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WWTP
Engineering Report 2022
DRAFT

April 2022

MONROE
WASHINGTON

Prepared for

City of Monroe
Public Works Department
806 West Main Street
Monroe, WA 98272

Engineering Report
City of Monroe
Wastewater Treatment Plant

DRAFT

April 2022

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Acknowledgments

We would like to acknowledge the contributions from various collaborating parties in the development and review of this Report as follows:

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List of Acronyms and Abbreviations

%	percent
°C	degrees Celsius
ºF	degrees Fahrenheit
Δ	change / difference
AA	average annual
AACE	Association for the Advancement of Cost Engineering
AADWF	annual average dry weather flow
AAF	average annual flow
ADWF	annual dry weather flow
APLR	Annual Pollutant Loading Rate
AOTE	actual oxygen transfer efficiency
avg	average
BHC	BHC Consultants, LLC
BOD	biochemical oxygen demand
BOD/TSS	biochemical oxygen demand/total suspended solids
BOD_5	5-day biochemical oxygen demand
$cBOD_5$	5-day carbonaceous biochemical oxygen demand
CCL	Ceiling Concentration Limits
CEPT	chemically enhanced primary treatment
CERB	Community Economic Revitalization Board
CIP	capital improvement plan
City	City of Monroe
cfm	cubic feet per minute
CFR	Code of Federal Regulations
cfu	coliform forming unit
County	Snohomish County
CPLR	Cumulative Pollutant Loading Rate
CWA	Clean Water Act
DBB	Design-Bid-Build
DO	dissolved oxygen
DOC	Department of Corrections
DT	dry ton
Ecology	Washington State Department of Ecology
EPA	Environmental Protection Agency (also referred to as “United States Environmental Protection Agency”)
ESCO	Energy Services Company
ESPC	Energy Savings Performance Contracting
EQ	Exceptional Quality
F/M	food-to-microorganism ratio
fBOD	filtered biochemical oxygen demand
fCOD	filtered chemical oxygen demand
ffCOD	filter flocculated chemical oxygen demand
FEMA	Flood and Emergency Management Agency

Fe_3O_4	magnetite
FIRM	Federal Emergency Management Agency
FOG	fats, oils, and grease
ft	feet
ft^2	square foot (square feet)
GMA	Growth Management Act
gpcd	gallons per capita per day
gpd	gallons per day
gpm	gallons per minute
H2S	hydrogen sulfide
HDPE	high-density polyethylene
HP	horsepower
HRT	hydraulic retention time
I/I	infiltration and inflow
Kennedy Jenks	Kennedy/Jenks Consultants, Inc.
lb	pound
MBR	membrane bioreactor
MCRT	mean cell residence time
MDF	maximum day flow
mg	milligram(s)
MG	million gallons
mg-N/L	milligrams per liter as nitrogen
mg/L	milligrams per liter
$MG(OH)_2$	magnesium hydroxide
MGD	million gallon(s) per day
mJ/cm2	millijoules per centimeter squared
ml	milliliter(s)
MLE	Modified Ludzack-Ettinger
MLR	mixed liquor recycle
MLSS	mixed liquor suspended solids
mm	millimeter
MM	maximum month
MMF	maximum month flow
MP	*Microthrix parvicella*
MPN	Most Probable Number
mV	millivolt
NaOCl	sodium hypochlorite
NaOH	sodium hydroxide
NEPA	National Environmental Policy Act
NH3	ammonia
NH_4-N	ammonium
NO_x	nitrogen oxide
NPDES	National Pollutant Discharge Elimination System
NPV	net present value
O&M	operations and maintenance
OP	orthophosphate
OPCC	opinion of probable construction cost

Orange Book	*Criteria for Sewage Works Design* published by the Washington State Department of Ecology
ORP	oxidation reduction potential
PCL	Pollutant Concentration Limits
PDF	peak daily flow
PFAS	polyfluoroalkyl substances
PFU	Plaque Forming Unit
PFRP	Process to Further Reduce Pathogens
pH	potential hydrogen (also referred to as “power of hydrogen”)
PHF	peak hour flow
Plan	2015 Utility Systems Plan
PO_4-P	phosphorus
ppcd	pounds per capital per day
psi	pounds per square inch
PSRP	Process to Significantly Reduce Pathogens
PWB	Public Works Board
RAS	return activated sludge
RBC	rotating biological contactor
RCAC	Rural Community Assistance Corporation
RCW	Revised Code of Washington
SBC	submerged biological contactor
scfm	standard cubic feet per minute
SBC	submerged biological contactor
SEPA	State Environmental Policy Act
SERP	State Environmental Review Process
SFHA	Special Flood Hazard Area
SIU	Significant Industrial User
SOTEs	standard oxygen transfer efficiencies
SP	screw press
SRF	State Revolving Fund
SRT	solids retention time
SVI	sludge volume index
TIN	total inorganic nitrogen
TKN	total Kjeldahl nitrogen
TMDL	total maximum daily load
TP	total phosphorus
TSS	total suspended solids
USDA	United States Department of Agriculture
UV	ultraviolet
VAR	vector attraction reduction
VFD	variable frequency drive
VOC	volatile organic compound
WA	Washington
WAC	Washington Administrative Code
WAS	waste activated sludge
WIFIA	Water Infrastructure Finance and Innovation Act of 2014
WSI	Wastewater Solutions Incorporated
WWTP	wastewater treatment plant

Executive Summary

The City of Monroe (City) owns, operates, and maintains the Monroe Wastewater Treatment Plant (WWTP) located at 522 South Sams Street in Monroe. The Monroe WWTP is permitted to discharge to the Skykomish River in accordance with the facility's National Pollutant Discharge Elimination System (NPDES) permit number WA0020486.

This NPDES permit went into effect on 1 December 2018 and includes an interim effluent pH limit range from 6.0 to 9.0 standard units. The permit includes the following requirement: submit an Engineering Report according to the requirements of Washington Administrative Code (WAC) 173-240-060 for facility improvements, including those necessary to meet the final effluent limits for pH. This Report is a supplement to the report titled "*Engineering Report – City of Monroe Wastewater Treatment Plant pH and Filament Control"* (draft version dated December 2019; final and DOE approved version dated March 2020). The submission and approval of the pH focused report fulfilled the NPDES permit requirement as detailed in the "Summary of Permit Report Submittals." It followed WAC 173-240-060 for facility improvements, primarily focused on those necessary to meet the revised final effluent limits for pH included in the updated permit (WA0020486).

The City selected the Consultant team (Team) led by Kennedy/Jenks Consultants, Inc. (Kennedy Jenks) in association with BHC Consultants, LLC (BHC) to prepare this 2022 Engineering Report in accordance with WAC-173-240-060 for comprehensive facility improvements. This Report summarizes the analysis performed to evaluate the ability of the WWTP owned by the City to meet treatment objectives over the planning period extending to 2040. This Report includes the flows and loads, existing conditions, and baseline performance and capacity assessments as detailed in the March 2020 report; moreover, this Report provides the comprehensive facility plan for capital improvements and can be used to guide the operations and expansion of the WWTP through the 2040 planning horizon.

A summary of the four recommended capital improvements projects is as follows:

- pH and Filament control: The City must meet the pH-specific requirements of the NPDES permit by 31 December 2022 by fulfilling the following: 1) completion of construction and installation of facilities and equipment necessary to maintain compliance with final effluent limits for pH; and, 2) submission to Washington State Department of Ecology (Ecology) of a Declaration of Construction of Water Pollution Control. As noted in Section ES-1 below, construction activities are underway for addressing pH and filament control. The improvements include upgraded magnesium hydroxide system, a new sodium hydroxide dosing system, upgraded sodium hypochlorite dosing system, baffling of aeration basins 1 and 2, and enhanced mixed liquor return controls. The design package of plans and specifications submitted to Ecology in December 2020 contains further details.

- Solids Treatment and Handling Upgrades: The decision to upgrade the solids treatment and handling to Class A is a risk-based mitigation strategy to address the risks of solids handling, storage, and hauling. The upgrades to produce Class A biosolids would consist of several elements including: 1) installation of a new biosolids dryer and odor control system, 2) installation of a new dewatering screw press, 3) construction of a new two-story steel building for the dryer, screw press, and ancillary equipment, and 4) replacement of the existing PE Sludge Flow Meter and TSS Meter

- Secondary Treatment Upgrades: The City intends to upgrade the secondary treatment processes to address the high solids loading on the secondary clarifiers, which is projected to be exceeded during the planning period. The membranes for the preferred sidestream MBR upgrades would be retrofitted into the existing submerged biological contactor (SBC) tanks that are no longer in service, allowing them to be repurposed. A new MBR support building would be required to house permeate pumps, membrane blowers and chemical cleaning systems for the membranes. MBR permeate will combine with secondary effluent from the parallel existing conventional activated sludge process in the existing secondary effluent pipeline before being sent to UV disinfection.

