FISHERMAN BAY SEWER DISTRICT

Old Fish Bay Lumber Building

295 Village Road, # 101

P O Box 86

Lopez Island, Washington

98261

GENERAL SEWER PLAN & FACILITIES PLAN

Prepared By:
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Project # 2020-105
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November 2021

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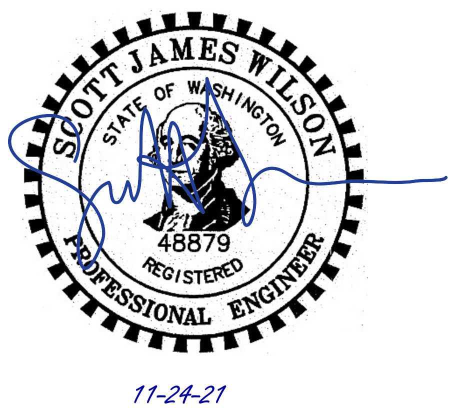
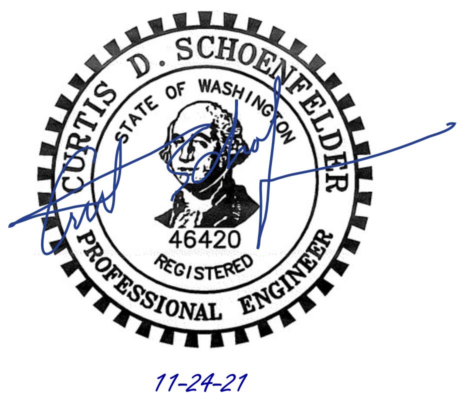
Prepared for:

Fisherman Bay Sewer District

By:

Wilson Engineering, LLC





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List of Abbreviations

$CBOD_5$	5-Day Carbonaceous Biochemical Oxygen Demand
cu ft	cubic feet
DO	Dissolved Oxygen
ERU	Equivalent Residential Unit
F/M	Food to Microorganism Ratio
GMA	Growth Management Act
GPD	gallons per day
GPM	gallons per minute
HRT	Hydraulic Residence Time
IFAS	Integrated Fixed-Film Activated Sludge
kW	kilowatt
kW/hr	kilowatt-hour
lbs	pounds
MBR	Membrane Bioreactor
MCRT	Mean Cell Residence Time
mg/L	milligrams per liter
MGD	million gallons per day
MLE	Modified Ludzack-Ettinger (Process)
MLSS	Mixed Liquor Suspended Solids
MLVSS	Mixed Liquor Volatile Suspended Solids
MMDF	Maximum Month Daily Flow
psi	pounds per square inch
RAS	Return Activated Sludge
rpm	revolutions per minute
SCFM	standard cubic feet per minute
sq ft	square feet
STEP	Septic Tank Effluent Pumping (System)
SVI	Sludge Volume Index
TIN	Total Inorganic Nitrogen
TKN	Total Kjeldahl Nitrogen
TN	Total Nitrogen
TSS	Total Suspended Solids
VSS	Volatile Suspended Solids
WAS	Waste Activated Sludge
WWTP	Wastewater Treatment Plant

Executive Summary

Background

The purpose of this General Sewer and Facilities Plan (Plan) is to provide a recommended plan for required improvements to the existing wastewater treatment facility and collection system to address aging infrastructure & challenging equipment, future flow and loading capacity, future nutrient removal requirements, and current standards for redundancy and reliability. This report evaluates the District's wastewater needs based on projected residential population growth and commercial and industrial demands on the treatment system through the year 2043.

Fisherman Bay Sewer District is located on Lopez Island in San Juan County, State of Washington. The District operates a wastewater treatment plant and a sewer collection system that serves a portion of the residents on Lopez Island. Users in the District include residents, a school, a few retail businesses, restaurants, hotels, and offices. The District's collection system consists entirely of a septic tank effluent pumping (STEP) system and pressurized PVC and HDPE sewer main piping. The District serves a population of approximately 819. Wastewater flow to the WWTP is primarily domestic sewage from residential areas within the District. There are no significant sources of industrial wastewater.

The existing wastewater treatment plant consists of a pretreatment anaerobic cell followed by an aerated lagoon facility. The plant is located at 620 Lopez Road North on Lopez Island. A constructed wetland is used to polish the lagoon effluent prior to plant effluent chlorine disinfection and final discharge. Treated effluent is piped approximately one half mile and discharged through an outfall diffuser into the San Juan Channel. The District operates the plant under a discharge permit (WA0030589, See Appendix J) issued by the Washington State Department of Ecology (DOE). The current permit was issued on February 1, 2017 and will expire on February 28, 2022. The permitted capacity of the plant is 53,000 gpd MMDF and 66 lb/day $CBOD_5$ max month influent loading.

Regulatory Requirements

As a municipal wastewater treatment facility, the District's WWTP is regulated by the NPDES permit issued by the Department of Ecology. The District's current NPDES permit (Appendix J), No. WA-0030589, was issued on February 1, 2017, and expires February 28, 2022. This Plan is in response to aging and overloaded infrastructure in the collection system and wastewater treatment facility. This Plan is also in response to future anticipated nutrient removal requirements. This Plan includes an evaluation of the WWTP existing conditions and provides recommendations for improving and maintaining adequate capacity to ensure long-term NPDES permit compliance.

Flow and Loadings

The existing and future flows and loadings to the wastewater treatment plant were studied through a 22-year planning period (2043). This planning period was used based on the assumption that significant treatment plant upgrades would be completed in the year 2024.

Existing influent flows are 0.0304 MGD (Annual Average). The maximum monthly influent flows average 0.053 MGD. This average max month flow is exactly the 0.053 MGD permit limit for max month flow.

Influent $CBOD_5$ levels have averaged 27.7 lbs/day (Average Daily) and 62.4 lbs/day (Max Month) over the last 4 years. Influent TSS levels have averaged 6.4 lbs/day (Average Daily) and 15.7 lbs/day (Max Month). The influent max month $CBOD_5$ loading is nearing the permit limit of 66 lbs/day $CBOD_5$. Low influent TSS loading is the result of receiving wastewater from a Septic Tank Effluent Pumping (STEP) system. There is no influent TSS loading permit limit.

Projected flows and loadings were determined based on yearly growth of existing flows and loadings as well as population growth expected by the District over the next 22 years (2043). A population growth rate of 3.0% was used to project future flows and loadings. Projected Max Month flow in 2043 is estimated to be 0.105 MGD. Projected Peak Day flow in 2043 is estimated to be 0.349 MGD.

Existing Sewer System Evaluation

Collection System

The District's collection system is a septic tank effluent pumping (STEP) system. Each individual connection includes a septic tank, a pump with controls and discharge pipe to the sewer main flowing to the District's wastewater treatment plant. The District's existing collection system contains approximately 27,900 linear feet (5.3 miles) of pressurized PVC sewer main piping, isolation valves, combination air release/vacuum valves, and clean outs. It is made up of piping 2 to 6 inches in diameter. Figure 4-1 in Appendix A shows the collection system pipe and appurtenances.

The District performs routine maintenance and repairs or replaces piping, pumps, tanks, valves, and air valves on an as-needed basis. The District has an ongoing septic tank inspection and replacement program. For this study a hydraulic capacity analysis of the collection system was performed for peak hourly flow (PHF) conditions for existing and build out conditions considering growth within the current District boundary and potential growth outside the current District boundary. Recommended improvements from the evaluation of the District's current operations and maintenance programs and the collection system capacity are discussed in Chapter 6.

Inflow and Infiltration

Infiltration and Inflow (non-sewage flows) increase the volume of wastewater in a sewer conveyance system causing pipelines and other infrastructure to be sized larger than necessary, operate at higher pressures, or increasing the risk of sanitary sewer overflows. Infiltration and inflow also increase the cost of treating sewage at the WWTP. STEP systems are pressurized and therefore have the benefit of very low or no I&I in the collection system piping. However, the District has historically suspected it has a problem with I&I in the collection system, primarily at and around septic tanks and connections.

An Infiltration and Inflow Analysis was completed as part of this Plan and is included as Appendix C. Rainfall and flow data analysis has quantified infiltration and inflow for comparison to EPA standards. The analysis concludes that infiltration is considered non-excessive, but inflow is considered excessive during larger rain events. The I&I Analysis also summarizes and discusses other observations and factors and identifies areas on which to focus improvements. The District has an ongoing septic tank inspection and replacement program been mitigating the I&I contributions in the last several years and is committed to rehabilitation for reducing I&I flows.

Wastewater Treatment Facility Evaluation

Aging infrastructure and capacity are the primary concerns of the District and a significant reason for this report. The existing plant is between 15-42 years old and has reached or will soon reach its end of life. Treatment has been effective through the wastewater treatment plant, however, many components, valves, and piping within the plant are no longer functioning, failing, or under capacity for future flows and loads. The existing treatment plant is also not capable of nutrient removal to the levels anticipated in future permit limits. In addition, the existing plant outfall is undersized for future flows.

Treatment Process Alternatives & Recommendation

Four treatment alternatives have been evaluated in this report based on Cost Effectiveness (Engineering, Construction and Operations), Treatment Effectiveness, Operations and Maintenance Demands, and Site Layout.

The four treatment alternatives evaluated are:

1. Alternative 1 - Activated Sludge (AS) with Biological Nutrient Removal (BNR) (i.e., Aeromod)
2. Alternative 2 – Activated Sludge (AS) with Biological Nutrient Removal (BNR) (i.e., Smith & Loveless)
3. Alternative 3 - Lagoon Upgrades with Biological Nutrient Removal (BNR) (i.e., Triplepoint)
4. Alternative 4 - Integrated Fixed Film Activated Sludge (IFAS) with Biological Nutrient Removal (BNR) (i.e., STM-Aerotor)

After a thorough study of the potential alternatives, Alternative 1 was determined to be the best solution for the District based on its ability to treat the expected flows and loadings to the permit conditions, future nutrient removal capabilities, as well as its low construction and operations costs.

Additional recommended improvements are presented in Chapter 6.

Executive Summary: Alternatives Cost Comparison

Process Alternatives	Total Cost	Annual O&M Cost	Total 22-yr Net Present Worth
Alternative 1 – Activated Sludge 1 - Aeromod	$4,074,000	$235,700	$8,972,803
Alternative 2 – Activated Sludge 2 – Smith & Loveless	$7,140,000	$248,700	$12,308,995
Alternative 3 -Lagoon Upgrade BNR - Triplepoint	$4,984,000	$266,400	$10,520,873
Alternative 4 – IFAS with BNR – STM Aerotor	$5,712,000	$308,100	$12,115,569

Future Sewer Service Requirements

The District will only provide sewer service where it is legally possible to do so considering applicable zoning and development regulations. Future condition projections include ultimate conditions (buildout) and the rate of growth. Buildout and rate of growth are affected by many ever-changing variables such as zoning, service area, specific type of developments, macro and local economic conditions, demographic changes, and other factors. The rate of growth can fluctuate considerably with short term rapid growth or very little growth depending on local economic conditions.

Potential Growth Within District Limits

The District plans to extend the sewer collection system within the District limits as the opportunity arises, such as in conjunction with a road reconstruction project or a new development project. Much of the District's growth within the current boundary, particularly growth known or expected in the next 20 years, is infill not requiring any major collection system extensions. UGA is a significant component of the District's future growth. The UGA boundary is almost entirely within the District's current boundary and significant growth on Lopez Island will be in the vicinity of the Lopez Village area within the District's service area. At this time, there are a few potential properties within the District limits that could be subdivided or grouped to create a development and could require extension of sewer mains.

Potential Growth Outside District Limits

The Growth Management Act (GMA) prohibits the extension of public sewers into rural areas. The District will only expand the sewer collection system outside their current boundary if either; a) the area is designated by San Juan County as Urban Growth Area (UGA) or Limited Area of More Intense Rural Development (LAMIRD), or b) San Juan County grants Conditional Use Permit Approval for the extension by showing it is necessary to protect public health and safety and the environment.

The hydraulic analysis performed in support of this plan has evaluated the District's sewer capacity to serve projected growth to build-out including two areas outside the current boundary: 1) Weeks Point Way Bay, and 2) Whiskey Hill Area. While specific conveyance projects to individual parcels have not been included in the plan, the District has determined that the areas of growth outside District limits can be adequately served with the construction of projects as described for each area. The cost of such improvements will be borne by development unless or until the District adds the project as a capital facility improvement.

Future Improvement Projects

This section describes the significant improvement projects that are scheduled for the next twenty years. The District has developed 10-year and 20-year sewer capital improvement plans which are included in Appendix G, and includes the anticipated project schedule and estimated project costs.

Additional or enhancements to existing programs are recommended as follows and described in more detail in the Plan:

Operations and Maintenance Improvements

1. Collection System, Septic Tank Inspection and Replacement – continue and enhance.
2. Collection System, Isolation Valve Exercising – implement.
3. Collection System, Air Valve Monitoring and Maintenance - continue and enhance.
4. Collection System, Line Flushing and Clean-Out Installations – implement.
5. Collection System, I&I Cross-Connection Investigations – implement.
6. Collection System, I&I Inflow Point Source Repairs – continue.

Administrative, Financial, and Planning Improvements

1. Emergency Response Plan – complete draft and routinely update.
2. GIS Development and Maintenance – continue to update.
3. Sewer Service Rate Increases – monitor and update.
4. Infiltration and Inflow Reduction Program – continue and enhance.

Collection System Capital Improvement Projects

1. Septic Tank Replacements – Ongoing.
2. Miscellaneous Sewer Line Replacement and Repair
    a. TIP Related Projects – none known, continue to monitor.
    b. Valve Replacements and Additions – known replacements needed, additional locations known.
    c. Capacity or Condition Related Projects – growth based pipe upgrades identified, potential operational flexibility project identified, continue to monitor for condition based replacements.
3. Developer Extension Projects – none known currently, one potential project in planning period.
4. Utility Local Improvement Districts – none known currently.

Sewer Rate Structure and Revenue Planning

Requirements for Connection to the District System

The requirements for connecting to the District sewer system are listed in District Resolution No. 2018-12 Administrative Code and Operations Resolution (included in Appendix F). Developed properties that lie within the District service area boundary are required to connect if the sewer is within or will be within 200 feet of the property line, subject to the capability of sewer service being provided by the District. The resolution also includes provisions for sewer main extension application agreements and permitting where necessary for the District to provide service. All connections to the District's system must be designed and installed in accordance with the requirements set forth in Resolution No. 2018-12 as well as the accompanying referenced District Sanitary Sewer Specifications (included in Appendix D). Connecting system designs must be reviewed and approved by the District Superintendent, installed by a registered licensed installer, and must be inspected by the Superintendent at various stages of installation (New Installation Checklist included in Appendix D).

Revenue Planning

The District performs a review of the sewer rate schedule regularly to determine that these charges are sufficient to generate revenue to offset the cost of all necessary operation and maintenance of the District sewer system, including projected capital improvement expenditures. In the event that this review indicates a necessary revision of user charges, or connection charges, the District amends the master rate schedule by formal resolution of the District Board of Commissioners. The District also investigates grants, loans, and possibly bonds to fund Capital Improvement Projects in the near term. The District seeks additional grant/loan funds from USDA-RD, Public Works Assistance Account (Loan), State Revolving Fund Grant/Loan (Ecology), and/or procure bonds for the near term major sewer capital projects as needed.

Sewer Rate Structure

The District sewer service rates and charges are summarized below and shall be subject to change by resolution of the District Board of Commissioners as conditions warrant. Full details of rates, charges, and fees including administrative fees are included in the District Master Rate Schedule-11, effective 1/1/2021, which are attached in Appendix F. The District bills for sewer service on a monthly basis.

1. Sewer Service Rates
   The sewer service rates, user fees, and miscellaneous incomes go to the District's general fund. The general fund is used for operating and maintaining the collection system and the plant, general office supply, employee salary and benefits, insurance and bond payment, engineering and legal services, utilities and rents, and miscellaneous expenses.

   Residential customers are billed the base rate and not billed for usage and are billed on an ERU basis, with incremental ERUs for larger dwellings with greater than 3 bedrooms or ADUs. The incremental ERU basis is also applied to multi-family residence connections. The District offers a discount to low or fixed income residential customers.

   Commercial customers are billed a commercial class base rate in addition to the ERU fee. ERUs are assigned based on the type of commercial use. Some commercial customers have effluent meters and they are billed for actual metered use, with a base volume allowance before an excess rate per gallon is charged. All new commercial customers are metered. Commercial customers not on effluent meters are charged based on 85% of water utility meters.

2. Sewer Connection Fee
   The sewer connection fee charges go to the District's reserve fund. The reserve fund is used for collection system and plant improvements and expansions. However, when it is needed, the District will use the reserve fund for general operating purpose. The District currently assesses the Sewer Connection Fee based on the assigned ERU value for each connection. The connection fee per ERU is the same for residential and commercial type connections. The District also charges for materials, at cost plus 15%, and labor rates for all District required materials and labor requirements necessary for connection installations and inspections.

3. Surcharge Fees
   A monthly surcharge fee of $5 per month per ERU is applied to all customers based on purchased ERUs, in additions to monthly sewer service rates. This surcharge fee is for the 1995 Wastewater Treatment Plant Expansion and is applied to the 1995 revenue bond, which was refinanced in 2003, and will be paid off in August 2022.

4. Cost per Service
   The District's current average cost per service is about $1,005 per ERU/year in terms of debt service and operation and maintenance costs. This cost includes $946 per ERU/year in operation and maintenance costs including employees, administrative and miscellaneous. Debt service costs are $59 per ERU/year. Debt service is low in the near term and current payments will be completed in year 2022. However, with the anticipated completion of major loan-funded capital WWTP and other projects, it is expected to increase by about $367,000 as newer debts are incurred (circa 2023). See Table 7-3 for existing and projected cost per service in terms of operations and maintenance costs and debt service.

Funding Capacity

The District has significant planned capital expenditures over the next approximate 22 years (2021 – 2043). The District has Hardship Status based on the Median Household Income (MHI) study performed fall 2020. As such, DOE or USDA loans for CIP projects in the future are anticipated to quality for approximately 50% (this could be more or less) loan forgiveness or grants and is reflected in the expenses for capital projects below. A summary of the anticipated revenues and expenditures for the District's wastewater system over the next 22 years is shown in the table below.

Executive Summary: Funding Capacity

	Low Estimate	Mean Estimate	High Estimate
Revenue [1]			
General Fund	$17,190,000	$19,100,000	$21,010,000
Reserve Fund	$2,160,000	$2,400,000	$2,640,000
Total Revenue	**$19,350,000**	**$21,500,000**	**$23,650,000**
Expenses [1]			
O&M / Admin	$15,660,000	$17,400,000	$19,140,000
Capital Projects [2]	$5,400,000	$6,000,000	$6,600,000
Debt Service [3]	$1,578,000	$1,753,000	$1,928,000
Total Expenses	**$22,638,000**	**$25,153,000**	**$27,668,000**

1. Annual growth and inflation increases included.
2. Assumes $6M of the estimated $12M is 50% grants (or forgivable loan) and the remaining $6M is funded.
3. Assumes $6M loan at 20-yr term and 2% interest rate.

As shown in the above table it is projected that the District may not have a sufficient revenue stream to fund operations and maintenance, debt service, and capital improvements. It is recommended that the District consider a rate increase based on a sewer rate study. One potential scenario considered in this analysis implements a 8.5% rate increase per year for the next 4 years to offset the projected deficiency. With a 8.5% rate increase for the next 4 years, the revenue mean estimate for 2021-2043 (22 year total) is projected to be about $25.5M and greater than the projected total expenses mean estimate for the same period. The base sewer fee would increase from $83 per ERU to approximately $115 per ERU.

Any future surplus funds can be allocated/reserved for emergency projects, unanticipated projects, and/or non-development related sewer extensions. It is the District's stated policy that land developers shall fund sewer extensions to unserved areas. The District's existing sewer collection and treatment systems have sufficient capacity (with planned improvements) to provide sewer service for all growth within the District service area boundary and outside for the next twenty years and through forecasted build-out.

1.0 - BACKGROUND INFORMATION

Purpose

This General Sewer and Facilities Plan (Plan) for the Fisherman Bay Sewer District (District) was prepared at the request of the Fisherman Bay Sewer District and in accordance with the Washington State Department of Ecology (DOE) requirements as presented in WAC 173-240-050 and 173-240-060, and the sewer-water district planning requirements as presented in RCW 57.16. This report is a replacement to the 2008 Wastewater System Master Plan.

The purpose of this Plan is to provide a recommended plan for required improvements to the existing wastewater treatment facility and collection system to address aging infrastructure & challenging equipment, future flow and loading capacity, future nutrient removal requirements, and current standards for redundancy and reliability. This report evaluates the District's wastewater needs based on projected residential population growth and commercial and industrial demands on the treatment system through the year 2043.

This Plan includes a schedule for the District to provide adequate sewer collection and treatment capacity in accordance with Washington DOE requirements. In addition, this Plan is intended to be used to apply for and receive either grants or loans from the Department of Ecology, USDA, CDBG, or other funding sources for Sewer Capital Improvement Projects. Finally, this General Sewer Plan and Facilities Plan is intended to satisfy the requirements of the Washington State Growth Management Act (GMA – RCW 36.70A.070 (3)).

The authorized representative for the District is listed below.

Tom McDaniel
District Commissioner
Fisherman Bay Sewer District
P.O. Box 86
Lopez Island, WA 98261
360-468-2131

Background

Fisherman Bay Sewer District is located on Lopez Island in San Juan County, State of Washington. The District operates a wastewater treatment plant and a sewer collection system that serves a portion of the residents on Lopez Island. Users in the District include residents, a school, a few retail businesses, restaurants, hotels, and offices. The District's collection system consists entirely of a septic tank effluent pumping (STEP) system and pressurized PVC and HDPE sewer main piping. The District serves a population of approximately 819. Wastewater flow to the WWTP is primarily domestic sewage from residential areas within the District. There are no significant sources of industrial wastewater.

The existing wastewater treatment plant consists of a pretreatment anaerobic cell followed by an aerated lagoon facility. The plant is located at 620 Lopez Road North on Lopez Island. A constructed wetland is used to polish the lagoon effluent prior to plant effluent chlorine disinfection and final discharge. Treated effluent is piped approximately one half mile and discharged through an outfall diffuser into the San Juan Channel. The District operates the plant under a NPDES discharge permit (WA0030589, See Appendix J) issued by the Washington State Department of Ecology (DOE). The current permit was issued on February 1, 2017 and will expire on February 28, 2022. The permitted capacity of the plant is 53,000 gpd MMDF and 66 lb/day $CBOD_5$ max month influent loading.

Service Area

The service area within the District boundaries is approximately 320 acres. The District is currently establishing its urban growth boundaries in compliance with the Growth Management Act (GMA).

See Appendix A for service area, location, and vicinity maps.

Scope and Objective

General

This Plan will identify needed capital facility improvements to the District's sewer collection system and treatment plant infrastructure based on existing and future capacity needs, and replacement of aging infrastructure. These needed improvements become Capital Projects with a preliminary scope, cost estimate, and proposed schedule. The District has various funding sources available for sewer capital projects including (but not limited to) sewer rates and connection fees, bonds, loans, grants, utility local improvement districts (ULIDs), and developer extension contracts.

Scope and Objective

The purpose of this General Sewer Plan and Facilities Plan is to provide a comprehensive overview of the existing sewage collection and wastewater treatment facilities currently operated and maintained by the District. In addition, this report addresses proposed future facilities development and population growth within the District's boundaries. This report evaluates the District's wastewater facility needs based on projected residential population growth and commercial and industrial demands on the collection and treatment system through 2043, based on population projections developed pursuant to policies and procedures described in the GMA. This evaluation includes the District's urban growth areas around Lopez Village.

This report will cover the following topics:

- system owner/operator information
- sewer system layout including a description of the existing system boundaries,
- description of existing collection and treatment facilities including recently completed improvements
- discussion of development trends within District's sewer boundaries
- discussion of existing and future collection and treatment issues such as current and future sewer flows, and infiltration and inflow (I & I)
- discussion of sewer rate structure and revenue planning
- discussion of present and future development alternatives within the District's boundaries and wastewater treatment facilities
- outline of future improvement projects within the District

Overview of Growth Management Implications on this General Sewer Plan and Facilities Plan

This General Sewer Plan and Facilities Plan for the Fisherman Bay Sewer District seeks to comply with the San Juan County Comprehensive Plan and the requirements of the Growth Management Act. The primary reasons for the District to create its plan at this time are:

- to ensure compliance with regulations requiring regular updates
- to incorporate capital improvements made in the last several years
- to reflect changes to the Lopez Village Urban Growth Area boundaries over the last several years
- to model and analyze the collection system's capacity to meet existing and future needs, and identify capital projects where necessary to meet those needs
- to outline and update the District's Sewer Capital Improvement Plan for the sewer system
- to ensure the District's ability to set and collect appropriate connection charges and sewer service charges for all District facilities.

This Plan considers all aspects of District operations including normal daily plant and system operations, emergency response needs and capabilities, facility and network refurbishment, and, of course, the capacity expansion required to accommodate both the population growth defined in the reference documents and anticipate future development.

