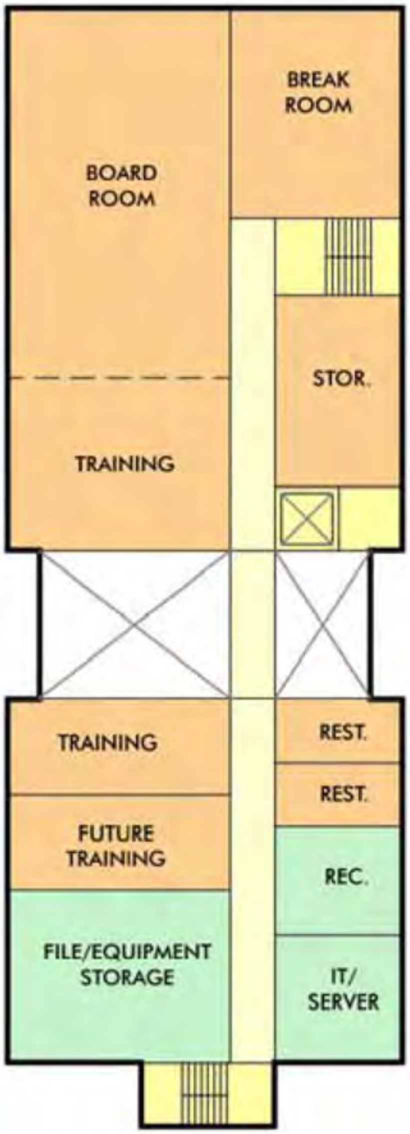




Views to
Marina Hills
Port Views
LOTT + Port
Administration
Building
Entry
Commerical
Building
View to Plant
Major Approach
Existing Firs



FIRST FLOOR



SECOND FLOOR

SUMMARY MATRIX

	A	B1	B2
			

OPTIONS	A	B1	B2
existing site CONSTRAINTS & FEATURES	●	−	−
phasing & CONSTRUCTABILITY	+	−	−
EXPANSION potential	−	−	−
CONNECTION to plant	+	+	+
CIRCULATION in and around site	●	+	+
PARKING	●	−	●
opportunities for AESTHETIC	●	+	+
opportunities for SUSTAINABILITY	●	+	+
opportunities for COLLABORATION	−	+	+

RECOMMENDATION: if feasible from a cost standpoint, site B, option 1 seems to

COST ANALYSIS

(Cost information to follow in final draft.)

COST MATRIX

	OPTION	PROGRAM	AGENCIES	COST/ YEAR
SITE A		WATER QUALITY LAB & CONTROL BUILDING	LOTT PLANT	$2.5 million online 2007
		A ADMINISTRATION BUILDING	LOTT ADMINISTRATION	$2.8 million online 2007
SITE B		B1 ADMINISTRATION BUILDING	LOTT + PORT ADMINISTRATION	$6.0 million online 2008
			LOTT ADMINISTRATION	$3.7 million online 2008
		B2 ADMINISTRATION BUILDING	LOTT + PORT ADMINISTRATION	$6.0 million online 2008
			LOTT ADMINISTRATION	$3.7 million online 2008
SITE C		C1 ADMINISTRATION BUILDING	LOTT + PORT ADMINISTRATION	$4.8 million online 2008
		C2 ADMINISTRATION BUILDING	LOTT + PORT ADMINISTRATION	$4.8 million online 2008

CONCLUSION/ RECOMMENDATION

(Conclusion and recommendation to follow in final draft with Brown & Caldwell feedback.)

APPENDIX E

Site Feasibility

The Master Plan Report, issued by the LOTT Alliance and Brown & Caldwell Engineers, identified three sites for the new administration building. The current administration building is slated for demolition upon expansion of the primary sedimentation tanks. Possible collaboration with the Port of Olympia required the team to study the feasibility and efficiencies gained from a joint use office building. Michael Willis Architects worked with LOTT and the Port to analyze the feasibility of the three identified sites for zoning and site restrictions, programming, and cost.

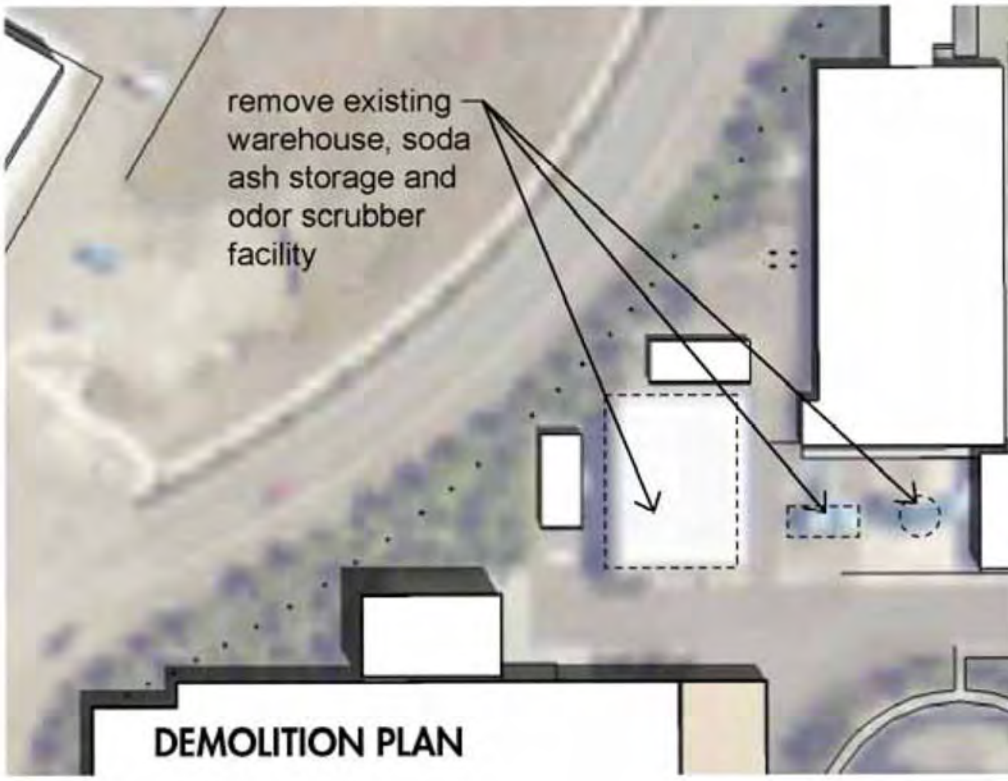
Site Options:

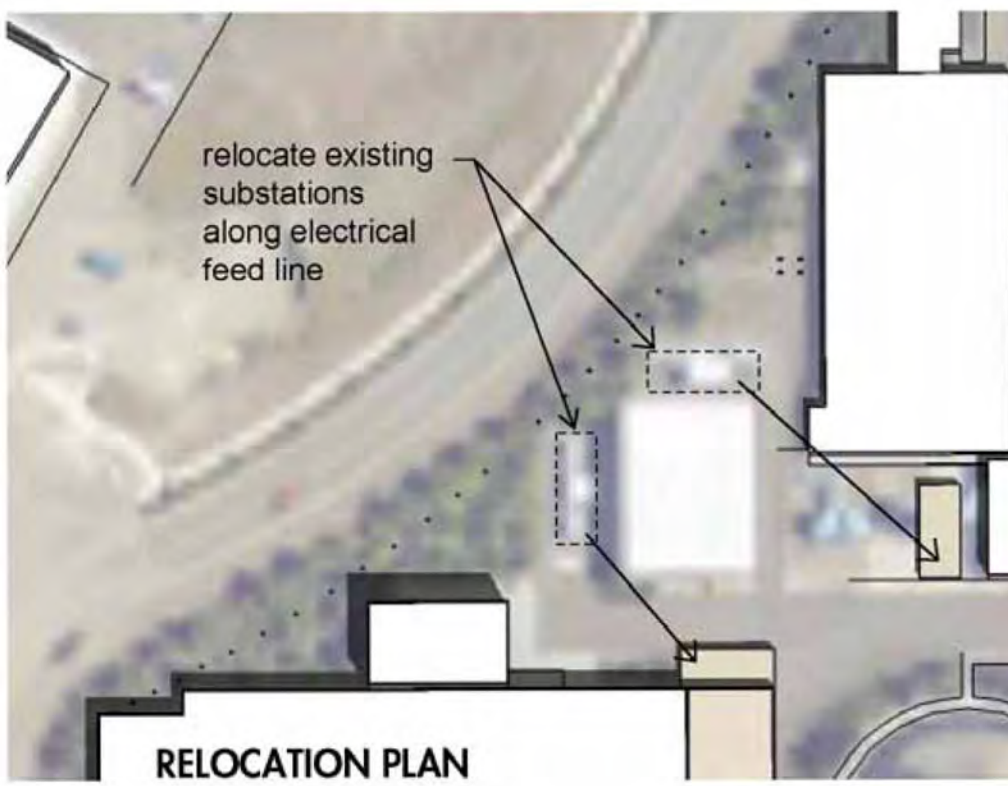
Site B. The primary focus for this study was specifically the feasibility of building an administration building on Site B. Located at the north end of the plant, site B utilized land that would not be used for other process expansion in the future. Site B's proximity to other Port of Olympia property also made it a possible site for a joint office building. However, several constraints on the site limited the amount of program space and parking that would be accommodated. Additionally, existing electrical substations would need to be relocated to accommodate any construction on the site. Michael Willis Architects researched the following site constraints and possible solutions: zoning restrictions, code restrictions, parking requirements and configurations, area and height restrictions and maximums, existing utility locations and impacts, and substation relocation.

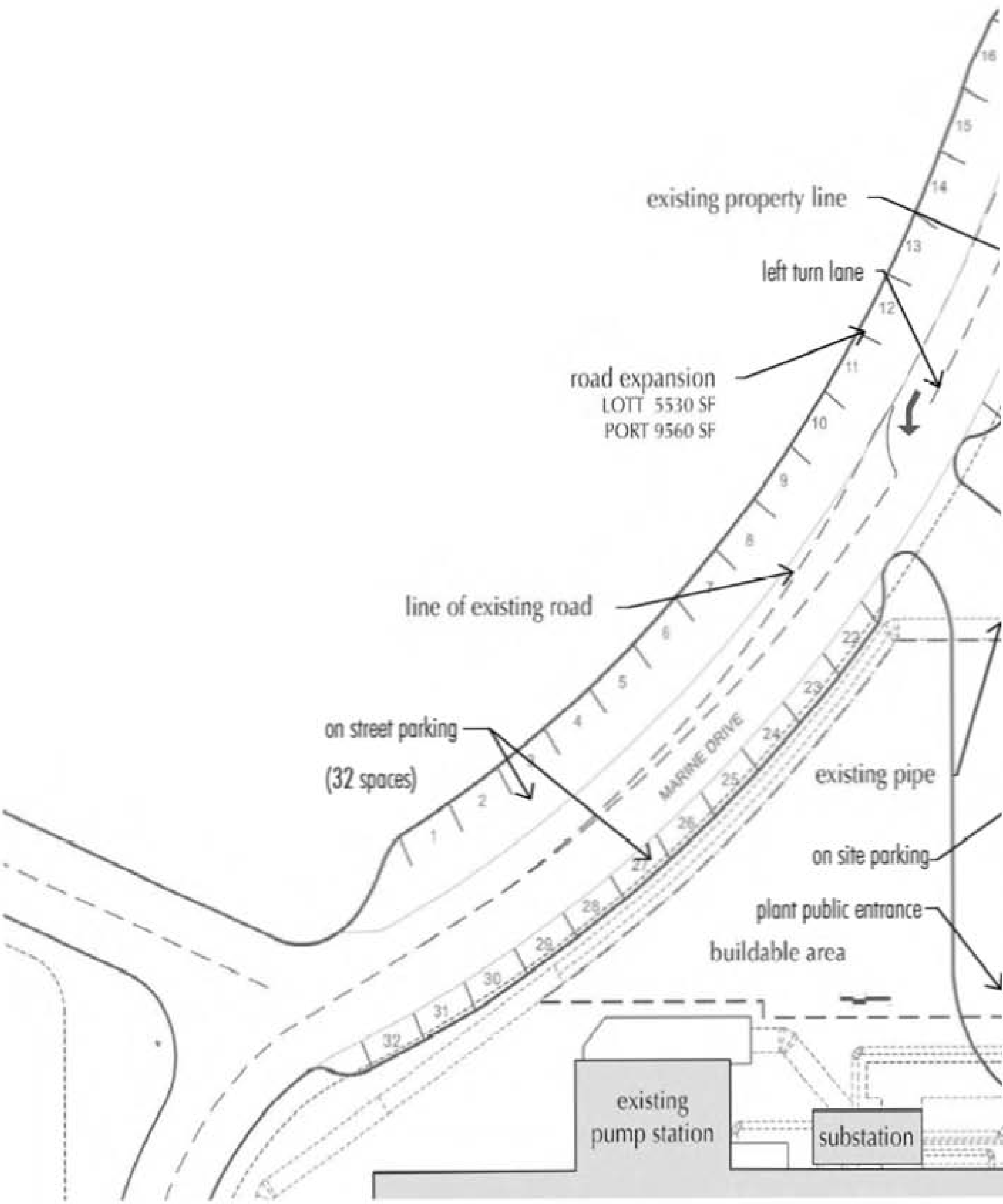
Other Site Options. As described in Chapter 14, two other sites were under consideration for the administration building. Site A, located at the south end of the plant, was not a desirable location for Port of Olympia offices, but a feasible option for a LOTT only project and the preferred location for the Water Quality Lab. Site C, located on Port property north of the plant was not reviewed in this study.

The following feasibility study is split into two sections. The first section is the primary feasibility study and explored 3 building configurations on Site B, which included the Port of Olympia as a joint occupant in the project. During the course of the feasibility study, the decision was made by the Port of Olympia to not be involved in the administration building project. The decision automatically eliminated the possibility of using Site C, changed the parameters of using Site B, and opened up the possibility of using Site A. The second section of this chapter analyses several configurations for the administration building and lab on Site A and two building configurations on Site B that accommodated only LOTT program needs.


existing boat works site
existing street
existing substation
existing substation
existing pump station
existing warehouse
existing scrubber
EXISTING SITE 'B'


remove existing warehouse, soda ash storage and odor scrubber facility
DEMOLITION PLAN


relocate existing substations along electrical feed line
RELOCATION PLAN



existing property line
left turn lane
road expansion
LOTT 5530 SF
PORT 9560 SF
line of existing road
on street parking
(32 spaces)
MARINE DRIVE
existing pipe
on site parking
plant public entrance
buildable area
existing pump station
substation

LOTT Reduced Space Program

Administration Building

Department	Space	Quantity	sf	subtotal	total	notes	adjacencies
Interpretive Center	exhibit	1	2917	2917		3,500 sf including circulatio	public area and loadin
	office	1	150	150			
	area total				3067		
Admin Offices							
Executive Director	office	1	225	225		(Mike Strub)	"conversation pit" w/sofas
	restroom	1	70	70			
General Counsel	office	1	175	175		(Rick Hughes)	to executive office
	office	1	150	150		Human Resources Coordinato	
	conference room	1	150	150		area for 6 people	to executive office
Business Manager	office	1	175	175		(Howard Weisberg)	to executive office
	work space	1	100	100		Admin Asst., (Karen Bart)	
	work space	1	100	100		Admin Asst., (Jana Mowatt	
	work space	1	100	100		Systems Analyst, IT (Mike McKenzie	
	office	1	150	150		Payroll Coordinator	
	office	1	150	150		Accountant	
Program Manager	office	1	175	175		Program Manager (Karla Fowler	to executive office
	office	1	150	150		Industrial Waste Supervisor (Ken Butti	
	office	1	150	150		Communications Coordinato	
	office	1	150	150		Planner	
	cubicle	1	100	100		Office Assistant, Karen Tourney	
Engineering Manager	office	1	175	175		(Brian Topolski)	to executive office
	office	1	175	175		Project Engineer (Eric Hielema)	
	cubicle	1	150	150		Eng./Construc. Technician (Dennis O'Connell)	adj to plan layout area
	cubicle	1	150	150		Eng./Construc. Technician (Richard Dickson)	adj to plan layout area
	cubicle	1	150	150		Eng./Construc. Technician (Michelle Barnett)	adj to plan layout area
	plan / layout area	1	600	600		layout, plans, plotter area, wall of slide out map	include informal meeting area/table
	cubicle	1	150	150		Eng./Construc. Technician	
	office	1	150	150		Asset Mnager	
Facilities Manager	office	1	175	175		(Laurie Price)	
	area total				4,145		
Future Growth	20% growth				1,592		
Ancillary Spaces							
	small restrooms	2	80	160			
	small conference room	1	200	200		locate in plant near engineer	central to other offices
	med. conference room	1	240	240		multimedia, 8-10 people, with acoustic privac	central to other offices
	document production	1	400	400		local copy/work room adjacent to offices	
	IT server	1	150	150			
	file / equp storage	1	150	150		verify size	
	area total				1,300		
TOTAL					7,037		
	20% Circulation				1407		
TOTAL LOTT SF					8,444	22 existing staff plus consideration for growth	

Public Spaces (LOTT only)