- Plantwide Pumps and UV Disinfection Upgrades: The City plans to upgrade the hydraulic capacity of various processes of the WWTP during the planning period. The improvements include replacement of ultraviolet disinfection units, replacement and/or retrofit of various pumps (effluent, influent, 3W), and miscellaneous piping.

The estimated total project costs for the four projects are detailed below in Section ES-1. The costs reflect a Class 4 opinion of probable construction cost (OPCC) - applicable for 1% to 15% design - as defined by the Association for the Advancement of Cost Engineering (AACE) and has an expected accuracy range of -20 percent (%) to +30%. The detailed cost analysis includes life-cycle costs (where applicable) and operations and maintenance costs. The City's decision to select the combination of projects detailed in the table below included capital and operations and maintenance costs as well as the considerations of savings from risk reduction pertaining to solids upgrades. The combination of improvements selected by the City results in cost savings when annualized through the end of the planning period.

Table ES-1: Estimated Total Project Costs and Anticipated Implementation Schedule for Capital Improvements

Capital Improvement Project	Estimated Total Project Cost (2020 Dollars)[a][b]	Estimated Mid-Point of Construction
pH and Filament Control	$2.79M [c]	In-construction
Solids Treatment and Handling Upgrades	$15.42M	2023
Secondary Treatment Upgrades	$20.03M	2027
Plantwide Pump & UV Disinfection Upgrades	$5.13M	2029

Notes:

(a) Operation and maintenance costs for the life of the projects are presented in Appendix G.
(b) Cost estimating was conducted in 2020. Dollar figures are in 2020 dollars to be consistent with the values as presented to the City Council for review and approval on 14 July 2020, with the exception of the pH and Filament Control project. The submission of this report in 2022 reflects delays experienced due to the COVID-19 pandemic and development of the Effluent Mixing Zone Study.
(c) The original estimate for the pH and Filament Control project was $1.76M (2020 Dollars). The costs shown reflect the anticipated costs at the completion of the project as reported by the City. It is noted that the increase of costs are a product of the market volatility and supply chain issues pervasive during the COVID-19 pandemic.

Section 1: Introduction

1.1 Report Purpose

The City of Monroe (City) owns, operates, and maintains the Monroe Wastewater Treatment Plant (WWTP) located at 522 South Sams Street in Monroe. The Monroe WWTP is permitted to discharge to the Skykomish River in accordance with the facility's National Pollutant Discharge Elimination System (NPDES) permit number WA0020486 (Appendix A).

The City selected the Consultant team (Team) led by Kennedy/Jenks Consultants, Inc. (Kennedy Jenks) in association with BHC Consultants, LLC (BHC) to prepare this 2022 Wastewater Treatment Plant (WWTP; Plant) Engineering Report (Report), which must comply with state and federal requirements.

This Report is a supplement to the report titled "*Engineering Report – City of Monroe Wastewater Treatment Plant pH and Filament Control*" (draft version dated December 2019; final and DOE approved version dated March 2020). The submission and approval of the pH focused report fulfilled the NPDES permit requirement as detailed in the "Summary of Permit Report Submittals." It followed Washington Administrative Code (WAC) 173-240-060 for facility improvements, primarily focused on those necessary to meet the revised final effluent limits for pH included in the updated permit (WA0020486). This Report summarizes the analysis performed to evaluate the ability of the WWTP owned by the City to meet treatment objectives over the planning period extending to 2040. This Report includes the flows and loads, existing conditions, and baseline performance and capacity assessments as detailed in the March 2020 report; moreover, this Report provides the comprehensive capital improvement plan and can be used to guide the operations and expansion of the WWTP through the 2040 planning horizon. The WAC requirements for wastewater facilities plans (also referred to as Engineering Reports) are outlined in Section 1.5 below.

This Report will be submitted to the Washington State Department of Ecology (Ecology) for review, comment, and approval.

1.2 Background

The City's current Sanitary Sewer System Plan was updated in 2015 as part of the Utility Systems Plan (2015 Utility Plan) (BHC 2015). This Plan provides the public and regulatory agencies with information on the City's plans for sewer system extensions to areas designated as urban under the Growth Management Act. According to the 2015 Utility Plan, several necessary improvements were identified at the WWTP to meet process capacities, equipment obsolescence, and efficiency needs. All the physical improvements for the Plant recommended in the 2015 to 2021 Capital Plan have been completed.

The 2015 to 2021 Capital Plan also identified a need for a detailed WWTP Engineering Report (Report), a WWTP Rerating Study (Capacity Analysis), a Mixing Zone Analysis, and a Biosolids Management Study. This Report includes a comprehensive assessment of facility-wide improvements. The Biosolids Management Study is included as Section 5 of this Report. Upon further consideration with regards to the goals of this Report, a separate rerating study was determined to be unnecessary. The findings from the Mixing Zone Analysis are detailed in Section 3.2 and the Final Effluent Mixing Zone Study Report is available on Ecology's Permitting and Reporting Information System website.

1.3 City of Monroe Service Area and Wastewater Treatment Plant Overview

The City is in western Snohomish County on the Skykomish River as illustrated on Figure 1-1. Founded in 1864, and incorporated in 1902, the City has grown to a population of 17,304 as of the 2010 Census and is estimated at 19,363 as of 2018. The current wastewater system service area encompasses 5,191 acres, which includes the Southwest Study Area identified in the 2015 Utility Plan. The collections system consists of 42.3 miles of gravity sewers, 6.2 miles of force mains, and 10 lift stations.