Documents Incorporated by Reference

The District maintains several documents that are relevant to this General Sewer Plan and Facilities Plan that are hereby incorporated by reference. Since the nature of these documents require them to be updated separately from the General Sewer Plan or Facilities Plan, they have not been integrated into this Plan. Some of these documents have been attached as Exhibits for convenience and are current as of the Plan publication date, but are subject to change and should not be considered the official version of the document.

The documents incorporated by reference include:

- Developer Extension Agreement - Master Form
- Lopez Village Abbreviated Coordinated Water System Plan
- Fisherman Bay Water System Plan
- Milagra Water System Plan

Previous Reports

A draft Comprehensive Plan was prepared in July 1976, then scaled down in May 1977, and adopted by the Commission of the District in 1978 to describe this new District, its boundaries and its responsibilities. The General Sewer Plan and the Engineering Report were approved by the Department of Ecology (DOE) in August 1979. Amendment No. 1 to the Comprehensive Sewer Facilities Plan was prepared in April 1984 by James E. Wilson & Associates. When the original lagoon plant was expanded in 1994, an Engineering Report was prepared by Anne Symonds & Associates, Inc. and approved by the DOE.

The most recent FBSD Master Plan, "Fisherman Bay Sewer District Wastewater System Master Plan", was produced by Stantec Consulting, Inc. with the cooperation of the District. It was approved by the District in August of 2008. The 2008 plan focused on the wastewater treatment plant and provided the base material that has been updated for this new Plan.

In 2009, Stantec provided a report titled: "FBSD WWTP Capacity Rerating Engineering Report" that served as the critical basis that allowed the Washington State Department of Ecology (DOE) to rerate the Fisherman Bay Wastewater Treatment Plant to process up to 53,000 gallons per day (GPD).

System Owner/Operator Information

Office Location and Governing Information

The sewer collection and treatment facilities covered in this report are owned and operated by:

Fisherman Bay Sewer District
Old Fish Bay Lumber Building
295 Village Road, # 101
P O Box 86
Lopez Island, Washington 98261
(360) 468-2131 – Office Telephone

The lead operator is Roy Light, a Group III operator. The primary contact for the District is Tom McDaniel.

Fisherman Bay Sewer District was formed in 1974 by San Juan County Commissioners, by Resolution No. 30-1974 and approved by District residents in a special election on April 30, 1974. The intent of the District and its mission is to protect the entire Fisherman Bay environment and the health of its residents by providing secondary wastewater treatment at a centralized facility.

Operations Information

The District is responsible for planning, construction, and operation/maintenance of all public sewer facilities within the District's boundaries. The operation and maintenance of the District's facilities is overseen by a lead operator who works with a support staff consisting of office administrative staff and operations and maintenance crew. The District contracts for legal counsel and consulting engineers. The District operates out of the offices at the Old Fish Bay Lumber Building, 295 Village Road, # 101, Lopez Island, WA, and the Wastewater Treatment Plant at 620 Lopez Road, Lopez Island, WA.

District Boundaries and Sewer Service Areas

General District Boundary Information

The planning area generally consists of three main areas: the Lopez Village, the East Shore North (ESN) and the East Shore South (ESS). However, citing past discussions with the County Council and President of the County Council, the District has determined there is no chance for the East Shore South area to be annexed to the District. Thus, it is not considered in this report and analyses.

These boundaries were developed with the first Comprehensive Plan in 1976 when the District was established by the County. The planning area included in the first comprehensive plan, written in 1976 by ARC Engineers of Redmond, WA, reflect the intention of the County to protect the people, water resources, and environment of Fisherman Bay.

In 2008, San Juan County planning policy designated the Lopez Village core as a Village Commercial Land Use District urban growth area. The District's 2008 Wastewater Master Plan shows that the district's service area includes all the parcels within the Lopez Village UGA. The District also retains the right to serve parcels located outside of the UGA that had been part of Utility Local Improvement Districts (ULIDs) prior to the establishment of the GMA.

Existing Sewer Service Areas

The District's service area initially consisted of the Lopez Village area only. In August 1983, the Eastshore North area was annexed into the District. Currently the far north boundary of the service area is approximately 1/4 mile north of the Sunset Lane. The San Juan Channel shoreline is generally the west boundary of the service area. The Whiskey Hill Road is the far south boundary, and the east boundary is generally between Fisherman Bay Road (County Road #103) and Charlie Lane. The District's service area encompasses approximately 320 acres of land. Figure 1-1 in Appendix A show the current service area.

Proposed Sewer Service Areas

Zonings in the District's service area include Lopez Village Urban Growth Area (UGA), Marine Center LAMIRD (limited area of more intense rural development), Growth Reserve, Village Commercial (VC) District and Rural Farm Forest (RFF).

The Lopez Village Commercial Land Use District UGA covers an area of about 197 acres and includes the Lopez Village Commercial Core as well as properties north and south of the village core. Approximately 151 parcels are part of this area. Figure 1-2 in Appendix A shows this UGA area. A majority of the UGA lies within the District's current service area.

The base density in the Lopez Village Urban Growth Area was four single-family dwelling units per acre in 2008 with no minimum lot size. The 2018 Lopez Village subarea plan raises the base density to six units per acre in the Village Residential designation. There is no base density in the Village Commercial designation.

Density bonuses in the Lopez Village Urban Growth Area development regulations encourage the creation of affordable housing units. The Lopez Village Subarea Plan raises the density bonus from a maximum of eight units per acre to twelve units per acre provided that a development meets the requirements for water conservation and number of affordable housing units outlined in the San Juan County Code.

The LAMIRD consists of approximately 26 acres. Density in the LAMIRD is governed by the VC land use district as listed in SJCC18.30.040, Table 3.1., Allowable and Prohibited Uses in Activity Center Land Use Districts, allow a residential density of four (4) dwelling units per acre.

The Growth Reserve area shown on Figure 1-3 in Appendix A covers approximately 57 acres of land within the District boundaries. Density in the Growth Reserve area as well as the RFF zoning area is one residential dwelling unit per five (5) acres.

Other Service Area Characteristics

Appendix A, Figures 1-4 and 1-5 show Adjacent Water Purveyors and Soils Topography.

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2.0 - REGULATORY REQUIREMENTS

The purpose of this section is to identify the federal, state, and local regulations that affect the planning and design of wastewater facility improvements. Fisherman Bay Sewer District's existing WWTP and outfall are located in Washington State and are therefore regulated by the Department of Ecology. Collection system projects are not covered in this chapter; however, the permitting required for these projects will likely include local and San Juan County permits and also potentially an Archeological and Cultural Resources Survey depending on the funding source.

Federal Clean Water Act – NPDES

The National Pollutant Discharge Elimination System (NPDES) is part of the Clean Water Act (CWA). Most NPDES permits have a five-year life span, and they place limits on the quantity and quality of discharged pollutants. As a municipal wastewater treatment facility, the District's WWTP is regulated by the NPDES permit issued by the Department of Ecology. The District's current NPDES permit (Appendix J), No. WA-0030589, was issued on February 1, 2017, and expires February 28, 2022. Permittees must submit a complete application for permit renewal at least 180 days prior to the expiration (in this case, September 1, 2021)

Additionally, the NPDES permit requires a plan when flows or waste loads entering the WWTP exceed 85% of design criteria for three consecutive months or the projected plant flow or loading exceeds 100 percent of any design criteria in the reporting month or if significant improvements are needed to keep the plant in compliance. This Plan includes an evaluation of the WWTP existing conditions and provides recommendations for improving and maintaining adequate capacity to ensure long-term NPDES permit compliance. The current NPDES permit facility loading design criteria is:

Maximum Month Design Flow (MMDF)	0.053 MGD
$CBOD_5$ Influent Loading for Maximum Month	66 lb/day

National Environmental Policy Act (NEPA)

The National Environmental Policy Act (NEPA) requires assessing the environmental impacts of federal actions (any action, such as funding, use of federal resources, etc.), considering those impacts while making decisions, and disclosing those impacts to the public. The improvement project funding source will determine if NEPA is required. For federal granting agencies, such as USDA Rural Development and Department of Commerce, an Environmental Assessment report will be required prior to construction. However, for federal funding through the Department of Ecology (such as the Clean Water State Revolving Fund), Ecology's State Environmental Review Process (SERP) will meet federal requirements.

State Environmental Review Process (SERP)

Per Appendix N of the Washington State Department of Ecology Publication 20-10-024 the Clean Water Act requires Ecology to ensure a complete review of the potential environmental impacts of treatment works projects financed through the State Water Pollution Control Revolving Fund. Ecology may use the National Environmental Policy Act (NEPA) or they may provide a state equivalent review for approval by the EPA. This review is referred to as the State Environmental Review Process, or SERP.

The components of environmental review (facility plan, reasonable alternative, SEPA, permitting, mitigation, public outreach) provide the necessary items for Ecology to make a SERP determination. These components make up what is often referred to as a SERP package.

The SERP package contains elements of environmental and cultural review that Ecology can use to make a complete SERP review of the project. The SERP package requirements were updated in January 2021 and include the following components:

1. SEPA Review Documentation including the SEPA checklist and Threshold Determination
2. Evidence of public participation opportunities throughout the project
3. Documentation of the socioeconomic, Environmental Justice and Civil Rights impacts of the project
4. Completed Ecology Executive Order 05-05/Section 106 Cultural Resources Review
5. Designated Equivalency Projects Section
6. Documentation of other permits, environmental laws or consultations triggered by the project or its funding

The SERP package is submitted to the Ecology project manager and environmental coordinator for review. The SERP deadline depends on the loan type and phase of the project being funded (i.e., planning, design, construction, etc.). Table 2-1 shows the timing for various loan types and phases.

Table 2-1: SERP Timing

Loan Type/Phase	SERP Deadline
Planning Phase	Include as a deliverable in the funding agreement
Design Phase	Include as a deliverable in the funding agreement
Design & Construction Phase	Before starting construction
Construction Only Phase	Before signing the funding agreement

State Environmental Policy Act (SEPA)

The State Environmental Policy Act (SEPA), as presented in WAC 197-11-960, requires all governmental agencies to ensure that applicable environmental concerns are addressed in the process of project planning and documentation. Projects that have potential environmental impacts must complete a SEPA Checklist to satisfy planning and disclosure requirements. San Juan County is a SEPA lead agency for projects occurring within District limits. As part of this planning document a planning level SEPA and its determination are included. A project SEPA, and determination by the District, which is a SEPA lead agency, will be required prior to construction. The project SEPA checklist and determination will need to be completed during the design phase of each project presented in this facilities plan. The District intends to submit the SEPA checklist during the design phase of each project presented in this plan. Note that projects receiving funds from the Clean Water State Revolving Fund (Department of Ecology) will also need to comply with SERP (see discussion above).

Investment Grade Efficiency Audit (IGEA)

Per Engrossed Substitute House Bill 1497 Section 1021 projects involving repair, replacement, or improvement of a wastewater treatment plant or other public works facility for which an investment grade audit is obtainable, the public works board must require as a contract condition that the project sponsor undertake an investment grade audit.

There are currently four ways that a project can meet the IGEA requirement:

1. Provide documentation that IGEA requirements have been met in the past
    - An audit showing potential energy savings
    - A design review
    - Documentation must be less than 3 years old
2. Provide a third-party design review of the project
    - The design review will focus on the energy intensive process: motors, pumps, blowers, etc.
    - A design firm can sub-out to a qualified third party for "peer review" on the energy components
    - The design review can also be conducted by the power provider, if available.
3. Demonstrate that the project has no "obtainable" energy savings
    - This only applies to projects receiving funding with no energy use, i.e., "pipes and pavement"
4. Complete a preliminary energy audit and/or an IGEA on the existing system
    - An IGEA will identify cost effective energy strategies to save power and money
    - The audit can be prepared by the power provider or an Energy Services Company (ESCO)

Cost and Effectiveness Analysis (CEA)

Projects receiving funding from the Clean Water State Revolving Fund (CWSRF) must certify that a Cost and Effectiveness Analysis (CEA) has been conducted. A CEA must include a comparison of the life-cycle costs of alternatives, taking into account:

- The cost of constructing the project or activity
- The cost of operating and maintaining the project or activity over the life of the project or activity
- The cost of replacing the project or activity
- The selection, to the maximum extent practicable, of a project or activity that maximizes the potential for efficient water use, reuse, recapture, and conservation, and energy conservations.

The CEA certification is completed in the Ecology Administration of Grants and Loans system (EAGL), and must occur prior to loan signing for activity projects, facility design projects, facility construction projects, and combined facility design/construction projects. The content of this plan is intended to cover the CEA requirements for the recommended projects.

Archaeological and Cultural Resources Survey

In November 2005, the Governor of Washington signed Executive Order 05-05 which requires state agencies to review capital construction projects for potential impacts to cultural resources. This review is to be done in conjunction with the Department of Archaeological and Historic Preservation (DAHP) and any affected Tribes.

If the project receives federal funding, the federal counterpart to Executive Order 05-05, Section 106 of the National Historic Preservation Act will be required instead. On the part of the funding recipient the cultural review process forms are the same and are still submitted to the Ecology project manager and environmental coordinator.

Unless one has been completed recently, an archaeological and cultural resources survey will need be completed during any design phase of WWTP improvements projects where ground disturbance is required (including geotechnical testing). During design, the District will contract with a state approved archaeologist to perform the survey and to consult with the DAHP and affected Tribes. The archaeologist's report will include survey findings as well as any recommended mitigations such as construction monitoring.

Note that for projects that will be using Department of Ecology funding, the cultural resources must be completed before any ground disturbance, and Department of Ecology will need to perform its own cultural resources review, getting concurrence from DAHP and tribes.

Stormwater Permitting in the State of Washington

As part of the federal Clean Water Act, the Department of Ecology administers the State of Washington's Construction Stormwater General Permit. Construction runoff is considered a point source of water pollution and therefore an NPDES permit is required. The State of Washington has developed a General Permit for Construction Stormwater.

Construction stormwater permit coverage is required if the project disturbs more than one-acre of land and the possibility exists of stormwater runoff entering waters of the state or conveyance systems that deliver stormwater to waters of the state.

As such, depending on project size, future WWTP improvements may require coverage under the Construction Stormwater General Permit. This would entail preparation of a project-specific Stormwater Pollution Prevention Plan (SWPPP), which would be submitted to and reviewed/approved by the County during the design phase.

San Juan County Codes

The District's collection system and treatment facility is located within San Juan County's jurisdiction. It is anticipated that the following permits will be required by the County:

- Building Permit (to include plumbing and electrical)
- Land Disturbance / Critical Areas Permit
- SEPA Checklist
- Right-of-way / Utility Encroachment Permits

Regulatory Summary

A summary of the regulatory requirements for improvements to the Fisherman Bay Sewer District WWTP is presented in Table 2-2.

Table 2-2: Summary of Regulatory Requirements

Permit/Report	Agency	Comments/Timeframe
NPDES Permit	Department of Ecology	The design of future improvements will meet current and anticipated future NPDES requirements. A new permit will be issued during Q1 2022.
NEPA	Federal – varies depending on project/federal trigger	To be submitted during design phase if project receives federal funding (such as USDA). Environment Assessment to be completed prior to construction.
SERP	Department of Ecology (as required by EPA)	Timeframe varies, see Table 2-1.
SEPA	District/Ecology	Planning SEPA: To be submitted with engineering report, sewer plan, or facilities plan. Project SEPA: If required by SERP, to be submitted per Table 2-1
IGEA	Ecology	To be completed during design phase.
CEA	Ecology	Certification to be completed prior to loan signing.
Cultural/Archaeological Survey	DAHP	To be completed during design phase.
Shoreline Permit	San Juan County	To be submitted during design phase.
HPA	WDFW / USAC	Not required for wastewater treatment plant. Will be required for any outfall project.
Aquatic Lease	WDNR	May be required for outfall improvements, to be completed during the design phase.
Construction Stormwater Permit	Ecology	To be submitted during design phase.
Building, Electrical and Plumbing Permits	San Juan County	To be submitted during design phase.

Water Bodies

There are no significant surface water bodies near the wastewater treatment plant site. In the event of overflow, wastewater would flow to nearby stormwater ditches and to the San Juan Channel.

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3.0 - FLOWS AND LOADINGS

This section describes and analyzes the existing and future flows and loadings to the wastewater treatment facility through a 22-year planning period (2043). Quantifying the existing loading to the WWTP is necessary to determine the level at which future flows and loadings will be used to size upgrades to the WWTP that will be required to meet the demands of future growth and regulatory requirements.

Existing Wastewater Flows

Wastewater flow is continuously measured at the WWTP through an influent and effluent flume measured by an ultrasonic level sensing flow meter. The location of the influent flume is just upstream of pipe bends which has resulted in problematic flow measurements. Water in the influent flume will overflow the flume resulting in inaccurate measurements at high flows. The effluent flume does not have the same problem as peak flows are equalized in the treatment plant.

The influent flows and loadings vary with seasonal population increases due to tourism during the summer months. Summer population increases begin in April, peak in July, and end after September.

Annual Average

Table 3-1 presents the annual average wastewater flows as recorded at the District WWTP influent during the years 2017 through 2020.

Table 3-1: Fisherman Bay Sewer District WWTP Annual Average Flow

Year	Flow (MGD)
2017	0.0298
2018	0.0310
2019	0.0330
2020	0.0280
Average =	0.0304

Monthly Average

Table 3-2 presents monthly average flow measured at the WWTP influent flume for the years 2017 through 2020. It also shows wet weather (November – May) and dry weather (June – October) averages for each year. It should be noted that influent flows in the summer of 2020 were substantially lower than previous years as a result of the Covid-19 pandemic reducing tourism to the island.

Table 3-2: Fisherman Bay Sewer District WWTP Monthly Average Flow

Month/ Year	Flow (MGD)			
	2017	2018	2019	2020
Jan	0.0355	0.0266	0.0381	0.0290
Feb	0.0254	0.0277	0.0271	0.0294
Mar	0.0303	0.0247	0.0266	0.0205
Apr	0.0252	0.0262	0.0266	0.0160
May	0.0357	0.0243	0.0274	0.0196
Jun	0.0350	0.0292	0.0309	0.0213
Jul	0.0372	0.0469	0.0834	0.0300
Aug	0.0310	0.0484	0.0347	0.0335
Sep	0.0270	0.0360	0.0277	0.0312
Oct	0.0227	0.0268	0.0236	0.0290
Nov	0.0232	0.0270	0.0223	0.0287
Dec	0.0249	0.0288	0.0243	0.0447
Annual Average:	**0.0294**	**0.0310**	**0.0327**	**0.0277**
Wet Weather (Nov-May) Average	**0.0286**	**0.0268**	**0.0268**	**0.0268**
Dry Weather (June-Oct) Average	**0.0306**	**0.0375**	**0.0401**	**0.0290**

Peak Month, Peak Day and Peak Hour

Table 3-3 summarizes peak month and peak day flows as recorded at the WWTP influent flume for the years 2017 through 2020. The average annual peak month flow for the period is 0.053 MGD and the average annual peak day flow is 0.177 MGD. Peak month and peak day flows have historically occurred during either winter months (i.e., December) coinciding with rain events and inflow and infiltration (I&I) in the collection system or summer months (i.e., July or August) coinciding with high tourism and summer residents.

Table 3-3: Fisherman Bay Sewer District WWTP Peak Month and Peak Day Flows

Year	Peak Month Flow (MGD)	Month	Peak Day Flow (MGD)	Month
2017	0.037	July	0.101	July
2018	0.048	August	0.115	December
2019	0.083	July	0.179	July
2020	0.045	December	0.312	December
Average =	0.053	Average =	0.177	
Maximum =	0.083	Maximum =	0.312	
Percent of Limit =	157%		--	
Permit Limit =	0.053		--	

Existing Wastewater Loadings (CBOD, TSS)

The WWTP's influent wastewater quality is characterized below in Table 3-4 and Table 3-5 in terms of 5-day Carbonaceous Biochemical Oxygen Demand ($CBOD_5$) and Total Suspended Solids (TSS). $CBOD_5$ and TSS are the primary concern due to their influence on sizing and selection of wastewater treatment facilities.

Table 3-4: Fisherman Bay Sewer District WWTP Influent CBOD and TSS Loading

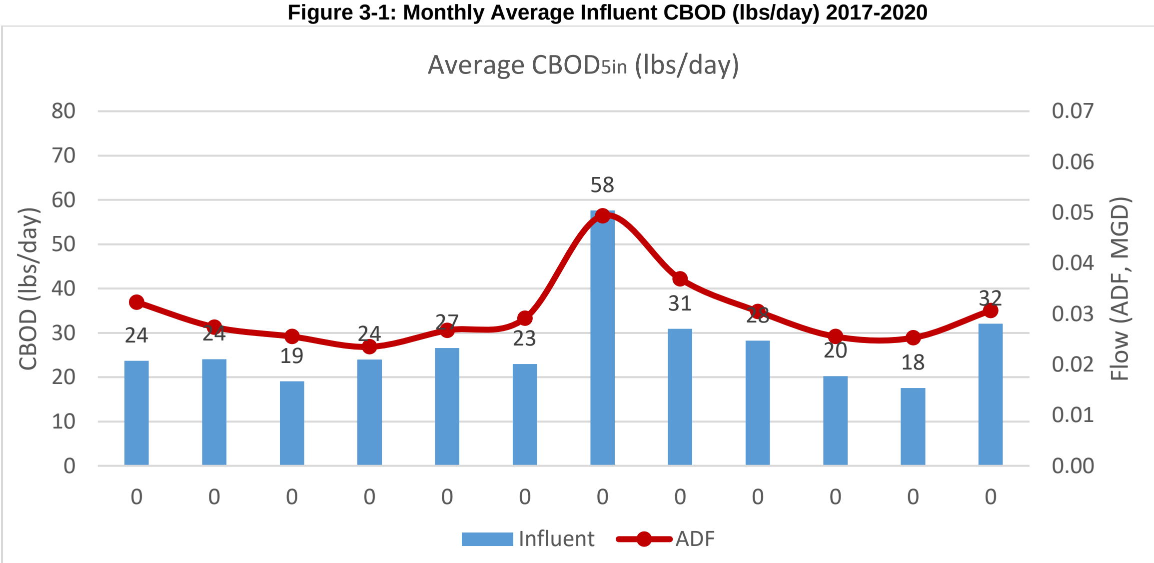
Year	Average Daily CBOD (lb/day)	Max Month CBOD (lb/day)	Average Daily TSS (lb/day)	Max Month TSS (lb/day)
2018	28.6	58.3	5.7	11.1
2019	28.8	74.4	7.0	23.0
2020	25.8	54.7	6.5	13.1
Average =	27.7	62.4	6.4	15.7
Maximum =	28.8	74.4	7.0	23.0
Percent of Limit =	42%	113%		
Permit Limit =	**66.0**	**66.0**		

Table 3-5: Fisherman Bay Sewer District WWTP Influent CBOD Loading, Wet and Dry Weather

Summer = July-AugWinter = Jan-Feb	Summer CBOD5in	Summer CBOD5in	Winter CBOD5in	Winter CBOD5in
	(mg/L)	(lbs/day)	(mg/L)	(lbs/day)
Average =	142.7	57.6	99.0	23.9

Peak month influent CBOD loading is currently about 62.4 lb/day or about 94% of the permit limit of 66 lb/day. Figure 3-1 below shows that July historically has high flows and loads (CBOD) entering the WWTP. This is due to increased tourism, particularly in the month of July.

Figure 3-1: Monthly Average Influent CBOD (lbs/day) 2017-2020



Existing Nutrient Loading

Table 3-6 below shows the results of recent sampling analyzing influent and effluent nutrient levels. TKN is especially high, averaging 72.2 mg/L. The CBOD to TKN ratio is also especially low, averaging 1.6. Despite these influent levels, the plant has been successful at removing TKN, with an average effluent TKN of 6.1 mg/L.

Table 3-6: Nutrient Loading

	INFLUENT				EFFLUENT			
Sample Date	**TKN (mg/L)**	**AMMONIA (mg/L)**	**CBOD (mg/L)**	**CBOD:TKN RATIO**	**TKN (mg/L)**	**AMMONIA (mg/L)**	**NOx (mg/L)**	**TIN (mg/L)**
6/27/2018	45.5	42.0	142	3.1	4	2.44	0	2.44
9/5/2018	133	70.1	118	0.9	4.36	3.98	0	3.98
5/16/2019	83.4	56.1	124	1.5	6.21	5.51	0.73	6.24
7/10/2019	72.7	64.1	129	1.8	2.07	1.03	0.22	1.25
10/15/2019	65.6	61.1	71	1.1	4.91	3.61	4.69	8.30
5/7/2020	47.2	46.8	99	2.1	12.8	11.5	1.53	13.03
7/7/2020	72.7	71.3	73	1.0	0.97	0.63	0.84	1.47
9/15/2020	58.9	58.5	129	2.2	0.99	0.16	4.38	4.54
12/9/2020	70.7	61.9	65	0.9	18.8	18.2	3.47	21.67
AVERAGE	**72.2**	**59.1**	**105.6**	**1.6**	**6.1**	**5.2**	**1.8**	**7.0**

Future Projected Wastewater Flows

Wastewater average daily flow is projected to increase at a growth rate of 3.0% which is based on historical growth and future anticipated developments within the service area. Data was not available from 2008 to 2021. Table 3-7 shows historical ERU data since 1996. Table 3-8 displays the existing and projected average and peak flows to the WWTP from the collection system.