Department	Space	Quantity	sf	subtotal	total	notes	adjacencies
General							
	Reception / Lobby	1	500	500			
	Public Restrooms	2	80	160			
	Cafe	1	0	0		coffee cart only in lobby - may consider cafe or cafeteria w/vendor	
	Board Room / Conference Room	1	1000	1000			
	Training	1	750	750		sized for LOTT	
	Small Kitchen	1	100	100			
	Small Storage	1	100	100			
	Break/Lunch/Vending	1	300	300			not public, with exterior space
Utility / Service							
	Loading/Receiving	1	150	150			
	Mechanical	1	400	400			
	Electrical	1	400	400			
TOTAL					3,860		
	20% Circulation				772		
TOTAL SHARED SF					4,632		

Summary

Total LOTT sf			65%		8,444		
Total Shared Space sf			35%		4,632		
Building Total					**13,076**		

Water Quality Lab

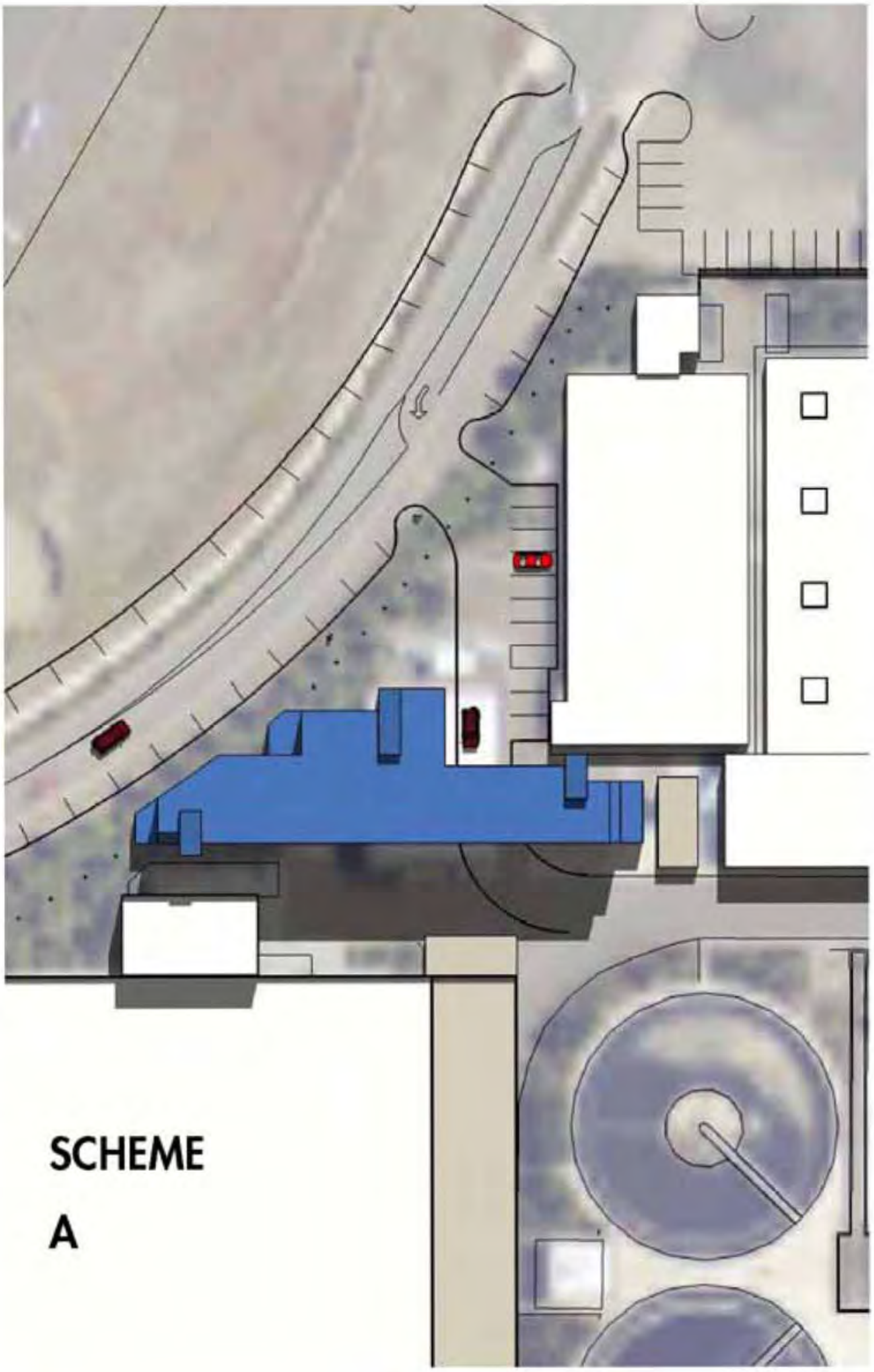
Department	Space	Quantity	sf	subtotal	total	notes	adjacencies
Water Quality Lab						including wet/dry bench areas, analytical work areas, and library - from lab staff based on existing areas, shown as minimum	
	wet chemistry	1	930	930			
	nutrient room	1	150	150			
	microbiology	1	220	220			
	chemical prep	1	100	100		alcove	
	digestion room	1	120	120			
	DI & water system	1	50	50		closet	
	operator's lab	1	0	0		verify - in plant , 140 sf	
	sample/receiving	1	150	150			
	area total				**1,720**		
Analytical Space							
	Process Supervisor	1	175	175		Wayne Robinson - need table and chair in office	
	analyst workspace	1	100	100			
	lab tech work space	1	100	100		2 lab techs with small desk and locker	
	library	1	100	100			
	area total				**475**		
Utility/ Service							
	bottled gas storage	1	80	80		exterior door	
	lab services and control center MEP	1	300	300		exterior doors	
	area total				**380**		
TOTAL LAB ADJACENT TO ADMINISTRATION BUILDING					**2,575**		
Ancillary Space	storage room	1	100	100			
	restrooms	2	80	160		2 fixtures each, no showers,no bank of lockers	
	break/conf room	1	200	200			
	entry vestibule	1	150	150		only need vestibule entry	
	area total				**610**		
TOTAL							
	20% Circulation				515		
TOTAL LAB SF					**3,700**		

Plant Areas

Department	Space	Quantity	sf	subtotal	total	notes	adjacencies
Facilities/Maint							
	Operations Supervisor	1	150	150		office, Ben McConky	
	Maintenance Superv'r	1	150	150		office (open)	
	small conference room	1	150	150		locate in plant near engineer	
	area total				**450**		
Office Storage							
	records / archives	1	200	200			
	misc. storage	1	400	400			
	area total				**600**		
General							
	staff break room	1	200	200		will be needed only if current ops break room needs to be converted to locker rooms for ADA	
	additional locker room	1	200	200		verify how many needed, could remodel current area to accommodate	
	operator's lab	1	140	140			
	area total				**540**		
storage relocations							
	Storage Building	1	4000	4000		relocate for new access road and/or administration building; only a portion of the contents will be kept, some high-bay space neede	
	Inventory Building	1	1620	1620		relocate if current area returned to vehicle maintenanc	
	Electrical Supply	1	1450	1450		relocate if adj. area returned to vehicle maintenance, use for vehicle maintenance suppor	
	area total				**7,070**		
TOTAL LAB SF					**8,660**		

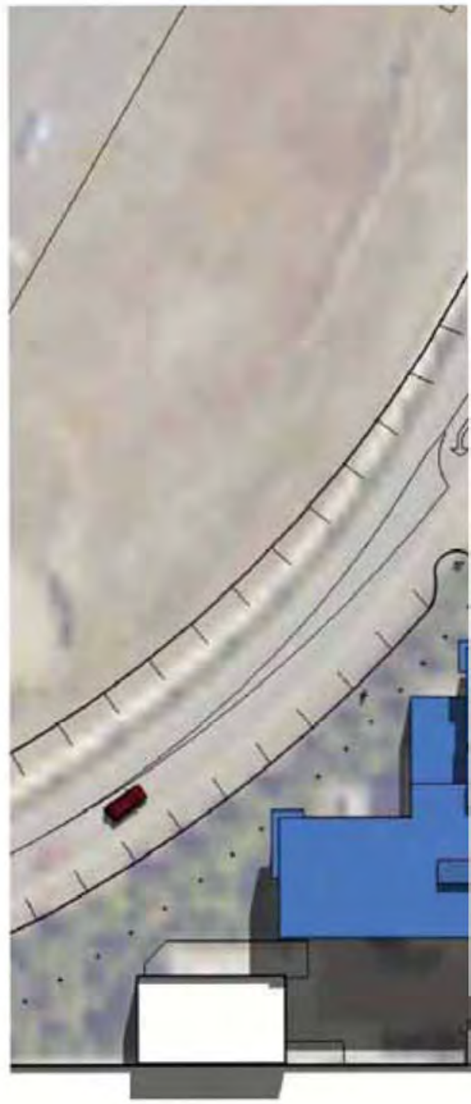
Plant Control Area

Department	Space	Quantity	sf	subtotal	total	notes	adjacencies
Control Center							to be locatd in unused plant space
	control room/server w/one workstation	1	400	400		Prefer central plant location - Can downsize - usually only one operator present	
	UPS + Electrical	1	200	200			
	Mechanical	1	150	150		none needed if shared with lab or another bldg w/ HVAC; small area if separate	
total					**750**		



SCHEME

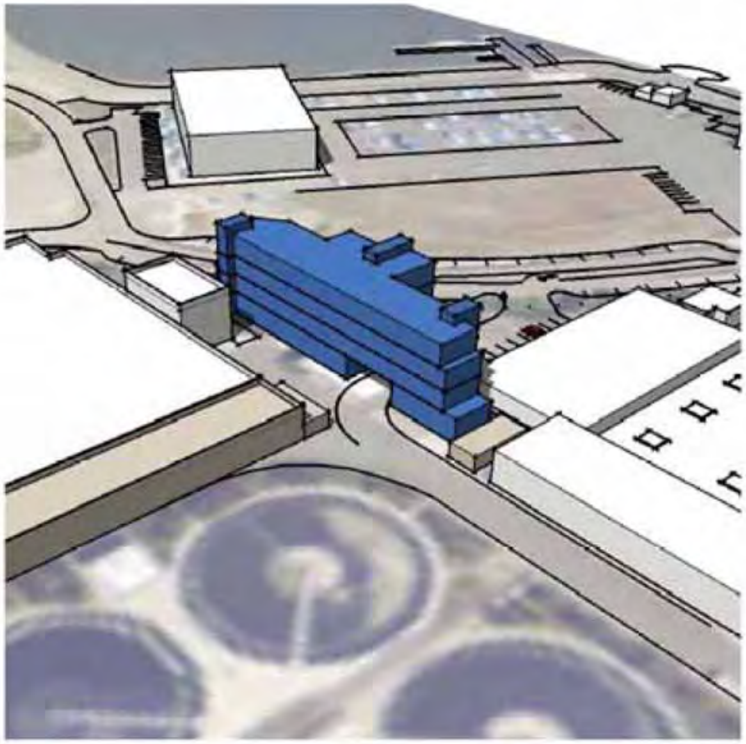
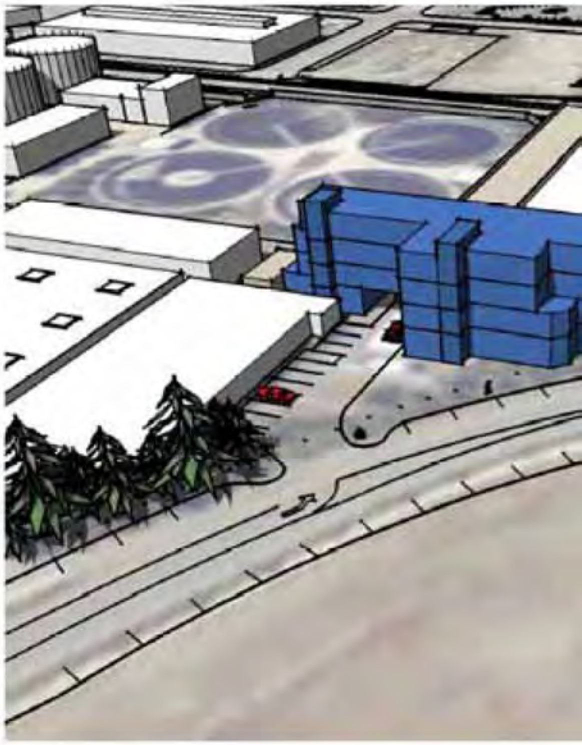
A