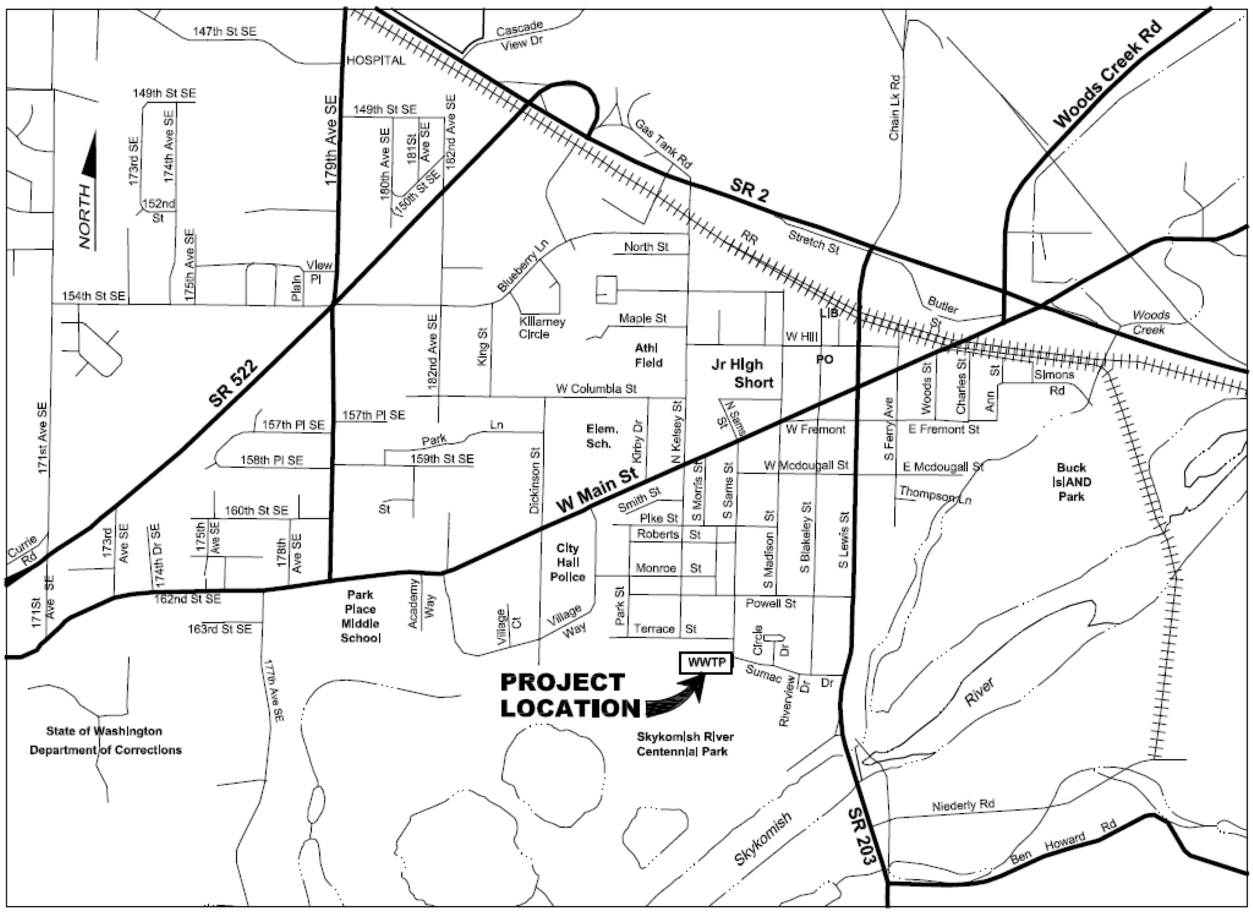
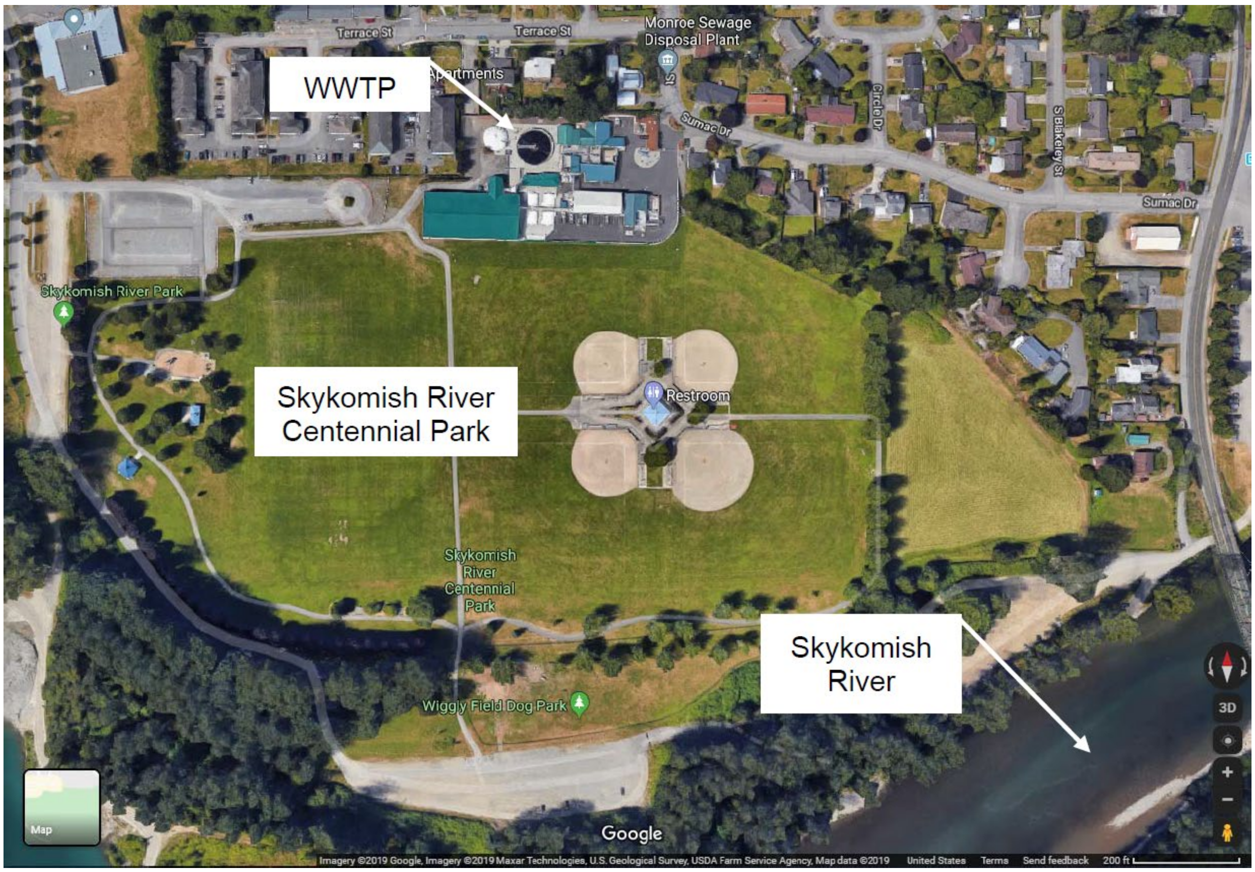


Figure 1-1: Project Location

The City owns, operates, and maintains a secondary WWTP implementing a Modified Ludzack-Ettinger process, which is located immediately north of the Skykomish Centennial Park (Figure 1-2). The WWTP has a design capacity of 2.84 million gallons per day (MGD) based on the design Maximum Month Flow (MMF). Further details regarding the extent of the service area tributary to the WWTP are included within the 2015 Utility Plan (Refer to Figure SS 4.1 Existing Sewer System).



(Source: Google Maps)

Figure 1-2: Aerial View of the City of Monroe's WWTP in relation to the Skykomish Centennial Park and Skykomish River

The WWTP liquid stream consists of a headworks structure with two mechanical fine screens, an influent lift station, and a mechanical vortex type grit removal system that provides preliminary treatment. The screened and de-gritted influent flows by gravity through two rectangular primary clarifiers, three aeration basins with anoxic and aerobic zones, two circular secondary clarifiers, ultraviolet light (UV) disinfection, and an effluent pump station. The disinfected WWTP effluent is discharged to the Skykomish River (Figure 1-2) via a 30-inch diameter final effluent pipe and four 12-inch diameter outfall diffusers.

Solids stream treatment consists of three aerobic digesters in series, sludge transfer pumps, and a belt press for dewatering. The dewatered sludge is hauled by trucks to the former compost facility site at the Monroe Correctional Complex where it is stored for a period and then reloaded onto larger trailers for delivery to a Beneficial Use Facility by a contract hauler. The sludge cake is incorporated into the soil (beneath the surface) in order to meet the vector attraction reduction requirement.

1.4 Establishment of City's Goals

During a workshop held on 12 March 2019 with the Team and the City, the following goals emerged as priorities for the City:

- A successful project is defined as one that provides a roadmap to efficient, achievable, reliable, and sustainable compliance.
- Ensure that the current processes meet the new pH limit established by the City's new NPDES permit and address operational goals.
- This Report should include a 20-year planning horizon extending to 2040. Population, flow, and load projections through 2035 will follow the 2015 Utility Plan. Projections will be extrapolated to 2040, assuming 2 percent (%) annual population growth and the same per capita flow and load factors established in the 2015 Utility Plan.
- City-provided direction to assume pre-treatment of wastewater at the prison [Department of Corrections (DOC)] continues over the course of the planning horizon.
- Coordination with Ecology will be important for the project: 1) to ensure the Engineering Report addresses Ecology's requirements; and 2) to remain abreast of the direction of any potential changes to nutrient source reduction requirements into Puget Sound.

1.5 Regulatory and Treatment Requirements

The following sections provide details regarding Washington State's regulatory requirements as they pertain to this Report and the WWTP.

1.5.1 Washington State Regulatory Requirements

The Report must comply with the following requirements: WAC 173-240-060; Revised Code of Washington (RCW) 36.70A, which details the Growth Management Act; and RCW 82.02.

1.5.1.1 Washington State Administrative Code Requirements

Table 1-1 below details the requirements of WAC 173-240-060 as they pertain to the content of this Report.

Table 1-1: Requirements for an Engineering Report per WAC 173-240-060

Text from WAC 173-240-060	Location in Report
The engineering report shall include the following information, together with any other relevant data as requested by Ecology:	
(a) The name, address, and telephone number of the owner of the proposed facilities, and their authorized representative.	• Cover Sheet
(b) A project description including a location map and a map of the present and proposed service area.	• Section 1.3 • Figure 1-1 • 2015 Utility Plan (Figure SS 4.1)
(c) A statement of the present and expected future quantity and quality of wastewater, including any industrial wastes which may be present or expected in the sewer system.	• Section 2.3 • Section 2.4 • Section 2.5
(d) The degree of treatment required based upon applicable permits and regulations, the receiving water, the amount and strength of wastewater to be treated, and other influencing factors.	• Section 1.5
(e) A description of the receiving water, applicable water quality standards, and how water quality standards will be met at the boundary of any applicable dilution zone. (173-201A-10Q WAC).	• Section 1.5 • Section 3
(f) The type of treatment process proposed, based upon the character of the wastewater to be handled, the method of disposal, the degree of treatment required, and a discussion of the alternatives evaluated and the reasons they are unacceptable.	• Section 4 • Section 5
(g) The basic design data and sizing calculations of each unit of the treatment works. Expected efficiencies of each unit, the entire plant, and character of effluent anticipated.	• Section 3.3
(h) Discussion of the various sites available and the advantages and disadvantages of the site(s) recommended. The proximity of residences or developed areas to any treatment works. The relationship of a 25-year and 100-year flood to the treatment plant site and the various plant units.	• Section 3.2 • Section 4 • Section 5
(i) A flow diagram showing general layout of the various units, the location of the effluent discharge, and a hydraulic profile of the system that is the subject of the engineering report and any hydraulically related portions.	• Section 3.2
(j) A discussion of infiltration and inflow problems, overflows and bypasses, and proposed corrections and controls.	• Section 2.5 • 2015 Utility Plan • Appendix C
(k) A discussion of any special provisions for treating industrial wastes, including any pretreatment requirements for significant industrial sources.	• Section 2.5 • 2015 Utility Plan • Appendix D
(l) Detailed outfall analysis or other disposal method selected.	• Section 3.2 •
(m) A discussion of the method of final sludge disposal and any alternatives considered.	• Section 5