Table 3-7: Fisherman Bay Sewer District Historical ERU Count

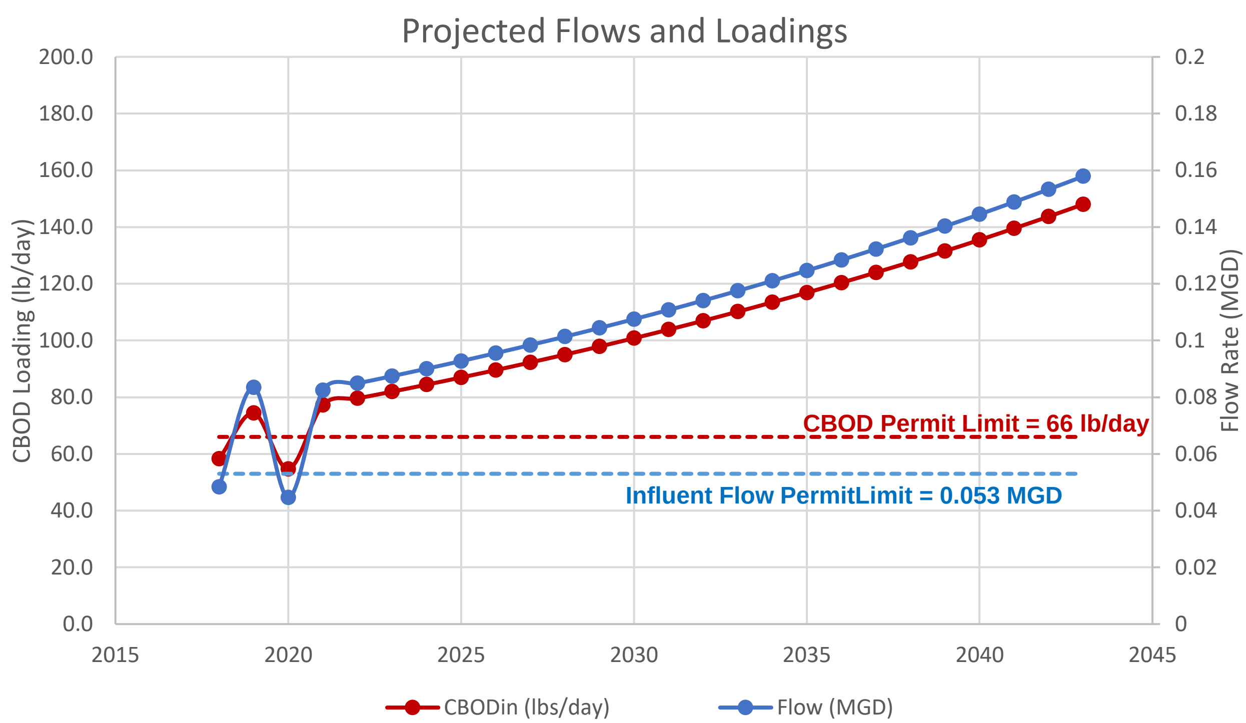
Year	ERUs
1996	213
1997	223
1998	224
1999	234
2000	234
2001	234
2002	255
2003	257
2004	258
2005	295
2006	297
2007	309
Current 2021	389

Table 3-8: Fisherman Bay Sewer District WWTP Projected Flows

Parameter	2021	Projected 22 years 2043
ERUs	389	745
Average Daily Flow (MGD)	0.030	0.060
Peak Month Flow (MGD)	0.053	0.105
Peak Week Flow (MGD)	0.120	0.23
Peak Day Flow (MGD)	0.177	0.349
Peak Hour Flow (MGD)	0.354	0.698
Peak Instantaneous (MGD)	0.707	1.40

Figure 3-2 shows the existing and projected influent flows and loadings to 2043, based on the 3.0% growth rate. Average flows and loads are already at or above design criteria limits showing that improvements to the WWTP should be made as soon as possible.

Figure 3-2: Existing Peak Month Influent Loading and Flow 2018-2020.
Projected Peak Month Influent Flow and Loading 2021-2043.



Future Projected Wastewater Loadings (CBOD, TSS)

Influent loadings of CBOD and TSS are expected to increase proportionally with increase in flow. In other words, the concentration will remain the same, while the loading will increase as the flow increases. Table 3-9 displays the projected loadings to the WWTP compared to the permit limits.

This Plan details the alternatives and the selected approach to upgrading the WWTP. The planned date for completion of the WWTP upgrade is 2023.

Table 3-9: Fisherman Bay Sewer District WWTP Projected Loadings

	Permit Limits	2021 Average	22 years (2043)
ERU Estimate	--	389.25	746
Average CBOD (lb/day)	--	29	57
Peak Month CBOD (lb/day)	66	75	148
Projected Average TSS (lb/day)	--	7	14
Projected Peak Month TSS (lb/day)	--	23	45

4.0 - EXISTING SEWER SYSTEM EVALUATION

4.1 - Collection System and Delivery System

This section describes and analyzes the existing District collection system. The collection system is a septic tank effluent pumping (STEP) system with pressurized delivery system piping that conveys wastewater directly to the District Wastewater Treatment Plant. Analysis of the current and future projected wastewater flows for the system, as well as a discussion of the system inflow and infiltration, is included.

System Description

The District's collection system is a septic tank effluent pumping (STEP) system. Each individual connection includes a septic tank, a pump with controls and discharge pipe to the pressurized sewer main flowing to the District's wastewater treatment plant. The District inspects the septic tanks on a regular schedule and the pumps as needed. The STEP system is operated and maintained by the District. The District has standardized their submersible pumps and septic tank installations and is working on updating tanks and pumps not meeting the standards. There are a few remnant different types of submersible pumps in use, but they have similar motor and discharge characteristics to the standard. The District typically receives about one to two calls each month from users for assistance. All pumps are equipped with audible alarms. The District reviews and approves new connections and enforces septic tank maintenance requirements. A copy of the District's New Installation Checklist is included in Appendix D.

The District's existing collection system contains approximately 27,900 linear feet (5.3 miles) of pressurized PVC and HDPE sewer main piping, isolation valves, combination air release/vacuum valves, and clean outs. It is made up of piping 2 to 6 inches in diameter. Table 4-1 summarizes the collection and delivery system piping components for the District collection system.

Table 4-1: Fisherman Bay Sewer District Collection System – Component Listing

System Component	Approximate Quantity
Isolation Valves	28
Air Release/Vacuum Valves	13
Clean Outs	5
2-inch PVC	8,690 LF
3-inch PVC	3,660 LF
4-inch PVC	8,320 LF
4-inch HDPE	1,930 LF
6-inch PVC	5,000 LF

The District previously had no digital mapping files. Piping and other infrastructure locations and information has been provided by District staff and paper map records. This data was integrated into a GIS database as part of this study. Figure 4-1 in Appendix A is based on this GIS database and shows the sewer pipe and appurtenances locations.

System Capacity and Condition

Sewer zones and trunk main information including size, length, elevations, and capacity information is included as part of the sewer hydraulic capacity analysis included in Appendix H. For the hydraulic analysis the collection system was evaluated under peak hourly flow (PHF) conditions for existing and build-out conditions. Build-out conditions were evaluated for: a) growth within the current District boundary plus, and b) potential growth outside the current District boundary. The criteria used to evaluate the capacity of the collection system main piping were:

- Pipe velocity < 5 ft/s
- Head loss (hL) < 1.5 ft / 100 ft of pipe
- Total Dynamic Head (TDH) < 200 ft

The total dynamic head criteria were determined based on the minimum recommended flow (5 gpm at 225 ft TDH) from the manufacturer pump curve and a conservative estimation of head loss of 25 ft through the service line (200 feet of 1-inch diameter pipe at 12 gpm) from the effluent pump to the main piping.

Hydraulic analysis information including sewer zones and system network nodes mapping, future ERUs mapping, sewer zone information table, analysis spreadsheet model calculations, and piping improvements map are all included in Appendix H. There are no new sewer main extension capital improvement projects currently planned. However, as a result of this Plan, there are planned improvement projects for existing sewer mains, which are detailed in Appendix H and Chapter 6, Section 2. There are also two areas of potential future growth outside of the current service area that would require sewer main extensions at the time of their development. Schedules for these potential projects are not included since they are outside service area boundaries and there are no known plans for their development.

The District's last two significant collection system capital projects include the following:

- 2018 – Replacement of the Normandy Ln sewer main with 4-inch HDPE, and
- 2005/2006 – Installation of the 4-inch East Loop Trunk Fisherman Bay Road to WWTP.

The District performs routine maintenance and repairs or replaces infrastructure such as valves and air valves on an as-needed basis. Currently there are several known "frozen" isolation valves that need to be replaced. These valve replacements are identified in Chapter 6, Section 2. Other routine maintenance programs including valve exercising, air valve maintenance, and line flushing are recommended and discussed in Chapter 6, Section 1.A. Concurrent with development of a line flushing program it is recommended to install additional force main/pressure system type cleanouts where needed.

The District has an ongoing septic tank inspection and replacement program. The District's policy is to inspect each residential tank every two (2) years and each commercial tank every year, and excluding year 2020 impacted by COVID-19, has historically achieved this goal. The District also performs yearly grease trap tank inspections. They keep a database of inspection records and condition status. Observations from system operators are made during routine septic tank investigations, and occasionally during special customer callouts for tanks being in alarm status, etc. The District keeps a database of their routine septic tank inspections, and records information including last inspection date, status, and date last pumped. The status is classified with codes; 1 (OK), 2 (monitor), 3 (deficiency to be fixed at a time of sale or change of use), and 4 (needs replacement or repair). The status codes serve to rank the severity of their condition and is used for prioritizing the replacement of septic tanks. The District has a goal of replacing all status 4 tanks immediately, which includes status 3 tanks when those properties sell or when continued monitoring changes the status to 4. In a typical year, the District can achieve around 10 replacements. The tank replacements are contracted and thus have minimal effect on staffing needs other than design reviews and acceptance inspections. The District keeps active records of replacements and a planned replacement schedule.

Inflow and Infiltration (I & I)

Infiltration and Inflow (non-sewage flows) increase the volume of wastewater in a sewer conveyance system causing pipelines and other infrastructure to be sized larger than necessary, operate at higher pressures, or increasing the risk of sanitary sewer overflows. Infiltration and inflow also increase the cost of treating sewage at the WWTP. Infiltration and inflow cannot be totally eliminated in a system.

STEP systems are pressurized and therefore have the benefit of very low or no I&I in the collection system piping. However, the District has historically suspected it has a problem with I&I in the collection system. Many of the septic tanks in the District are very old and it is suspected that the I&I occurs mainly through connections and joints with structures and septic tanks. Other potential sources of I&I at septic tanks include sunken or low access risers or inspection ports, failing or missing riser or port covers/lids, broken gravity pipes to tanks, broken or missing cleanout caps, or direct stormwater connections. The District has identified areas that are likely high contributors and inspections, repairs and replacements will target these areas first.

The District has been mitigating the I&I contributions in the last several years and is committed to rehabilitation for reducing I&I flows. The District has an ongoing septic tank inspection and replacement program and has implemented a database to record and track this information. The District has standardized their septic tank and pumping system requirements and performs inspections and requires the use of modern construction techniques for new sewer system and septic tanks. A copy of the District's Sanitary Sewer Specifications and New Installation Checklist and are included in Appendix D.

An Infiltration and Inflow Analysis was completed as part of this Plan and is included as Appendix C. Rainfall and flow data analysis has quantified infiltration and inflow for comparison to EPA standards. The analysis concludes that infiltration is considered non-excessive, but inflow is considered excessive during larger rain events. The I&I Analysis also summarizes and discusses other observations and factors and identifies areas on which to focus improvements.

As noted above, the District has a septic replacement program and it is included in the capital improvement plan (e.g., CIP: annual Septic Repairs and/or Replacements). The CIP also includes implementing field investigations as recommended in Appendix C including continued septic tank inspections, implementing a cross-connection investigation plan, and implementing an inflow point source repair plan. I&I (and inflow in particular) should be reduced where economically feasible or where specific problems are identified.

4.2 - Pumping Facilities

The Fisherman Bay Sewer District's collection system is a septic tank effluent pumping (STEP) system. The District has standardized their STEP system and requires new pumps to be Orenco Systems Effluent Pump Model PF100511, 10 gpm, 1/2 HP. The pumps are 4-inch submersible effluent pumps with a 1-1/4 inch discharge size. The design flow is 10 gpm @ 170 feet total dynamic head (TDH). The have a recommended minimum operating point of 5 gpm @ 225 ft TDH and a shut off head of 250 ft TDH, or 108 psi. The pump catalog cut sheet showing detailed pump information and pump curves is included in Appendix I. There are a few remnant different types of submersible pumps in use, but they have motor and discharge characteristics similar to the standard.

Each pump system has a local pump control panel with elapsed time meter and event counter. The panels have audible and visible alarm. The control panel catalog cut sheet showing detailed information is included in Appendix I. It is recommended that individual pumping meter data be collected in a database and be reviewed periodically. This meter data could be useful for monitoring for abnormal flow conditions or verify suspect areas with higher I&I.

A common issue with STEP systems occurs after power outages. Often, when power returns after extended outages, an abnormally high number or even all STEP systems turn on and overwhelm the collection and delivery piping system resulting in high flows to the wastewater treatment plant. Installing timers to control the pumping systems by areas or groups can help alleviate this problem. For example, commercial areas could be set to pump at a time different than residential areas. Potential timer installation should also consider reserve tank storage volume. The District might consider evaluating and installing timers, which can also help dampen peak flows under normal operating conditions.

For STEP systems, pumping facilities improvements typically align with septic tank improvements. It is recommended the District expand their septic tank inspection and replacement database to include pump specific information for better tracking of those facilities separately. The proposed sewer capital improvement plan includes an ongoing program for septic tank upgrades, which includes pump upgrades, improvements, and replacement of aging equipment.

4.3 - Wastewater Treatment Facility Evaluation

The purpose of this section is to evaluate the existing WWTP and its components with respect to capacity, reliability, and redundancy.

Wastewater Treatment Plant Performance

Facility Description & History

The Fisherman Bay WWTP was originally built in 1979 for a design capacity of 27,500 gallons per day (gpd). The original plant consisted of an influent flow metering unit, a single-cell aerated lagoon (L-1), and a chlorine disinfection unit. In 1995, growth demands in the area prompted the District to expand the plant to a two-cell aerated lagoon system by adding a new aerated facultative lagoon (L-2) that operated in series with lagoon L-1. The 1995 expansion also included a new chlorine contact chamber, a new chlorine feed pump, and a new laboratory building. The expansion increased rated capacity to 34,000 gpd and 56 lb. $CBOD_5$ per day for the summer months (April to November), and 23,000 gpd and 38 lb. $CBOD_5$ per day for the winter months (December to March).

The District modified lagoon L-2 in 2003 by dividing the basin into three (3) cells with floating baffles. A new influent flow tank and an anaerobic cell were also constructed. In April 2004, lagoon L-1 was taken out of treatment service. In 2006, a subsurface flow constructed wetland was constructed for polishing the lagoon effluent before disinfection. The existing lagoon L-1 was decommissioned in 2008, and reconfigured in 2009 as an effluent storage pond that will equalize effluent flow during extreme rain events.

A vicinity map of the existing Wastewater Treatment Plant is shown in Appendix A, Figure 4-6. A plant layout map of the existing Wastewater Treatment Plant is shown in Appendix A, Figure 4-7.

Treatment Process

The District operates a “Class 1” facility serving residents and small businesses of Lopez Village. The plant does not receive any significant industrial process wastewater flow, only domestic flows from residences, light commercial, and institutional customers. The District employs one Group I operator and another operator in training to manage the day-to-day operations of the plant, on-site lab, and collection system. The current plant consists of the following components: influent metering, influent flow tank, anaerobic pretreatment cell, aerated/facultative lagoon, constructed wetland, chlorine disinfection system, and effluent metering system. An offline storage lagoon is also available to provide effluent flow equalization during wet weather (if necessary).

A schematic diagram and hydraulic profile of the existing WWTP process is included in Figures 4-2 and 4-3 in Appendix A. Wastewater influent enters the facility in the southwest corner via a 4 inch or 6 inch PVC force main (there is disagreement between asbuilt documents on the size of this force main) coming from the south along Lopez road, and a 4 inch PVC force main coming from the east from Fisherman Bay Road, near the south edge of the property. The two 4 inch force mains join together near the entrance of the plant and head north in a 6 inch PVC force main to the influent metering station. The influent flow metering consists of a flume where the liquid level is measured by a water level sensor. Piping is configured so that flow can be bypassed around the influent flow meter or sent to the front end of the L-2 lagoon. After flow leaves the influent flow metering station, it is sent to the influent flow tank for grease, scum, and some grit removal. Raw wastewater then continues to the Anaerobic Pretreatment Cell where anaerobic bacteria removes some influent BOD and digests settled sludge. Flow then continues to the L-2 lagoon which consists of three (3) cells separated by floating baffle curtains. The first cell is Aerated Cell No. 1 which has constant aeration. The second cell is Aerated Cell No. 2 which is aerated primarily at night only. The third cell is the Polishing Cell used for settling. Flow moves between the cells via openings in the baffle curtains. The opening between Cell No. 1 and Cell No. 2 is 18"x18" and the opening between Cell No. 2 and the Polishing Cell is 6"x6". Wastewater flows by gravity to the subsurface constructed wetland. Flow enters the wetland along the north side, travels through the wetland media, and exits from the south end. After leaving the wetland wastewater flows by gravity to the chlorine contact chamber for disinfection. Final effluent leaves the chlorine contact chamber and flows through an effluent flume where liquid level is measured with a battery powered Stevens water level sensor. The final effluent then leaves the plant through a 4-inch, 2,800 LF gravity outfall which discharges to the San Juan Channel.

The L-1 lagoon is located in the southwest corner of the plant property. This lagoon is not in operation, but could be utilized as effluent equalization if necessary.

Additional details regarding the individual components and equipment of the treatment plant are included below.

Sample Locations

Influent composite samples are taken at the influent metering station from the influent flow meter flume. Effluent samples are taken from the effluent flow meter flume. Effluent samples consist of both composite and grab samples.

Influent Flow Metering Station

The influent flow metering station consists of a fiberglass flume where the liquid level is measured by a non-contacting ultrasonic water level sensor. The flume is a trapezoidal type with 60° V-notch, throat manufactured by Free Flow. Piping is configured so that flow can be bypassed around the influent flow meter or sent to the frontend of the L-2 lagoon. The flume flow meter and sampling equipment are located in a small shed. Both instantaneous flow and totalized daily flow rate are measured by the water level sensor and recording in a Greyline Instruments, OCF 5.0 Open Channel Flow Monitor. Data is stored in the monitor and downloaded regularly via USB drive.

The flume type is typically very accurate when calibrated correctly and the flow in and out of the flume is controlled properly. Research from the 2008 Wastewater System Master Plan suggests the flume has a capacity of roughly 0.213 MGD, however, the operator has indicated the flume overflows regularly during high flow events. Piping entering and leaving the flume is 4 inch PVC. It is believed that there is an issue with the hydraulics downstream of the flume with either the piping configuration or valving which is causing this backup during high flows. As a result, the flow meter results are not accurate for measuring peak flow events effectively.

In 2019, a technical memorandum was written by Wayne Haefele & Associates, Inc. addressing these flow meter issues and making recommendations for replacement. This project was approved by the Department of Ecology, but it was decided to delay the project until after this plan was completed with the intention of combining all improvements as a single construction project and possibly changing the configuration of the improvements to align with improvements to the rest of the plant. This memorandum is included as Appendix M.

Influent Flow Tank

The influent flow tank was installed to provide for scum, grease, and grit removal upstream of the plant to prevent downstream corrosion, specifically in manhole #4. The tank can be used to divert flow directly to the L-2 lagoon and bypass the anaerobic pretreatment cell. The tank was also configured with the option of splitting the flow between the anaerobic pretreatment cell and a future second anaerobic pretreatment cell which was never constructed. The design capacity of the tank is 1,000 gallons, which provides 0.45 hours detention time for the permitted 53,000 gpd flow.

Over the years, significant corrosion has developed on the interior of the tank. This is due the hydrogen sulfide gas buildup inside the tank which is completely covered.

The 2019 technical memorandum written by Wayne Haefele & Associates, Inc. also addresses and makes recommendations for replacement of this influent flow tank. As described previously, this project was approved by the Department of Ecology, but it was decided to delay the project until after this plan was completed with the intention of combining all improvements as a single construction project and possibly changing the configuration of the improvements to align with improvements to the rest of the plant. This memorandum is included as Appendix M.

Anaerobic Pretreatment Cells

The Anaerobic Pretreatment Cell consists of a single-layer HDPE lined earthen pond and a six (6) foot diameter, 5 foot high concrete manhole pit at the bottom. The pond has 2:1 side slopes, side water depth of 15 feet, 3 feet of freeboard, and volume of 83,000 gallons. The pond was designed to have 2 days hydraulic retention time. Therefore, the cell has a hydraulic capacity of 41,500 gallons based on 2 days HRT.

Influent enters the cell from the bottom of sump and flows upward through a sludge blanket similar to an up flow anaerobic sludge blanket (UASB) reactor. The pond is effective at removing a small amount of BOD and settling grit and solids. According to the 2008 Plan, the original design goal for the cell was to remove 50% of influent BOD_5 to control algae growth in the L-2 Lagoon, reduce solids accumulation in the downstream lagoon, and reduce aeration energy required in the L-2 Lagoon.

The cell was covered with an HDPE floating liner for odor control. This has proven to be successful and odor has not been a problem from this cell since covering.

Based on the 2008 Plan, the average removal rates of the anaerobic pretreatment cell were 27% for $CBOD_5$. The $CBOD_5$ removal was hindered by limited influent organics from the STEP system, low influent wastewater temperature, and recirculation from the L-2 lagoon introducing oxygen which is detrimental to the anaerobic bacteria. Overall, the cell has been mildly effective at reducing algae growth in the L-2 lagoon, improving L-2 performance, and saving aeration energy. The portion of the liner that is visible appears to be in good condition. Growth of grass and brambles were observed and should be remove to prevent damage to the liner.

Solids are removed annually from the cell.

L-2 Lagoon

The L-2 lagoon consists of a single 60 mil HDPE liner, has a side water depth of 10 feet, 3 feet of freeboard and a nominal capacity of 515,000 gallons. The lagoon was originally constructed in 1995 and retrofitted in 2003 when it was separated into three (3) cells to reduce short circuiting through the lagoon. The cells are divided by 36 mil UV resistant Hypalon™ floating baffles. The first cell is Aerated Cell No. 1 which has constant aeration and a volume of approximately 257,500 gallons. The second cell is Aerated Cell No. 2 which is aerated primarily at night only and has a volume of approximately 128,750 gallons. The third cell is the Polishing Cell used for settling and has a volume of approximately 128,750 gallons. Flow moves between the cells via openings in the baffle curtains. The opening between Cell No. 1 and Cell No. 2 is 18 inch x18 inch and the opening between Cell No. 2 and the Polishing Cell is 6 inch x 6 inch.

Table 4-2: L-2 Lagoon Information

Lagoon Section	Purpose	Size
Aerated Cell No. 1	Constant Aeration	257,500 gallons
Aerated Cell No. 2	Night Aeration	128,750 gallons
Polishing Cell	Solids Settling	128,750 gallons
Total for L-2 Lagoon		515,000 gallons

Aeration in cells 1 and 2 is performed by floating surface aerators. Cell 1 is constantly aerated by a 3 HP Aqua turbo surface aerator, Model AER00150-30. Cell 2 is aerated only during the night by a 2 HP Aqua Turbo surface aerator. At the end of 2020, the cell 1 aerator failed. This aerator was repaired and placed back into service at the beginning of 2021. The cell 2 aerator has also had problem so a new Aqua Turbo aerator (AER-AS 0150-30 Floating Aerator 304 2 HP 1800rpm 230V 60Hz 1-ph with Baldor Motor 2 HP 145TDZ) was ordered and will be placed in cell 2 during the summer of 2021.

Based on the 2008 Plan, the aerators have a capacity of 109 lb BOD_5/day organic loading. Current peak month CBOD is 75 lb/day and future peak month CBOD is projected to be 148 lbs/day. Assuming CBOD is 85% of BOD gives a current peak month BOD of 88.2 lb/day and a future peak month BOD of 174.1 lb/day. The aerators are sufficient at the current loading rate, but well under capacity for the future peak month loading.

Duckweed has been a significant problem in the L-2 lagoon. The duckweed is most prevalent in the polishing cell and is then passed on to the constructed wetland manifold. This causes clogging in the piping downstream of L-2 and can cause reduced dissolved oxygen and poor BOD removal in the L-2 lagoon.