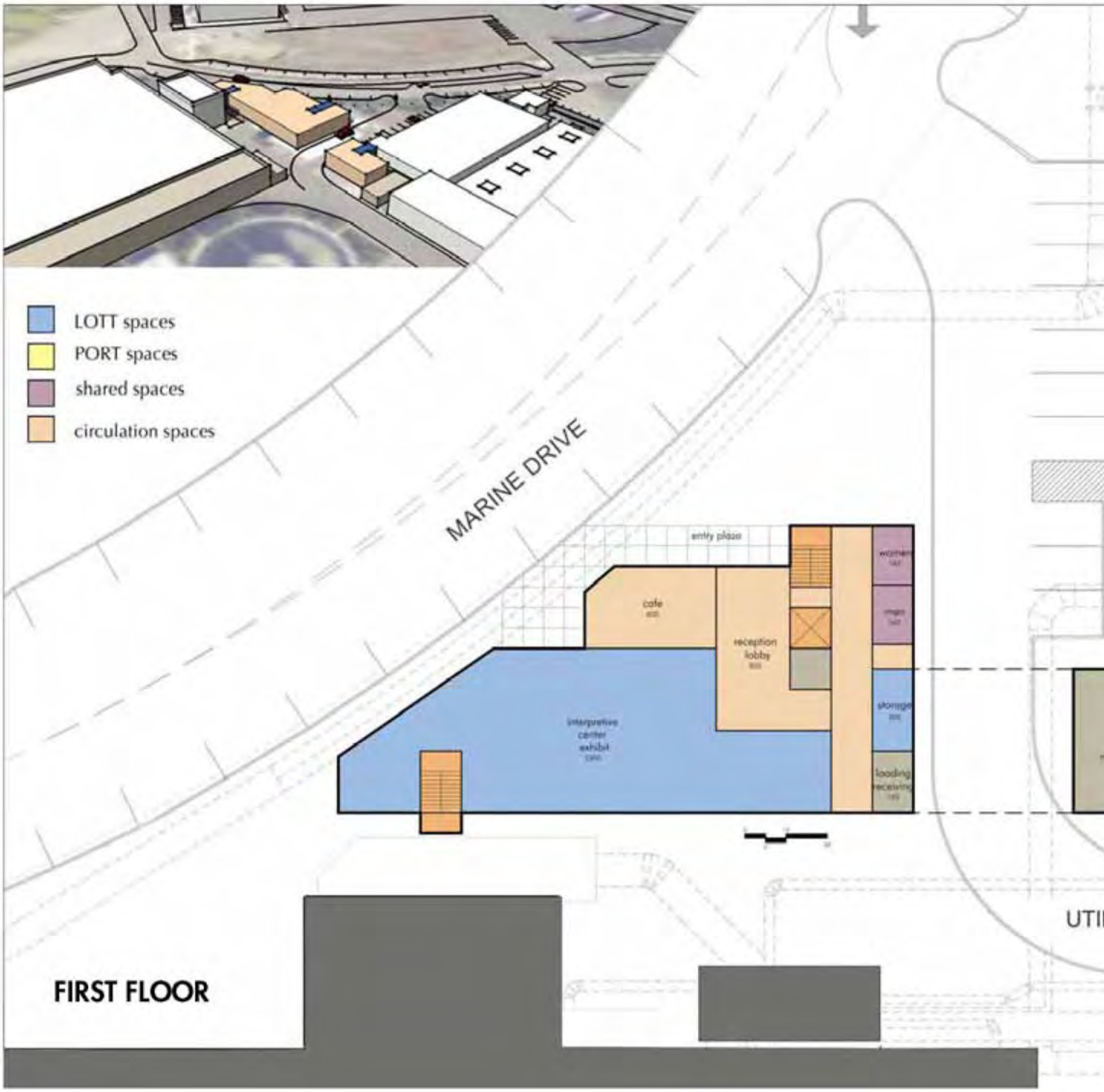


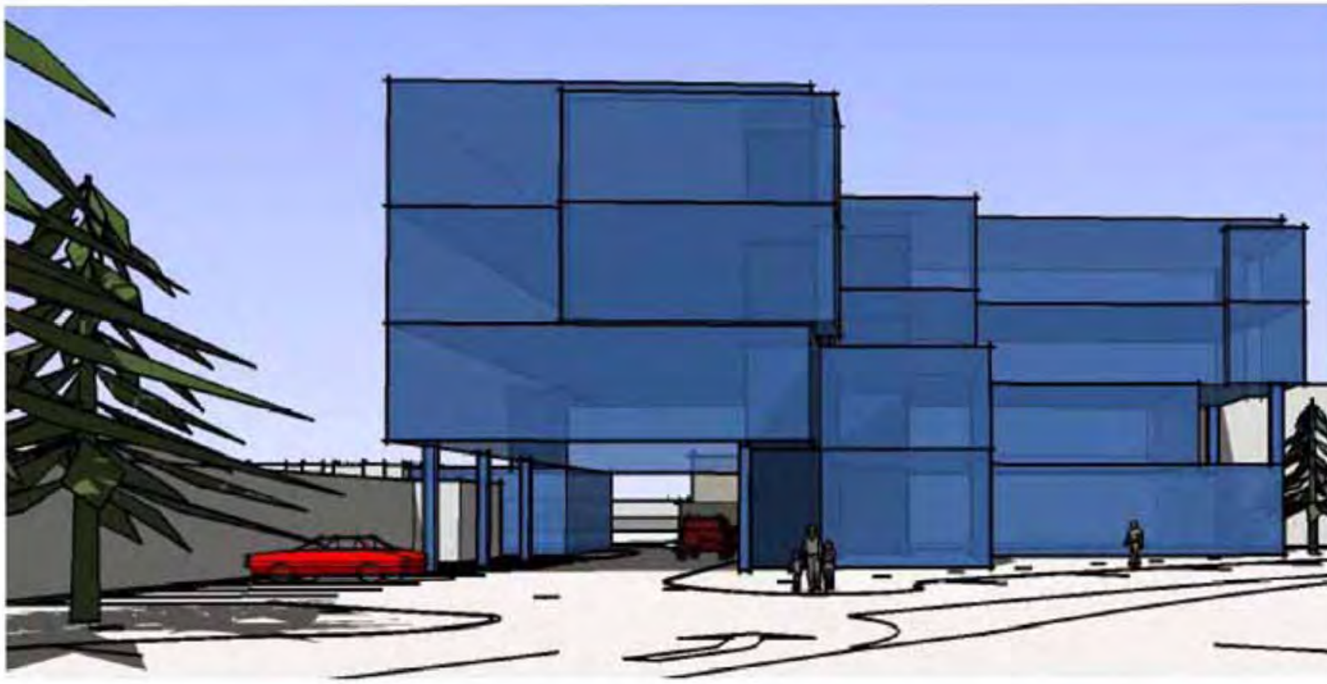
SCHEME

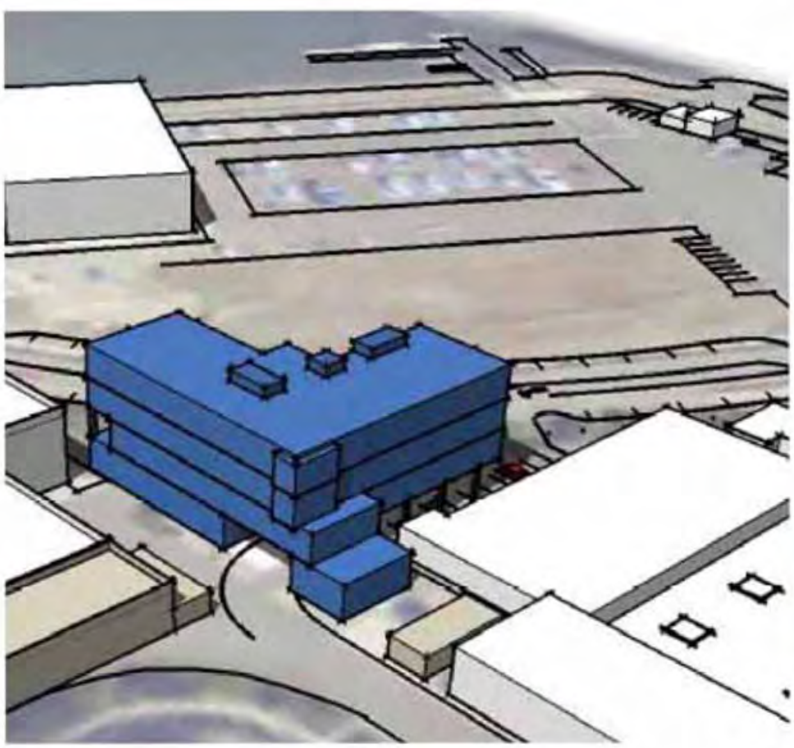
B

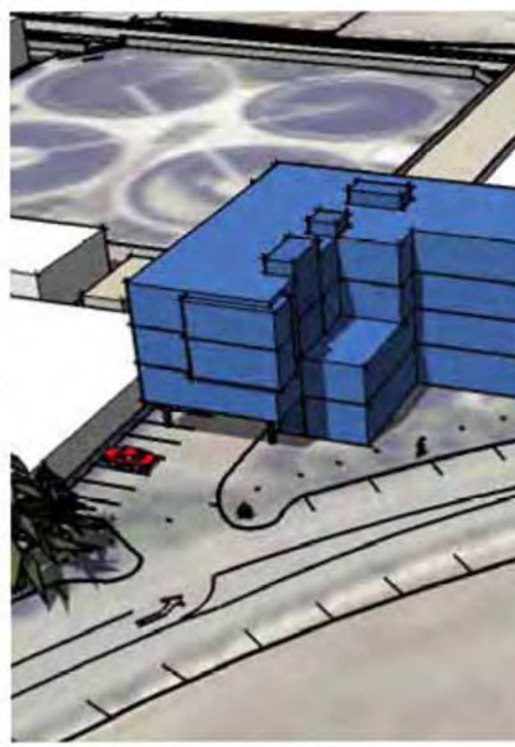
BUILDING CONFIGURATIONS

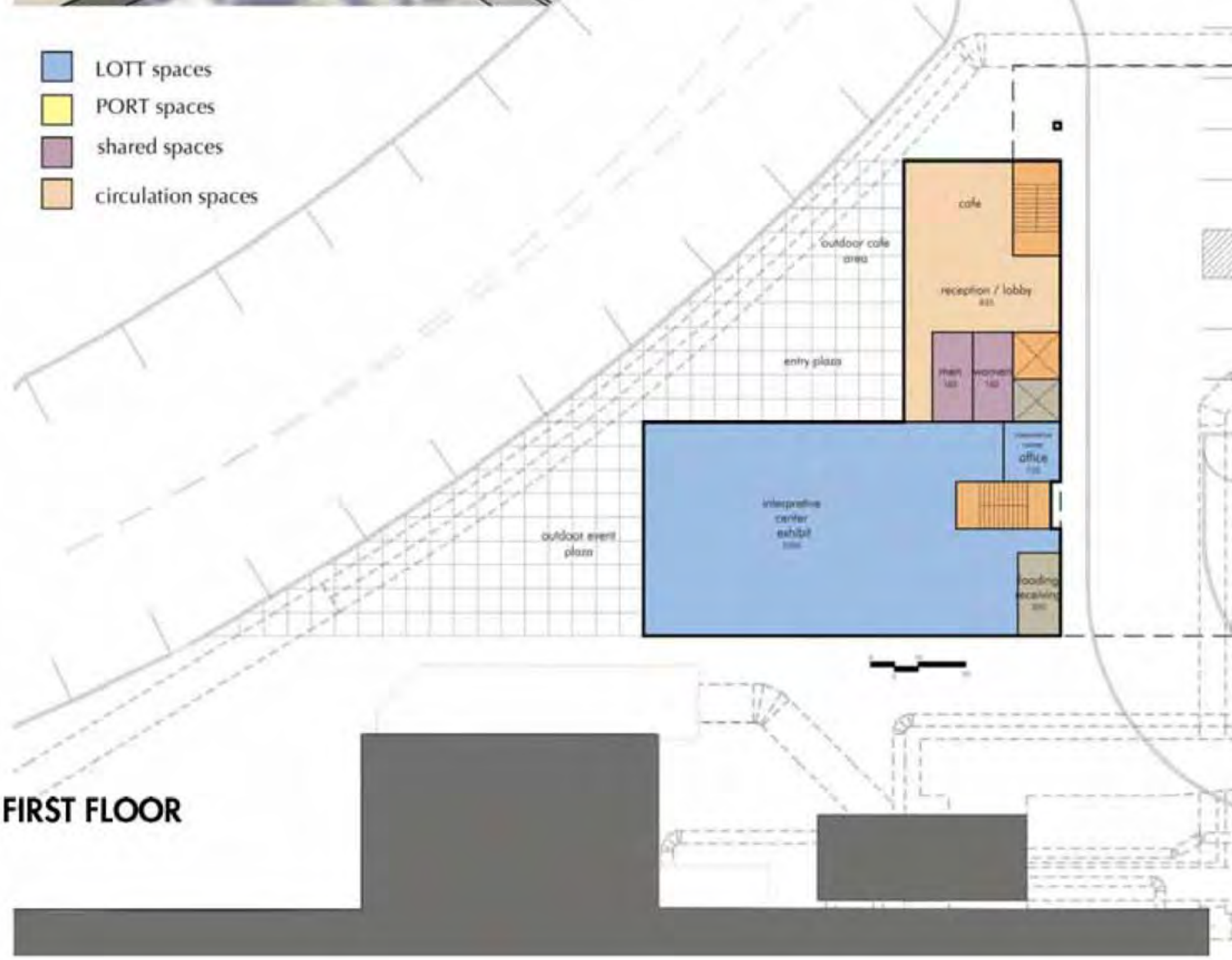





LOTT spaces
PORT spaces
shared spaces
circulation spaces
MARINE DRIVE
entry plaza
cafe
reception lobby
interpretive center exhibit
storage
loading receiving
UTIL
FIRST FLOOR

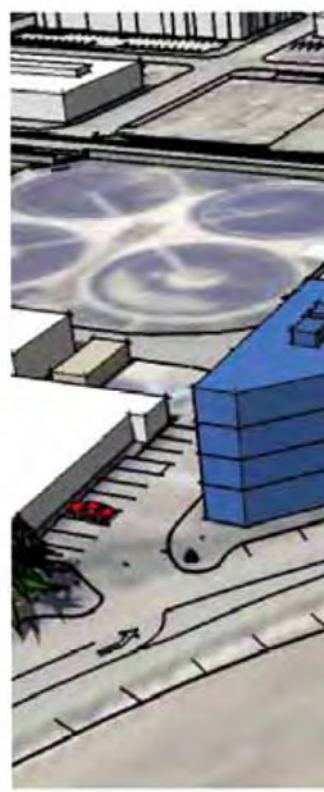




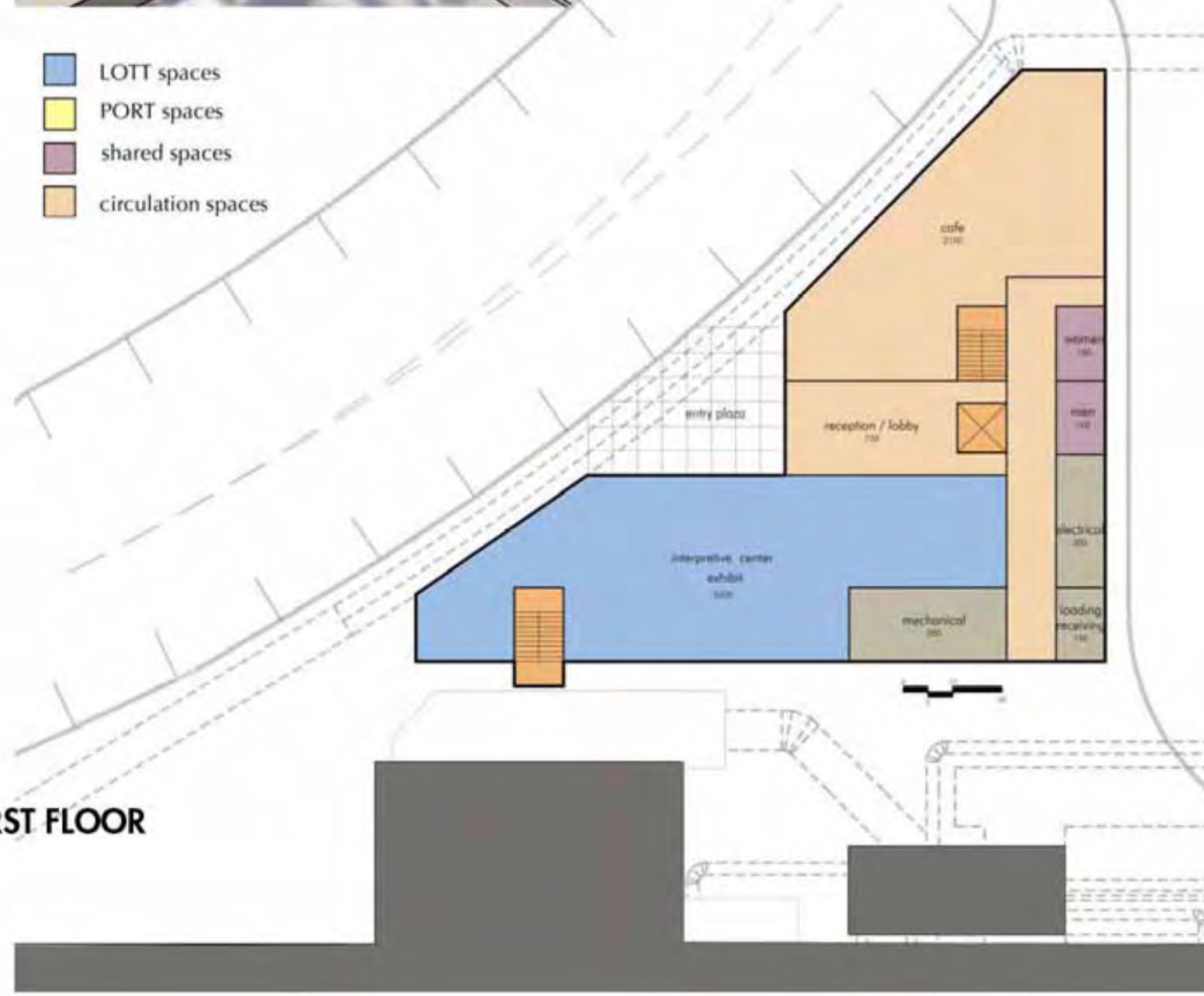



LOTT spaces
PORT spaces
shared spaces
circulation spaces
cafe
outdoor cafe area
reception / lobby
entry plaza
men
women
office
interpretive center exhibit
outdoor event plaza
loading receiving

FIRST FLOOR



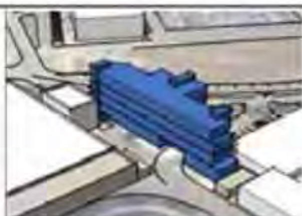
- LOTT spaces
- PORT spaces
- shared spaces
- circulation spaces