Text from WAC 173-240-060	Location in Report
(n) Provision for future needs.	• Section 2.1 • Section 2.3 • Section 2.4
(o) Staffing and testing requirements for the facilities.	• Section 6.4 • 2015 Utility Plan
(p) An estimate of the costs and expenses of the proposed facilities and the method of assessing costs and expenses. The total amount shall include both capital costs and also operation and maintenance costs for the life of the project and shall be presented in terms of total annual cost and present worth.	• Section 6.1 • Appendices G
(q) A statement regarding compliance with any applicable state or local water quality management plan or any such plan adopted pursuant to the federal Water Pollution Control Act as amended.	• Section 1.5 • Section 6.4
(r) A statement regarding compliance with SEPA and NEPA, if applicable.	• Section 1.5 • Section 6.4 • Appendix B

1.5.1.2 Revised Code of Washington Requirements

The RCW includes guidance and requirements for planning within the City and at the WWTP. Both RCW 36.70 A and RCW 82.02 are pertinent to this Report and the City's implementation of any recommendations within this Report. Additionally, requirements of RCW 90.48 related to water pollution control are captured under WAC 173-240-060 mentioned above.

RCW 36.70A details the role of the Growth Management Act (GMA), which requires comprehensive planning to address population growth in "fast-growing" cities and counties. The City is within Snohomish County, which is one of 18 counties required to incorporate full GMA planning. The GMA includes 14 goals that provide the basis for comprehensive planning. The 14 goals include (refer to RCW 36.70A.020 and RCW 36.70A.480): concentrated urban growth; sprawl reduction; regional transportation; affordable housing; economic development; property rights; permit processing; natural resource industries; open space and recreation; environmental protection; early and continuous public participation; public facilities and services; historic preservation; and shoreline management.

Of additional importance to this Report and the discharge from the WWTP to the Skykomish River, RCW 36.70A.172 highlights the importance of the use of best available science as it pertains to critical areas: "*counties and cities shall include the best available science in developing policies and development regulations to protect the functions and values of critical areas. In addition, counties and cities shall give special consideration to conservation or protection measures necessary to preserve or enhance anadromous fisheries*."

RCW 82.02 includes guidance regarding the authority of the county, city, and/or town in taxation and charges that are or are not permitted under Washington State law. Of additional importance to this Report and the capital improvements proposed within this Report, RCW 82.02.020 states: "*Nothing in this section prohibits counties, cities, or towns from imposing or permits counties, cities, or towns to impose water, sewer, natural gas, drainage utility, and drainage* *system charges. However, no such charge shall exceed the proportionate share of such utility or system's capital costs which the county, city, or town can demonstrate are attributable to the property being charged*.” RCW 82.02.050 also details the use of impact fees and any limitations.

1.5.1.3 State Environmental Policy Act

The State Environmental Policy Act (SEPA) is Washington State’s parallel statute to the National Environmental Policy Act (NEPA). Statewide rules for SEPA compliance are issued by Ecology, with individual agencies maintaining a set of procedures to ensure SEPA compliance with their proposed actions.

As a part of this Report, a SEPA checklist was completed to perform an environmental review to comply with SEPA (Appendix B). While the Report itself is a non-project action, the 6-year Capital Improvement Plan (CIP) projects discussed within the Report have been sufficiently developed to allow proceeding into design. As a result, the SEPA checklist has been performed for the projects listed in the 6-year CIP.

As a part of SEPA, the State Environmental Review Process (SERP, WAC 173-98-100) is necessary to be eligible for financial assistance from state water quality grants and loans administered by Ecology. SERP was created to ensure that environmentally sound alternatives are selected and comply with NEPA and other environmental laws and regulations. The City may potential state funding for projects recommended in this Report as available and appropriate. If funding is pursued, SERP requirements will need to be satisfied and this Report may need to be amended to accommodate SERP. Additional information on funding is provided in Section 6.3.

1.5.2 State Implementation of Federal Clean Water Act

In 1972, the federal government passed the Clean Water Act (CWA) with a goal of reducing pollution in the nation’s waterways. The following sections detail the role of the State of Washington in the implementation of the CWA.

1.5.2.1 Washington State Surface Water Quality Standards

In the State of Washington, Ecology serves as the local regulatory body to protect the quality of water by implementing the surface water quality standards and setting pollution limits. The standards include: protections for four types of “designated uses” (including aquatic life, recreation, drinking water supply, and miscellaneous uses); water quality criteria; and policies for protection of the waters against future pollution. The surface water quality standards are implemented via WAC 173-201A. Improvements in this Report will be consistent with those required by CWA and overseen by Ecology.

1.5.2.2 Section 402 and NPDES Permit Requirements

Permits to discharge to waterways were made a requirement of the federal CWA under section 402; hence, the NPDES was put in place to limit pollution from point source discharge. Municipal sewage treatment plants were given guidelines based on technology standards to meet certain treatment limits listed in their NPDES permit. The U.S. Environmental Protection

Agency (EPA) has delegated the process of issuing NPDES permits to most states, although a handful of states currently do not issue their own permits. In Washington, Ecology administers NPDES discharge permits to WWTPs. Discharge limits under the current NPDES permit (WA0020486) held by the City are summarized in Table 1-2. The interim pH limit is effective through the end of 2022, with the final limit taking effect at the start of 2023. See Appendix A for further information regarding the permit.

Table 1-2: Monroe WWTP NPDES Permit (WA0020486)

Parameter	Effluent Limits	
5-day carbonaceous biochemical oxygen demand ($cBOD_5$)	Average Monthly	Average Weekly
	30 mg/L	45 mg/L
	711 lbs/day	1066 lbs/day
	85% removal of influent BOD_5	
Total suspended solids (TSS)	Average Monthly	Average Weekly
	30 mg/L	45 mg/L
	711 lbs/day	1,066 lbs/day
	85% removal of influent TSS	
pH	Minimum	Maximum
	6.0 (Interim)	9.0
	6.7 (Final)	9.0
Fecal Coliform	Monthly Geometric Mean	Weekly Geometric Mean
	100 cfu/100 ml	200 cfu/100 ml
	Influent Limits	
Maximum Month Flow	2.84 MGD	
BOD_5 Loading	6,090 lbs/day	
TSS Loading	5,940 lbs/day	

Notes:

mg/L = milligrams per liter
lbs/day = pounds per day
cfu = coliform forming units
ml = milliliter
% = percent

1.5.2.3 Section 303(d) and Receiving Water Summary

Effluent discharged from the WWTP is received into the Skykomish River, which is a tributary of the Snohomish River. The most recent water quality assessment approved by EPA in 2016 does not indicate any Category 5 listings that would require total maximum daily loads (TMDLs) or other water quality improvement projects for the segment of the Skykomish River that receives the WWTP effluent. Within that segment, the 2016 water quality assessment identifies only copper, silver, and lead as Category 2 listings. A Category 2 listing means the river segment shows some evidence of a water quality problem with respect to the parameters identified, but not enough to show persistent impairment. In such instances, Ecology continues to monitor and collect information on these parameters to determine if a consistent impairment develops.

The river segment immediately upstream of the segment receiving the WWTP effluent has Category 5 listings for temperature and dissolved oxygen.

1.5.2.4 Future Regulatory Considerations

While future permit requirements are presently unknown, it is expected that there will eventually be more stringent effluent limits imposed on nitrogen. Ecology is currently working on the Puget Sound Nutrient Source Reduction Project collaboratively with stakeholders. The result of this study will likely culminate in reductions to nutrient loads and concentrations discharged to Puget Sound. Ecology has indicated nutrient reduction will largely be focused on nitrogen, but not limited to nitrogen. Initial evaluations by Ecology have used total inorganic nitrogen (TIN) limits of 8 milligrams per liter as nitrogen (mg-N/L) and 3 mg-N/L, suggesting that concentration limits of around 8 mg-N/L might be applied to WWTPs that are smaller and/or in less critical areas and that limits of around 3 mg-N/L might be applied to WWTPs that are larger and/or in more critical areas.

Although the WWTP is not currently included in the list to be regulated under the general permit, it is likely that it could be added during a future renewal and reissuance of the general permit. The findings included in Section 3 of this Report will inform future actions for the City to undertake to address future regulatory requirements.

1.5.3 EPA Reliability Requirements

Ecology has several requirements regarding reliability of wastewater treatment plants that are outlined in the *Criteria for Sewage Works Design* or "Orange Book" (Ecology 2008). Additionally, EPA has provided additional guidelines in the *Design Criteria for Mechanical, Electric, and Fluid System and Component Reliability* (EPA 1974). Table 1-3 summarizes these reliability requirements and guidelines for each component. The Monroe WWTP is permitted with a reliability classification of Class II. Improvements in this Report will be consistent with those required for a Class II facility.