The HDPE liner should be inspected for penetrations. If penetrations exist, the liner should be repaired or replaced if needed. The design guidelines suggest additional layers adjacent to the liner to prevent penetrations from roots.

Constructed Wetland

The constructed wetland (wetland) is of a configuration that is commonly referred to as a Horizontal Flow Constructed Wetland (HFCW). This configuration of wetland creates anerobic and anoxic zones to perform treatment. The wetland has a liner to hold a permeant pool of standing water to isolate it from groundwater. Both the influent and effluent enter and exit the wetland through subsurface headers. There are multiple pollutant removal mechanisms at work to remove TSS, BOD, Nitrogen, and Phosphorus, but the following evaluation focuses on nitrogen removal.

The constructed wetland was built in 2006 and was designed for 41,424 gpd flow. The wetland is lined with a single 36 mil HDPE liner and has a bottom slope of 1.0% from inlet to outlet. The interior side slope is 2:1 and a total media volume of 31,000 cubic feet.

The wetland media consists of approximately 30% ¾-inch washed clean gravel and 70% 2-inch minus shredded tire chips. Media depth varies from 30-inch to 45-inch.

Comparison of Fisherman Bay HFCW to Current Design Practices

The HFCW is currently dominated with Phalaris arundinacea (Reed Canary Grass). Although the original design called for Typha spp (Cat Tails) and Bulrush, utilizing Reed Canary Grass in HFCWs is a current design practice.

The media consists of shredded tires for 70% of the footprint near the inlet and gravel for 30% of the footprint near the outlet. The tires have a higher porosity than the gravel as reported in the 2008 Plan. Higher void ratios benefit this system for removal of nitrogen because they provide more areas for water and surface area for microbial interaction. The 2008 Plan indicates that the tires initially had released higher TSS and iron as small pieces worked through the system and the steel belts deteriorated, but the tires stabilized after the first year. However, the District believes the iron levels are still elevated from the wetland media. Wastewater Treatment in Constructed Wetlands with Horizontal Sub-Surface Flow by Jan Vymazal and Lenka Kropfelova was published in 2008 (Design Guide) and it provides detailed design guidelines for HFCWs backed by research from many installations throughout the world and of various configurations. In our review of Design Guide and other documents on HFCWs we found no discussion of the use of shredded tires for media. The use of shredded tires for media is not current design practice. The current predominate practice is to use gravel for media.

There is some variability on the current approach to length to width ratio of HFCW. However, the current guidelines in the Design Guide are to make the wetland with a greater width than length. Early practice was to make wetlands length to width ratios greater than 1 to promote plug flow. The wetland at FB WWTP was designed longer than wider. The Design Guide suggests length to width ratios of less than 1, because the treatment occurring in the wetland decreases exponentially from the inlet. There is also emphasis on even distribution of water across the inlet to prevent channeling and uneven loading.

The media depth is 30 to 45-inches with a sloped top and bottom and the current practice is to have an average depth of 24-inches with a sloped bottom and flat top. The wetland currently has a water surface that is at or above the top of the media. Current practice is to have the water level at 2-inches below the top of the media. Having a water level below the top of the media is helpful in confirming that the wastewater is moving through the media rather than short circuiting by moving across the top of the media.

There are significant variations on how wetlands are constructed and operated based on region, wastewater characterization, available land, and climate. In general, local plants are utilized in each region to prevent the introduction of invasive species. These plant choices play a role in competing with weed species in the wetlands, harvesting of litter to remove nitrogen from the system, and variability in treatment mechanisms based on plant structure and nutrient uptake. In tropical climates, constructed wetlands are more uniformly managed throughout the year, such as harvesting litter multiple times each year and having inlet and outlet headers above ground for ease of maintenance. For the Fisherman Bay constructed wetland the litter should not be harvested because it results in minimal nitrogen removal, removes insulation in winter thereby reducing denitrification, and makes the Reed Canary grass susceptible to invasion by weeds. Wetlands in this climate are designed with submerged inlet and outlet headers to keep them from freezing in the winter.

The wetland, in combination with the polishing cell of the L-2 lagoon, has been effective at Total Suspended Solids removal with an average TSS removal of 88% and an average TSS concentration of 3.76 mg/L.

Nitrogen reduction

Nitrogen transformation and removal in wastewater wetlands is a very complicated process consisting of multiple nitrogen conversions some of which remove nitrogen from the system and some that simply convert it from one type to another. Other constructed wetlands such as the vertical flow constructed wetland (VFCW) provide aerobic environments that result in different and more complete conversions of nitrogen from one form to another. VFCW is also a very common wetland type and is often used in conjunction with HFCW to achieve greater treatment results. Although there is some overlap in the types of transformations that occur in VFCW and HFCW each of these wetland types are dominated by different conversion types due to differences in oxygen availability.

For the HFCW wetlands in this climate there are three predominant ways in which nitrogen is removed permanently from the wastewater and the system; volatilization in the form of N_2O; nutrient uptake which results in increase in or harvesting of biomass; and denitrification. "Volatilization is very limited by the fact that HFCWs do not have a water surface and algal activity…" (Design Guide, pg. 289). Nutrient uptake happens as the plants are filling in, growing height, and building the root mass, but uptake becomes minimal once the root mass has been built out. Alternatively, harvesting the leaf litter from above the media can also remove nitrogen via the nutrient uptake pathway, but this also plays a small to non-existent role in our temperate climate. This leaves denitrification as the primary means of removing nitrogen from systems like the FB WWTP wetland. Denitrification occurs in anerobic environments by bacteria, that through a series of conversions, converts nitrates into dinitrogen. The nitrogen leaves the system as it off gases in the form of dinitrogen.

Since the influent wastewater to the FB WWTP contains nitrogen primarily in the form of ammonia it must be converted to nitrates in order for denitrification to occur in the wetland. The nitrogen transformations of ammonification, ammonia volatilization, and nitrification must occur in an aerobic environment to convert the ammonia to nitrate. This transformation is primarily occurring in the L-2 lagoon cells 1 and 2 just upstream of the wetland. Volatilization of ammonia likely occurs in the L-2 lagoon, but this removes very little nitrogen. The effectiveness of nitrogen removal from the system is directly related to how complete is the conversion of ammonia to nitrates.

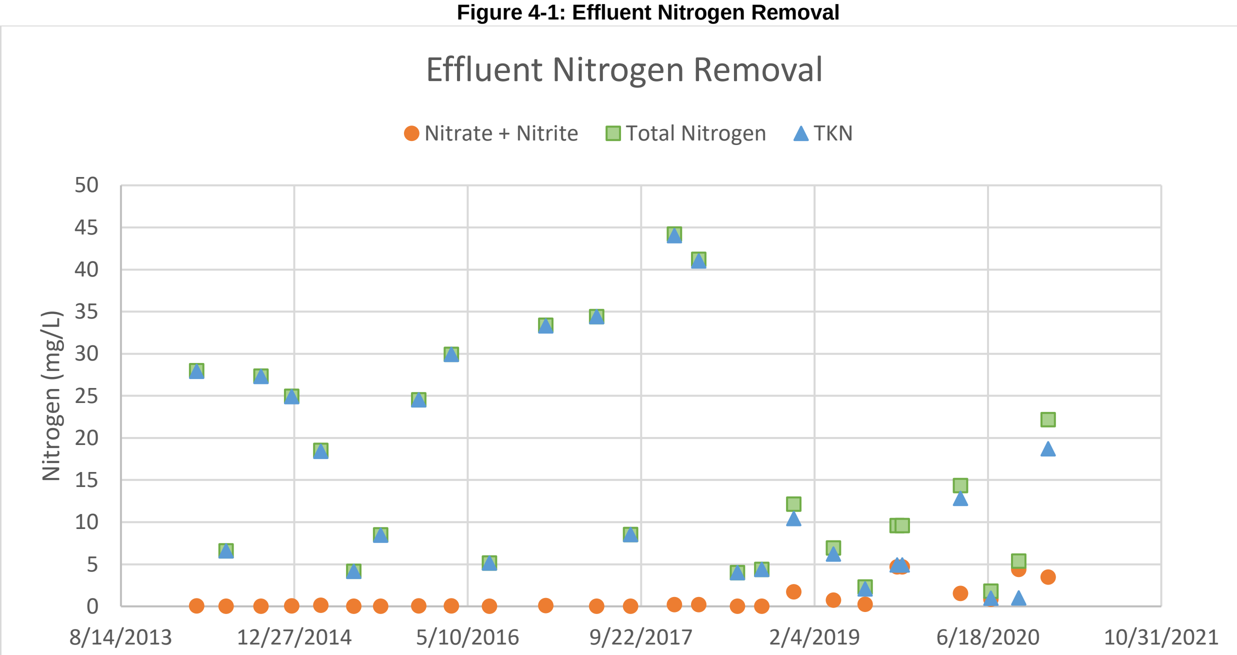
VFCWs are often used upstream of HFCWs. When VFCWs are placed before HFCWs there is significant overall reduction in nitrogen. In some cases, these hybrid systems are operated with separate compartments of VFCWs and HFCWs oriented in parallel, series, and with some recycled effluent mixed back with the influent. Some of these more intensive hybrid systems achieve great nitrogen reduction levels that could likely reduce nitrogen levels to be less than 8 mg/L.

Most constructed wetlands in use have some level of pretreatment to reduce TSS upstream of the wetland. In the Fisherman Bay system settling occurs in the individual septic tanks of the STEP system, the anaerobic pretreatment cell, and the polishing cell of the L-2 Lagoon.

Testing of TKN before and after the constructed wetland indicates an average removal rate of 22% which is on the lower end of expected removal rates. Design guidelines provide average removal rates for various configurations and methods of operations, but there is variability of influent concentrations, climate, plants, and overall configuration. The Design Guide reports average removal rates across hundreds of municipal systems worldwide in a variety of configurations and through seasonal differences. The average removal rates for Total Nitrogen (TN), ammonium (NH4+), and Total Kjeldahl Nitrogen (TKN), are reported to be 39%, 21%, and 42%. Individual systems show wide variability in removal rates, but there are strong correlations to an average.

In 2018 plant operators removed a buildup of sludge and media at the frontend of the constructed wetland. The buildup was causing short circuiting of the wetland around the sides. This improvement resulted in an increase in effluent Nitrate and Nitrite, but a significant decrease in effluent TKN, resulting in an overall decrease of Total Nitrogen.

Figure 4-1: Effluent Nitrogen Removal



<u>Disinfection: Chlorine Contact Chamber</u>

Effluent is disinfected using calcium hypochlorite tablets in a contact chamber. Tablets are placed manually by the operators through a tablet feeding tube and dosage is adjusted manually by varying the stream flow through the tablet feed device.

The chlorine contact chamber is a precast concrete tank, 8' wide, 10'-3" long, and 7'-6" deep. The tank has 3" wide and 5' tall concrete baffles. The contact chamber has a volume of 3,000 gallons at 5 feet of water depth. The contact chamber has 144,000 gpd flow capacity at the minimum 30 minute contact time.

Because the existing Peak Day Flow is 177,000 gpd, the contact chamber does not have capacity for existing peak day flows as well as flows greater than future peak month flows.

The District is in the process of upgrading from Calcium Hypochlorite tablets to pumping a Sodium Hypochlorite solution as a temporary improvement until major plant upgrades such as UV disinfection are completed.

Outfall

After effluent metering, plant effluent is discharged into the San Juan Channel via a 4-inch PVC outfall, about 2,880 feet in length, with a single 4-inch x 2-inch diameter reducer at the end. The outfall terminates 240 feet from the shoreline at a depth of 15-20 feet mean lower low water (MLLW). A reducer attached to the end of the pipe creates a single two-inch diffuser port. The "in water" portion of the outfall was repaired and anchored in 1994 and the missing 4x2-inch reducer was replaced. In 2004, an "in water" outfall inspection was performed, and the outfall was re-anchored, and the missing 4x2-inch reducer was replaced again. The "in-water" portion was inspected again in 2018 and May 2021, and found to be in serviceable condition overall. The pipe and anchors were in good condition and all bolts looked good on the anchors. The diffuser was also in good condition. The point of discharge in San Juan Channel is at coordinates Latitude: 48.533182N, Longitude: -122.920929W. (*https://goo.gl/maps/CoFy4fV4v4AkYBHj8)*

Minimal as-built information for the outfall was available for review. A drawing from 1973 and a hydraulic profile of the outfall system was found and is shown in Figures 4-4 and 4-5 in Appendix A. The capacity of the outfall is limited, in part, by the size, slope and condition of the pipe, and the sea level in the San Juan Channel. Its theoretical capacity is about 120 GPM. Under current average day and peak monthly flow conditions, and based on calculations, only the portion of the pipe that lies above the sea level flows by gravity. The remainder of the pipe flows full under pressure (submerged). Under current peak day flow conditions, the outfall is at its theoretical capacity. Without equalization, the outfall does not have capacity beyond current peak hour flows and future peak day flows.

It is understood that effluent can back up in the plant's L-1 lagoon during heavy rain events. It is not known if this is due to exceeding the pipe capacity, or a problem with the pipe, such as blockage (including air pockets at high spots), or pipe failure. An air relief system is shown on a profile of the outfall at station 4+10. The air relief system consists of two vertical burp pipes with 2-inch goosenecks located about three feet above grade. The air relief system appears to be in good condition.

Existing Staffing

The WWTP is staffed from 8 AM to 5 PM five days per week with 2 full time employees and 2-3 days per week with one part-time employee. The plant is not staffed during the weekends. The lead operator is Group III. The existing WWTP must have at least a Group I operator in reasonable charge of daily operation.

Design Criteria

Under WAC 173-220-150 (1)(g), influent flows and waste loadings must not exceed approved design criteria (Table 4-2).

Table 4-2: Existing Design Criteria for Fisherman Bay Sewer District Wastewater Treatment Plant

Parameter	Design Quantity
Maximum Month Design Flow (MMDF)	53,000 GPD (0.053 MGD)
$CBOD_5$ Influent Loading – Max. Month	66 lb/day

Current Wastewater flows to the treatment plant are approximately:

Average Annual Daily Flow: 0.030 MGD
Average Max Month Daily Flow: 0.053 MGD (0.083 MGD max value recorded)

At an average MMDF of 0.053 MGD the treatment plant is currently operating at design capacity for MMDF. However, this average max month flow was increased significantly by the July 2019 peak month flow of 0.083 MGD. If this outlier is removed the average max month flow is 0.44 MGD, which is under the design capacity for MMDF. The July 2019 flow and loading data should be considered as this was primarily the result of increased tourism and could happen again on a yearly basis. The flow data shows the plant does not have sufficient capacity for projected future growth.

Current Wastewater loads to the treatment plant are approximately:

Average Annual Daily $CBOD_5$: 27.7 lb/day
Average Max Month Daily $CBOD_5$: 62.4 lb/day (74.4 max value recorded)

Therefore, the plant is currently operating very near the design capacity for $CBOD_5$ max month influent loading and does not have room for growth.

Industrial Wastewater Producing Facilities

The Fisherman Bay Sewer District does not receive wastewater from industrial sources.

Facility Capacity

Table 4-4 shows the capacity of the major components of the existing WWTP. The table also shows the components which require capacity upgrades based on these capacities and projected peak flows.

Table 4-4: Existing WWTP Component Capacity

Component (No.)	Existing Capacity	Status
Influent Flow Meter	Design 0.214 MGD, actual capacity unknown.	The influent flow meter flume has hydraulic restrictions downstream causing backups into the flume. Flow meter replacement and reconfiguration is recommended with an inline mag meter.
Influent Flow Tank	0.45 hours detention time @ 53,000 gpd	The influent flow tank does not have capacity for future growth and has significant corrosion. Replacement and reconfiguration are recommended if the influent flow tank were to remain part of the process flow path.
Anaerobic Pretreatment Cell	41,500 gallons based on 2 days HRT	The anaerobic pretreatment cell is performing effectively and meets capacity for existing flows. The cell does not have capacity for future projected flows and loads. If the Anaerobic Pretreatment Cell were to remain, upgrades are recommended to accommodate future flows and loadings.
L-2 Lagoon	109 lbs BOD_5/day organic loading	The L-2 lagoon is performing effectively and meets capacity for average existing flows; however, it does not have capacity for large peak flow events observed in recent years and future projected flows and loads. Aerators are not sufficient for future projected flows and loads. If the L-2 lagoon were to remain, upgrades are recommended to accommodate future flows and loads.
Constructed Wetland	0.041 MGD	The constructed wetland is performing effectively, reducing TSS and Total Nitrogen. The wetland is 15 years old and nearing its end-of-life. The wetland does not have capacity for peak flow events or projected flows. Upgrades are recommended to accommodate future flows and loads and improve Total Inorganic Nitrogen reduction.
Chlorine Contact Chamber	0.144 MGD @ 30 minutes contact time	The chlorine contact chamber is performing effectively but is undersized for existing peak flows and projected flows. Disinfection upgrades are recommended to accommodate future flows.
Effluent Flow Meter	0.213 MGD	The effluent flow meter is performing effectively and does not appear to have capacity issues. No upgrades are recommended at this time unless larger treatment plant upgrades warrant reconfiguration of effluent metering, in which case a new inline mag meter is recommended.
Outfall	120 GPM	The outfall does not have capacity for existing peak day flows or future peak month flows. The exact location and condition of the outfall is also unknown. Upgrades are recommended to accommodate future flows.

Severity of Upgrade Need

Most Severe — Least Severe

Plant Piping Capacity

Existing plant piping ranges from 4 inches to 8 inches in diameter based on information provided in previous reports and construction drawings. The piping is anywhere from 15 to 42 years old. The majority of the piping was installed during the 1979, 1995, and 2006 upgrades. In all cases, the existing piping capacity exceeds the future projected instantaneous flow rate of 1.4 MGD. However, the exact condition, size, location, and material is not known with confidence. Precise asbuilts of the plant were not available or created. If any existing plant piping is to be reused, a video pipe inspection and locating is recommended to confirm the piping information.

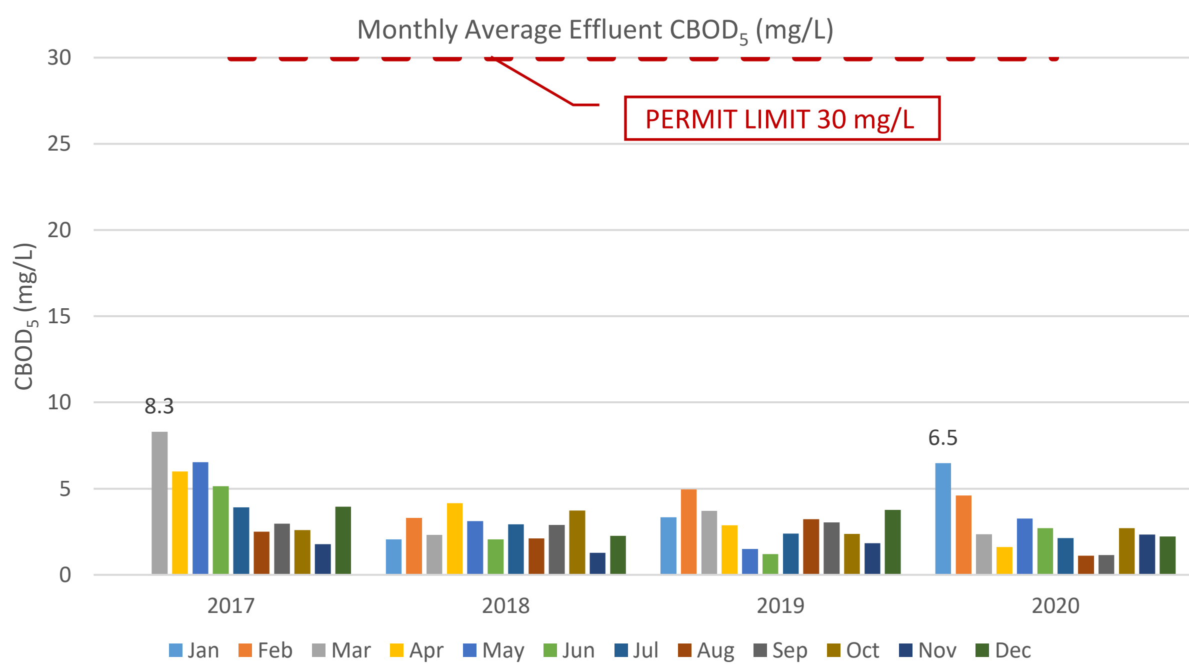
Performance

Treatment Plant Performance

In recent years, the wastewater treatment plant has been effective at meeting permit limits and has had no effluent permit limit violations. The plant exceeded the design criteria in July 2019 with a Max Month flow of 0.083 MGD (0.053 MGD limit) and a Max Month $CBOD_5$ of 74.38 lb/day (66 lb/day limit). In the summer of 2018, the plant observed 2 consecutive months exceeding 85% of the Max Month flow design criteria limit, 0.053 MGD.

Figure 4-6 below shows the monthly average effluent $CBOD_5$ relative to the permit limit. As you can see, the plant has been successful with $CBOD_5$ removal and shows no immediate concerns of meeting permit limits. Effluent $CBOD_5$ has averaged 3.12 mg/L over the last 4 years. Effluent TSS has been equally successful, with an average effluent TSS of 3.77 mg/L. Maximum effluent $CBOD_5$ was recorded at 9.79 mg/L and max effluent TSS was recorded at 13.81 mg/L, both well under the permit limit.

Figure 4-6: Effluent $CBOD_5$



Receiving Waters

<u>Description of the Receiving Waters:</u>

The Fisherman Bay wastewater treatment plant discharges to San Juan Channel on the west side of the island just north of Fisherman Bay. The discharge waterbody quality designation is ‘Extraordinary Marine Water’. The Town of Friday Harbor Wastewater Treatment Plant outfall, located 5 miles to the west on the other side of the San Juan Channel, is the closest nearby point source to the District’s outfall. There are no other significant point sources or non-point sources of pollutants nearby. Ambient background data as summarized from the Fact Sheet:

Table 4-5: Marine aquatic life uses and associated criteria from Fact Sheet

Parameter - Extraordinary Quality	Value used
Temperature (highest annual 1-D Max)	13 ˚C (55.4 ˚F)
pH (average)	pH must be within the range of 7.0 to 8.5 with a human-caused variation within the above range of less than 0.2 units
Dissolved Oxygen Criteria – Lowest 1-day Minimum	7.0 mg/L
Turbidity Criteria	• 5 NTU over background when the background is 50 NTU or less; or • A 10 percent increase in turbidity when the background turbidity is more than 50 NTU.

<u>Location of the Point of Discharge</u>

The point of discharge in San Juan Channel is at coordinates Latitude: 48.533182N, Longitude: -122.920929W. The outfall terminates 240 feet from the shoreline at a depth of 15 feet below mean lower low water (MLLW). A reducer attached to the end of the pipe creates a single two-inch diameter diffuser port.

<u>Applicable Water Quality Standards</u>

Applicable water quality standards are defined in water quality standards for surface waters of the state (WAC 173-201A), and more specifically for this site marine water quality standards (WAC 173-201A-210) for the Extraordinary category. Tier 1 Antidegradation requirements (WAC 173-201A-210) must be met. Additional detailed applicable water quality standards and discussion are presented in the Fact Sheet.

<u>How water quality standards will be met outside of any applicable dilution zone</u>

Water quality standards will be met outside of any applicable dilution zone by maintaining facility discharges in compliance with the discharge permit. As described in the Fact Sheet, Ecology conducted a reasonable potential analysis, using procedures established by the EPA and by Ecology, for each pollutant and concluded the facilities discharge/receiving water mixture will not violate water quality criteria outside the boundary of the mixing (dilution) zone if permit limits are met.

The concentration of nitrate in San Juan de Fuca ranges from 0.1 mg/L to 0.4 mg/L. The flow flux is approximately 129,000 cubic meters per second (cms) in San Juan de Fuca (Table 1). The flow flux is approximately 10,000 cms in San Juan Channel per Figure 1 (Banas et al. 1999). Importantly, the San Juan Channel is completely exchanged over a period of about 1 day (compared to months or years for the southern fjords). The flow from the Fisherman Bay WWTP is about 0.0028 cms. The existing WWTP total nitrogen (TKN + NO2 + NO3) discharge is about 16.6 mg/L. The WWTP discharge increases the total nitrogen concentration in San Juan Channel from 0.1 mg/L to 0.100002 mg/L or from 0.4 mg/L to 0.400002 mg/L. Assuming a linear relationship between algae growth and nitrate (which is a good assumption for this narrow range of concentrations), any potential DO decrease might be at worst proportional to the nitrate increase. In reality, the tidal exchanges are so great that such algae would be widely dispersed into the greater north Puget Sound area and the Strait of Juan de Fuca.

The near future WWTP upgrades are anticipated to decrease the total nitrogen discharge from 16.6 mg/L to less than 10 mg/L. This further lessens the negligible impact due to the WWTP discharge.