FIRST FLOOR

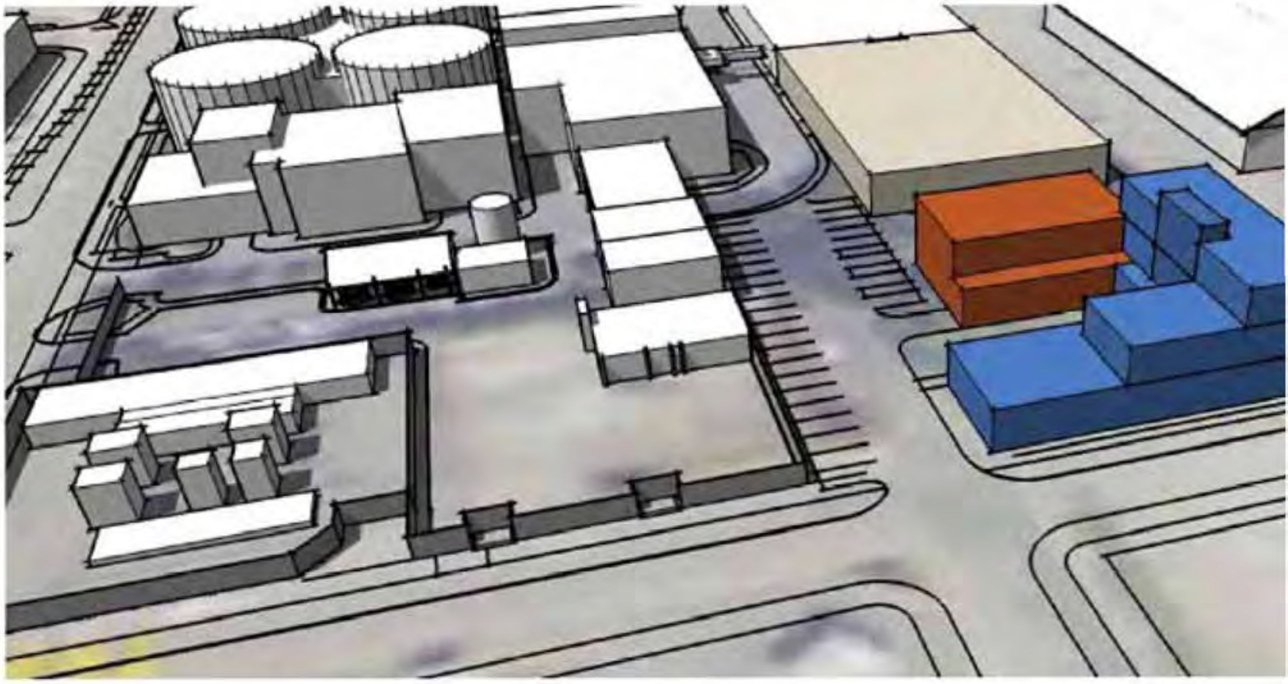
LOTT / Port Administration Building

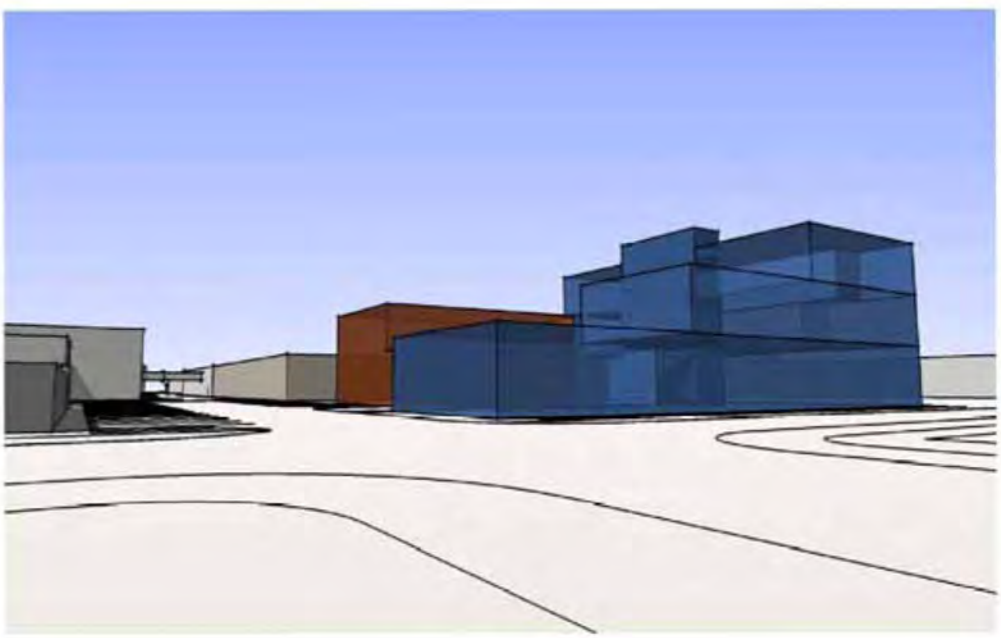
SUMMARY

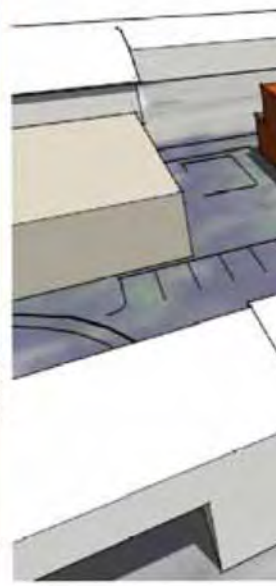
Scheme			square footage	cost per sf *	total cost**	LOTT %	Port %
PROGRAM		LOTT/ Port	31,850	$300	$12.90 M	$7.35 M	$5.55 M
		LOTT only	18,000	$315	$7.65 M	$7.65 M	-
		Leasable	0				
A		LOTT/ Port	36,613	$300	$14.83 M	$8.45 M	$6.38 M
		LOTT only	27,300	$310	$11.43 M	$11.43 M	-
		Leasable	1,100				
B		LOTT/ Port	38,900	$300	$15.75 M	$8.98 M	$6.77 M
		LOTT only	28,400	$310	$11.89 M	$11.89 M	-
		Leasable	3,150				
C		LOTT/ Port	36,438	$300	$14.76 M	$8.41 M	$6.35 M
		LOTT only	27,300	$310	$11.43 M	$11.43 M	-
		Leasable	3,000				

* Average $300/sf for 4-floor building
Average $310/sf for 3-floor building

** includes construction costs, soft costs and other ancillary costs







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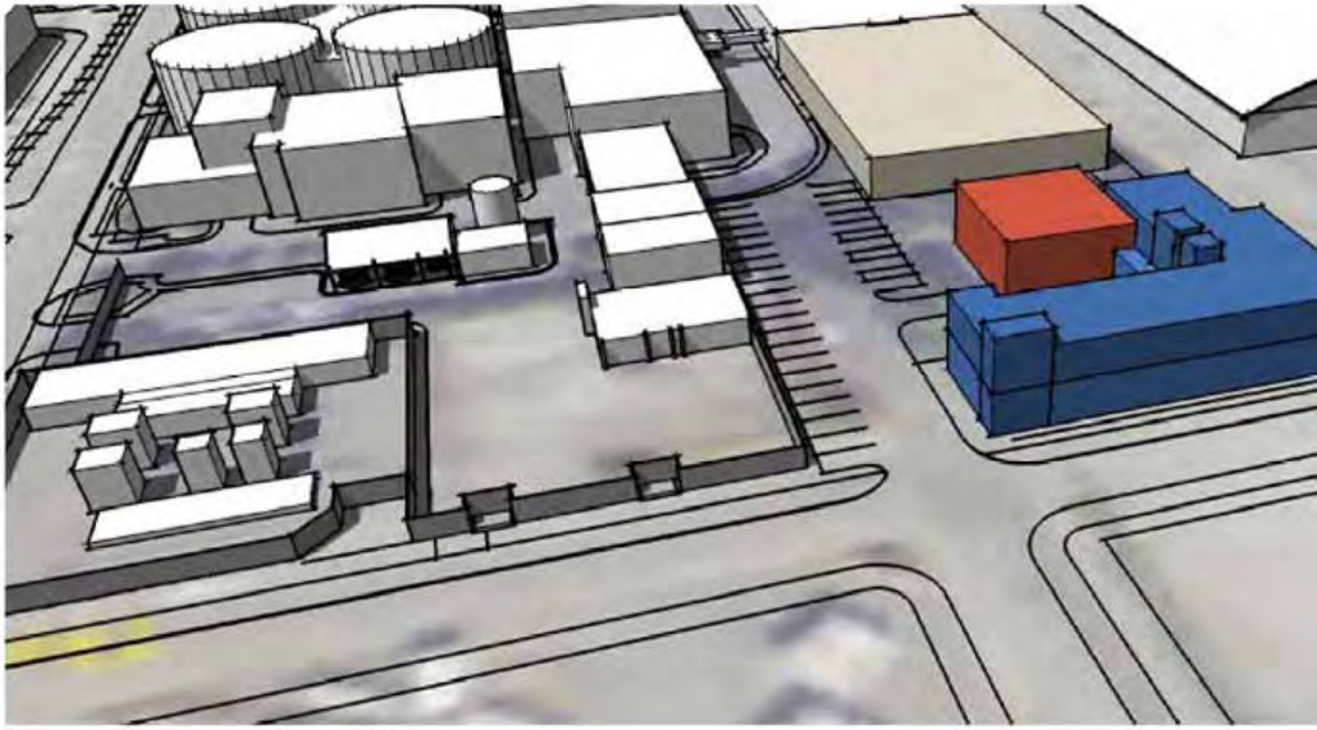
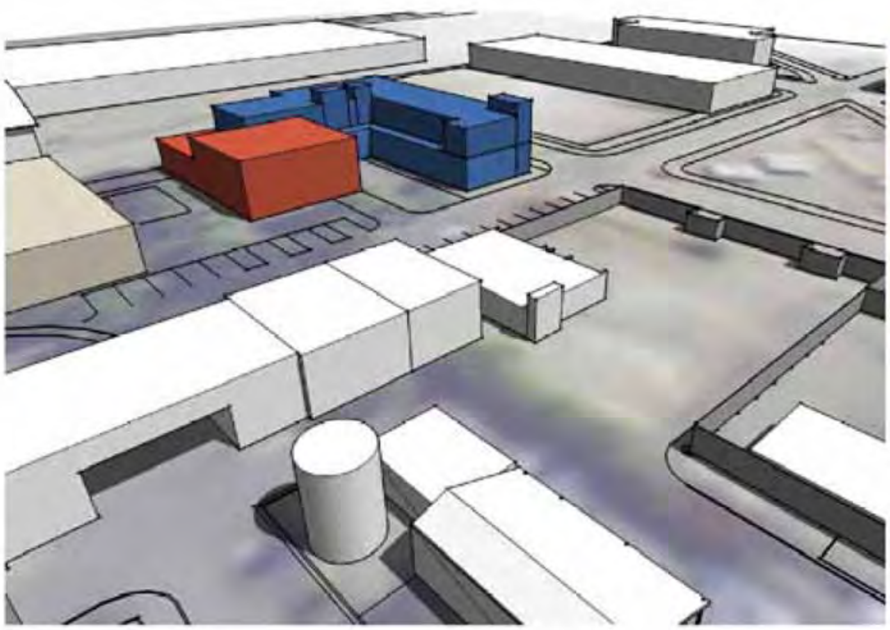
28 - h
LOTT Spaces
Lab
Circulation Spaces
lab expansion area
loading receiving
mechanical
electrical
locker room
locker room
break room
courtyard
reception / lobby
men
wom
board
training
interpretive center exhibit and office
Site A

FIRST FLOOR



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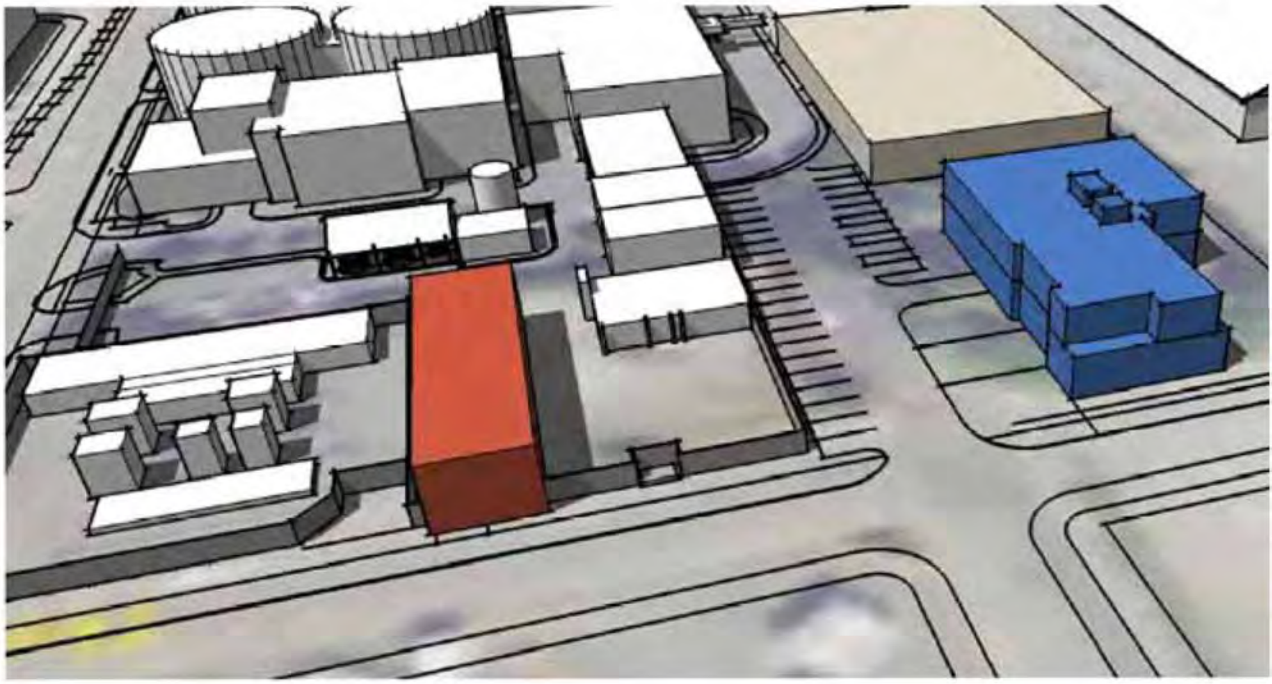
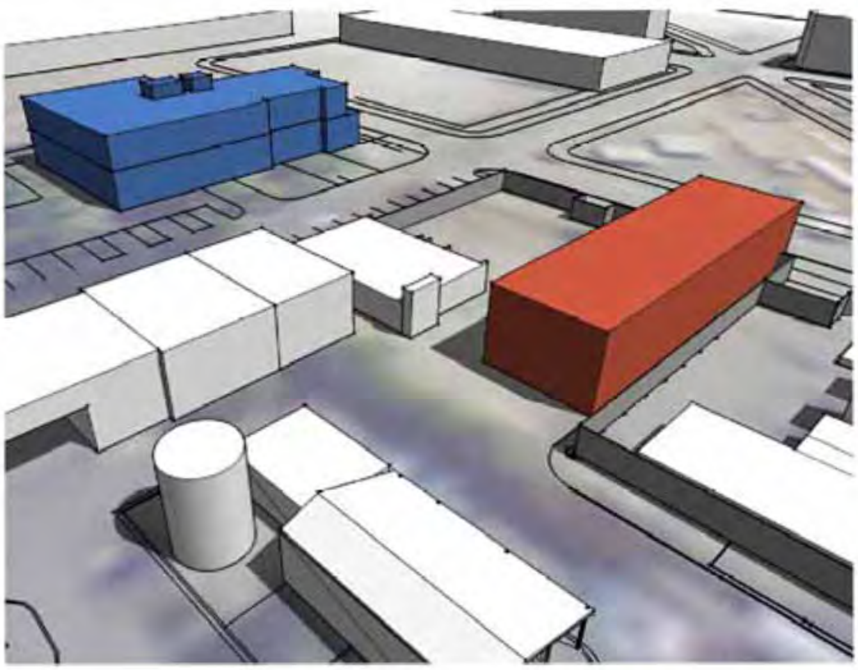
LOTT Spaces
Lab
Circulation Spaces
lab expansion area
loading receiving
locker room
locker room
break room
courtyard
reception / lobby
men
wom
board
training
interpretive center exhibit and office
Site A

FIRST FLOOR





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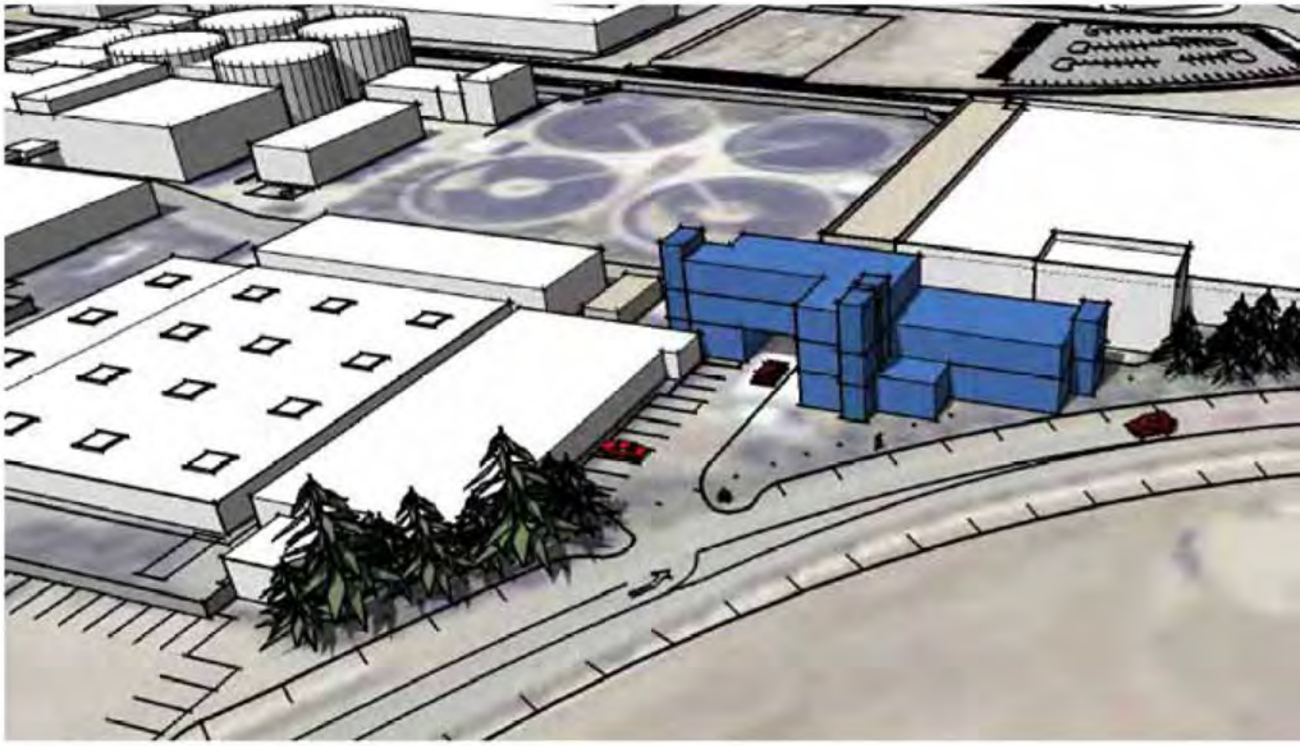
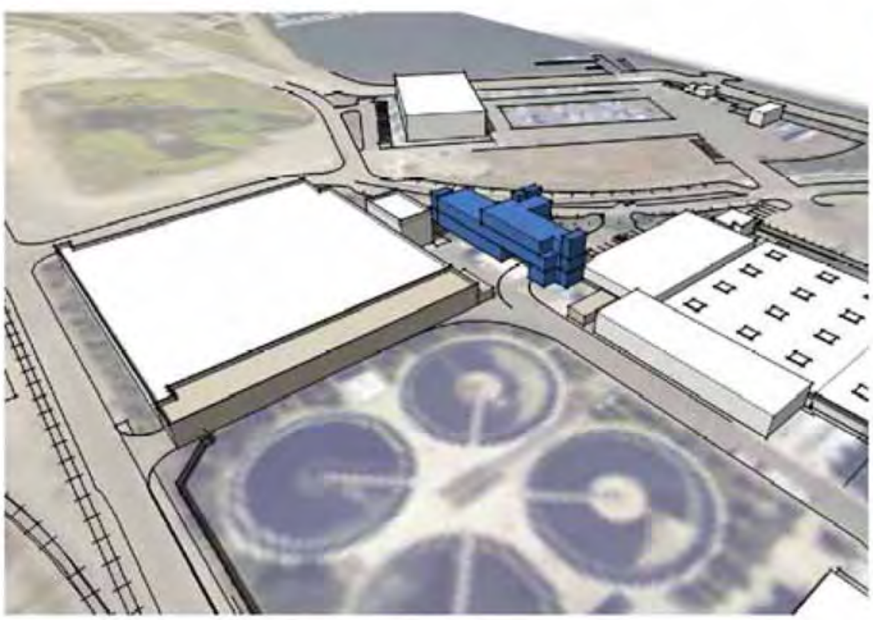
mechanical
electrical
loading receiving
locker room
locker room
break room
kitchen
men
wom.
reception / lobby
interpretive center exhibit and office
storage
training
board room
courtyard
LOTT Spaces
Lab
Circulation Spaces
Site A