Table 1-3: EPA Class II Reliability Requirements

Component	Class II Requirement
Reliability classification	Works discharging into navigable waters that would not be permanently or unacceptably damaged by short-term effluent quality degradation but could be damaged by continued (on the order of several days) effluent degradation.
Grit removal	Required if sludge is handled.
Mechanically cleaned bar screens	Backup manual screen required.
Pumps	Capacity to handle peak flow with any one pump out of service must be provided.
Primary sedimentation basins	With largest unit out of service, remaining units shall have capacity for at least 50% of the total design flow.

Component	Class II Requirement
Final sedimentation basins	With largest unit out of service, remaining units shall have capacity for at least 50% of the total design flow; backup not required for chemical sedimentation basins, filters, and activated carbon columns.
Aeration basin	At least two equal volume basins shall be provided.
Aeration blowers or aerators	Sufficient to provide for peak oxygen demands with the largest capacity unit out of service.
Diffusers	Designed so that isolation of the largest section of diffusers does not measurably impair oxygen transfer capability.
Sludge handling	Alternate methods of sludge disposal and/or treatment shall be provided for each sludge treatment unit operation without installed backup capability. No recycles permitted that will compromise liquid treatment.
Sludge holding tanks	May be used to back up downstream tanks.
Sludge pumps	A backup pump shall be provided for each set of pumps that performs the same function. The capacity of the pumps shall be such that with any one pump out of service, the remaining pumps will have capacity to handle the peak flow.
Aerobic sludge digestion	Backup aeration basin not required. At least two blowers shall be provided. Uninstalled backup blower is permissible. Largest section of diffusers can be isolated.
Dewatering	There shall be sufficient number of units to enable the design flow to be dewatered with largest capacity unit out of service or alternate disposal method. The backup unit may be uninstalled.
Electric power source	Two separate and independent sources of electric power shall be provided either from two separate utility substations or from a single substation and a backup generator located at the plant. Power shall be sufficient to operate all vital components, critical lighting and ventilation during peak wastewater flow except that vital components used to support the secondary processes (i.e., aeration basin blowers) need not be operable to full levels of treatment, but shall be sufficient to maintain the biota.
Power distribution	Vital components should be divided between at least two motor control centers. No single fault should result in disruption of electrical service to more than one motor control center.

Component	Class II Requirement
Instrumentation and control systems	Automatic control systems whose failures could result in a controlled diversion or a violation of the effluent limitations shall be provided with a manual override. Instrumentation whose failure could result in a controlled diversion or a violation of the effluent limitations shall be provided with an installed backup sensor and readout. Alarms shall be provided to monitor the condition of equipment whose failure could result in a controlled diversion or a violation of the effluent limitations. Vital instrumentation and control equipment shall be designed to permit alignment and calibration without requiring a controlled diversion or a violation of the effluent limitations.
Auxiliary systems	If a malfunction of the system can result in controlled diversion or a violation of the effluent limitations and the required function cannot be done by any other means, then the system shall have backup capability.

Section 2: Flows and Loads

Section 2 provides a summary of the historical and projected populations for residential, non-residential, and DOC, as well as historical and projected wastewater flows and loads for the City's sewer service area. The 2015 Plan is referenced throughout this section as it serves as the basis for many of the assumptions made herein.

2.1 Population

The population estimates used in this study are based on those developed in the 2015 Plan. Populations contributing sewage are separated into three groups: residential, non-residential (employment), and DOC inmates. Population estimates and projections were developed for each group for the years 2015, 2021, and 2035 as part of the 2015 Plan. Linear interpolation was used to calculate the populations for in-between years.

Per the 2015 Plan, this study assumes sewered basins begin septic-sewer conversion in 2015, and unsewered basins begin septic sewer conversion in 2025. A 2% growth rate was assumed for both residential and non-residential population growth from 2036-2040. DOC inmate population growth was assumed to linearly increase from 2036 to 2040 at the same rate as for 2015 to 2036 documented in the Plan. The Southwest Study Area referenced in the Plan was assumed to be sewered beginning in 2020.

Table 2-1 summarizes the resulting population numbers used to project wastewater flows and loads. Figure 2-1 graphically illustrates the growth of the three aforementioned populations subsets from 2010 to 2040.

Table 2-1: Sewered Population Forecasts for the City of Monroe and Urban Growth Area

Year	Residential Population[(a)]	Non-Residential Population[(a)]	DOC Inmate Population[(b)]
2010	11,392	7,189	2,536
2015	12,587	7,809	2,500
2020	14,356	8,479	2,585
2026	16,514	9,264	2,686
2040	23,093	11,646	2,923
Build-out	28,573	12,440	3,092

Notes:

(a) Population includes the Southwest Study Area.
(b) The inmate population represents the average daily population.

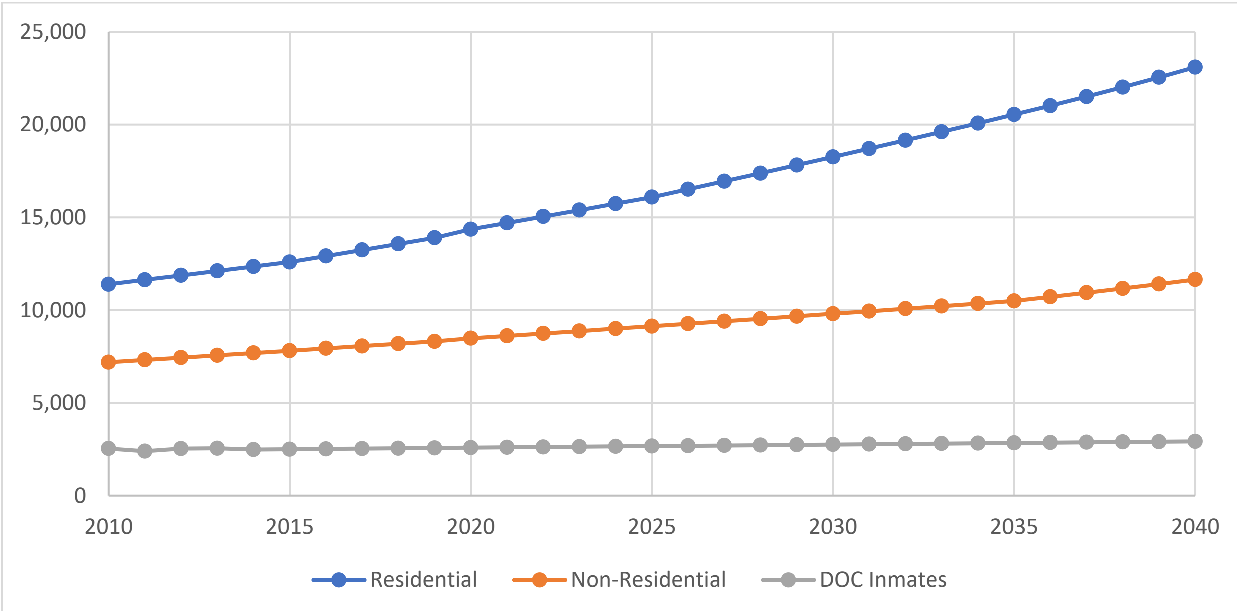


Figure 2-1: Sewered Population Forecast, 2010 through 2040

2.2 Existing Flows

A summary of wastewater flows for 2011 through 2020 is shown in Table 2-2, which is based on data presented in the 2015 Plan and recent data from the City. Because peak hour flow data was not available for 2011, 2012, 2019 and 2020, the peaking factor for peak hour flow is based on the average peak hour flow for 2013 and 2014 (through 12 November 2014).

Table 2-2: Existing Flows

Year	Average Annual Flow (MGD)	Maximum Month Flow (MGD)	Maximum Day Flow (MGD)	Peak Hour Flow (MGD)
2011	1.50	1.88	2.89	No Data
2012	1.63	2.22	3.64	No Data
2013	1. 55	1.94	3.18	6.87
2014	--	--	--	6.68
2019	1.59	1.87	3.81	No Data
2020	1.79	2.55	4.55	No Data

2.2.1 Diurnal Flows

Hourly flow data were provided for the period beginning on 13 August 2018 and ending on 19 August 2018. These data were averaged for each hour to produce a diurnal curve normalized to the flow rate, as illustrated on Figure 2-2. A diurnal curve was developed to model performance of the WWTP during diurnal changes in flow and loads to determine whether adequate treatment and capacity are maintained.