Mixing Zone Analysis

The discharge outfall extends to approximately 240 feet offshore on the west side of Lopez Island in open waters (i.e., not in Fisherman Bay). The outfall diffuser port is 15.2 feet below mean lower low water (MLLW). The mixing zone diameter is 630 feet. The diffuser at the end of the outfall pipe consists of one 2-inch diameter port.

Future flows are projected to be higher. The outfall mixing zone is herein modeled to determine the dilution factors based on the future increased flows. Dilution modeling is performed using the EPA's "Visual Plumes" UM3 (Version 18b) computer modeling software. All values input to the model are derived and applied to the model per the DOE Permit Writer's Manual. The Brooks far-field algorithm model was transitioned to within the modeling simulations where appropriate.

Effluent flows input into the model are the 2043 projected flows. The future maximum average monthly flow of 0.105 MGD is used for the chronic criteria dilution analysis. The future max average daily flow of 0.349 MGD is used for the acute criteria dilution analysis.

Ambient conditions modeled are 10^{th} and 90^{th} percentile current velocities for acute, 50^{th} percentile current velocity for chronic, and stratified and uniform density profiles.

Six scenarios were evaluated, each with different combinations of effluent flow, ambient current velocity, and ambient density profile. Ambient current velocities at the nearest NOAA monitoring station in the vicinity are used. Ambient velocities at the bottom (5-m depth) are reduced to account for lower bottom velocities. Salinity-Temperature-Depth data from DOE's Ambient Monitoring and Assessment Program for Puget Sound for the nearest station in the vicinity are used. Very little stratification develops at this location due to the high current velocities and high water volume exchange rates.

Table 4-6: Dilution Factor (DF) results from the six evaluated scenarios

Mixing Zone	Scenario	Ambient Velocity (ft/sec)	Density Profile (Max or Min)	Dilution Factor
Acute Criteria	1	2.48 to 1.10	Max	88
Acute Criteria	2	2.48 to 1.10	Min	89
Acute Criteria	3	0.30 to 0.20	Max	105
Acute Criteria	4	0.30 to 0.20	Min	107
Chronic Criteria	5	1.32	Max	1091
Chronic Criteria	6	1.32	Min	1007

The dilution model input/output files are shown in Appendix N.

The active NPDES permit and Fact Sheet list the dilution factors as:

Chronic Criteria: DF = 776
Acute Criteria: DF = 110

The dilution factors for the future flows would be:

Chronic Criteria: DF = 1007
Acute Criteria: DF = 88

<u>Reasonable Potential Analysis</u>

A Reasonable Potential Analysis was performed for, ammonia, fecal coliform, temperature, pH, and dissolved oxygen. These are the only parameters that could potentially exceed water quality standards. The Reasonable Potential Analysis calculations are shown in Appendix N. Included are the results for:

1. Existing WWTP
2. Upgraded WWTP, Existing Outfall
3. Expanded WWTP, Upgraded Outfall

The Reasonable Potential Analysis shows that none of these parameters have the potential to exceed water quality standards.

Solids Handling Evaluation

Currently the wastewater treatment plant has no biosolids handling. Sludge that builds up in both the Anaerobic Pretreatment Cell and the L-2 lagoon is removed with a vactor truck on an annual basis. This is performed by A-1 Septic and the biosolids are hauled to Anacortes for further treatment.

5.0 - FUTURE SEWER SERVICE REQUIREMENTS

The District will only provide sewer service where it is legally possible to do so considering applicable zoning and development regulations. See the District Resolution No. 2018-12 Administrative Code and Operations Resolution, attached in Appendix F. Details for potential developer extension facilities that are included in this section are conceptual; their infrastructure improvement projects are highly dependent on the nature of the development.

Future condition projections include ultimate conditions (buildout) and the rate of growth. Buildout and rate of growth are affected by many ever-changing variables such as zoning, service area, specific type of developments, macro and local economic conditions, demographic changes, and other factors. The rate of growth can fluctuate considerably with short term rapid growth or very little growth depending on local economic conditions. For this report, the projections are based on present available information including current boundary, zoning requirements and growth rates.

Potential Growth within District Limits

The District plans to extend the sewer collection system within the District limits as the opportunity arises, such as in conjunction with a road reconstruction project or a new development project. Much of the District's growth within the current boundary, particularly growth known or expected in the next 20 years, is infill not requiring any major collection system extensions.

<u>ERU and Population Projections</u>

UGA is a significant component of the District's future growth. The UGA boundary is almost entirely within the District's current boundary, all except 24 acres east of Weeks Point Way, and it is assumed that the whole UGA area will be served by the District in the future. According to the San Juan County's Comprehensive Plan, the goal of the UGA is to control future growth sprawl in rural areas and orderly grow in the County's towns, and accommodating approximately 50% growth within the UGA. This means that significant growth on Lopez Island will be in the vicinity of the Lopez Village area, and within the District's service area.

This report divides the existing and buildout condition estimates for growth within the District limits into two (2) areas: UGA area, and the District's service area outside of UGA. These areas, including land use designations and zoning densities, are shown on Figures 1-2 and 1-3 included in Appendix A.

The ERU estimates for these areas are presented in Table 5-1 below. GIS and the District's customer database information in conjunction with the San Juan County Polaris Parcel Search website was first used to map out existing ERUs in the District. The parcels shapefile from San Juan County was then used to determine potential ERUs for undeveloped parcels based on the acreage and zoning density as follows:

- UGA – 8 units / acre, maximum density meeting bonus criteria
- Marine Center (MC) LAMIRD – 4 units / acre
- Outside of UGA and MC LAMIRD – 1 unit / 5 acres

A few assumptions were made that are worth noting. In cases where individual parcels were less than 5 acres in the 1 unit / 5 acre density areas, those individual parcels were each counted as 1

ERU. In cases where developed single large parcels located in the denser UGA area had a home adjacent a large field, it was assumed the field would be subdivided and developed at the assumed maximum density. Any developed parcels within the District boundary but not currently served by the District were assumed to eventually be served for the buildout condition.

The existing ERU count for the UGA area is 245. The estimated potential new ERU for the UGA area (within current boundary) is 461. Therefore, the total buildout ERU for the UGA area is 706. The existing ERU count for all areas is 390 ERU (consisting of 187 residential and 203 commercial). The estimated potential new ERU for all areas (within current boundary) is 519 ERU. Therefore, the total buildout ERU for all areas is 909 ERU.

The population estimates for the District are based on 2.1 persons per ERU, which is assumed to be the same as a household. This population estimate is in accordance with the Lopez Village Subarea Plan adopted by the San Juan County Council on October 14, 2019, and is representative of Lopez Island, as compared to 2.04 per household for San Juan County and 2.6 per household for Washington State.

Table 5-1: ERU Summary and Population Projections within District Boundary

Description	UGA	Outside UGA, but within District Boundary	Total
Area (acres)	197 (173 in District)	147	320
Existing ERU	245	145	390
Estimated Potential ERU	461	58	519
Total Buildout ERU	**706**	**203**	**909**
Estimated Existing Population Equivalent (people)	514	305	819
Estimated Future Population Equivalent Increase (people)	968	122	1,090
Estimated Buildout Population Equivalent (people)	1,483	426	1,909
Calculated Flow / ERU			136 GPD / ERU @ MMDF

The calculated population equivalent seems high due to the high commercial ERUs which represent 52% of the total ERUs in the District. The calculated population equivalent includes several elements including residents in the District, visitors and tourists to the District, employees living outside the District and people who live and work within the District. The actual residential population within the District is much smaller and is more closely represented by the residential ERU population estimate which is 187 ERU x 2.1 people/ERU = 393 people for existing conditions. The existing population equivalent of the entire District estimated at 819 people, including the commercial ERU population, is probably representative of the summer season when visitors to the District are at their highest.

Potential Sewer Main Extensions

Sewer Extensions with Road Reconstruction (TIP Projects):

Of the road projects identified on the County's 2021-2026 Six-Year Transportation Improvement Program (TIP), there are no candidates for installing sewer extensions to newly served areas in conjunction with the road reconstruction projects.

There is one project, TIP No. 16 Fisherman Bay Rd Shoulder Widening, which overlaps with District sewer lines. However, it appears to be shoulder widening only and not involving any major existing roadway rebuilding. The sewer line along this TIP project, from Normandy Ln north to Lopez Rd, does not need to be replaced due to capacity. If the District has any concerns with the age or condition of this main, it might consider obtaining more details from the County on the scope of the roadway project to determine if it is practical to replace the main before or concurrent with the TIP project.

Additional sewer extensions or upgrades with road projects in the County's TIP may be possible in future phases, and will be evaluated during periodic updates.

Hummel Lake Rd:

An approximately 11 acre parcel was recently purchased south of Hummel Lake Rd. The parcel is in the UGA and mostly zoned as Lopez Village Residential with a small area of LV Center adjacent Fisherman Bay Rd. If developed at max density of 8 units/acre the site could consist of 88 ERU. The extents of the parcel, aligning with the current extents of the District boundary, is approximately 1,300 feet from the sewer main on Fisherman Bay Rd. The District expects this parcel to be developed within the next 20 years.

Other Developer Extensions / Local Improvement Districts:

There are several other properties remaining within the District limits that could be subdivided or grouped to create a development. For any new development that would require extension of sewer mains the property owner will be required to enter into a developer extension agreement with the District whereby the owner becomes responsible for all design, construction, and inspection costs associated with the new branch sewer line. Design and construction will be required to conform to District Sewer Specifications and Standards (Appendix D). At the time the new line goes into operation, the District will be granted ownership of, and operation and maintenance responsibilities for all new sewer facilities associated with the development.

A local improvement district or utility local improvement district (LID/ ULID) can be a funding alternative for areas with multiple owners and where significant infrastructure improvements are needed. The process involves a vote of those who will be assessed, but also allows the assessment to be paid off over a period of time (up to twenty years).

Potential Growth outside District Limits

The Growth Management Act (GMA) prohibits the extension of public sewers into rural areas. RCW 36.70A.110(4) provides in part:

> In general, it is not appropriate that urban governmental services be extended to or expanded in rural areas except in those limited circumstances shown to be necessary to protect basic public health and safety and the environment and when such services are financially supportable at rural densities and do not permit urban development.

The District will only expand the sewer collection system outside their current boundary if either; a) the area is designated by San Juan County as Urban Growth Area (UGA) or Limited Area of More Intense Rural Development (LAMIRD), or b) San Juan County grants Conditional Use Permit Approval for the extension by showing it is necessary to protect public health and safety and the environment.

The hydraulic analysis performed in support of this plan evaluated the District's sewer capacity to serve projected growth to build-out including the two areas outside the current boundary as discussed below. While specific conveyance projects to individual parcels have not been included in the plan, the District has determined that the areas of growth outside District limits can be adequately served with the construction of projects as described below. The cost of such improvements will be borne by development unless or until the District adds the project as a capital facility improvement.

Appendix H includes maps that show the future areas to be served by District sewer. Below is a summary description of the areas and the projects required to provide sewer service. Previously, the East Shore South area had been considered, but this area is no longer considered a potential area of expansion for the District.

<u>Weeks Point Way Bay</u>

There are 24 acres of UGA area outside of the current District boundary located east of Weeks Point Way. Although much of this area is water or marsh and is undevelopable, approximately 9 acres of this area appears to be developable. The Comprehensive Land Use designation is Lopez Village Industrial (LVI) and is zoned for potential maximum of 8 units/acre. Due to the variability of potential industrial/commercial type connections, the maximum density is assumed for a build-out potential, or 9 acres x 8 units/acre = 72 ERU.

Sewer service to this area would likely be conveyed either to the east 6-inch main along Fisherman Bay Rd, or to the north 6-inch main along Lopez Rd, both an approximate distance of 600-700 feet. It appears to be most likely, and is assumed in the hydraulic analysis, that this area would be conveyed east to Camas Ln and connecting to the Fisherman Bay Rd main. Either way, easement(s) would be required through the parcels between this land and the roads. For 72 ERU, the peak flow is estimated to be 60-80 gpm and the sub-main pipe size would be 3-inch. At the time of this report preparation, there are no known development plans for this area.

Whiskey Hill Area

There are approximately 40 acres just south of the current District boundary located along Whiskey Hill Rd east of Fisherman Bay Rd. This area is already developed with single family residences and consists of approximately 70 lots with approximately 10 lots currently not built on. The total build-out potential is 70 ERU. This area is not currently designated as UGA or LAMIRD. Correspondence with San Juan County Department of Community Department (Planning) has indicated that it is unlikely this area would be designated as a LAMIRD in the future because of GMA requirements and the general sentiment around designating new areas for more intense development on the island. However, future service to this area is considered in this Plan for future potential consideration, although it is not included in the CIP projects. Any potential future extension to this area must be consistent with the GMA, County Comprehensive Plan, and San Juan County Code.

Sewer service to this area would consist of a submain along Whiskey Hill Rd from the upper extents of the area down the hill to Fisherman Bay Rd, approximately 4,300 LF. For 70 ERU, the peak flow is estimated to be 60-80 gpm and the sub-main pipe size would be 3-inch.

One important consideration for the County considering allowing sewer service into the area is ensuring that it is financially feasible. For example, the extension of service into the area should not create a burden on the system to serve an area with too few connections to offset the cost of providing the service. In the case of this area, the development is a relatively dense subdivision with 1/2-acre parcels. The estimated project construction cost is $630,000 including design, construction administration, and sales tax. This cost estimate includes the connection of all services to the main, but does not include the materials and installation for the STEP system or service line up to the main connection. For 70 ERUs, the cost per ERU is $9,000, which is less than the system connection fee and is considered reasonable.

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6.0 - FUTURE IMPROVEMENT PROJECTS

The purpose of this section is to evaluate, identify and describe the recommended improvements to the existing sewer collection and wastewater treatment facilities. Improvements of this section will consist of site improvements and selection of the recommended treatment alternative. The goal of alternative evaluation is to select an alternative that is cost-effective, reliable, low maintenance, fits within site constraints, and has effective treatment and capacity for current and future flows and loadings.

The District has developed 10-year and 20-year sewer capital improvement plans (CIP), which are included in Appendix G. The CIP includes the anticipated project schedule and estimated project costs. It should be noted that the Capital Improvement Plan in years 2032 – 2041 is planning level, is based on the best information available at this time, and may not include all future sewer capital projects. The CIP will continue to be financed and updated as more information becomes available. It is recommended to review and update the CIP annually.

6.1 - O&M and Administrative Improvements

Operations & Maintenance Improvements

<u>Collection System – Septic Tank Inspection and Replacement</u>

The District has an ongoing program that they have implemented for years. Over the last few years, the District has been developing their Septic inspection and replacement database, and it is recommended to continue development to make the database a comprehensive tool for logging records, observations, and planning for all District operators and personnel. It is also recommended to expand the database to include pump system information for better tracking of those facility components.

<u>Collection System – Isolation Valve Exercising</u>

The District has identified several isolation valves that are "frozen" and either inoperable or very difficult to operate. These valves should be scheduled for replacement, and are discussed in Section 6.2. It is recommended that the District implement a valve exercising program. Valves should be exercised annually and should be scheduled and planned for at the same time each year when it is convenient for the Operators. If there are valves that are difficult to operate, they many need to be exercised more frequently (twice per year).

<u>Collection System – Air Valve Monitoring and Maintenance</u>

It is recommended the District implement an air valve monitoring and maintenance program and incorporate it into their database for tracking. Air valves should be inspected annually or more frequently depending on their performance or location. Air valves that are located on mains where pumping downhill occurs (i.e., Milagra, Erisman, Normandy, Dragon Run) should be monitored more closely to ensure they are functioning and performing properly. During inspections of air valves, the District's automatic air valves should be vented manually, and conditions reported using one of the five conditions below:

- Condition 1, No Air – effluent only, is representative of those air release locations below static or energy grade lines where no air or gas is accumulating or where the accumulation is being properly released by the air valve.
- Condition 2, Minor Air – small bubbles, can usually be expected where an adequately monitored manual air valve is located. This may not apply to the District's system which has all automatic air valves.
- Condition 3, Continuous Air – large pockets of air (1 minute or more), indicates excessive accumulation of gas or air. The problem may indicate mechanical malfunction of the automatic air valve. If there is a blow off valve beneath the air valve, it should be bled by opening this blow off. The process should be repeated for two additional days. If air continues to escape after several days of manual bleeding, the air valve should be replaced or repaired.
- Condition 4, Vacuum – air drawn into the system, indicates that siphoning is occurring. Locations that are subject to siphonage are those with elevations above the energy grade line. These are usually at the beginning of gravity sections. Condition 4 may be the result of an automatic air valve with a plugged orifice or mechanical apparatus that is frozen shut. In either case, movement of air back into the system is restricted and repair or cleaning of the mechanism is required.
- Condition 5, Passive – no air, vacuum, or effluent, is typical of automatic air valve locations that are above the static or energy grade lines and at which air is being properly expelled.

Depending on the elevation relative to the energy grade line, condition (1) and (5) are normally ideal. Back-flushing or cleaning of automatic air valves should be scheduled according to each location's priority rating and usually should be performed at least once a year. Operators may find that certain locations require service more frequently than others.

<u>Collection System – Line Flushing and Clean-Out Installations</u>

In the case of STEP collection systems, flushing of main lines is rarely needed because the effluent is relatively free of solids. However, similar to the District's recent experiences at the bottom of Milagra Ln, occasionally service or main lines can become damaged and soil and aggregate material can enter the collection system. This is more likely in areas of the collection system above the static grade line where line pressures may not always be present. However, line flushing cannot occur if clean-outs are not installed where flushing access points are needed.

Rather than determine a flushing schedule solely based on the calendar year, it is recommended that pumping issues be monitored. Flushing needs could also be determined by pressure monitoring, if equipped with the proper equipment. Pressure monitoring stations would typically be set up at air valve locations. Increased pressures, or observed isolated pumping issues, could be an indication of air entrainment or the need for flushing.

<u>Collection System – I&I Cross-Connection Investigations</u>

The District should continue to identify potential issues on the private side of the septic systems in order to reduce infiltration and inflow sources to the sewer system. Where any storm water cross-connections are possible or suspected the District could implement investigations to find and address them. For some gravity sections, smoke testing might be possible, and the District would hire specialty contractors to perform the work. Multiple locations of smoke testing should be identified and coordinated to take advantage of a smoke testing contractor's mobilization efforts to the District. For areas where smoke testing is not feasible, due to lack of gravity flow conditions or access points, dye testing might be used to test potential cross-connections. If any are found they should be documented and followed up on immediately and fixed as soon as possible. Records should continue to be updated as cross-connections are removed and as new locations are discovered through future investigative work.

Collection System – I&I Inflow Point Source Repairs

The District staff has observed likely sources of inflow that originates in the gravity sewer on the customer side of the septic tank systems, including broken or missing clean out caps or likely broken sections of shallow sewer piping. The District inspects and observes these deficiencies during routine septic inspections and call outs for site specific issues and alarming events. The District should continue to implement and develop their program in which they note these observations in the database records and immediately make plans to repair deficiencies, including contacting and coordinating with the owner, obtaining necessary equipment and materials, and coordinating with any contractors that may be required to perform the repair work. These deficiencies are often easy and cost-effective ways to reduce I&I.

Administrative, Financial, and Planning Improvements

Emergency Response Plan

The District intends to complete their draft Emergency Response Plan (ERP) that outlines District priorities and activities in response to an emergency event such as natural disasters, vandalism, catastrophic equipment failures, etc. The District will update the existing ERP, as necessary, to ensure compliance with applicable regulations and requirements of agencies. The District plans to conduct emergency response training exercises and drills with staff to enhance emergency preparedness.

Geographic Information System (GIS) Development / Maintenance

As part of this plan, the District's consultant began development of a sewer system GIS to aid in planning, administration, and operation and maintenance record keeping for the District's sewer facilities. To date, the GIS includes known isolation valves, air valves, clean out, and pipe locations, and some data on pipe size and material, in addition to the general District information including topography, property parcels, roads, zoning, and land use planning. This information will be provided to the District in a format that be accessed using free software.

Sewer Service Rate Increases

The District will implement recommended incremental rate increases resulting from the District's routine financial rate studies. The rate increases will ensure that the District is adequately recovering the true costs of operating the system, budgeting for replacing assets as they reach the end of their useful service line, and paying back all existing and anticipated loan funds. By adequately recovering the true costs for system operation and maintenance, the District staff will be able to perform adequate, routine maintenance activities, which will add to the service life of the system and effectiveness of collection, transmission, and treatment of the wastewater. Additionally, implementing rate increases recommended in any rate studies will allow the District to maintain the appropriate reserves required for emergencies, if revenues meet regular expenses.

Continued Development of Infiltration and Inflow Reduction Program

As part of this activity, the District will continue to develop and update the prepared infiltration and inflow reduction program (Corrective Action Plan) developed as part of the I&I Analysis (see Appendix C) conducted for this Sewer Plan. The program will include septic tank inspection and replacement, cross-connection investigations, repairing or replacing inflow point sources, implementing and enforcing design and construction standards, as well as other I&I mitigation measures. Reference Appendix C for current program plans and timelines.

6.2 - Sewer Collection Capital Improvement Projects

Septic Tank Replacements - Ongoing

The District's goal is to replace failed tanks immediately and others needing repairs when properties sell or when continued monitoring reveals failure for immediate replacement. The proposed schedule and locations for these replacements in the next 6 years is included in Appendix C and in the District's Sewer Capital Improvement Plan (see Appendix G).

Each septic tank will be evaluated to determine the specifics upgrades and extents of replacements required. Replacements will typically include new tank, pump, and controls at the least. Replacement of the aged tank, pump, and control equipment will result in decreased I&I flows, increased reliability, reduced emergency call-outs, and reduced operation costs.

Miscellaneous Sewer Line Replacement and Repair

TIP Related Projects

The District should review underground utility needs when the County prepares to do any major work on District area roads. As part of this planning process, the projects on the County's current 2021-2026 Six-Year Transportation Improvement Program (TIP) projects were evaluated to determine the associated sewer collection system needs. One TIP project in the District area; is TIP Project No. 16 Fisherman Bay Rd Shoulder Widening. This road project may not be invasive enough, or the sewer main located such that, it justifies replacing the sewer line along this section of project. The existing 6-inch sewer main does not need to be replaced or upgraded due to capacity. If the project and existing pipe conditions warrant replacement, the project would replace approximately 3,200 linear feet of existing 6-inch PVC with new 8-inch HDPE (nominal inside diameter > 6-inches) and appurtenances. This potential project is not anticipated and thus is not included in the District's CIP list of projects at this time.

Valve Replacements and Additions

The District has identified several isolation valves that are "frozen" and either inoperable or very difficult to operate. These valves should be scheduled for replacement. Planning for valve replacements will take careful planning and coordination to ensure that sewer flows can adequately be temporarily diverted or bypassed during the replacement construction.

Valves known to require replacement include:

- Two valves at the intersection of Fisherman Bay Rd and Sunset Ln (3" and 4" sizes)
- One valve on the East Trunk Loop 4" just east of the WWTP

According to available records, the following locations do not currently have isolation valves and valves should be added:

- Intersection of Lopez Rd and Weeks Rd
- Intersection of Weeks Rd and Washburn Pl
- Intersection of Fisherman Bay Rd and Normandy Ln

Capacity or Condition Related Projects

As part of this plan a hydraulic analysis of the collection system main piping was performed, see Appendix H for more information. Based on this analysis there are a few pipe improvement projects that are identified, which are shown in the following table.

Table 6-1: Piping Upgrade Projects

No.	Location	Description	Anticipated Timing of Deficiency
1	WWTP Influent Line	Replace 250 LF of 4-inch PVC with 10-inch HDPE; Add/replace isolation valves, clean outs, and appurtenances; Coordinate with WWTP upgrades.	Now
2	South Loop Trunk / Lopez Rd between WWTP and Weeks Point Way	Replace 1,900 LF of 4-inch PVC with 8-inch HDPE; Add/replace isolation valves, clean outs and appurtenances.	439 ERUs, approx. year-2025
3	East Loop Trunk / WWTP to Fisherman Bay Rd	Replace 1,350 LF of 4-inch PVC with 8-inch HDPE; Add/replace isolation valves, clean outs and appurtenances.	540 ERUs, approx. year-2032
4	Milagra Ln	Replace 1,200 LF of 2-inch PVC with 4-inch HDPE; Add/replace isolation valves, air release/vacuum valves, clean outs and appurtenances.	19 ERUs, approx. year-2028
5	East Loop Trunk / Fisherman Bay Rd, Sunset to Lopez	OPERATIONAL FLEXIBILITY PROJECT: Replace 2,300 LF of 4-inch PVC with 8-inch HDPE; Add/replace isolation valves, air release/vacuum valves, clean outs and appurtenances.	N/A. Install approx. year-2039

Project No. 1 should be installed concurrent with the WWTP Upgrades. Projects 2, 3, and 4 are highly dependent on growth, and are currently scheduled based on District-wide projected growth of 3% per year. Growth should be monitored and these projects moved to earlier or later in the schedule as appropriate. The above improvement projects also provide adequate capacity to allow for the two areas of potential growth outside of the District boundaries as discussed in Chapter 5. Project No. 5 is not required from a capacity standpoint, assuming that the East Loop Trunk and South Loop Trunk are operated with both loops fully operating and functional. This project would allow for operational flexibility by providing adequate capacity for buildout peak hour flow to the plant with the South Loop Trunk out of operation. Because the project is only an operational flexibility project, it is planned for many years out.