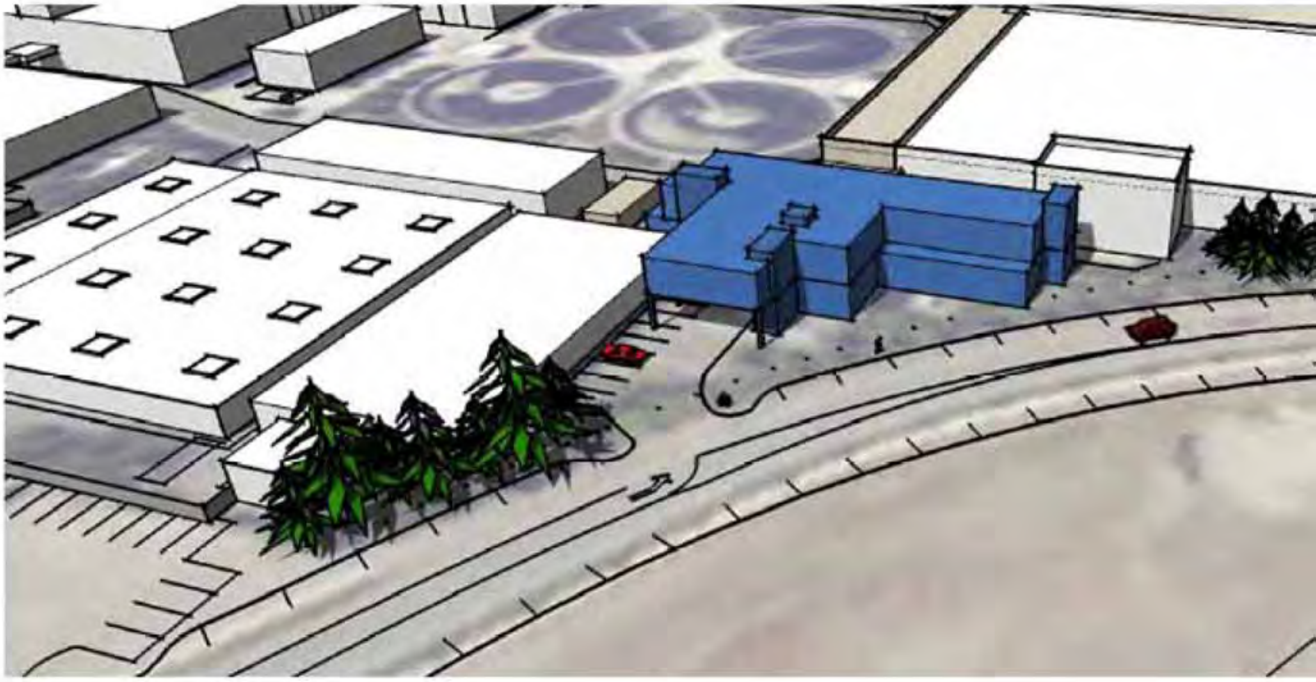
FIRST FLOOR

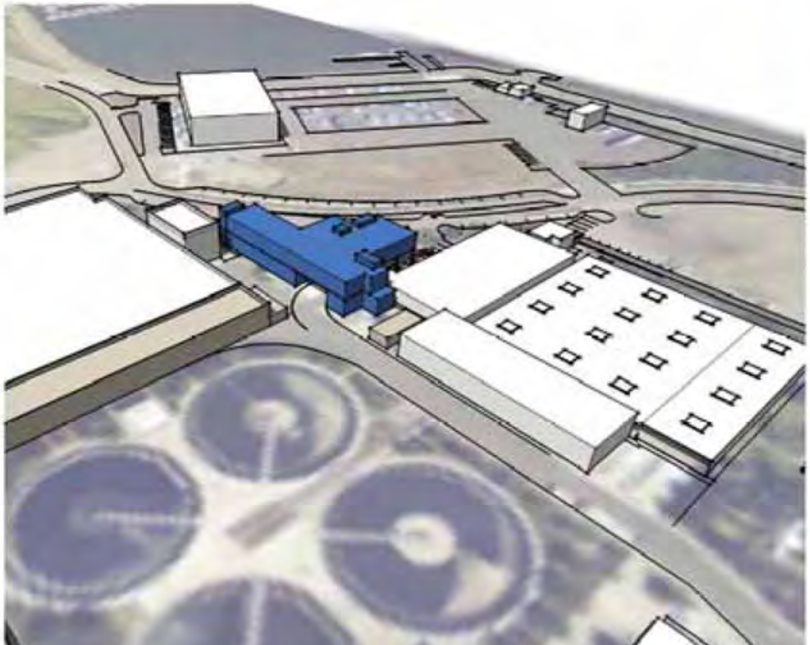




- LOTT Spaces
- Lab
- Circulation Spaces

FIRST FLOOR





LOTT Spaces
Lab
Circulation Spaces
MARINE DRIVE
reception / lobby
wom.
men
entry plaza
mechanical
interpretive center exhibit and office
loading receiving
electrical

FIRST FLOOR

APPENDIX F

Site Utilization

The Master Plan Report, issued by the Lott Alliance with Brown & Caldwell Engineers, identified and analyzed the future demands on the Budd Inlet Wastewater Treatment Plant. The Report concluded that a number of processes in the existing plant need to be replaced or expanded to provide enough capacity for future growth. Among them, the existing Primary Sedimentation Tanks are in urgent need for expansion and upgrade. Expansion of the Primaries, however, will require demolition of the existing administration building which contains the water quality lab, plant control room, and engineering offices for the plant. In addition, construction of Folding Tanks adjacent to the First Aeration Basins will eliminate the current secondary exit from the plant. In the Master Plan Report, Michael Willis Architects worked with LOTT and B&C to evaluate a number of options and locations for replacing the administration building, lab and control room and providing secondary exits from the site. In order for LOTT to finalize decisions about how to proceed on plans for new construction and remodeled areas, a Space Utilization Analysis was requested to clarify how existing spaces are currently used, where opportunities for reorganization exist within the plant, and what functions need to be accommodated in new construction.

Michael Willis Architects was engaged by the LOTT Alliance to conduct the Space Utilization Analysis of the existing plant. The purpose of the review was to identify unused and under utilized space within the existing plant facility, to suggest possible areas in which specific program elements can be relocated, and to recommend possible functions that can be located in these areas in the future. In conjunction with the Space Utilization Analysis, Michael Willis Architects assisted the LOTT Alliance in reviewing current and future space program needs and evaluating options for the construction of a future administration building, water quality lab and plant control room that will be needed as a result of the expansion of the Primary Sedimentation Tanks.

The first priority for the Space Utilization Analysis was to identify the most appropriate location to relocate the control center, which currently is staffed, but which in the future will become a server hub rather than a traditional control room. The second priority was to identify possible locations where the water quality lab could be relocated and constructed before the existing administration building is demolished. And the third priority was to identify locations where the contents of the existing warehouse and the substations on "Site B" can be relocated in order to allow for a future administration building with plant exit.

The following report outlines

- the program elements identified for a new administration building and water quality lab
- the program elements identified for location within existing areas of the plant
- other structures or facilities that may be constructed in the future
- an inventory of existing spaces in the plant that were identified as unused or under used
- recommendations for programmatic functions that could be located in these under used areas
- a summary of this study

Program to Locate in Plant

The following program needs to be accommodated within the existing plant. It excludes spaces assumed to be located in the new administration building.

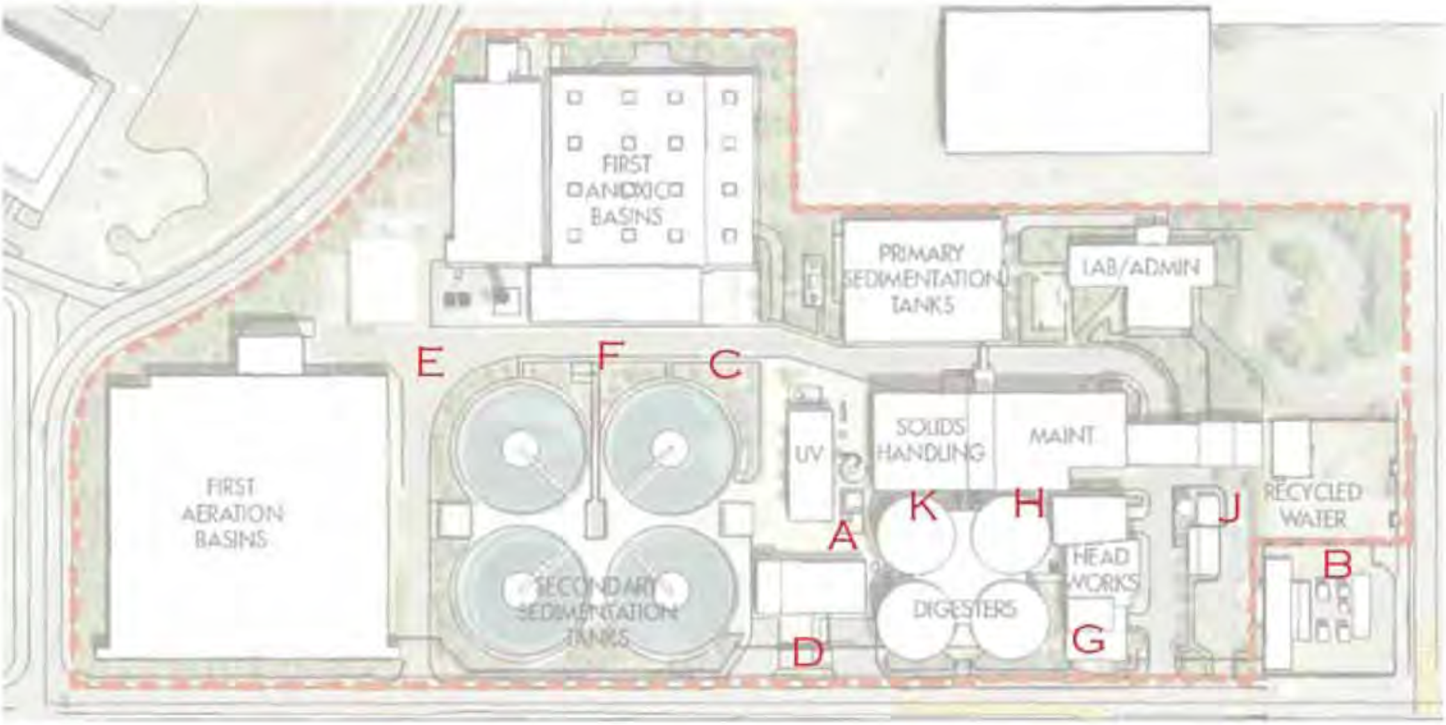
Plant Areas						
Department	Space	Quantity	sf	subtotal	total	notes
Facilities/Maint.						
	Operations Supervisor	1	150	150		office. Ben McConky
	Maintenance Superv'r	1	150	150		office (open)
	small conference room	1	150	150		locate in plant near engineers
	area total	3			450	
Office Storage						
	records / archives	1	200	200		locate in plant
	misc. storage	1	400	400		locate in plant
	area total				600	
General						
	staff break room	1	200	200		will be needed only if current ops break room needs to be converted to locker rooms for ADA
	additional locker room	1	200	200		verify how many needed, could remodel current area to accommodate
	operator's lab	1	140	140		
	area total				540	
storage relocations						
	Storage Building	1	4000	4000		relocate for new access road and/or administration building; only a portion of the contents will be kept, some high-bay space needed
	Inventory Building	1	1620	1620		relocate if current area returned to vehicle maintenance
	Electrical Supply	1	1450	1450		relocate if adj. area returned to vehicle maintenance, use for vehicle maintenance support
	area total				7,070	
TOTAL LAB SF					8,660	

Plant Control Area						
Department	Space	Quantity	sf	subtotal	total	notes
Control Center						
	control room/server w/one workstation	1	400	400		Prefer central plant location - Can downsize - usually only one operator present; verify size with plant staff
	UPS + Electrical	1	200	200		
	Mechanical	1	150	150		none needed if shared with lab or in another bldg w/HVAC; small area if separate
total					750	

Program to Locate in Plant

Water Quality Lab						
Department	Space	Quantity	sf	subtotal	total	notes
Water Quality Lab						including wet/dry bench areas, analytical work areas, and library - from lab staff based on existing areas, shown as minimum
	wet chemistry	1	930	930		
	nutrient room	1	150	150		
	microbiology	1	220	220		
	chemical prep	1	100	100		alcove
	digestion room	1	120	120		
	DI & water system	1	50	50		closet
	operator's lab	1	0	0		verify - in plant , 140 sf
	sample/receiving	1	150	150		
	area total				1,720	
Analytical Space						
	Process Supervisor	1	175	175		Wayne Robinson - need table and chair in office
	analyst workspace	1	100	100		
	lab tech work space	1	100	100		2 lab techs with small desk and locker
	library	1	100	100		
	area total				475	
Utility/ Service						
	bottled gas storage	1	80	80		exterior door
	lab services and control center MEP	1	300	300		exterior doors
	area total				380	
TOTAL LAB ADJACENT TO ADMINISTRATION BUILDING					2,575	
Ancillary Space	storage room	1	100	100		
	restrooms	2	80	160		2 fixtures each, no showers,no bank of lockers
	break/conf room	1	200	200		
	entry vestibule	1	150	150		only need vestibule entry
	area total				610	
TOTAL						
	20% Circulation				515	
TOTAL LAB SF					3,700	

Existing Plant Space Summary



ZONE LEGEND

Zone	Area	Size	Summarized Recommendation	Page #
A	Area A in zone adjacent to UV area	1600 sf	available for future storage or process expansion	6-7
A	Area B in zone adjacent to UV area	1170 sf	available for future storage	6-7
B	Water Quality Lab	5000 sf buildable	a variety of configurations possible within buildable area	8
C	Centrate Storage Tank	2200 sf	*below grade:* general storage, tank as foundation *above grade:* relocated storage contents from storage warehouse if needed , offices, breakroom, and conference room	9-10
D	Effluent Pump Storage 1204	300 sf	only allowed use is electrical	11-12
D	Effluent Pump Flare Control	150 sf	can be used for archive storage	11-12
D	Effluent Pump Old Pre- Treatment Room	255 sf	will be used for future 500 KW emergency generator	11-12
D	Effluent Pump Storage 1205A	225 sf	will be used for future 500 KW emergency generator	11-12
E	Storage Warehouse & Odor Control	4851 sf	to be removed only if required for secondary exit for plant	13
E	Odor Scrubber Area	4250 sf	add pre-fab building for relocated inventory and electrical supply storage	15

Existing Plant Space Summary

Zone	Area	Size	Summarized Recommendation	Page #
F	Blower Building Lab	275 sf	add some space from office B and share this room between the operator's lab and the main control room	14
F	Blower Building Office A	180 sf	expand into hallway, reorient room, combine with office B to convert to 2 offices and elec supply for the control room	14
F	Blower Building Office B	225 sf	current occupants to move to new admin bldg , expand into hallway, reorient room, combine with office A to convert to 2 offices and elec supply for the control room	14
F	"Squirrel Room"	1152 sf	only allowed use is mechanical	14
G	Headworks Building Vestibule	625 sf	only allowed use is mechanical, access to adjacent mechanical room	15
G	Headworks Building Exercise Room	450 sf	use not permitted by NFPA 820 code rules	15
H	Maintenance Building Locker Rooms	n/a	may require upgrade for ADA, and if required,expand into the current break room	16-17
H	Maintenance Building Break Room	450 sf	relocate to new admin bldg or other plant space if required	16-17
H	Maintenance Building East Catwalk	650 sf	general storage	16-17
H	Maintenance Building West Catwalk	450 sf	misc. storage	16-17
J	Inventory Building	1620 sf	possible to convert to vehicle maintenance	18
J	Electrical Building	1450 sf	possible to convert part to support for vehicle maintenance	18
K	Solids Building Polymer Storage Tank	360 sf	process storage only	19