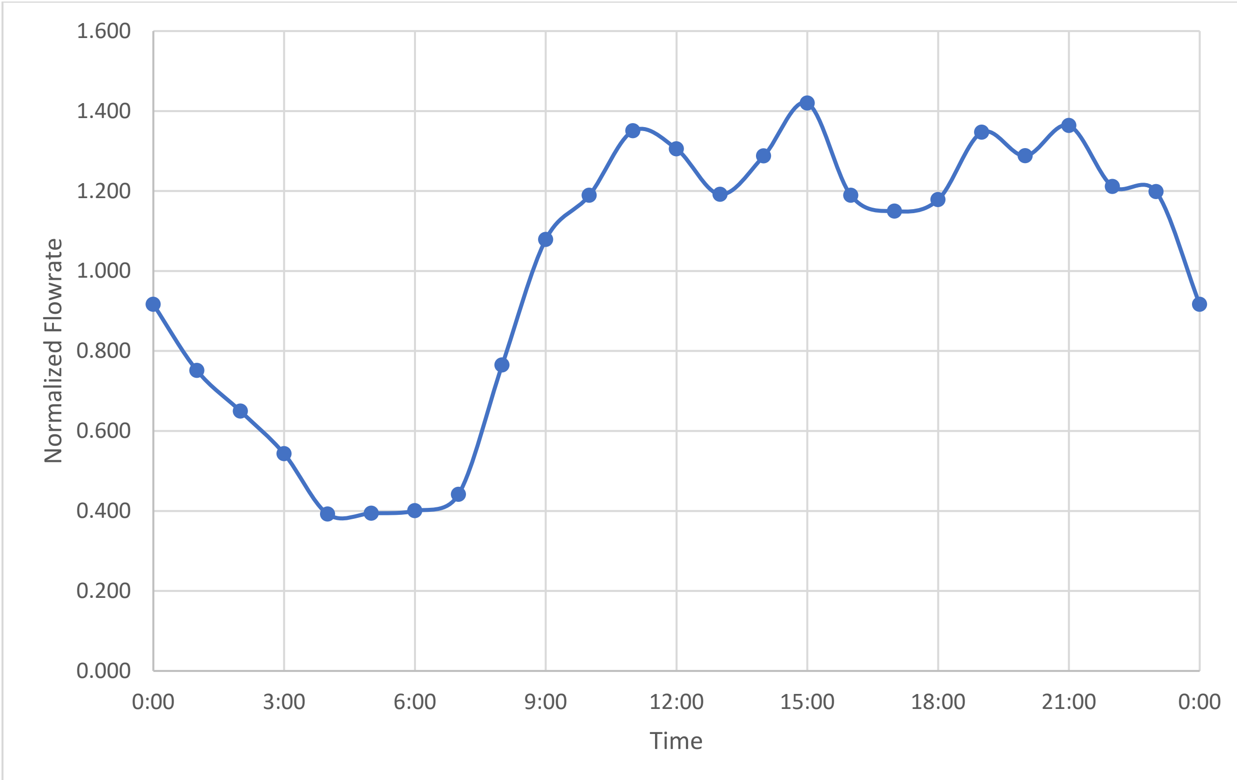


Figure 2-2: Normalized Typical Diurnal Curve (Flow Unitless)

2.3 Projected Flows

The projected flows for the years 2026 and 2040, and build-out include contributions for residential, non-residential, and DOC populations based on per capita flows of 67.4 gallons per capita per day (gpcd), 48.6 gpcd, and 159.4 gpcd, respectively, as established in the 2015 Plan. The residential and non-residential flows include contributions from the Southwest Study Area beginning in 2020. Per-capita flows for each population group were assumed to remain constant throughout the planning period, consistent with the 2015 Plan. As per the 2015 Plan, it was assumed that sewered basins begin septic-sewer conversion in 2015 and that unsewered basins begin the septic-sewer conversion in 2025. A summary of the projected flows is provided in Table 2-3. Projected flows include conditions for average annual flow (AAF), maximum month flow (MMF), maximum day flow (MDF), and peak hour flow (PHF). Figure 2-3 graphically illustrates the projected wastewater flow rates between 2010 and 2040. The different flow conditions are defined as follows:

- **Average Annual Flow** – This flow condition is defined as the average of daily flows during the year.
- **Maximum Month Flow** – This flow condition is defined as the highest monthly average flow. This flow condition is of particular interest because the NPDES permit includes a limit for MMF and this flow is typically used as the basis for evaluating capacity of the biological treatment process.

- **Maximum Day Flow** – This flow condition is defined as the maximum day flow in a given year.

- **Peak Hour Flow** – This flow condition is defined as the peak sustained flow rate occurring during a 1-hour period. It is used to size the collection and interceptor sewers, pump stations, flow meters, and WWTP hydraulic processes.

Table 2-3: Projected Wastewater Flow Rates

Year	AAF (MGD)	MMF (MGD)	MDF (MGD)	PHF (MGD)
2026	1.99	2.57	4.12	8.50
2040	2.59	3.34	5.36	11.0
Buildout	3.02	3.90	6.26	12.9

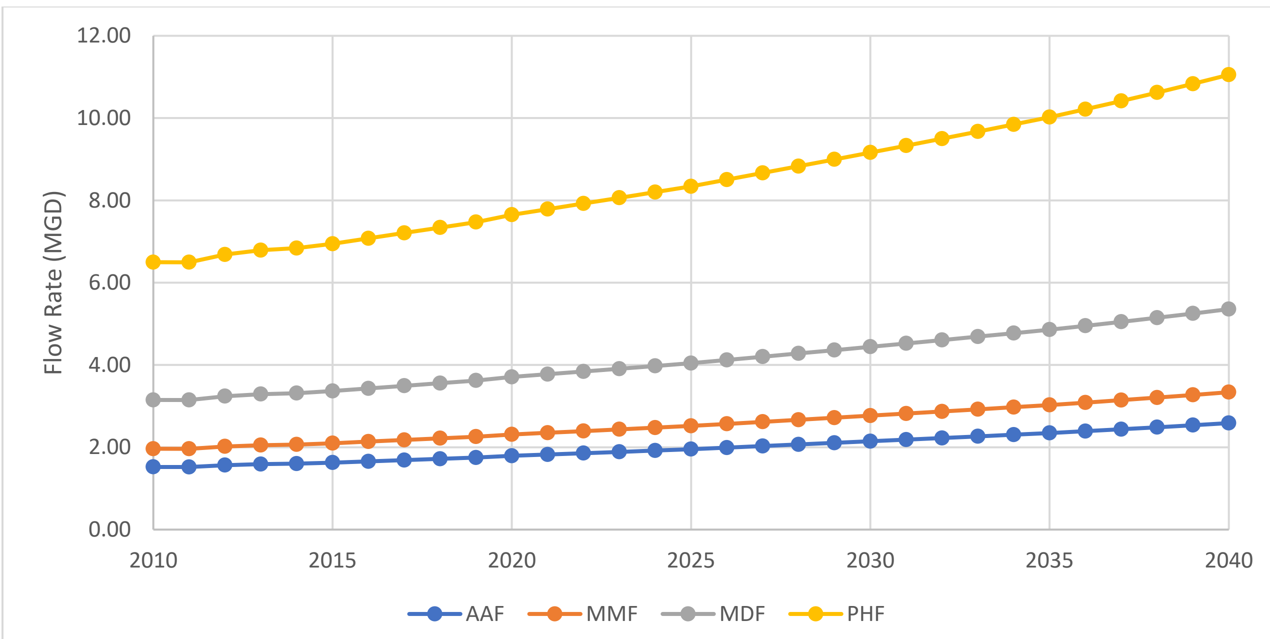


Figure 2-3: Projected Wastewater Flows, 2010 through 2040

2.4 Projected Loads

Consistent with the 2015 Plan, residential and non-residential loading projections assume average annual (AA) biochemical oxygen demand (BOD) loading of 0.166 pounds per capita per day (ppcd), maximum month (MM) BOD loading of 0.203 ppcd, AA total suspended solids (TSS) loading of 0.167 ppcd, and MM TSS loading of 0.221 ppcd.

DOC inmate loading projections are based on AA BOD loading of 0.366 ppcd, MM BOD of 0.560 ppcd, AA TSS of 0.324 ppcd, and MM of TSS of 0.639, as documented in the 2015 Plan. Assumptions for BOD and TSS removal from DOC pretreatment lagoons are the same as used in the 2015 Plan, which assumed BOD removal of 83% and TSS removal of 82%. As with the flow projections, the load projections include contributions from the Southwest Study Area beginning in 2020 and assumes that sewered basins begin septic-sewer conversion in 2015 and that unsewered basins begin the septic-sewer conversion in 2025. A summary of the projected wastewater loads is provided in Table 2-4. Figure 2-4 illustrates the increase in loads from 2010 to 2040.