One additional nominal deficiency was identified in the hydraulic analysis. The Weeks Point Way main is at capacity (based on pipe velocity of slightly higher than 5 ft/s) and a TDH of just under the criteria limit of 200-ft. This branch main is fully developed with no additional future growth. At the time of this report preparation, the District has secured grant funding and is in the preliminary phases of replacing this main. Thus, the project is not included in this Plan.

Developer Extension Projects

The District will review applications by Developers to extend District sewer facilities. The District requires the Developer to provide engineered plans prepared in accordance with the District Standards, and requires regular inspections to ensure installation is according to the approved plans.

One potential project within the next 20 years is a developer extension along Hummel Lake Road, An 11 acre parcel along here was recently purchased.

Utility Local Improvement Projects

The District will review any petition from property owners for extension of sewer service. Under certain conditions, the District may install new facilities for specific areas under the Utility Local Improvement District (ULID). ULID funded projects are paid for by the property owners within the ULID, either in lump sum or over time (with interest).

6.3 - Wastewater Treatment Alternatives Evaluation

The purpose of this section is to identify and describe the improvement alternatives to the existing wastewater treatment facilities. The goal of this evaluation is to select an alternative that is cost effective, reliable and low maintenance, fits within site constraints, and has effective treatment and capacity for current and future flows and loadings.

Design Criteria

As described in Chapter 4.0, the current plant is at or nearing its end-of-life. Components of the plant are between 15 and 42 years old. To address the aging infrastructure and the need for future nutrient removal, a significant upgrade to the wastewater treatment plant is needed. The tables below identify the design criteria used for sizing and evaluating wastewater facility alternatives.

Table 6-2: Current Permitted Influent Flow / Loading Limits

Current Permitted Facility Load Limits	
Maximum Month Design Flow (MMDF)	0.053 MGD
$CBOD_5$ Influent Loading for Maximum Month	66 lb/day

Table 6-3: Existing Influent Flows and Loadings

	Flow	BOD		TSS		Ammonia*		TKN*	
	(MGD)	(lb/day)	(mg/L)	(lb/day)	(mg/L)	(lb/day)	(mg/L)	(lb/day)	(mg/L)
ADF	0.030	29	114	7	25	16.8	61.2	19.7	71.7
MMDF	0.053	75	170	23	34				
Max Day	0.177	75	51	23	16				
PHF	0.354	75	25	23	8				
PIDF	0.707								

*Influent Ammonia and TKN data come from quarterly influent samples.

Table 6-4: Future (2043) Influent Design Flows and Loadings

	Flow	BOD		TSS		Ammonia		TKN	
	(MGD)	(lb/day)	(mg/L)	(lb/day)	(mg/L)	(lb/day)	(mg/L)	(lb/day)	(mg/L)
ADF	0.060	57	114	14	26	113	61.2	132	71.7

MMWWF	0.105	148	170	45	34				
Max Day	0.349	148	51	45	15				
PHF	0.698	148	25	45	8				
PIDF	1.40								

Future Max Day flow was calculated by multiplying Average Daily Flow by 5.36, which is the observed peaking factor of existing influent flows.

Peak Hourly Flow was calculated by multiplying Max Day Flow by 2.0. Recorded peak hourly flows were not used as the flow metering system has shown to be inaccurate at peak flows. This equates to an Hourly to Average Daily Flow peaking factor of 10.7.

Peak Instantaneous Design Flow was calculated by multiplying Peak Hourly Flow by 2.0. Recorded peak instantaneous flows were not used as the flow metering system has shown to be inaccurate at peak flows.

Table 6-5: Additional Effluent Design Criteria

Parameter	Limit	Condition
pH range	6-9	Min-Max (Std. Units)
Fecal Coliform	200/100 mL	Monthly Geometric Mean
Fecal Coliform	400/100 mL	Weekly Geometric Mean
BOD	30 mg/L	Ave Monthly (85% Removal)
	45 mg/L	Ave Weekly
TSS	30 mg/L	Ave Monthly (85% Removal)
	45 mg/L	Ave Weekly
Design Population (ERUs)	746	
Total Inorganic Nitrogen (TIN)	10 mg/L	

Treatment Alternatives

Four treatment alternatives have been evaluated in this report based on Cost Effectiveness (Engineering, Construction and Operations), Treatment Effectiveness, Operations and Maintenance Demands, and Site Layout.

The four treatment alternatives evaluated are:

1. Alternative 1 - Activated Sludge (AS) with Biological Nutrient Removal (BNR) (i.e., Aeromod)
2. Alternative 2 – Activated Sludge (AS) with Biological Nutrient Removal (BNR) (i.e., Smith & Loveless)
3. Alternative 3 - Lagoon Upgrades with Biological Nutrient Removal (BNR) (i.e., Triplepoint)
4. Alternative 4 - Integrated Fixed Film Activated Sludge (IFAS) with Biological Nutrient Removal (BNR) (i.e., STM-Aerotor)

Alternative treatment facility locations were not considered due to high anticipated costs of relocating, existing collection system configuration, availability of land at the existing plant site, and lack of available land in other locations.

All treatment alternatives were evaluated to meet the design criteria presented in tables 6-2 through 6-5.

For each alternative, other improvements are shown to complement the proposed alternative. These improvements are not required for all alternatives, but are shown to explain the sequence of treatment and how each alternative would function within the entire treatment plant. These major improvements, which are discussed in more detail in section 6.4, are listed below.

Improvements shown with each alternative:

1. Conversion of the Pretreatment Anaerobic Cell to influent equalization basin
2. Conversion of L-2 lagoon to biosolids stabilization basin (Required for Alt. 2 & 4, not included with Alternative 3)
3. New operations building for UV disinfection, aeration blowers, and lab.
4. Upgrade and continue treatment with the constructed wetland (Required for Alternative 3)

<u>Plant Classification</u>

Per WAC 173-230-330, each alternative would have the following classification criteria based on a design flow less than 1 MGD:

Alt. 1 – Activated Sludge with BNR = Classification II

Alt. 2 – Extended Aeration with BNR = Classification II

Alt. 3 – Lagoon Upgrade with added BNR = Classification I

Alt. 4 – IFAS with BNR = Classification II

In addition, wetland treatment with a design flow less than 1 MGD requires Classification I.

Alternative 1 – Activated Sludge 1 with Biological Nutrient Removal (BNR) – Aeromod System

<u>Process Description</u>

The Aeromod SEQUOX process, is an activated sludge process that uses cyclical aeration to achieve biological nutrient removal. The treatment process consists of an anoxic selector tank, two stages of aeration basins, two clarifier tanks, and two aerobic digester tanks.

Influent combines with return activated sludge (RAS) in the anoxic selector tank before it flows into the first stage aeration basin. Aeration in the first and second stage is turned on and off on a 2-hour cycle for BOD removal and nitrification in aerobic conditions, and denitrification in anoxic conditions. The sequence of aeration in the first stage aeration basin is opposite to that of the second stage, which results in a plug flow process with sequential nitrification/denitrification reactions. Aeration is by coarse bubble diffusers installed on the basin floor.

Similar to a conventional activated sludge process, flow enters the clarifier from the second stage aeration basin, where the solids settle to the bottom and clear effluent is collected from the surface and sent to UV disinfection.

Waste activated sludge (WAS) is sent from the second stage aeration tank to the aerobic digester tank. During the wasting events, supernatant from the digester is decanted back to the aeration basin over a fixed level weir. Digested sludge can be periodically transferred to a repurposed L-2

Costs (Construction / Operations & Maintenance)

The estimated costs for this option, including contingency, sales tax, and engineering, were determined to be approximately $4.1 million. The significant costs for this alternative are the excavation, backfill, concrete, and installation of the Aeromod system.

The annual operations and maintenance costs for this alternative are very low. The main operating cost is the power required to run the blowers for aeration. It should be noted that for all four alternatives the operations costs are similar and not a significant factor when comparing the alternatives.

The net present worth 22-year life cycle cost for this alternative is $8,972,803.

Treatment Effectiveness

The effluent from the Aeromod system is estimated to be less than 10 mg/L BOD_5, 10 mg/L TSS, 1 mg/L ammonia as TKN, and 5 mg/L TIN. When configured with chemical addition, the process may be able to achieve 3 mg/L TIN limits; however, this limit is not common and could be difficult to achieve year round with STEP influent. The Aeromod process uses a long hydraulic retention time (HRT) and solids retention time (SRT), which makes the system more forgiving to shock loads and hydraulic surges than conventional activated sludge. Considering the variable flows and loadings at Fisherman Bay, this process would help maintain effluent quality throughout the entire year.

The Aeromod system has a long list of installations in the US. From conversations with operators the system is effective and easy to operate and maintain.

The Aeromod system has an advantage over the other alternatives with its integral sludge digestors. This will allow sludge to thicken over time and reduce the frequency of sludge removal from the plant. It will also allow provide a head start in biosolids handling if future biosolids handling options are ever considered, such as treating biosolids to Class B biosolids or constructing a composting system.

A disadvantage of the Aeromod system is the rectangular clarifiers. In general, circular clarifiers, such as those presented in Alternative 2, perform better than rectangular clarifiers. However, given the low TSS entering the treatment plant from the STEP system, meeting TSS limits should be easy to achieve with all alternatives.

Operations & Maintenance

The sequential oxidation process is relatively low maintenance. RAS pumping and solids wasting are performed with airlift pumps, and the clarifier has no motors, gears, or electrical components. The major equipment maintenance requirements are the blowers, flow meters, and electronic actuators. In addition, the diffusers used in the aeration basins and digester are accessible without turning off the blowers or draining the tanks, so the basins will not require draining to inspect and clean the diffusers.

The cyclic aeration is automated, and blowers are automatically turned up or down based on the DO levels in the aeration basins, so the plant will not require constant attention or manual adjustments.

This system will require routine maintenance, inspection, and cleaning of its major components. The clarifiers will require cleaning of the clarifier basin, weirs and launders and require inspection. In addition, the aeration system will require occasional cleaning of diffusers, which can be raised to the surface without the need to take the basin offline.

<u>Site Layout</u>

The most significant advantage of this alternative is its small footprint. No flow splitter or RAS pump station will be needed. The entire activated sludge system, clarifiers, and digestors are included in a single package. The compact system utilizes a common wall design which saves costs on concrete and piping between basins. In addition, the integral digestor can be used alone without the need to convert the L-2 lagoon to a solids holding basin.

See Appendix B, Figure 6-1 & 6-2 for a conceptual layout of this alternative.

Alternative 2 – Activated Sludge 2 with Biological Nutrient Removal (i.e., Smith and Loveless)

This alternative specifically evaluates the activated sludge system offered by Smith and Loveless. The system is known as the OXIGEST Wastewater Treatment System. It is a package system in the configuration of a donut or bullseye. The Smith and Loveless system was used as the basis of this alternative evaluation, however, other wastewater equipment vendors provide similar systems with this configuration.

<u>Process Description</u>

This process consists of an activated sludge biological treatment and clarification system configured in a concentric ring configuration with aeration and anoxic basins along the outer ring and a clarifier on the inside. The process uses a long sludge age activated sludge process to create a cost-effective treatment solution capable of nutrient removal. Influent wastewater enters the anoxic basin where it is mixed with Return Activated Sludge, then flows to the aeration basin for biodegradation and mixing of the activated sludge. Aeration is performed by fine bubble diffusers on the basin floor. After aeration the mixed liquor enters the post-anoxic basins for additional nutrient removal.

Suspended solids are then separated from effluent in the clarifier. Clear effluent flows from the surface of the clarifier over weirs to disinfection. Sludge is drained from the bottom of the clarifier as Waste Activated Sludge (WAS). Return Activated Sludge is recycled to the front end of the anoxic basin. For the proposed alternative two identical trains would be installed to achieve greater redundancy and flexibility.

<u>Costs (Construction / Operations & Maintenance)</u>

The estimated construction costs for this option, including contingency, sales tax, and engineering, were determined to be approximately $7.1 million. This alternative is the most expensive of the four alternatives. The significant costs for this alternative are the equipment costs, excavation, backfill, concrete, and installation of the Smith & Loveless system. In addition, the system would require a flow splitter and conversion of the L-2 lagoon as biosolids stabilization which raised the costs substantially.

The annual operations and maintenance costs for this alternative are very low. The main operating cost is the power required to run the blowers for aeration. It should be noted that for all four alternatives the operations costs are similar and not a significant factor when comparing the alternatives.

The net present worth 22-year life cycle cost for this alternative is $12,308,995.

Treatment Effectiveness

The effluent from this alternative is estimated to be less than 10 mg/L BOD, and 10 mg/L TSS. The process has a long Hydraulic Retention Time and Solids Retention Time (HRT/SRT) which allows the system to be more forgiving to shock loads or hydraulic surges. Given the variable flows typical in Fisherman Bay this design would help maintain quality effluent through the entire year.

The system is configured to reduce Total Nitrogen to 15 mg/L. This would be a substantial reduction from current Total Nitrogen effluent; however, it does not meet future Total Nitrogen limits which are expected to be 10 mg/L or less.

Operations & Maintenance

This system will require routine maintenance, inspection, and cleaning of its major components. The clarifiers will require cleaning of the clarifier basin, weirs and launders and require inspection and maintenance of the clarifier drive motor. In addition, the aeration system will require occasional cleaning of diffusers in the aeration basin. The system will also include feed forward pumps between basins, RAS pumps, WAS pumps, flow meters, electronic WAS valves, and blowers all requiring routine servicing. The redundancy provided by two cells would make maintenance of the system simple when a cell needs to be drained for cleaning.

Site Layout

See Appendix B, Figure 6-3 & 6-4 for a conceptual layout of this alternative. The proposed layout would utilize the space south of the constructed wetland for the two cells. Each cell would consist of an outer ring with anoxic and aeration basins and an internal clarifier in the center. With two cells and a flow splitter this alternative does take up the most space.

Because this system does not include a sludge digestor, a sludge holding basin would be required for waste activated sludge (WAS). The L-2 lagoon would need to be converted to a solids holding basin.

The existing L-2 lagoon would be repurposed as biosolids stabilization and the constructed wetland would remain as a tertiary treatment option.

Alternative 3 – Lagoon Upgrade with Biological Nutrient Removal (i.e., Triplepoint)

This alternative specifically evaluates the lagoon upgrade and biological nutrient removal system offered by Triplepoint. This alternative would keep and upgrade the existing lagoons in their current configuration but add nutrient removal. The nutrient removal system is known as the NitrOx+D Wastewater Treatment System and the lagoon aeration system is known as the Ares system. The NitrOx+D system consists of four basins configured to remove Total Nitrogen. The

Triplepoint system was used as the basis of this alternative evaluation, however, other wastewater equipment vendors provide similar systems with this configuration.

Process Description

This alternative would keep the existing lagoons and constructed wetland configuration but would upgrade the aeration system in the L-2 lagoon and add a nutrient removal system. The nutrient removal system would pull mixed liquor from Aerated Cell No. 2 of the L-2 lagoon and send the treated flow back to the polishing cell after nutrient removal. The pre-treatment lagoon would remain in its current configuration with only upgrades to the liner system to extend the life of the basin. The aeration system in the L-2 lagoon would be replaced with submersible diffusers to improve the effectiveness and capacity of the lagoon. The diffusers would be supplied air by new air piping and blowers.

The nutrient removal system would consist of four new concrete basins arranged in series. The first basin would be a pre-anoxic basin where influent mixed liquor from Aerated Cell No. 2 would be mixed with return activated sludge (RAS). The second and third basins would be a Moving Bed Bioreactor (MBBR) with aeration. This MBBR system consists of hundreds of small plastic media which remain in the basin and develop a biofilm. This effectively increases the surface area and the capacity of the basin. The final basin is a post-anoxic basin for additional nutrient removal.

After the nutrient removal system mixed liquor is sent back to the L-2 lagoon into the polishing cell and then to the constructed wetland.

Costs (Construction / Operations & Maintenance)

The estimated construction costs for this option, including contingency, sales tax, and engineering, were determined to be approximately $5.0 million. The significant costs for this alternative are the equipment costs, excavation, backfill, concrete, and installation of the aeration and nutrient removal system. In addition, the system would require the addition of a RAS pump station and upgrades to the existing lagoon liners and constructed wetland media.

The annual operations and maintenance costs for this alternative are very low. The main operating cost is the power required to run the blowers for aeration. It should be noted that for all four alternatives the operations costs are similar and not a significant factor when comparing the alternatives.

The net present worth 22-year life cycle cost for this alternative is $10,520,873.

Treatment Effectiveness

The effluent from this lagoon system is estimated to be less than 10 mg/L BOD, and 10 mg/L TSS. The process has a long Hydraulic Retention Time and Solids Retention Time (HRT/SRT) which allows the system to be more forgiving to shock loads or hydraulic surges. Given the variable flows typical in Fisherman Bay this design would help maintain quality effluent through the entire year.

The system is configured to reduce Total Inorganic Nitrogen to 3 mg/L; however, this limit is not common and could be difficult to achieve year-round.

The downside of the lagoon system is the potential for odor, algae blooms, and duckweed growth. The system also has the disadvantage of relying on the polishing cell and constructed wetland for solids removal versus the other alternatives that utilize clarifiers which are more reliable for solids separation. Using the polishing cell and constructed wetland has been effective at meeting TSS limits, but problems such as duckweed would likely continue requiring ongoing maintenance and the constructed wetland would have a shorter lifespan as it would receive a higher concentration of solids compared with the other alternatives with clarifiers.

Operations & Maintenance

Overall, this lagoon system would be simple to operate with hydraulic retention times offering operators flexibility to handle shock loads and hydraulic surges. However, this system would add the nutrient removal basins which would add some complexity compared to the existing system. The nutrient removal system would require additional monitoring, maintenance, and cleaning not included in the current lagoon system. Likewise, the upgraded aeration system would require increased maintenance and inspection not included with the existing surface aerators.

This full system will still require routine maintenance, inspection, and cleaning of its major components. Additional monitoring and maintenance of the aeration system and blowers would be required for both the lagoon aeration and MBBR aeration.

Site Layout

See Appendix B, Figure 6-5 & 6-6 for a conceptual layout of this alternative. The proposed layout would utilize the space south of the constructed wetland for added nutrient removal basins. This is the only alternative that would continue use of the pre-treatment lagoon and rely on the constructed wetland for suspended solids removal.

Alternative 4 – Integrated Fixed-Film Activated Sludge (IFAS) with Biological Nutrient Removal (BNR) – STM Aerotor

Process Description

The process used in Alternative 4 is an activated sludge integrated fixed-film treatment process, such as WesTech's STM-Aerotor process. The process includes an anoxic zone for denitrification, and an aerobic zone with rotating media disc wheels followed by external circular clarifiers.

This alternative includes three trains in parallel, each with one anoxic zone and one aerobic zone containing one media disc wheel. Influent enters the anoxic zone and combines with return activated sludge (RAS) from the clarifier and internal recycle flow (IR) from the aerobic zone. After the anoxic zone flows continue to the aerobic zone/IFAS basin.

In the aerobic zone fixed-film grows on the media discs, which trap atmospheric air when above the water surface. The trapped air is slowly released as coarse bubble aeration upon submergence of the discs. Aeration is controlled by speeding up or slowing down the rotation of the media discs using a variable speed drive. The rotating media disc wheels also contain a mixing paddle to ensure mixing in the basin below the aerated portion of the tank. The aeration method used in this process allows anoxic zones to develop within the IFAS basin, which helps promote denitrification.

As with a conventional activated sludge process, flow enters the two external clarifiers from the aerobic zone, where solids settle to the bottom and clear effluent is collected from the surface and sent to UV disinfection.

Costs (Construction / Operations & Maintenance)

The estimated costs for this option, including contingency, sales tax, and engineering, were determined to be approximately $5.7 million. The significant costs for this alternative are the equipment costs, excavation, backfill, concrete, and installation of the STM Aerotor system. In addition, the system would require a flow splitter, a RAS Pump, and conversion of the L-2 lagoon as biosolids stabilization which raised the costs substantially.

The annual operations and maintenance costs for this alternative are low. The main operating cost is the power required to run the STM drives. It should be noted that for all four alternatives the operations costs are similar and not a significant factor when comparing the alternatives.

The net present worth 22-year life cycle cost for this alternative is $12,115,569

Treatment Effectiveness

The effluent from the process is estimated to be less than 10 mg/L BOD_5, 10 mg/L TSS, 1 mg/L ammonia as TKN, and 10 mg/L TN. The fixed-film increases the solids retention time (SRT) which makes the system more forgiving to shock loads, and improves sludge settleability. The disadvantage of this system is its aeration control. Rather than using conventional blowers to supply air, it pulls the air down within the rotating tubes and slowly releases that air as it rotates. As the oxygen demand increases the rotation speed increases. While this method is more cost-effective, it is not as efficient as conventional blowers feeding air through diffusers. As a result, achieving TN effluent levels significantly below 10 mg/L is not likely for this system.

Operations & Maintenance

The activated sludge fixed film process is relatively low-maintenance. The process achieves aeration through the rotation of the media disc wheels, so the system does not use blowers or air diffusers. The drive unit for the media disc wheels is above the water surface, and the only required routine maintenance for the drive unit is drive lubrication, so the aerobic zones do not require routine draining. DO probes monitor the dissolved oxygen in the aerobic zones, and the rotation speed of the media disc wheels will automatically increase or decrease to maintain optimum DO levels, so the plant will not require constant attention or manual adjustments.

The anoxic basins each include a submersible mixer, which can be retrieved for maintenance without draining the basin.

The operations and maintenance required for the two external clarifiers would be very similar to alternatives 1 and 2 with routine inspection and clearing.

Site Layout

This alternative would have a similar site layout as alternatives 1 and 2. A flow splitter would need to be added to evenly distribute flow between the three trains.

Because this system does not include a sludge digestor, a sludge holding basin would be required for waste activated sludge (WAS). The L-2 lagoon would need to be converted to a solids holding basin.

The constructed wetland could be used as tertiary treatment to further reduce Total Inorganic Nitrogen and Suspended Solids.

See Appendix B, Figure 6-7 & 6-8 for a conceptual layout of this alternative.

6.4 - Recommended WWTP Improvements

The purpose of this section is to identify and describe the recommended improvements to the existing wastewater treatment facilities. Improvements of this section will consist of site improvements and selection of the recommended treatment alternative. The goal of treatment alternative evaluation is to select an alternative that is cost effective, reliable, low maintenance, fits within site constraints, and has effective treatment and capacity for current and future flows and loadings.

WWTP Recommended Alternative

Description of System

Based on the evaluation of each treatment process alternatives, Alternative 1 – Activated Sludge with Biological Nutrient Removal – The Aeromod System, is recommended as the best alternative for the Fisherman Bay Sewer District. The process is fundamentally an extended-aeration activated sludge process and thus is effective at treating variable flow and waste loads. The process contains typical characteristics of extended-aeration systems, including long hydraulic and solids retention times, high microorganism concentration, and low food:microorganism ratio (F/M). Primary clarification is unnecessary and would not be utilized. The system which is proposed for the District can achieve denitrification by biological means to meet the anticipated future effluent limits.

The treatment process consists of an anoxic selector tank, two stages of aeration basins, two clarifier tanks, and two aerobic digester tanks. A more detailed description of this alternative can be found in Section 6.3. In Appendix B, the following figures detail the recommended alternative:

- Figure 6-1: Conceptual Site Plan
- Figure 6-9: Detailed Flow Schematic
- Figure 6-10: Hydraulic Profile

Future Expansion

The recommended system has been sized and will be designed to easily satisfy the design criteria presented in Section 6.3. However, if future expansion becomes necessary, the treatment plant could expand into property east of the proposed improvements. This space would allow for a second Aeromod system as shown in Figure 6-1 in Appendix B.

Redundancy

The recommended treatment plant improvements will meet all reliability and redundancy requirements for a Class II WWTP as defined by Ecology in the DOE Orange Book Table G2-9. The proposed treatment system will provide two parallel trains of unit processes, as required by Ecology for systems with a peak hourly flowrate three times the average annual flow rate.

Schedule

Funding - Apply for Grants / Loans: October 2021

Notification of Funding Received: June 2022

Design Phase:	June 2022 – February 2023
Ecology Review:	February 2023 – March 2023
Bid Phase:	April 2023 – May 2023
Construction Phase:	June 2023 – March 2024 (12 months)

Future Nutrient Effluent Limits

The District is aware that the Department of Ecology is taking steps to limit the growth of nutrient discharges to the Puget Sound through the Puget Sound Nutrient Source Reduction Project.