Zone Adjacent to UV Basins

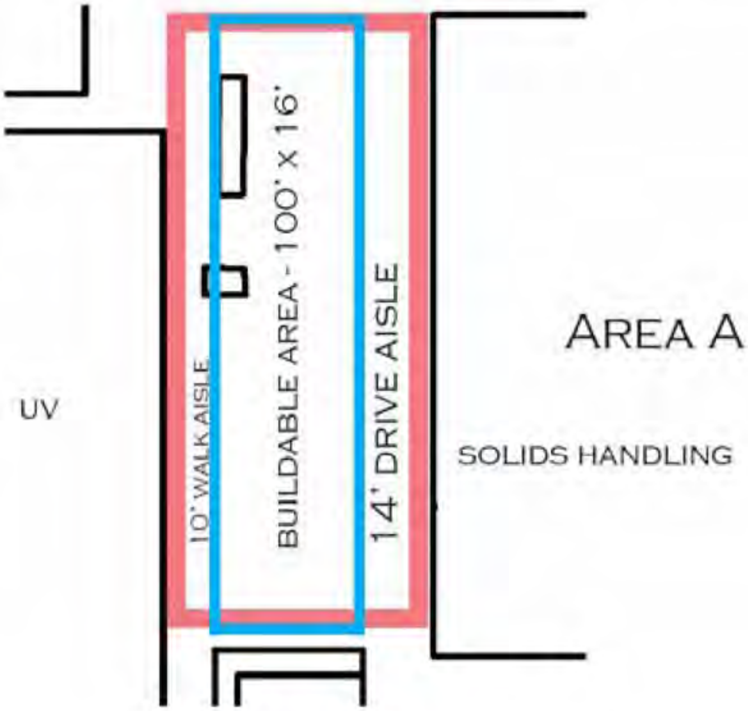
A

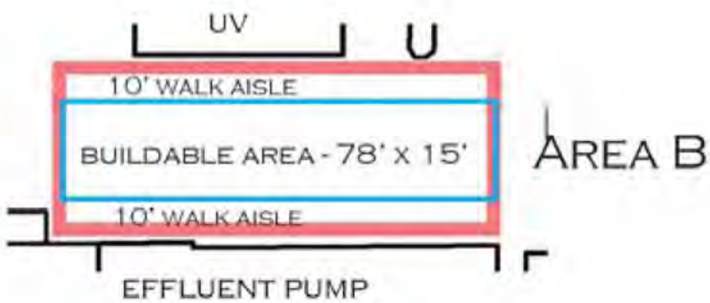
B

C

D

Zone Adjacent to UV Basins





Area	Current use	Size	Recommendations
Area A	• nothing below grade in this area	1600 sf 16' X 100'	• available for future storage or process • build with minimal foundations / light frame metal building • build a row of 20' wide storage lockers
Area B	• wet wells below	1170 sf 15' X 78'	• available for future storage if use light frame metal building

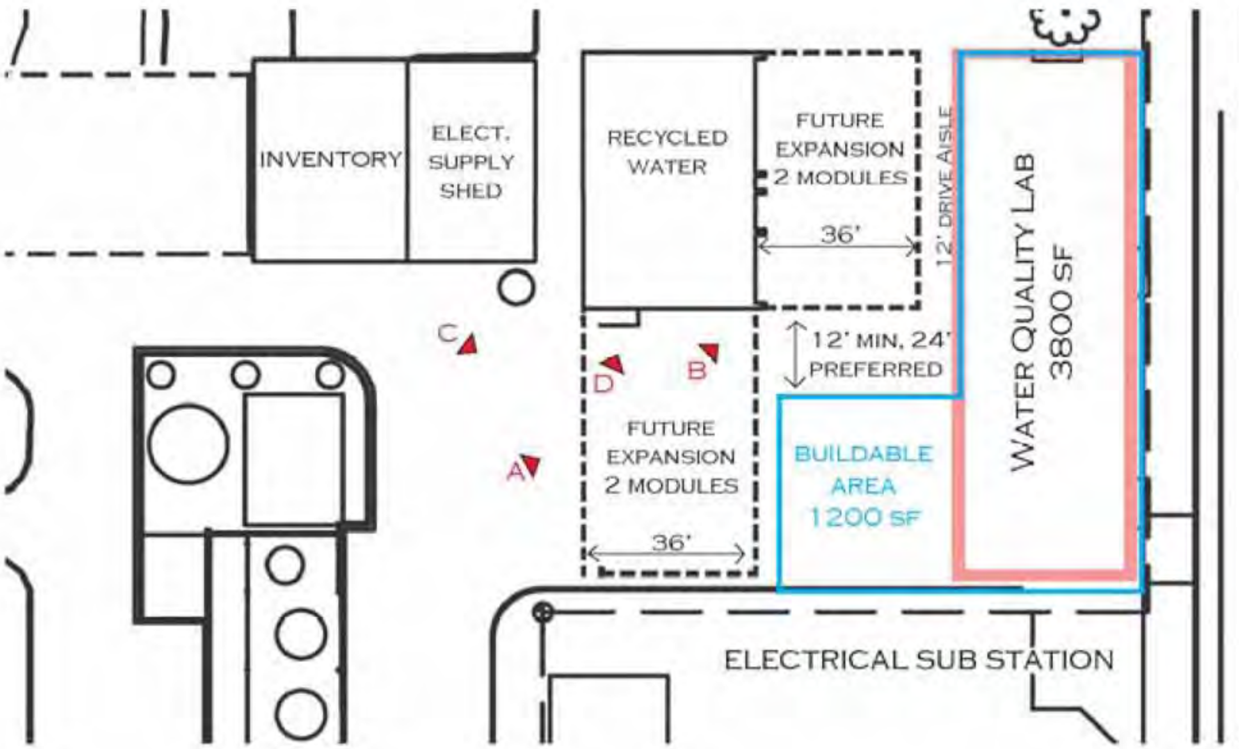
Zone West of Recycled Water

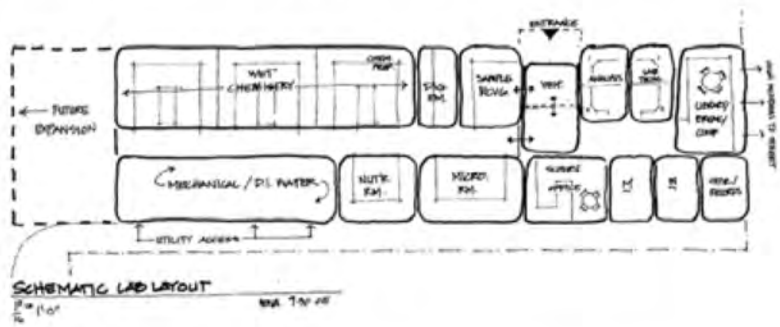
A

B

C

D





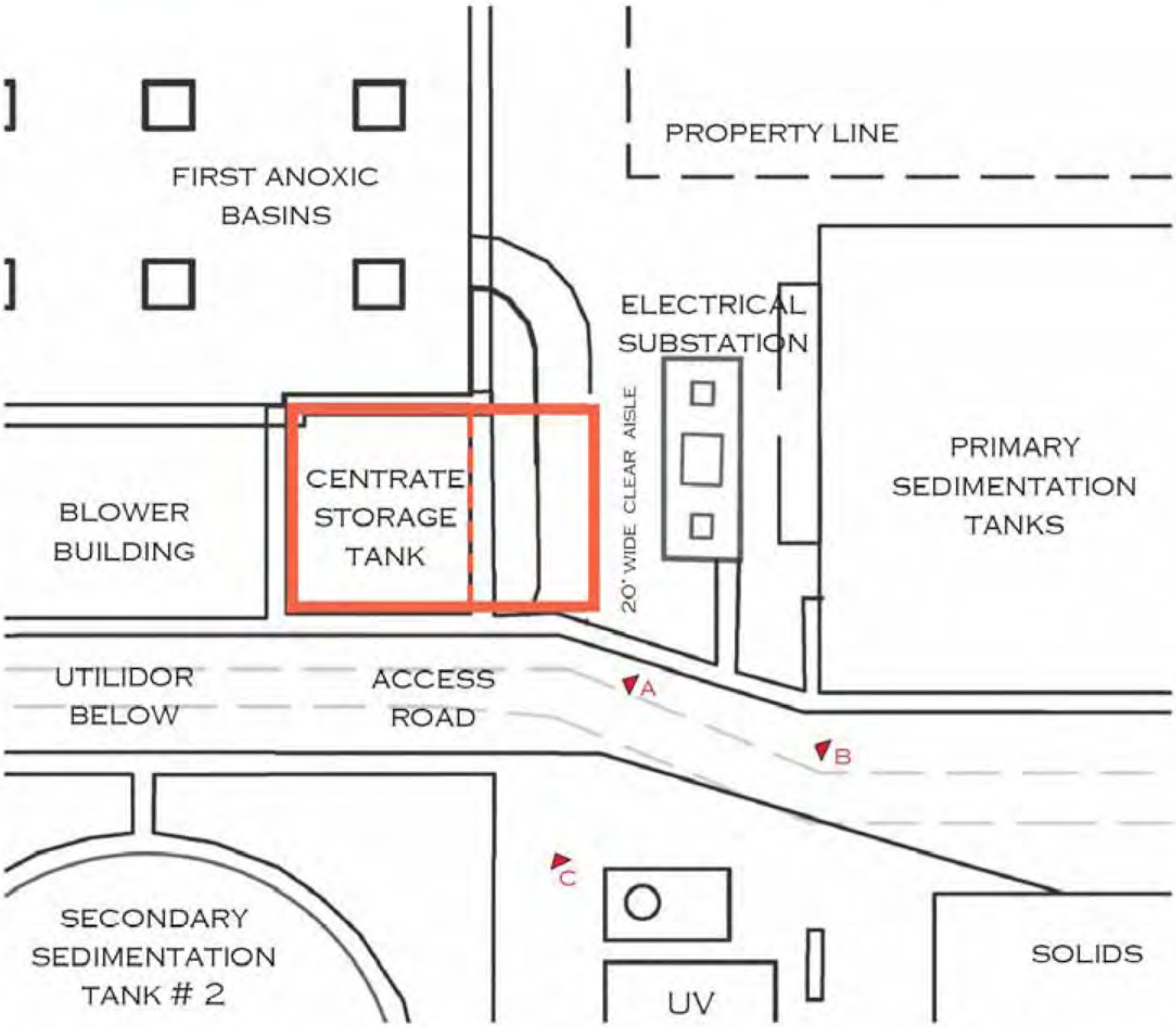
Area	Current use	Size	Recommendations
Lab	• parking lot • no utilities below	5000 sf	• Lab could be in a variety of configurations within buildable area

Centrate Storage

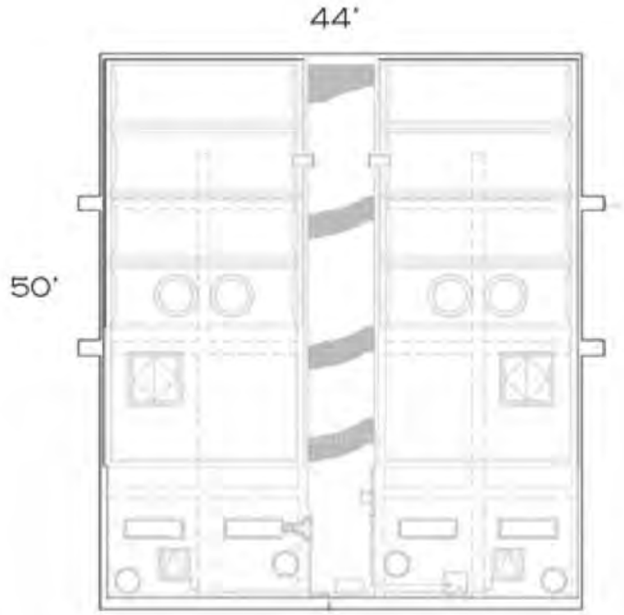
A

B

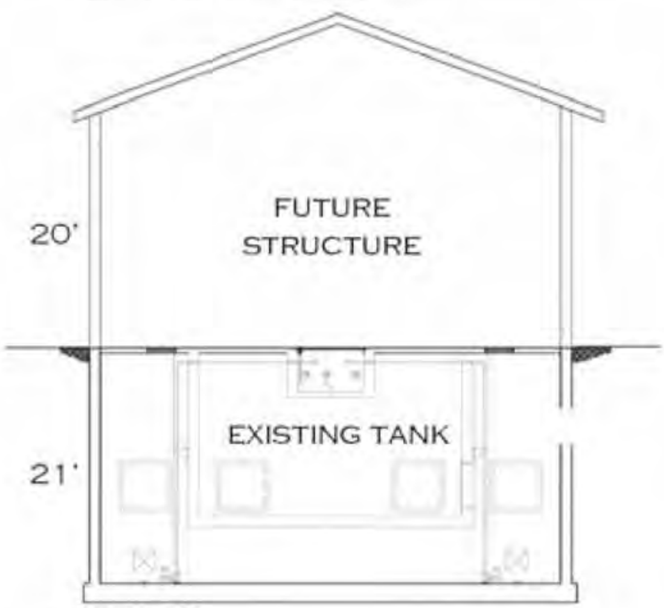
C



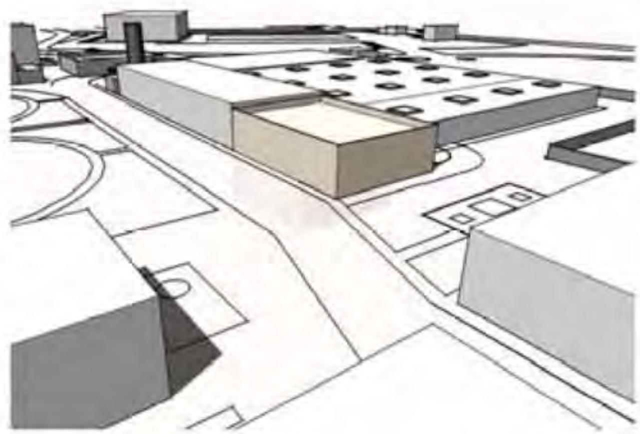
Centrate Storage



EXISTING TANK PLAN



SECTION



Area	Current use	Size	Recommendations
Centrate Tank	• There is a large amount of electrical material below grade near electrical substation • already de-commissioned	2200 sf 50' x 44'	• *Below Grade* - gut the tank, make the space general storage, and use as a foundation for structure above • add stair and lift • *Above Grade* - storage contents relocated from the storage warehouse if needed, with mezzanine for additional storage and/ or offices, locker, breakroom spaces, restroom, conference room

Effluent Pump Building

A

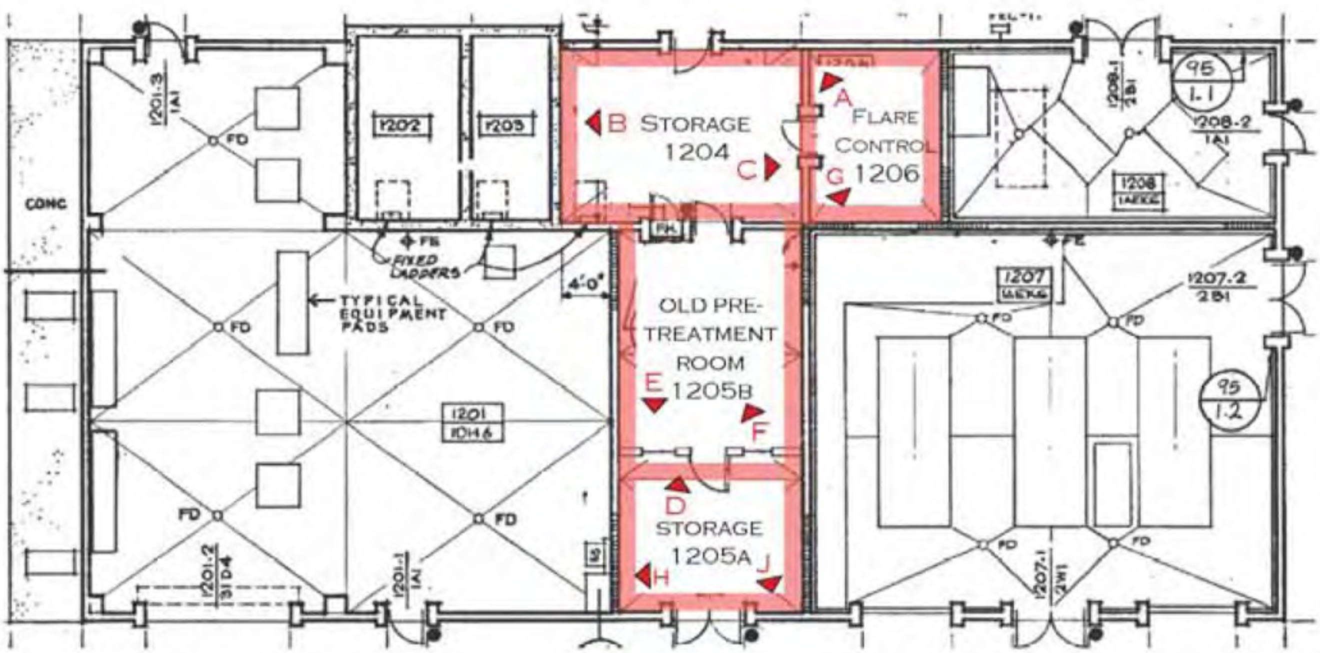
B

C

D

E

F



EXISTING PLAN

G

H

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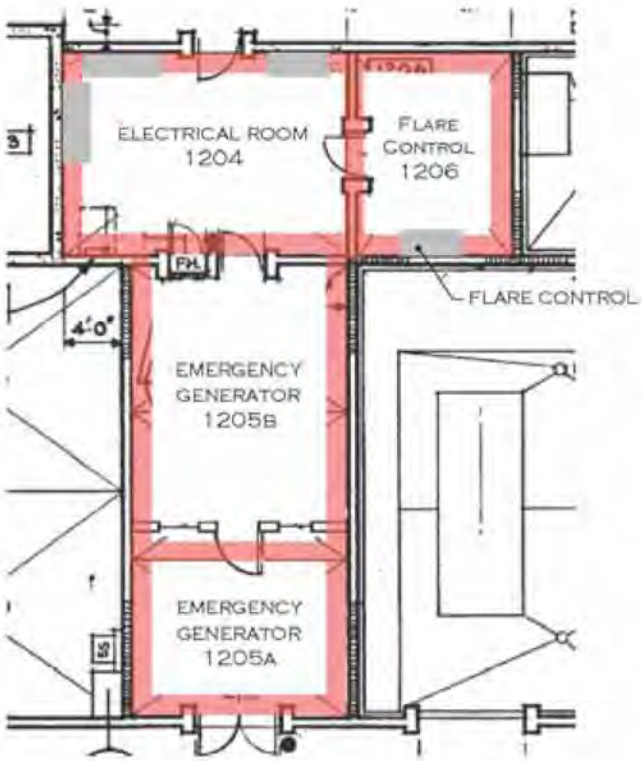
K