Table 2-4: Projected Wastewater Loads

Year	AA BOD (lbs/day)	MM BOD (lbs/day)	AA TSS (lbs/day)	MM TSS (lbs/day)
2026	4,440	5,500	4,460	6,000
2040	5,940	7,340	5,970	8,010
Buildout	6,980	8,630	7,030	9,410

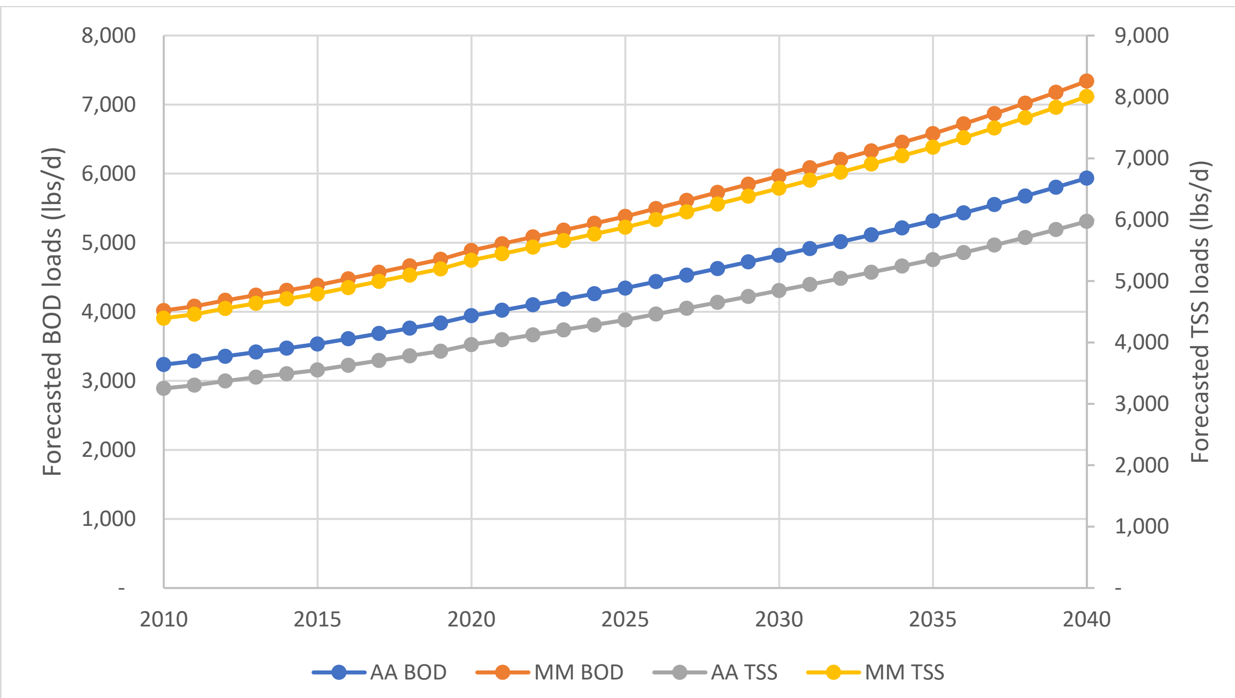


Figure 2-4: Projected Wastewater Loads, 2010 through 2040

2.4.1 DOC Pretreatment Lagoons Removed from Service

While unlikely, it is possible that the DOC could remove its pretreatment lagoons from service within the planning horizon, sending the full BOD and TSS loads to the WWTP. A summary of the projected loads with the pretreatment lagoon removed from service is provided in Table 2-5.

Table 2-5: Forecasted Loads with DOC Pretreatment Lagoon Removed from Service

Year	AA BOD (lbs/day)	MM BOD (lbs/day)	AA TSS (lbs/day)	MM TSS (lbs/day)
2026	5,250	6,740	5,170	7,410
2040	6,820	8,700	6,750	9,540
Buildout	7,920	10,100	7,850	11,000

Although removal of the DOC pretreatment lagoons results in higher BOD and TSS loading to the WWTP, continuation of pretreatment is considered a worse condition. The pretreatment lagoons remove most of the BOD produced by DOC, which is a valuable carbon source in driving denitrification at the WWTP. Additionally, the pretreatment lagoons not only do not remove nitrogen, but the concentration of ammonia-nitrogen increases through degradation of organic matter in the lagoons. This results in less efficient nitrogen removal, as the influent levels of nitrogen are increased, and the available carbon needed to assist with removal of nitrogen is decreased.

Furthermore, DOC pretreatment often produces algae within the lagoons. Due to the minute size of some algae particles, a significant portion of the algae that reaches the WWTP can pass through the treatment process, as it is difficult to remove, and subsequently reduce UV transmittance, which impacts disinfection, and yields higher effluent BOD and TSS.

Although the wastewater load projections assume the maximum month loads for the DOC and the residential and non-residential populations occur at the same time, this would not necessarily be the case. If these maximum month loads do not overlap, the WWTP could operate without significant changes were the pretreatment lagoons removed from service. If there were only brief spikes during maximum month loading, these could be managed through control of the sludge inventory. However, if increased loadings persist throughout the maximum month, the facility would need to have capacity above the planned 2040 loads presented herein, which may require additional improvements. The 2031 loading with DOC pretreatment lagoons removed from service is approximately equal to 2040 loading with pretreatment.

Although the City does not have specific data for the DOC pretreatment lagoon effluent, the effluent from similar lagoons would be expected to have variable alkalinity and pH depending on algal growth, sludge blanket, and seasonal effects (EPA 2002; Richard 2003). Due to long retention times within the lagoon, particulate matter will tend to settle and anaerobically degrade, thereby releasing significant ammonia. This greater ammonia load requires increased nitrification, which consumes additional alkalinity and can adversely impact effluent pH. Conversely, BOD will tend to be reduced in the lagoon through biological activity and settling of particulates. This can yield a much lower BOD to nitrogen ratio than seen in typical domestic wastewater making denitrification more challenging. Lagoon effluent can also be a source of filamentous organisms, which can impact settleability of activated sludge in the secondary clarifiers. Each of these items could negatively impact the WWTP’s ability to reliably meet more stringent pH criteria. The proposed pH reliability project would improve and expand chemical alkalinity addition capabilities, improve biological alkalinity recovery in the secondary treatment process and improve the ability to remove filamentous organisms that can inhibit biological treatment goals.

2.5 Additional Considerations

The 2015 Utility Plan provides information regarding additional considerations as required by WAC 173-240-060, such as infiltration and inflow (I/I) problems, overflows and bypasses, and industrial wastes. A summary of these considerations is as follows:

- Section SS 5.4 of the 2015 Utility Plan concludes that I/I is not excessive: "*Previous investigations and the current review of recent flow data indicate that I/I is non-excessive in the City's sewer system. The per capita average annual sewer flows indicate non-excessive I/I in that they are lower than typical per capita rates*." The baseline I/I is reported in Table SS 5-3 of the 2015 Utility Plan. In a letter submitted to Ecology on 5 September 2016, the WWTP Manager noted that the City had non-excessive inflow during wet weather and non-excessive infiltration during dry weather (see Appendix C).

- Section SS 5.5 of the 2015 Utility Plan noted that overflows/violations and bypasses are not an issue at the WWTP: "*The WWTP has consistently met the effluent limitations and remained in compliance with the NPDES Permit. The WWTP has never had to bypass*." Since the authorship of the 2015 Utility Plan, the WWTP had a violation in TSS in February 2017, violations for TSS and BOD in March 2017 related to *Microthrix parvicella* (MP), and an authorized discharge (spill), but no other effluent violations since those mentioned here.

- Section SS 5.2.1 of the 2015 Utility Plan also concludes: "*While there is a non-residential sewage component, there are no significant industrial discharges to the City's sewer system*." Furthermore, the City's staff conducted an Industrial User Survey during the summer through fall 2016. In a letter dated 27 October 2016, the WWTP Manager provided a summary of the five industrial users deemed as either a Significant Industrial User (SIU) or a Potential Significant Industrial User. As noted within the letter, the City did not identify any problems associated with the five SIUs (see Appendix D). Under the current NPDES permit (WA0020486), an Industrial User Survey is due to be submitted to Ecology by 31 December 2022.

Section 3: Existing Conditions

Section 3 provides a description of the WWTP history, processes, and current performance, and an overview of unit process capacity. This section also describes the development, calibration, and validation of biological process and hydraulic models to assess capacity and performance under current and projected wastewater flows and loads. Along with a process audit conducted by Wastewater Solutions Inc. (WSI) and a facility walkthrough, these assessments were used to identify process deficiencies discussed herein.

3.1 Treatment Facility History

Currently, the facility includes influent pumping, screening, grit removal, primary sedimentation, conventional activated sludge, secondary clarification, UV disinfection, effluent pumping, sludge thickening, aerobic digestion, and sludge dewatering.