Further, our understanding is the Department of Ecology anticipates issuing a Puget Sound Nutrient General Permit (PSNGP) effective January 1, 2022. Currently, a second draft of the new General Permit has been released and the comment period for that draft ends August 2, 2021. A decision on permit issuance is scheduled to be made during Fall 2021. The current draft GP applies to the Fisherman Bay Sewer District as it is one of the 58 publicly owned domestic wastewater treatment plants discharging into the Washington Waters of the Salish Sea. The current draft GP identifies the Fisherman Bay STP under Special Condition S5, Category S, (WWTPs with small loads).

Requirements for Fisherman Bay as identified in the draft GP include:

(1) Monitoring: Monitor and report per the requirements in GP S6.B. This requirement adds sampling and reporting for Total Ammonia, Nitrate & Nitrite, TKN, and Total Inorganic Nitrogen.

(2) Nitrogen Optimization Plan: Submit one Optimization Report per the requirements in GP S5.B. This consists of developing, implementing, and maintaining a Nitrogen Optimization Plan. This plan must be submitted by March 31, 2026 with an optimization strategy selection due December 31, 2022.

(3) AKART Analysis: Submit an AKART Analysis per the requirements in S5.C. This analysis shall be done in accordance with RCW 90.48.010 for the purposes of evaluating reasonable treatment alternatives capable of reducing Total Inorganic Nitrogen (TIN). This report must be submitted by December 31, 2025.

It is also our understanding that a future Total Inorganic Nitrogen effluent limit may be required for all plants discharging to the Salish Sea. At this time, the Department of Ecology has not provided a future numeric effluent limit for the anticipated Total Inorganic Nitrogen parameter or a timeline for when this limit may go into effect. However, the treatment alternative recommended includes the capability of denitrification. With the recommended treatment process a Total Inorganic Nitrogen effluent level below 10 mg/L will be achievable.

All alternatives were evaluated for their performance of nutrient removal. Both Alternative 1 – Aeromod system and the Alternative 3 – Triplepoint System have shown to be most effective at nutrient removal. However, the Triplepoint system has less installations of their denitrification system and therefore less data to show effectiveness. Alternatives 2 and 3 showed to be less effective at nutrient removal.

If a final numeric effluent limit is determined that is below 10 mg/L the District intends to reevaluate and amend this engineering report at that time if it is determined to be necessary.

Nutrient removal may also be achievable through reclaimed water. In Chapter 8 reclaimed water is discussed further. At this time using reclaimed water to achieve nutrient removal is not planned, however, this may be an option in the future for the District to consider.

Supplemental carbon or alkalinity may be required in the future depending on nutrient limits. If required these costs could be as much as $50,000 per year for carbon addition and $18,000 per year for alkalinity addition.

Flow Equalization

Flow equalization is recommended at the wastewater treatment plant to handle influent peak flows which are significant and can result in disruption to the treatment process and overflows. These peak flows are a result of infiltration and inflow into an aging septic tank effluent pump (STEP) system. The highest peak flows also occur after power outages when all pumps turn on at the same time and send a high volume of wastewater to the plant. An equalization basin would allow operators more flexibility and confidence in the treatment system and reduce the need for emergency overtime hours.

It is recommended that the existing Anaerobic Pretreatment Cell be converted to an influent equalization basin as it currently is not being used in the existing treatment process. The lagoon has roughly 83,000 gallons of storage. Other lagoons such as the L-1 or L-2 lagoon could be converted to an equalization basin depending on the treatment alternative selected, however, the Anaerobic Pretreatment Cell is the recommended location based on its size, location, and availability. The location is preferred as it is furthest away from planned development and minimizing odors is an important consideration for the District. The influent flow would continue being sent to the cell and then pumped at a constant rate to the front end of the preferred treatment alternative. A floating or submersible mixer would be recommended for the equalization basin to keep the raw wastewater well mixed and reduce odors. Similarly, a return activated sludge system would also be recommended to reduce odors. This system would send a small amount of return activated sludge from the bottom of the clarifiers or polishing cell to the equalization basin where the sludge would mix with the influent raw wastewater and consume the odor causing bacteria.

The downside of this recommendation is cost, the potential for odor, and the additional operations and maintenance added. The capital costs are estimated to be $678,500 as shown in Appendix K – Estimate 7D. These costs would add a significant amount to the total plant upgrade costs, but would provide a significant long-term benefit to the plant.

<u>Schedule</u>

To be completed as part of the upgrade to Alternative 1.

Outfall Improvements

The existing outfall does not have capacity for current peak hour flows of 245 gpm, assuming the outfall is in new condition. Since the outfall is not new and the condition is unknown, it is likely the capacity is even less.

Since the current outfall has a theoretical capacity of about 120 GPM under perfect conditions, it does not have capacity for the future peak day or peak hour flows which are about 240 GPM and 480 GPM respectively.

Recommendation

It is recommended to replace the entire outfall with an 8-inch HDPE or PVC pipe and a larger capacity diffuser. This would provide capacity beyond the 2043 planning period and provide the District with a proper outfall with no risk of backing up into the plant. This solution would require utility easements through at least one neighboring property west of the existing plant. The outfall alignment would need to be designed to have proper slope and stability while working with property owners to find a suitable location. The recommended alignment for the new outfall would be parallel to the existing outfall in the same existing utility easement and maintaining the same diffuser location. County upland permits would likely be required, as well as permits with the Department of Ecology, Shoreline, SEPA, HPA, Army Corps of Engineers, and an updated DNR lease.

In addition, the District may wish to continue exploring the option of reclaimed water in the form of ground discharge of plant effluent. This is discussed further in Chapter 8 and could provide an effluent solution that would eliminate most effluent flow through the outfall. However, it is recommended to maintain an outfall in case reclaimed water options were not successful.

Since the outfall capacity is not an immediate concern, planning and evaluation of the ground discharge option could be completed over the next couple of years while the plant continues to discharge through the existing outfall. The L-1 lagoon could be reestablished as an effluent flow equalization basin to handle peak flow events over the capacity of the outfall.

See Appendix A, Figures 4-4 & 4-5 for information on the existing outfall. Head loss calculations are shown in Appendix O.

Schedule

Funding - Apply for Design Grants / Loans:	October 2023
Notification of Funding Received:	June 2024
Design & Permitting Phase:	June 2024 – June 2025
Ecology Review:	June 2025 – July 2025
Bid Phase:	August 2025 – September 2025
Construction Phase:	October 2025 – January 2026 (4 months)

Mixing Zone Analysis

The outfall mixing zone is herein modeled to determine the dilution factors based on the future increased flows and revised outfall. Dilution modeling is performed using the EPA's "Visual

Plumes" UM3 (Version 18b) computer modeling software. All values input to the model are derived and applied to the model per the DOE Permit Writer's Manual. The Brooks far-field algorithm model was transitioned to within the modeling simulations where appropriate.

Effluent flows input into the model are the 2043 projected flows. The future maximum average monthly flow of 0.105 MGD is used for the chronic criteria dilution analysis. The future max average daily flow of 0.349 MGD is used for the acute criteria dilution analysis.

Ambient conditions modeled are 10th and 90th percentile current velocities for acute, 50th percentile current velocity for chronic, and stratified and uniform density profiles.

The proposed outfall upgrades will have two 3-inch diameter ports spaced at least 9 feet apart.

Six scenarios were evaluated, each with different combinations of effluent flow, ambient current velocity, and ambient density profile. Ambient current velocities at the nearest NOAA monitoring station in the vicinity are used. Ambient velocities at the bottom (5-m depth) are reduced to account for lower bottom velocities. Salinity-Temperature-Depth data from DOE's Ambient Monitoring and Assessment Program for Puget Sound for the nearest station in the vicinity are used. Very little stratification develops at this location due to the high current velocities and high water volume exchange rates.

Table 6-6: Dilution Factor (DF) results from the six evaluated scenarios

Mixing Zone	Scenario	Ambient Velocity (ft/sec)	Density Profile (Max or Min)	Dilution Factor
Acute Criteria	1	2.48 to 1.10	Max	125
Acute Criteria	2	2.48 to 1.10	Min	127
Acute Criteria	3	0.30 to 0.20	Max	106
Acute Criteria	4	0.30 to 0.20	Min	106
Chronic Criteria	5	1.32	Max	1566
Chronic Criteria	6	1.32	Min	1556

The dilution model input/output files are shown in Appendix N.

Table 6-7: Minimum dilution factors for the three different conditions

	Acute Dilution Factor	Chronic Dilution Factor
Existing WWTP	110	776
Expanded WWTP Existing Outfall	88	1007
Expanded WWTP Upgraded Outfall	106	1556

Antidegradation Analysis

As the construction of a new outfall is considered a "new or expanded action", Ecology requires that a Tier II Antidegradation Analysis be performed for the WWTP discharge at the proposed effluent flow rates. The Tier II analysis includes an evaluation of whether the proposed action will cause measurable degradation to existing water quality at the edge of the chronic mixing zone. The definition of "measurable change" for parameters of concern is specified in WAC 173-201A-320 and summarized in Ecology's antidegradation policy requirements.

WAC 173-201A-320 states that the antidegradation analysis must be conducted when "the resulting action has the potential to cause a measurable change in the physical, chemical, or biological quality of a water body." Construction of the new treatment plant with outfall will increase the maximum monthly effluent flow (0.105 MGD). This will result in a lower acute dilution than that specified in the previous NPDES permit (i.e., the "resulting action"), necessitating a Tier II analysis.

> *(3) Definition of measurable change. To determine that a lowering of water quality is necessary and in the overriding public interest, an analysis must be conducted for new or expanded actions when the resulting action has the potential to cause a measurable change in the physical, chemical, or biological quality of a water body. Measurable changes will be determined based on an estimated change in water quality at a point outside the source area, after allowing for mixing consistent with WAC 173-201A-400(7). In the context of this regulation, a measurable change includes a:*
>
> *(a) Temperature increase of 0.3°C or greater;*
> *(b) Dissolved oxygen decrease of 0.2 mg/L or greater;*
> *(c) Bacteria level increase of 2 CFU or MPN per 100 mL or great-er;*
> *(d) pH change of 0.1 units or greater;*
> *(e) Turbidity increase of 0.5 NTU or greater; or*

Tier II evaluation of each of the parameters of concern identified by Ecology is presented in the following sections.

Reasonable Potential Analysis

A Reasonable Potential Analysis was performed for ammonia, fecal coliform, temperature, pH, and dissolved oxygen. These are the only parameters that could potentially exceed water quality standards. The Reasonable Potential Analysis calculations are shown in Appendix B. Included are the results for:

1. Existing WWTP
2. Expanded WWTP, Existing Outfall
3. Expanded WWTP, Upgraded Outfall

The Reasonable Potential Analysis shows that none of these parameters have the potential to exceed water quality standards.

Effluent and Ambient Water Quality Data for Reasonable Potential Analysis

Table 6-8: Effluent and Ambient Water Quality Data for Reasonable Potential Analysis

Parameter	Ambient Water Quality	Existing WWTP Effluent Water Quality	Expanded WWTP Effluent Water Quality
Temperature (°C)	12	22	22
pH	6.5	6.5	6.5
Dissolved Oxygen (mg/L)	6.5	4.0	4.0
Fecal coliform (cfu/100mL)	0	0-200	0-200
Ammonia (mg/L)	0.05	32	8.0

Temperature

The maximum allowable measurable change for temperature is an increase of 0.3°C. Average effluent temperature for the current outfall is 22°C. The design for the new treatment plant will not increase the HRT; therefore; effluent temperature increase is not anticipated. The temperature at the mixing zone boundary will be only 0.00°C to 0.01°C higher than ambient temperature.

Dissolved Oxygen

The maximum allowable measurable change for dissolved oxygen (DO) is a decrease of 0.2 mg/L. The Ecology Reasonable Potential Spreadsheet was used to assess the potential effect of the proposed modified permit limits for BOD on farfield dissolved oxygen concentrations. Values used in this modeling are described below:

- Effluent dissolved oxygen concentration is expected to be 4 mg/L or greater for the new plant.
- The $CBOD_5$ concentration is expected to be less than 10 mg/L for future plant operations. A value of 30 mg/L is used in the analysis to be conservative.
- Nitrogenous BOD is exerted by oxygenation of ammonia to nitrate. An ammonia- nitrogen (NH_3) concentration is expected to be less than 8 mg/L for future plant operations. A value of 8 mg/L is used in the analysis.
- Ambient DO is set at an average of 6.5 mg/L. Ambient DO can vary significantly; however, the results of this analysis are not sensitive to the ambient DO concentration.

Farfield dilutions in the model were calculated using Table VI-9 of the *Technical Support Document* as a reference. The maximum DO depletion is 0.010 mg/L, which is far below the 0.2 mg/L limit.

Fecal Coliform

The maximum allowable measurable change for fecal coliform (FC) bacteria is an increase of 2 colony-forming units per 100 mL (cfu/100 mL). The background concentration is assumed to be zero. The engineering report for the new wastewater treatment facility anticipates the maximum monthly effluent concentration to be no greater than 200 cfu/100 mL. Using 400 cfu/100 mL, the concentration at the chronic boundary would be 0.4 cfu/100 mL, which well under the 2 cfu/100 mL limit. water quality.

pH

The maximum allowable pH change is 0.1 units. The ambient pH is 7.50 and the low WWTP pH is expected to be 6.50. The pH at the mixing zone boundary will be unchanged - 7.50.

Turbidity

Antidegradation rules specify measurable change in turbidity as an increase of 0.5 NTU or greater at the chronic boundary. The turbidity is unlikely to increase with the new WWTP and the dilution factor is greater. Therefore, no increase is mixing zone boundary turbidity is expected. Even if the effluent turbidity was 100 NTU, the turbidity at the chronic boundary would be only 0.06 NTU, still well under the 0.5 NTU limit.

Toxic Substances

Measurable change for toxics is defined in the *Supplementary Guidance for Implementing the Tier II Antidegradation Rules* as “any detectable increase in the concentration of a toxic or radioactive substance.” “Detectable increase” is defined by Ecology as any change greater than the established quantification limit (QL) for the analytical method. The QL is typically the concentration at which the parameter can be *reliably quantified*, which is greater than the concentration at which the parameter can be *reliably detected*.

Summary of Antidegradation Analysis for Toxic Substances

Chlorine will be replaced by UV disinfection, so chlorine will be undetectable.

Ammonia will decrease from a 90th percentile concentration greater than 30 mg/L to a 90th percentile concentration less than 10 mg/L. Therefore, ammonia concentrations will be much less than currently and well under the Surface Water Quality Criteria. See table below and Appendix B.

Other toxics are not known to be present and, if present at trace amounts, would be diluted by 88 times to undetectable levels. See table below. The increase in concentration at the mixing zone boundary is less than the associated QL. Therefore, the calculated concentration difference meets the Tier II criterion for no “detectable increase.”

Table 6-9: Summary of Antidegradation Analysis

Parameter[1] (units)	Effluent Concentration[1]	QL	Mixed Conc.[2] Existing WWTP	Mixed Conc. Expanded WWTP	Conc. Difference
Acute DF Chronic DF			110 776	88 1015	
Ammonia (mg/L) Acute Criteria	32 (existing WWTP) 8 (Expanded WWTP)	0.3	1.853	0.613	-1.24
Ammonia (mg/L) Chronic Criteria	32 (existing WWTP) 8 (Expanded WWTP)	0.3	0.306	0.099	-0.207
Generic Toxic (µg/L) Acute Criteria	1	0. 5	0.010	0.012	+0.002
Generic Toxic (µg/L) Chronic Criteria	1	0. 5	0.001	0.001	0.000

[2] Generic Toxic is presented as a purely a mathematical demonstration that the mixing zone concentration would be below the QL.

Ultra-Violet Light (UV) Disinfection

Disinfection of final effluent is currently being performed with chlorine disinfection in a contact chamber. As discussed in Chapter 4, this contact chamber is under capacity. A UV disinfection system is recommended for disinfection to avoid the need to expand the chlorine contact basin and to avoid the continued handling of hazardous materials (i.e., chlorine gas and sulfur dioxide gas).

There are two types of UV systems available: open-channel and in-line. The in-line system provides disinfection in a closed pipe while the open-channel system is in a small trough. Both systems work by inactivating pathogens in the secondary effluent with UV radiation. The major advantage to UV, other than no chemicals, is the short hydraulic retention time required. This decreased retention time, in comparison to the chlorine contact tanks requires a small footprint. Both in-line and open-channel will require roughly the same space for installation and maintenance and can be placed within the existing chlorine contact tanks or an alternate location in that vicinity.

It is recommended that the UV disinfection system be configured with two UV banks, one duty and one redundant under peak design flows. Piping for the UV system will include new gravity pipe from the proposed WWTP clarifiers. The UV system will be placed in a concrete or steel channel approximately 22' long, 18.5" wide, and 12" deep. Equipment and final layout decisions will be made during the final design.

It is recommended that the UV system be housed in a dedicated room of the proposed operations building, protected from harsh weather and sunlight.

The UV systems are configured with a low flow set point and an associated timer. If flow goes below that set point the timer starts and once expired, the lamps begin turning off. These set points/timers are adjustable.

Schedule

To be completed as part of the upgrade to Alternative 1.

Constructed Wetland Improvements

Current design guidelines focus on constructing wetlands with a greater width than length which is a significant deviation from the current configuration. A reconfiguration of the current wetland to reduce the length to width ratio to less than 1 it would require a full-redesign of the facility including the bottom shape, media depth, inlet distribution, and outlet collection. Since this is beyond the scope of a minor change, we also don’t recommend making other changes to the water level or media depth. We don’t recommend any changes to the physical configuration of the wetland unless they are part of a complete redesign of the wetland.

HFCWs are expected to last 5-15 years based on loading. The existing wetland is 15 years old and is in need of upgrades. The wetland has also been observed in the past to have preferential pathways which reduces the effectiveness of the wetland and is likely the result of the inlet distribution or the outlet collection systems needing to be cleaned. If these systems are distributing/collecting flows evenly then preferential pathways could be the result of sludge buildup in the media or that the biomass of the Reed Canary Grass has filled in the voids such that there are no longer enough pathways open for wastewater to flow through the media. Either an excess of sludge build up or an overabundance of biomass could be reasons for rebuilding the wetland.

Rebuilding the wetland would consist of removing and replacing the media and plants. It is likely that if the biomass from the wetland was removed, the media could not be reused as it is likely to be intertwined with the biomass. We do not recommend using shredded tires as media in the future as they were observed to add iron to the effluent. The HDPE liner should be inspected for penetrations. If penetrations exist, the liner should be repaired or replaced if needed.

The inlet and outlet headers should be cleaned regularly to ensure even distribution. The wetland should be observed on a regular basis to see if any noticeable short-circuiting is occurring. It should be inspected to see if there is any noticeable sludge build up. Weeds should be removed, specifically horsetail if present. Reed Canary Grass, Cat Tails, bulrush, and native emergent plants are acceptable in the wetland.

Since the final nutrient removal requirements are still to be determined by the Department of Ecology, it is recommended that the constructed wetland remain as is and remain available for treatment of final effluent, until such time as the future permit limits have been determined and the nitrogen removal performance of the new treatment plant is known. If additional polishing or nutrient removal is determined to be necessary in the future, it is recommended that the wetland be rebuilt as described above.

Table 6-10 below shows the effectiveness of the existing plant on removal of TKN through the lagoon treatment system and the constructed wetland.

Table 6-10: TKN Removal

Sample Date	Inf. TKN	L-2 Eff. TKN	Percent Removal in Lagoons	Eff. TKN	Percent Removal in Const. Wetland	Total Percent Removal
3/18/2021	70.4	42.8	39%	30.4	29%	57%
3/24/2021	80.7	40.4	50%	34.3	15%	57%
Average	75.6	41.6	45%	32.4	22%	57%

Schedule

To be completed in the future if needed. It is recommended that this project is re-evaluated in the future after the new plant is online and nutrient removal performance has been evaluated and the Department of Ecology has determined future nutrient removal permit limits.

Operations Building

The District has identified a need for a new building to house a new WWTP laboratory, office area, and some of the proposed equipment (i.e., blowers for aeration, ultraviolet disinfection units, new controls, etc.). Features of the new operations building shall include:

1. Laboratory and equipment including sink, desks, vent hood, cabinets, drawers and office space and controls.
2. Blower room
3. UV Disinfection room

It is recommended that the new operations building be located just east of the existing lab building. This area would allow a building footprint of approximately 50-ft x 50-ft.

Schedule

To be completed as part of the upgrade to Alternative 1.

Flow Measurement

A new influent flow measurement system is recommended to replace the existing flume. The existing flume has historically been a maintenance issue and not a reliable source of flow measurement. It is recommended that a new mag meter be installed on the influent force main prior to the proposed influent equalization basin.

Mag meters are also recommended for the following locations:

1. After the influent equalization basin
2. RAS meter from each clarifier
3. WAS meter from each clarifier
4. After UV disinfection

Schedule

To be completed as part of the upgrade to Alternative 1.

PLC Control and SCADA System

The existing WWTP does not have a PLC control or SCADA system. It is recommended that the plant upgrades include a simple control and SCADA system to monitor the plant operations. This includes alarms, monitoring information, and supervisory control of equipment. The system will allow control and monitoring of the treatment process including the RAS system and WAS wasting system. The system will receive process signals from control panels throughout the plant and display this information at the SCADA computer in the Operations Building. Alarms from the new systems will be added to a dial-out system for notification of alarms and failures.

Schedule

To be completed as part of the upgrade to Alternative 1.

Power / Electrical Components

The upgraded treatment plant and equipment will require backup generator power and full integration with the existing PLC control and SCADA system.

The following electrical and control system improvements are recommended for the wastewater facility:

1. Bring in 3-Phase power.
2. Install Automatic Transfer Switch
3. Install plant backup generator: It is recommended that the generator meets the sizing and fuel capacity requirements to operate the plant under full load for a minimum of 24 hours.
4. Site Lighting: Install new LED site lighting around new proposed process equipment areas.

Schedule

To be completed as part of the upgrade to Alternative 1.

Influent Flow Tank

The existing influent flow tank is heavily corroded and problematic with downstream valves that won't turn. If the existing plant configuration is to remain, it would be recommended to replace the influent flow tank and replace the downstream valving. However, with the recommended improvements this influent flow tank will no longer be necessary and influent flow can either be sent to the influent equalization basin or to the front end of the preferred alternative. The existing influent flow tank is also used as scum and grease removal; however, it has been determined that the scum and grease are not significant and that having a dedicated influent tank or grease interceptor is not necessary moving forward.

Staffing and Testing Requirements

The WWTP is staffed from 8 AM to 5 PM five days per week with 2 full time employees and 2-3 days per week with one part-time employee. The plant is not staffed during the weekends. The lead operator is Group III. The proposed WWTP must have at least a Group II operator in reasonable charge of daily operation. After improvements have been made, the WWTP will require increased operations staff for process control, maintenance, lab operations, and general site work. It is recommended that an additional operator is hired when the plant upgrades are completed. The plant O&M requirements will allow the operators to also maintain the collection system.

Additional testing is anticipated as part of the nutrient removal requirements the Department of Ecology plans to implement as discussed earlier in Chapter 6.4.

Biosolids Handling

An aerobic digester is included as part of the recommended Aeromod system. The digester will reduce volatile solids decreasing the frequency and costs of biosolids handling. The biosolids will continue to be pumped and hauled to the Anacortes WWTP. If solids are removed from the digestor it is anticipated that the solids would be removed on a bi-weekly basis in a 3,000 gallon septic truck. Costs for biosolids removal from the digestor are estimated in Table 6-11 below.

Table 6-11: Biosolids Handling Costs

	Current Average Day Flow	Future Average Day Flow
Volume wasted from Digester	85 GPD	185 GPD
Volume pumped from Digester	2,550 gallons/month	2,590 gallons/two weeks
Trips per Year	12	26
Hauling & Tipping Fees	$0.75 / gal	$0.75 / gal
Total Annual Costs	$22,950	$50,505

However, in addition to the aerobic digester, conversion of the L-2 lagoon for long-term digestion and additional volatile solids reduction is recommended. This project would consist of removing the existing baffles and aerators and installing influent piping from the aerobic digester. Sending waste activated sludge to the L-2 lagoon for long-term digestion would further reduce the volatile solids and allow more flexibility in pumping and hauling biosolids. It is recommended that the District evaluate biosolids land application as a potential solution in the future. The long-term digestion basin would remain the same volume as the existing L-2 lagoon. The basin would be dredged every few years to remove solids.

Calculations are shown in Appendix O.

Construction Phasing

Phasing of construction will be necessary to ensure proper treatment through the existing plant during construction. Permit condition S5.C will be met as required. A proposed phasing schedule is outlined below.

1. Construct the recommended improvements (including the Aeromod system, Operations Building, UV disinfection, and associated piping). Continue lagoon operation during construction.
    a. The majority of process piping can be installed during this time.

    b. Also, during this time SCADA programming, and installation of D.O. monitoring in the aeration basins would be completed.
2. After Step 1 is complete and has been tested the influent and effluent tie in can be completed to bring the new plant online.
3. Following Step 2, the Anaerobic Pretreatment Cell can be taken offline and conversion to an influent equalization basin can begin, including construction of the influent equalization basin pump station and influent / effluent piping. Conversion of the L-2 lagoon to a biosolids stabilization basin and upgrades to the constructed wetland could occur during this time as well if needed.