Effluent Pump Building



FUTURE PLAN

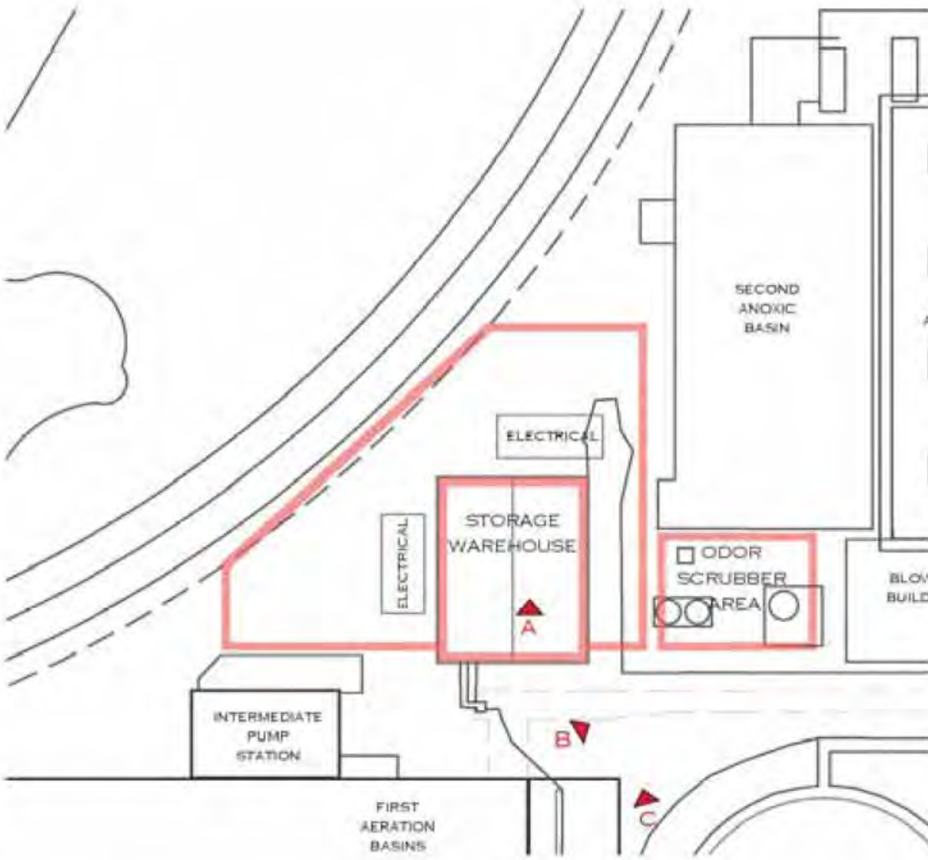
Area	Current use	Size	Recommendations
Room 1204	• no windows, no bathroom in the building • formerly an exterior space with concrete walls & floor • large electrical panels on 2 walls are active • currently has some misc., unorganized files • 2 elec. outlets	300 sf	• only allowed use is electrical
Room 1205A	• high bay area with space over room 1205b • exterior doors with access to street • some misc. storage cabinets, tools, shelves • concrete floor and janitor's sink • 4 elec. outlets	225 sf 15' X 15'	• may locate 500 KW emergency generator in this space
Room 1205B	• built as office with acoustic ceiling, vct floor, 2 walls of CMU, 2 walls of gyp., relites • 2 desk workstations, formerly ops, not used • no windows to exterior • 10 elec. outlets	255 sf 15' X 17'	• may locate 500 KW emergency generator in this space
Room 1206	• no windows, all concrete walls & floors • some lights, electrical, floor drains • currently has some misc. storage boxes, but uncategorized/organized • houses the flare control - must be kept or relocated • 4 elec. outlets	150 sf	• this room should remain the same

Storage Warehouse / Site 'B'


A


B


C



Area	Current use	Size	Recommendations
Storage Warehouse & Area	• high bay space • existing electrical substations restrict area	4851 sf 63' x 77'	• storage bldg to be removed in the future only if needed administration bldg • possible relocation to area above centrate tanks or in odor scrubber area • 50% contents can be relocated elsewhere in plant, remaining 50% to be disposed of • existing electrical substations may need to be relocated
Odor Scrubber Area	• equipment commissioned, but not currently used	4250 sf	• Pre-fab building with mezzanine for storage of relocated inventory supply and electrical supply buildings

Blower Building

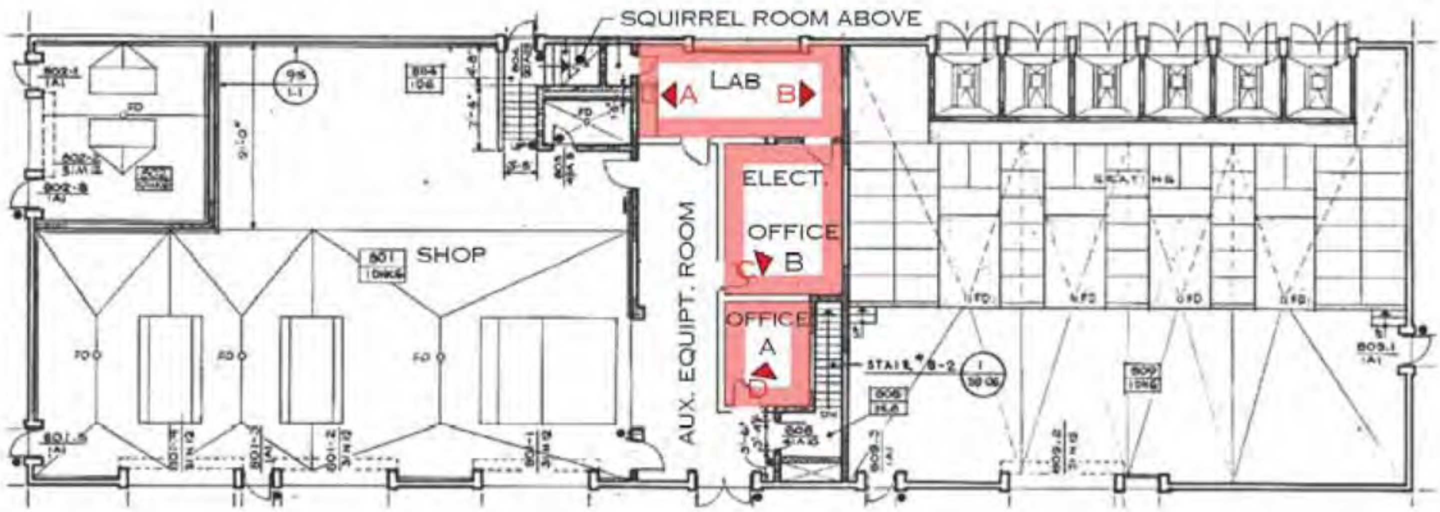
A

B

C

D

E



Area	Current use	Size	Recommendations
Office A	• existing acoustic ceiling, gyp walls, sheet vinyl floors, furniture • used to be the supervisor's office, not in use now except as temporary space • 8 elec. outlets	180 sf 12' x 15'	• convert to Operations Supervisor office at 150 SF
Office B	• existing acoustic ceiling, gyp walls, sheet vinyl floors, furniture • occupied by engineers, Richard and Eric • 4 elec. outlets	225 sf 15' x 15'	• current occupants, Richard & Eric, will move to the new Admin bldg • a portion of this space will go into the lab room and the rest will be converted to the Maintenance Supervisor's office @ 150 SF
Lab	• seldomly used as secondary control room • currently built-out for lab functions, but seldomly used • 26 elec. outlets	275 sf 12' x 23'	• can become the main control room for the plant • operator's lab functions only need one counter and sink • can expand partially into "office B" to accommodate new control room and operator's lab
Auxil. Equipt. Room	• currently noisy, but used as aux. shop & break area • electrical panelsline east walls • 3 roll up doors serve space	525 sf	• continue with current uses • could locate boat from storage warehouse if that building is removed
"Squirrel Room"	• mechanical area above lab, offices, and hallway • has very low duct work • contains some mechanical equipment, but mostly empty space • large window	1152 sf 24' x 48'	• only allowed use is mechanical

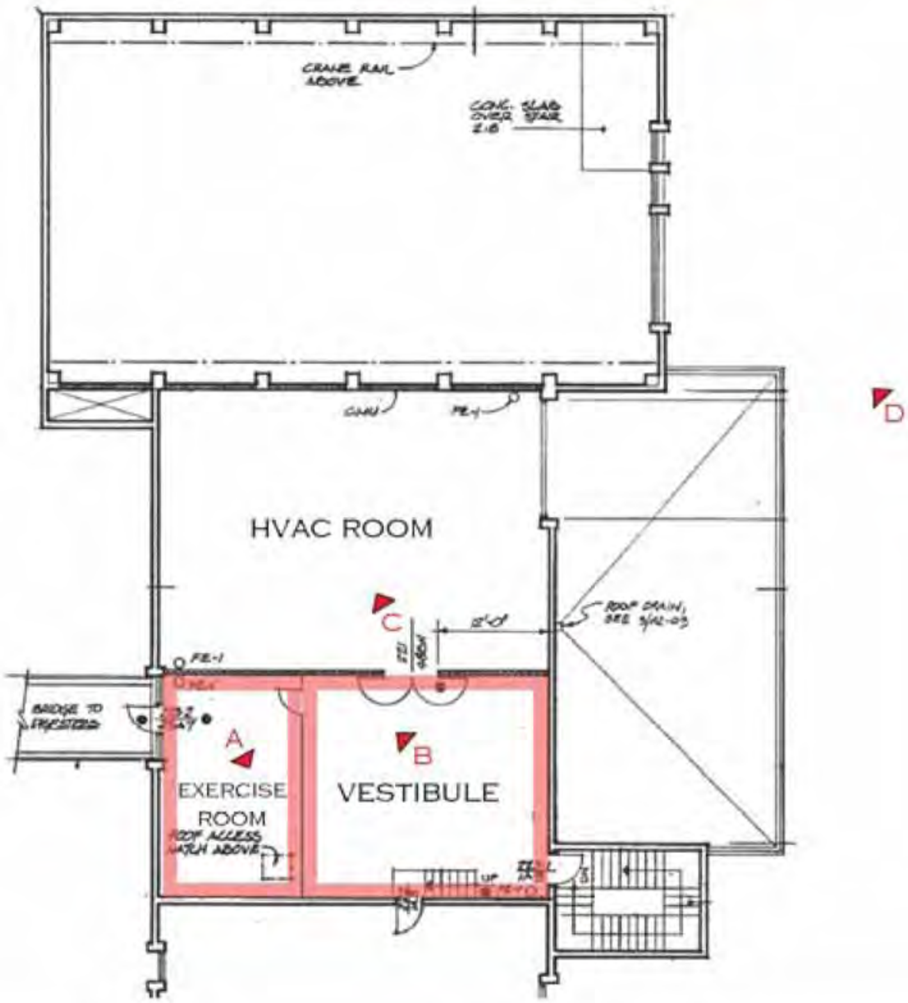
Headworks Building


A


B

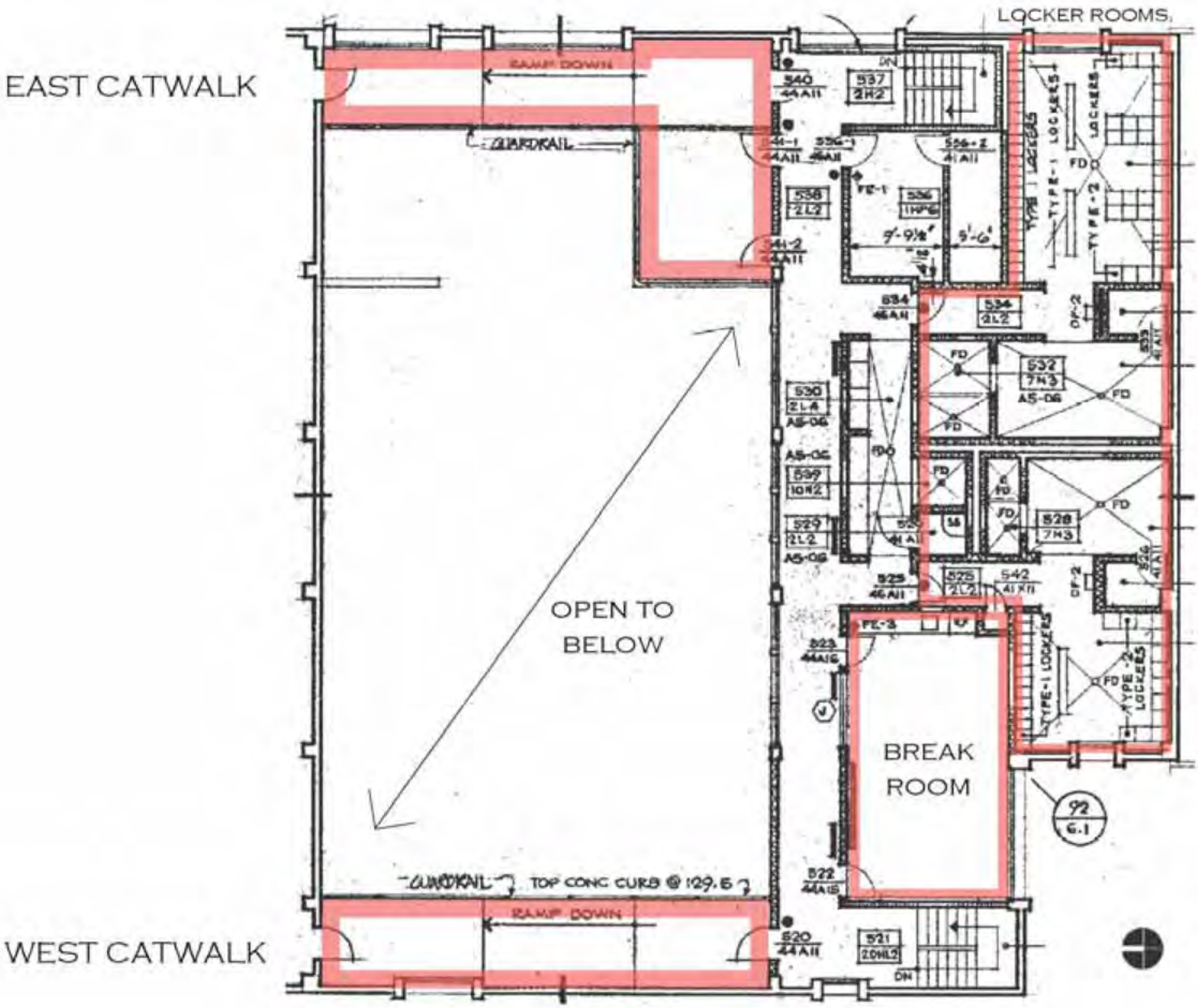

C


D



Area	Current use	Size	Recommendations
Exercise Room	• 8 elec. outlets	456 sf 19' x 24'	• not permitted by code (NFPA 820) to be an exercise room
Vestibule	• 8 elec. outlets • NFPA 820 space, code may not permit office use • HVAC not designed for people, only equipment • main access to HVAC room from stair tower and thru this room	635 sf	• wall, door, & mech., exiting modifications required for office use. Negotiation with local code officials to insure NFPA 820 code compliance required for any change.

Maintenance Building
second floor



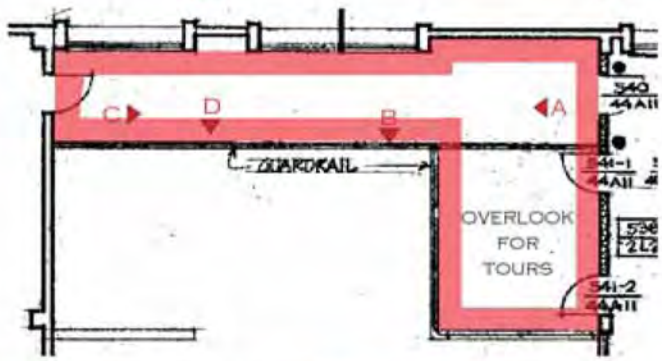
Maintenance Building

A

B

C

D

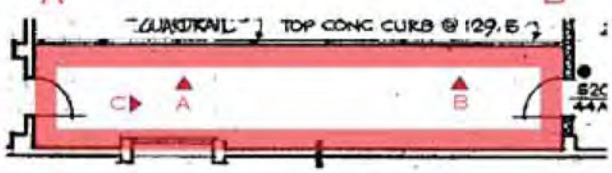


EAST CATWALK

A

B

C



WEST CATWALK

Area	Current use	Size	Recommendations
west catwalk	• Lockers are overflow for the staff • HVAC mechanical , 4 elec. outlets	450 sf	• use for misc. storage / lockers
east catwalk	• No fire sprinkler/ heat detectors, 2 elec. outlets • no elevator to 2nd floor • Tour groups use to overlook maintenance	650 sf	• use for general storage • cannot build out walls because they would be in conflict with the overhead crane
Locker Rooms	• Current # of lockers in men's are not sufficient. Overflow is on the west catwalk.		• Currently not ADA compliant or accessible, upgrade may be triggered from other work in the building. Could expand into break room area.
Break Room	• Break room for the plant.		• not ADA accessible, not used by many people • convert to additional space for locker rooms, if ADA upgrades are triggered • relocate to new admin building or other plant space if lockers need to expand into this area.

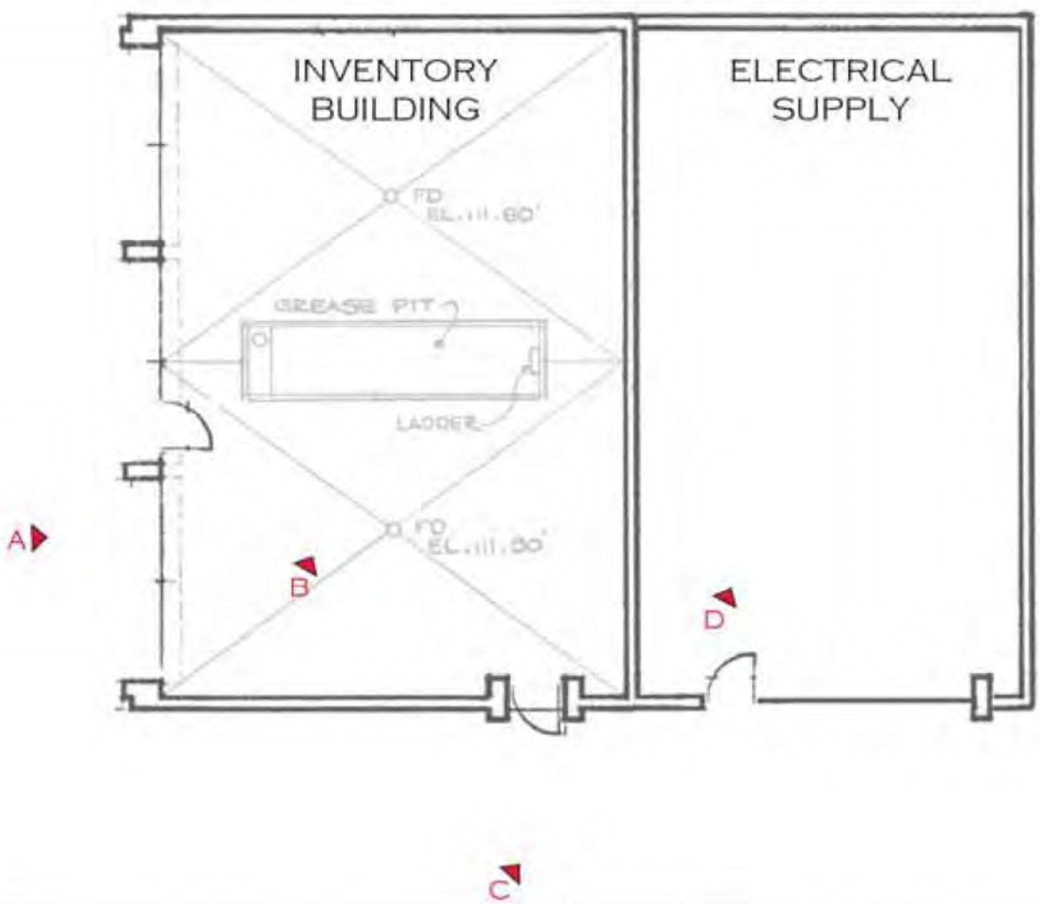
Inventory/ Electrical Building


A


B

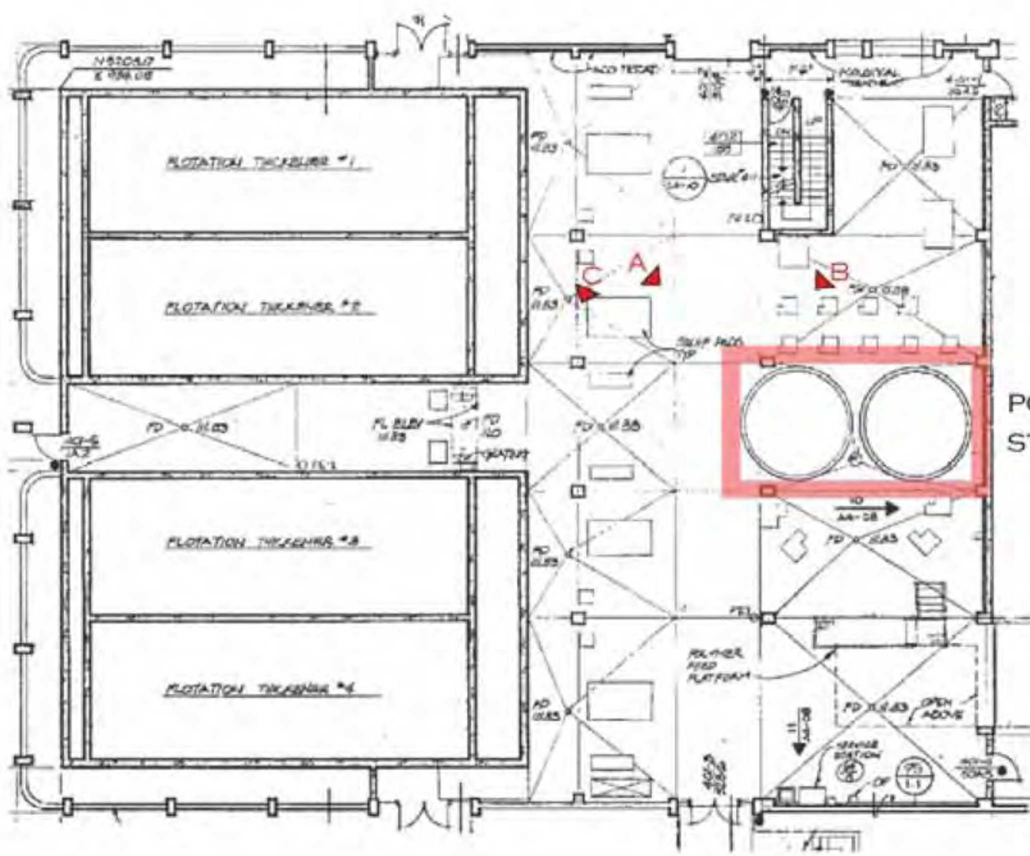

C


D



Area	Current use	Size	Recommendations
Inventory Building	• high bay space • built as a vehicle maintenance • now used for inventory storage • 16 elec. outlets around perimeter	1620 sf 41' x 31'	• can be converted back into vehicle maintenance • relocate contents into plant • is a conditioned space that could be used for parking vehicles that need freeze protection
Electrical Building	• high bay space • pre-fab, shed construction • lacks insulation, HVAC, electricity, and windows • not fully used for electrical supply	1450 sf	• not suitable for office occupancy • can be used for existing electrical supply and vehicle maintenance shop support

Solids Building



Area	Current use	Size	Recommendations
Polymer Storage Tanks	• loud environment • surrounded by tanks, equipment • ceiling height approx. 15' • fork lift access	360 sf 15' x 24'	• too loud for staff as occupants • remove polymer tanks for use as process storage only

Conclusions & Recommendations

Based on our observations during two site visits and discussions with plant staff, there are opportunities within the plant to remodel existing or construct new space within the plant to sufficiently accommodate most space needs outlined in the program, included spaces identified to be located in the plant as well as spaces removed from the Administration building program to reduce construction size. The office program, locker, and break room functions can only be accommodated within the plant with remodel of existing spaces and construction of new space as outlined below. The following are several conclusions and recommendations:

- The following areas are decommissioned or not in use, but require some modification or construction to be available for other usages:
  - Odor Control and Soda Ash Storage: by removing the unused facilities, this area can accommodate a new structure or plant parking
  - Centrate Storage: by removing or reusing the existing tank or foundations, this area can accommodate 3000 - 3500 sf of new building or plant parking as well as 2200 sf of basement space inside existing tank foundations.
  - Solids Handling, Polymer Tank area: by removing unused polymer tanks, this area can be used for 360 sf of process storage
  - Zone A between Solids and UV basins: this area can accommodate 1600 sf of building, either with full foundations or light weight construction and is recommended for plant storage or process expansion. This area could accommodate temporary trailers for admin. staff if needed during construction of new admin. building.
  - Zone B between Solids and Effluent Pump Storage: this area can accommodate 1170 sf of light, weight building that does not require foundations and is recommended for plant storage.
  - Zone west of the Recycled Water facility: this area can accommodate 6650 sf of building and is recommended for the Water Quality Lab if it is not located with the new Administration Building

- The following areas can be reused for office needs with minor remodeling:
  - Blower Building office and lab areas
  - Effluent Building office and storage areas (unless converted to emergency generator space)

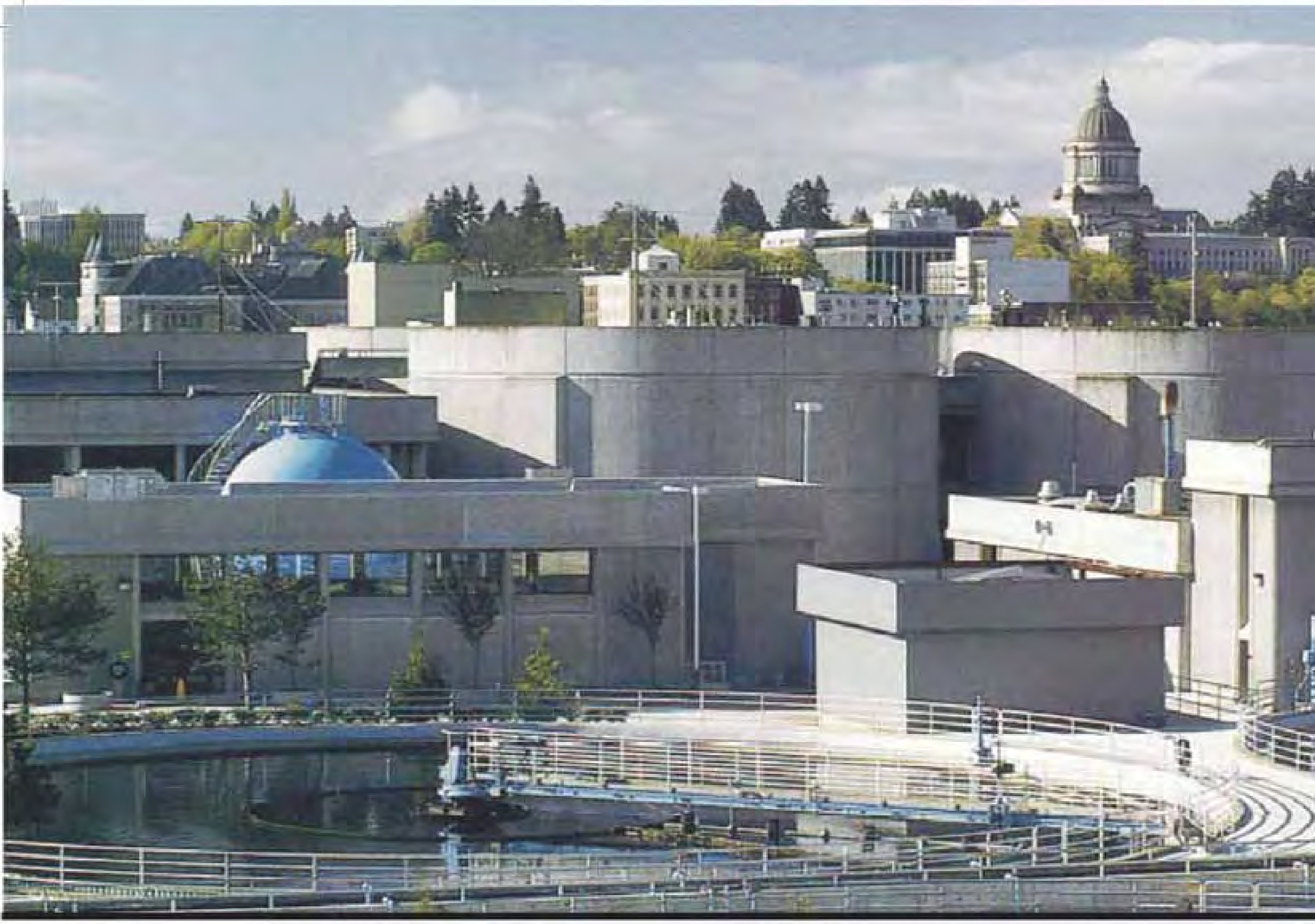
- The following areas do not have allowable uses beyond their current use:
  - Blower Building "Squirrel Room"
  - Headworks "Vestibule"
  - Maintenance Building "catwalks"
  - Effluent Building Electrical Room

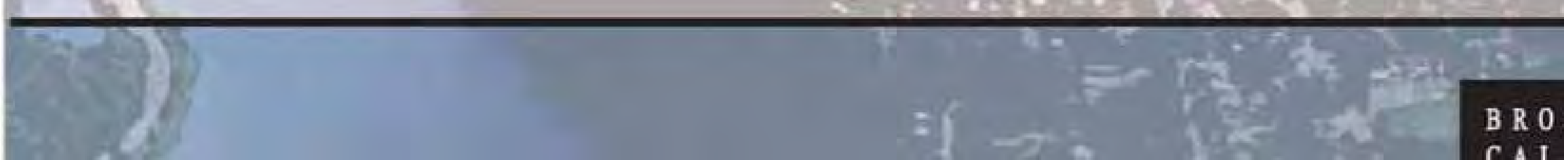
Conclusions & Recommendations

- The following areas may require upgrade to accommodate ADA requirements:
  - Locker Rooms in Maintenance Building
  - Break Room in Maintenance Building

Additional Recommendations

- The Water Quality Lab could be constructed within the plant either on "Site A" as noted in the Master Plan Report or in the zone south or west of the Recycled Water facility.
- The foundations of Centrate Storage are sufficient to support another structure and the location is central to many functions in the plant. For this reason, a new, 1-story, light weight building could be economically constructed over the existing tanks and consolidate the storage needs for the plant. By removing the internal walls and piping and adding a stair and lift, the existing tank below grade could be used for much of the plant storage needs, such as the contents of the Storage Warehouse and Electrical Supply. The building above grade can be used to store archives and contents from Inventory. If a more permanent or insulated structure is considered, the additional plant offices and conference room can be located here as well as a break room and/or exercise room instead of/ or in addition to the areas outlined in this report.
- If the area currently used for Inventory is converted back to its original use for vehicle maintenance, the contents of this area could be located in a central storage area, such as a new structure at Centrate Storage or elsewhere. The adjacent structure housing Electrical Supply could become support and storage for vehicle maintenance as well as Electrical Supply, or Electrical Supply could also move to a central storage area.
- The contents of the existing warehouse building located on "Site B" can be partially disposed of and partially relocated to several locations within the plant, including the high-bay space in the Blower Building, a new space over Centrate Storage or in smaller groups in Electrical Supply, Maintenance Building and the polymer tank area in Solids Handling.
- General construction in the plant may trigger requirements to remove accessibility barriers in the plant. The existing locker rooms and break room in the Maintenance Building are not currently accessible to disabled employees or tour groups. An elevator to the second floor will need to be added for the area to be accessible. In addition, the existing locker facility is not ADA compliant, and will need to be remodeled and expanded to comply with ADA and provide the number of lockers needed. The locker rooms may be expanded into the current Break Room area, and the Break Room could be located elsewhere in the plant, such as in the existing Blower Building, Effluent Pump Building, or in the new Administration Building.
- Both Operations Supervisor & Maintenance Supervisor offices could be located in existing areas with minor remodeling unless additional locker room or break room space is required.

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