Remaining improvements are not process sensitive and can happen on a typical construction schedule.

Projects included in this report that the district would like to start on include all projects listed in section 6.4 with the exception of the constructed wetland. The constructed wetland will remain mostly as is for now and remain available for treatment of final effluent, until such time as the future permit limits have been determined and the nitrogen removal performance of the new treatment plant is known. If additional polishing or nutrient removal is determined to be necessary the wetland will be rebuilt. At this time, the District would like to only replace the media of the constructed wetland.

It is anticipated that all of these projects would happen at the same time with the exception of the outfall.

7.0 - FINANCIAL INFORMATION

7.1 - Sewer Rate Structure and Revenue Planning

This financial analysis is intended to be a general overview of the District's financial structure and conditions, not a user rate study. The District has several funds in its accounting system. These funds include the general fund, the reserve fund, and the 1995/2003 revenue bond fund.

Requirements for Connection to the District System

The requirements for connecting to the District sewer system are listed in District Resolution No. 2018-12 Administrative Code and Operations Resolution. Resolution No. 2018-12 is included in Appendix F. Developed properties that lie within the District service area boundary are required to connect if the sewer is within or will be within 200 feet of the property line, subject to the capability of sewer service being provided by the District. The resolution also includes provisions for sewer main extension application agreements and permitting where necessary for the District to provide service.

All connections to the District's system must be designed and installed in accordance with the requirements set forth in Resolution No. 2018-12 as well as the accompanying referenced District Sanitary Sewer Specifications. The District Sanitary Sewer Specifications are included in Appendix D. Connecting system designs must be reviewed and approved by the District Superintendent, installed by a registered licensed installer, and must be inspected by the Superintendent at various stages of installation. The District's New Installation Checklist form is included in Appendix D.

Revenue Planning

The District performs a review of the sewer rate schedule regularly to determine that these charges are sufficient to generate revenue to offset the cost of all necessary operation and maintenance of the District sewer system. In the event that this review indicates a necessary revision of user charges, the District amends the master rate schedule by formal resolution of the District Board of Commissioners.

With the substantial updating of the Sewer Capital Improvement Program for this Plan, the District will incorporate the revised projected capital expenditures into its rate calculations. The result will be recommendations regarding sewer rate adjustments aimed at bringing revenues in line with annual operating and current and future capital obligations.

Additionally, any recommendations regarding changes to the connection charge for new customers connecting to the system will be reviewed and approved by the Board of Commissioners before implementation.

The District will also investigate grants, loans, and possibly bonds to fund the Capital Improvement Projects in the near term. The District will seek additional grant/loan funds from

USDA-RD, Public Works Assistance Account (Loan), State Revolving Fund Grant/Loan (Ecology), and/or procure bonds for the near term major sewer capital projects as needed.

Sewer Rate Structure

The District sewer service rates and charges are summarized below and shall be subject to change by resolution of the District Board of Commissioners as conditions warrant. Full details of rates, charges, and fees including administrative fees are included in the District Master Rate Schedule-11, effective 1/1/2021, which are attached in Appendix F. The District bills for sewer service on a monthly basis.

1. Sewer Service Rates

The sewer service rates, user fees, and miscellaneous incomes go to the District's general fund. The general fund is used for operating and maintaining the collection system and the plant, general office supply, employee salary and benefits, insurance and bond payment, engineering and legal services, utilities and rents, and miscellaneous expenses.

Residential

Residential customers are billed the base rate only and are not billed for usage. Residential customers with single-family homes with one to three bedrooms is considered 1 ERU. Larger single-family dwellings are assigned an additional 0.25 ERU per bedroom in excess of 3 bedrooms. Accessory Dwelling Units (ADU) are assigned as an additional 0.5 ERU. Residential customers are subject to the following rates:

Table 7-1: Residential Customer Monthly Sewer Fees

Description	ERU	Monthly Fee
Standard Single-Family Dwelling (1 to 3 bedrooms)	1	$ 83.00
Large Single-Family Dwelling (4 bedroom)	1.25	$ 103.00
Large Single-Family Dwelling (5 bedroom)	1.50	$ 123.00
Large Single-Family Dwelling (6 bedroom)	1.75	$ 143.00
Accessory Dwelling Unit	0.5	$ 44.00

The District also offers a discount to low or fixed income residential customers at 80% of the Standard Rate ($ 66.40 for standard single-family dwelling 1 to 3 bedroom).

The District also serves a few "contract" customers, which are located outside of the current District service area boundary. These customers are charged regular charges plus a 10% contract surcharge each month.

Multi-family residence connections in the District include apartment buildings or duplexes and each living unit is assigned as 1 ERU and charged the monthly fee for standard single-family dwellings as identified above. Trailer parks/courts are also included in this category and each pad or hook-up is assigned as 1 ERU and charged the monthly fee for standard single-family dwellings as identified above.

Commercial

Commercial customers are billed a commercial customer class base rate in addition to the monthly fee of $83.00 per ERU for the assigned number of ERUs. The base rate is $45.00 per month for flat base fee (non-metered), and $50.00 per month for capacity base fee (metered). Commercial customers are assigned ERUs based on the following table.

Table 7-2: Commercial Customer ERU Assignments

Description	ERU
Business/Retail Unit occupied by a single store, tenant, business, or office	1
Business/Retail Unit with more than one store, business, tenant, office	1 + 0.25/additional unit
Churches: without separate reception/meeting facilities with separate reception/meeting facilities	1 2
Laundromats (public), per washer	2
Medical Clinics / Dental Offices	2
Motels/Hotels, per unit	0.5
Public Restrooms, each toilet or shower	1
Public Meeting Facilities: without kitchen with kitchen	1 2
Barber Shop/Salons: per hair washing sink	1
Other Commercial (not included above)	TBD by District

Short term (30 days or less) residential and ADU rentals are billed as commercial customers. The initial ERU assignment is the same as the residential ERU assignments shown above.

For effluent metered commercial customers (capacity base fee) the volume rate is $0.028 per gallon of metered effluent. This rate applies up to a base of 3,000 gallons per assigned ERU. Any metered effluent in excess of the base volume is subject to a rate of $0.15 per gallon. The District requires any new commercial customers to be metered.

Commercial “contract” customers located outside of the current District service area boundary are charged regular charges plus a 10% contract surcharge each month.

Commercial customers not on effluent meters are charged based on water utility meters at the same volume rates as effluent metered customers. However, charges are calculated using water meter data discounted at 85% to account for non-sewer water use.

2. Sewer Connection Fee

The sewer connection fee charges go to the District’s reserve fund. The reserve fund is used for collection system and plant improvements and expansions. However, when it is needed, the District will use the reserve fund for general operating purpose. The current balance is the reserve fund is approximately $250,000 as of end of year 2020.

The District currently assesses the Sewer Connection Fee based on the assigned ERU value for each connection. The connection fee is $10,162 per ERU and applies to residential and commercial type connections. The District also charges for materials, at cost plus 15%, and labor rates for all District required materials and labor requirements necessary for connection installations and inspections.

3. Surcharge Fees

A monthly surcharge fee of $5 per month per ERU is applied to all customers based on purchased ERUs, in additions to monthly sewer service rates. This surcharge fee is for the 1995 Wastewater Treatment Plant Expansion and is applied to the 1995 revenue bond, which was refinanced in 2003, and will be paid off in August 2022.

4. Cost per Service

The District's current average cost per service is about $1,005 per ERU/year in terms of debt service and operation and maintenance costs. This cost includes $946 per ERU/year in operation and maintenance costs including employees, administrative and miscellaneous. Debt service costs are $59 per ERU/year. Debt service is low in the near term and current payments will be completed in year 2022. However, with the anticipated completion of major loan-funded capital WWTP and other projects, it is expected to increase by about $306,000 as newer debts are incurred (circa 2023). See the following table for existing and projected cost per service in terms of operations and maintenance costs and debt service.

Table 7-3: Annual Cost per Sewer Service

Year	2020	2027	2043
Expense	*(2020 dollars)*	*(2027 dollars)*	*(2043 dollars)*
Employees, Administrative, Operational, Miscellaneous (including Operational)	$946	$1,124	$1,780
Debt Service	$59	$790	$492
Total	**$1,005**	**$1,914**	**$2,272**

Funding Capacity

The District's general fund annual revenue is currently about $406,000 from user rate fees (customer billings) and other miscellaneous incomes. The general fund is used for office, collections system and the plant operations and routine maintenance and repairs. Sewer service rate fees and other incomes revenue are projected to increase at a 3% per year due to inflation and another 3% per year due to customer growth. The District's general fund annual revenue is conservatively anticipated to be in the range of $406,000 (2021) to $1,463,000 (2043) over the next 22 years.

The District's reserve fund annual revenue is currently about $50,000 from user connection fees (average of last four years). This has varied over the last four years, from about $33,000 average of years 2017 and 2018 to $67,000 average of years 2019 and 2020. The reserve fund is used primarily for capital improvements and expansions. The reserve fund is invested in bank CDs with various maturities and earning approximately 3 to 4% interests. Sewer service connection fees revenue is projected to increase at a 3% per year due to inflation and another 3% per year due to customer growth. The District's reserve fund annual revenue is conservatively anticipated to be in the range of $50,000 (2021) to $180,000 (2043) over the next 22 years.

Operations, maintenance, and administrative expenditures are currently about $368,000 per year. Operations, maintenance, and administrative costs are projected to increase at about 6% per year due to inflation and growth (3% due to inflation; 3% per year due to customer growth). Annual operations, maintenance, and administrative costs are expected to be in the range of $368,000 (2021) to $1,328,000 (2043) over the next 22 years.

There have been no recent major capital expenditures. Planned capital expenditures are expected to be in the range of $11,000,000 to $13,000,000 over the next approximate 22 years (2021 – 2043). However, the District has Hardship Status based on the Median Household Income (MHI) study performed fall 2020. As such, DOE or USDA loans for CIP projects in the future are anticipated to quality for approximately 50% (this could be more or less) loan forgiveness or grants and is reflected in the expenses for capital projects below. The Plan assumes an inflation rate of 3% per year to forecast future project costs. The remaining expenses include existing and future debt repayment. A summary of the anticipated revenues and expenditures for the District's wastewater system over the next 22 years is shown below in the following table. High and low estimates are approximately +/- 10%.

Table 7-4: Revenue and Expenses Summary 2021 – 2043 (22-year totals)

	Low Estimate	Mean Estimate	High Estimate
Revenue [1]			
General Fund	$17,190,000	$19,100,000	$21,010,000
Reserve Fund	$2,160,000	$2,400,000	$2,640,000
Total Revenue	**$19,350,000**	**$21,500,000**	**$23,650,000**
Expenses [1]			
O&M / Admin	$15,660,000	$17,400,000	$19,140,000
Capital Projects [2]	$5,400,000	$6,000,000	$6,600,000
Debt Service [3]	$1,578,000	$1,753,000	$1,928,000
Total Expenses	**$22,638,000**	**$25,153,000**	**$27,668,000**

1. Annual growth and inflation increases included.
2. Assumes $6M of the estimated $12M is 50% grants (or forgivable loan) and the remaining $6M is funded.
3. Assumes $6M loan at 20-yr term and 2% interest rate.

As shown in the above table it is projected that the District may not have a sufficient revenue stream to fund operations and maintenance, debt service, and capital improvements. It is recommended that the District consider a rate increase based on a sewer rate study. One potential scenario considered in this analysis implements a 8.5% rate increase per year for the next 4 years to offset the projected deficiency. With a 8.5% rate increase for the next 4 years, the revenue mean estimate for 2021-2043 (22 year total) is projected to be about $25.5M and greater than the projected total expenses mean estimate for the same period. The base sewer fee would increase from $83 per ERU to approximately $115 per ERU.

Any future surplus funds can be allocated/reserved for emergency projects, unanticipated projects, and/or non-development related sewer extensions. It is the District's stated policy that land developers shall fund sewer extensions to unserved areas. The District's existing sewer collection and treatment systems have sufficient capacity (with planned improvements) to provide sewer service for all growth within the District service area boundary and outside for the next twenty years and through forecasted build-out.

7.2 - WWTP Alternatives Costs

The purpose of this section is to identify and describe the total projects costs for the recommended treatment options proposed as facility improvements to the Fisherman Bay Sewer District wastewater treatment plant, including the projected operation and maintenance costs associated with each option. A summary of wastewater grant and loan programs is attached in Appendix E.

Summary of Alternatives Total Project Costs

<u>Treatment Alternative Estimates</u>

The treatment alternatives discussed in Chapter 6 have been evaluated and a cost estimate has been established for each, presented below in Table 7-5. The initial estimated construction costs suggest that Alternative 2 – Activated Sludge 2 with BNR (Smith & Loveless) process may be prohibitively expensive. The construction cost of Alternative 2 would be roughly $2.4 Million more than Alternative 1 and its 22-Year Life Cycle Cost Estimate, shown below in Table 7-6, confirms that Alternative 2 maintains a significantly higher cost when considering O&M expenses. The high cost of Alternative 2 is in part due to the high equipment costs. Alternative 1 has the lowest total project cost and 22-year life cycle cost. Further, more detailed construction costs of all the treatment alternatives are presented in Appendix K.

Table 7-5: Total Project Cost Estimates for Alternatives

Process Alternatives	Total Cost
Alternative 1 – Activated Sludge 1 - Aeromod	$4,074,000
Alternative 2 – Activated Sludge 2 – Smith & Loveless	$7,140,000
Alternative 3 -Lagoon Upgrade BNR - Triplepoint	$4,984,000
Alternative 4 – IFAS with BNR – STM Aerotor	$5,712,000

Table 7-6: Overall 22-Year Life Cycle Cost Estimates for Alternatives

Process Alternatives	Total Cost	Annual O&M Cost	Total 22-yr Net Present Worth
Alternative 1 – Activated Sludge 1 - Aeromod	$4,074,000	$235,700	$8,972,803
Alternative 2 – Activated Sludge 2 – Smith & Loveless	$7,140,000	$248,700	$12,308,995

Alternative 3 -Lagoon Upgrade BNR - Triplepoint	$4,984,000	$266,400	$10,520,873
Alternative 4 – IFAS with BNR – STM Aerotor	$5,712,000	$308,100	$12,115,569

Present worth for O&M was calculated assuming a discount rate of 0.5% and a useful life of 22 years.

After evaluation of the treatment technologies, the Aeromod Activated Sludge System, Smith & Loveless Activated Sludge System, Lagoon Upgrades with Triplepoint System, and the Westech STM Aerotor were selected as favorable alternatives. Detailed construction cost estimates for all treatment alternatives are presented in Appendix K. These estimates include an estimate of engineering services (including design, permitting, construction management), a 15% contingency, contractor profit, and sales tax at 8.3%. Higher engineering fees should be assumed if full time construction observation is needed.

Each estimate provides budgetary costs associated with the major components of that alternative. A high contingency is added to each estimate to cover unknown costs not detailed at this time. Each estimate also shows only the required components associated with that alternative. Optional improvements, such as converting the L-1 lagoon to an equalization basin, should be added to the alternative cost to get the total project cost.

Alternatives 1 and 3, the Aeromod system and the Lagoon Upgrades, alternatives have the lowest capital costs; the 22-year life cycle assessment was used to determine which is the more financially feasible option. The Aeromod alternative yields a lower cumulative cost over time due to the lower capital costs and annual operation and maintenance costs.

Total Project Costs

The District would like to proceed with a single construction project for the following upgrades:

1. Upgrade treatment system with Alternative 1.
2. Conversion of the Pretreatment Anaerobic Cell to Flow Equalization
3. UV Disinfection
4. Operations Building
5. Flow Measurement Improvements
6. PLC Control and Scada System and Electrical Improvements
7. 2W Water System Improvements
8. Conversion of the L-2 Lagoon to Biosolids Storage

The total project costs for these improvements has been estimated to be $8.3 Million and are detailed in Appendix K, Estimate 7H.

7.3 - WWTP Miscellaneous Improvements Costs

During the evaluation of the Fisherman Bay Wastewater Treatment Plant, items auxiliary to the treatment process were noted that need improvement. These auxiliary items are important to this facility plan and would help to fine tune the treatment process and avoid possible problems in the future. The cost estimates for each of the miscellaneous improvement items are presented in Appendix K.

These auxiliary improvements include the addition of a new operations building, UV system, conversion of the L-1 lagoon to an influent flow equalization basin, conversion of the L-2 lagoon to a biosolids storage lagoon, and upgrades to the existing constructed wetland. These costs are summarized in Table 7-7 below and detailed in Appendix K. The total cost shown below represents the total project capital costs including engineering services, contingency, and sales tax.

Table 7-7: Miscellaneous Improvments Total Project Costs

Improvement	Total Project Cost
Operations Building	$516,000
UV System	$288,000
Improvements to Constructed Wetland	$504,000
Convert Anaerobic Pretreatment Cell to EQ Basin	$678,500
Convert L-2 to Biosolids Storage Basin	$360,000
Outfall Upgrades	$805,000
2W Water System Improvements	$192,000

In some cases, these miscellaneous costs are required as part of a specific alternative.

- The improvements to the existing constructed wetland would be required as part of Alternative 3
- Conversion of the L-2 lagoon to biosolids storage would be required as part of both Alternative 2 and Alternative 4

7.4 - WWTP Operations and Maintenance Costs

The operations and maintenance (O&M) costs were estimated for each treatment alternative. Appendix K shows detailed estimates of each alternative's operation and maintenance costs. After comparing the O&M costs of each alternative the Alternative 1 – Aeromod O&M costs were determined to be the lowest. This difference is mainly due to the extra labor hours and energy requirements associated with the other alternatives. The O&M costs shown in Appendix K are only costs related to the alternative and do not represent the complete wastewater treatment plant operations and maintenance costs. In addition, it is anticipated that the Aeromod system will provide more digestion and produce solids at a higher concentration with its integral sludge digester, which in turn will result in lower solids handling costs when compared with the other alternatives.

Table 7-8: O&M Alternative Costs

Improvement	Annual O&M Cost	Total 22-yr Present Worth O&M Cost
Alternative 1 – Activated Sludge 1 - Aeromod	$235,700	$4,898,803
Alternative 2 – Activated Sludge 2 – Smith & Loveless	$248,700	$5,168,995
Alternative 3 -Lagoon Upgrade BNR - Triplepoint	$266,400	$5,536,873
Alternative 4 – IFAS with BNR – STM Aerotor	$308,100	$6,403,569

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8.0 - WATER RECLAMATION AND REUSE EVALUATION

The purpose of this section is to evaluate water reclamation and reuse requirements and alternatives for the Fisherman Bay Sewer District WWTP. As required by RCW 90.48.112, this Report must evaluate the "opportunities for the use of reclaimed water". Reclaimed water is defined in RCW 90.46.0 1 0 as "effluent derived in any part from sewage from a wastewater treatment system that has been adequately and reliably treated, so that as a result of that treatment, it is suitable for a beneficial use or a controlled use that would not otherwise occur, and is no longer considered wastewater."

Key differences between the requirements for water reuse and those for effluent disposal are the levels of reliability required within the treatment process, distribution, and use areas. The State of Washington's reuse treatment standards call for continuous compliance, meaning that the treatment standards must be met on a constant basis or the treated water cannot be used as reclaimed water.

Allowable Uses for Reclaimed Water

The Washington State Water Reclamation and Reuse Standards describe several allowable uses for reclaimed water, including:

- Agricultural irrigation;
- Landscape irrigation;
- Impoundments and wetlands;
- Groundwater recharge;
- Streamflow augmentation;
- Industrial and commercial uses; and
- Municipal uses.

Depending upon its end use, there are four categories of reclaimed water: Class A, Class B, Class C, and Class D. Class A has the highest degree of effluent treatment. In general, when unlimited public access to the reclaimed water is involved or when irrigation of crops for human consumption is the intended end use, the criteria will require Class A reclaimed water.

Reuse Evaluation

Factors that could lead a wastewater treatment provider to pursue reclaimed water include the following:

- Regulatory Requirements. Regulatory conditions are such that making reclaimed water is a viable option compared to continuing to discharge secondary effluent.
- Water Rights. In general, the ability to make and reuse reclaimed water could benefit a water purveyor's water rights situation. Since FBSD is not a water purveyor themselves, this is not directly applicable, but in theory an arrangement could be coordinated to provide groundwater recharge on behalf of one of the Lopez Island water systems to augment their source capacity. This opportunity is discussed further at the end of this chapter.
- Environmental Benefits. There can be environmental benefits in the right circumstances

to making reclaimed water versus secondary effluent.

- Cost Effectiveness. The cost to make and reuse reclaimed water is typically higher than the cost to make secondary effluent simply due to the higher level of treatment and monitoring required. In addition, control of the WWTP is more complex at a reclaimed water facility then a typical WWTP.

An evaluation of how each of these factors relates to the District's wastewater treatment utility is provided in the following sections.

Regulatory Requirements

Current regulatory requirements do not make reclaimed water a more viable option than continuing to make secondary effluent.

Water Rights

RCW 90.46.120 states that the owner has the exclusive right to any reclaimed water generated by the wastewater treatment facility. Consequently, reclaimed water has the potential to benefit water purveyors who are either water right deficient, or have adequate water rights but insufficient source capacity. Since the district is not a water purveyor, there is no opportunity for a direct benefit, however as mentioned previously, aquifer recharge with reclaimed water could theoretically benefit one of the nearby Lopez Island water systems (Fisherman Bay Water Association, Milagra Bay Water System, or the Common Field Water System).

According to the *Lopez Water Supply Report and Recommendations & Abbreviated Coordinated Water System Plan*, "The amount of water rights allocated in the aquifer serving Lopez Village exceeds the fresh-water resource…This means that a re-allocation is needed and no new water rights are available". As such, with anticipated population growth and future development in mind, groundwater aquifer recharge with reclaimed water could bolster the areas water rights situation.

Environmental Benefits

The groundwater aquifer is the sole source of fresh water for all of the water systems serving Lopez Village. As such, any successful efforts to recharge the groundwater aquifer would be beneficial to the community from an environmental and resource resiliency perspective.

The *Lopez Village Subarea Plan* states that "All areas of the County are considered a critical aquifer recharge area and are subject to critical area regulations. The area's ground water aquifer is the Village's only fresh water source. It is recharged solely by rainwater. Because freshwater resources are limited and there is a potential threat of saltwater intrusion, an adaptive management program regarding seawater intrusion into the Lopez Village Urban Growth Area water supply is in place. Under this program, evaluations are made to determine the quality and quantity of groundwater used for public water supplies in the Village. This program supplements other County water quality protections. If monitoring points out further degradation, the County may take appropriate action to cease the issuance of building permits in the Village until action is taken to prevent further seawater intrusion." While we are not aware of any such actions being taken as of yet, this illustrates the need for the added resiliency that water reclamation and reuse (in the form of groundwater recharge) could offer.

Cost-effectiveness

The District believes that if water reclamation and reuse is to be seriously considered, it must be cost-effective and affordable for its customers. There are two substantial cost factors that make it unlikely that water reclamation would be economically attractive on its own without a substantial benefit, such as regulatory compliance, to balance its considerable costs.

The major cost factor is that the District's WWTP would likely require significant improvements in addition to those already outlined in Chapter 6 with regard to tertiary treatment and SCADA monitoring and alarm systems. Additional improvements would be required to the plant to provide the process control required to reliably produce reclaimed water. This is particularly true if use of the reclaimed water would include human contact, a condition that would require the plant to produce Class A reclaimed water. It is estimated that these capital costs would be at least $7.5 million. In addition, a reclaimed water plant would increase operation and maintenance costs by $300,000-$400,000 per year and require a group III operator.

Summary

After evaluating the potential for water reclamation and reuse, it appears that the most potentially feasible usage would be to provide groundwater recharge to benefit one of the Lopez Village water purveyors. The actual feasibility of this will depend on both the geology and hydrogeology of Lopez Island, as well as the regulatory and permitting requirements. Preliminary research seems to indicate that both the soils and the depth of the groundwater aquifer may be favorable to groundwater recharge. The District does not believe there is currently a clear regulatory, environmental, or water right benefit to water reclamation and reuse. The costs are much too great to consider water reuse as being a cost effective alternative to its current collection and treatment system. Consequently, the District does not plan to pursue the construction of water reclamation and reuse facilities at this time. Based on historical well logs on the island, the soil profile in the vicinity of Lopez Village appears to generally consist of 12-18 in of topsoil, over 10 - 20 ft of silt/clay, over a deep layer of sand/gravel. The depth of the groundwater aquifer varies, but generally appears to be about 100-150 ft below grade.

One possible scenario could be to produce Class B reclaimed water, and inject it into the sand/gravel layer above the aquifer. If this is something that the District is interested in pursuing then it should be investigated further, starting with a meeting with all stakeholders (FBSD, Ecology, DOH) to determine requirements and next steps. An Engineering Report and Feasibility Study would likely be required by the lead agency (Ecology or DOH), which would evaluate the specific requirements and design constraints.