An overview of the historical improvements at the site of the existing WWTP is as follows:

- Primary Treatment Plant: Primary treatment began at the site of the existing WWTP with the construction of an Imhoff Tank in the 1950s.
- Secondary Treatment Plant: In the mid-1970s, the City upgraded the facility to a secondary treatment plant using rotating biological contactors (RBCs). The upgrades also included the following: influent pumps; an aerated grit chamber; three side hill screens; two rectangular secondary clarifiers; two chlorine contact chambers; two aerobic digesters; and a new outfall to the Skykomish River.
- Phase I Improvements: The WWTP was upgraded beginning in the 1990s for added capacity. These improvements included the addition of two rectangular primary clarifiers, four submerged biological contactors (SBCs), a new circular secondary clarifier, a third aerobic digester, and an effluent pump station. In 2000, the City also replaced the chlorine gas disinfection system with UV light disinfection.
- Phase II Improvements: The upgrades in the early 2000s included removal of the rectangular secondary clarifiers and the RBCs (installed in 1970s upgrades), and the installation of three new aeration basins with anoxic selectors and a second circular secondary clarifier. This phase also included a new belt filter press dewatering system.
- Phase III Improvements: The improvements in early 2010s included a new headworks with new influent screens, influent pumps and grit removal, increased UV disinfection capacity; and new effluent pumps.
- Energy Conservation Projects: Additional facility improvements occurred during the mid-2010s through the Washington State Department of Enterprise Services energy performance savings contracting mechanism with Trane as the energy service provider. The upgrades included digester blower replacement, aeration basin blower replacement, aeration basin diffuser upgrades, new aerobic digester diffusers, replacement of an odor scrubber, modifications to an existing odor scrubber, addition of sludge thickening,

replacement for the sludge dewatering polymer system, replacement of a secondary clarifier collector mechanism, replacement of both primary clarifier collector mechanisms and aluminum covers over the primary clarifier, and aerobic digester tanks.

The unit processes associated with the above improvements are further detailed in Section 3.2 below.

3.2 Unit Processes and Systems

This section provides a detailed narrative describing the existing unit treatment processes and components. A general site layout showing the location of the major unit processes, structures and buildings is illustrated on Figure 3-1.

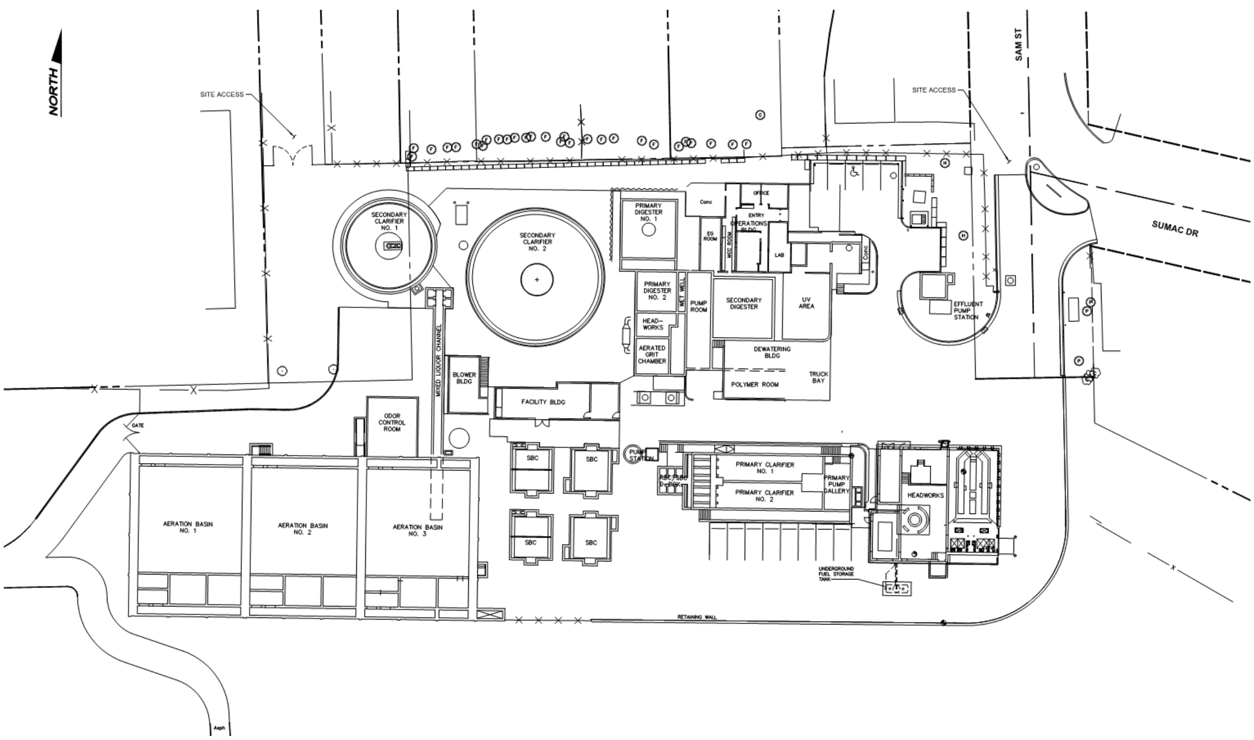


Figure 3-1: WWTP Site Layout

The existing WWTP includes protections against flooding due to its proximity to the Skykomish River. The Flood Insurance Rate Map (FIRM) number 53061C1376F produced by FEMA depicts the flood risks of the WWTP and surrounding areas (see Appendix E). The Federal Emergency Management Agency (FEMA) Flood Map Service Center provides a publicly available online resource (https://msc.fema.gov/portal/home) for downloading and producing official flood maps. Figures 3-2 and 3-3 below demonstrate the proximity of the facility to the Skykomish River and how the southern portion of the facility is within a Zone AE (depicted in turquoise), which is a type of Special Flood Hazard Area (SFHA). According to FEMA's website (https://www.fema.gov/flood-zones), SFHA are defined as: "*the area that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year. The 1-percent annual chance flood is also referred to as the base flood or 100-year flood*." The light brown area along the northern portion of the facility as shown on Figures 3-2 and 3-3 is deemed a “Zone X (shaded)”, which are areas between the 100-year (1% annual chance of flooding) and 500-year flood (0.2% annual chance of flooding). As shown on these figures, the predicted flood elevation at the WWTP is about 54 feet. To protect the WWTP from flooding, the City placed fill along the southern section of the facility to increase the ground elevation and constructed a retaining wall to elevation 60 feet along the southwestern, southern and eastern borders of the facility as part of the Phase II and Phase III WWTP improvements described above in Section 3.1.

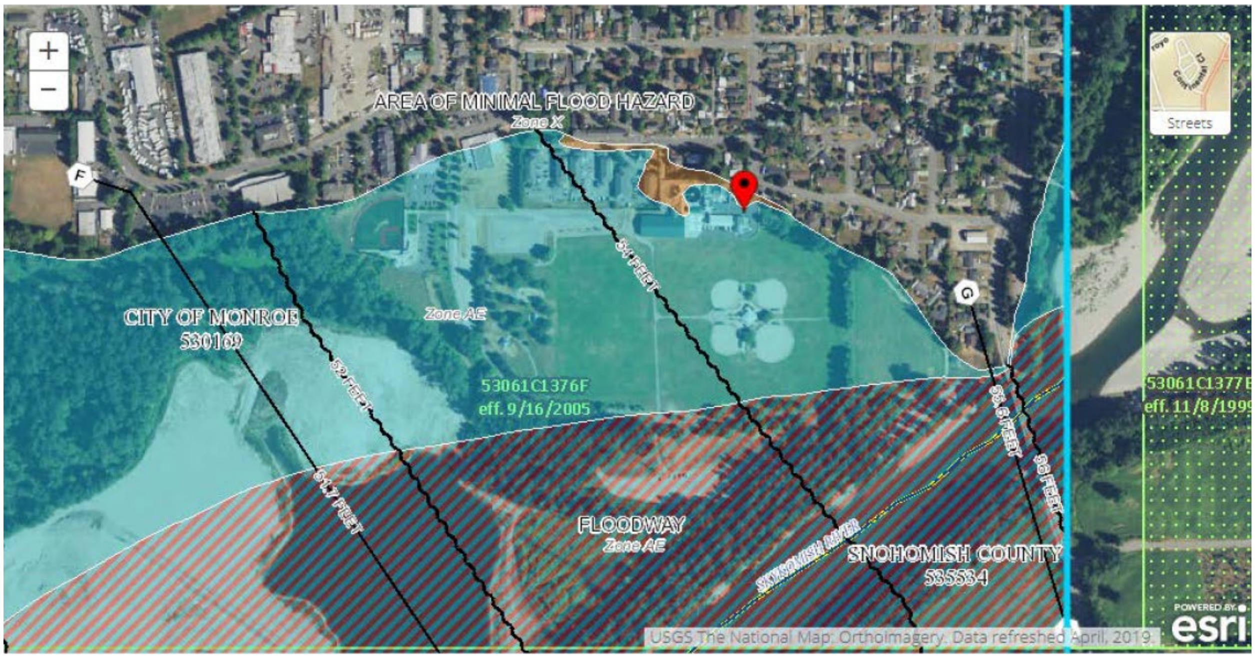


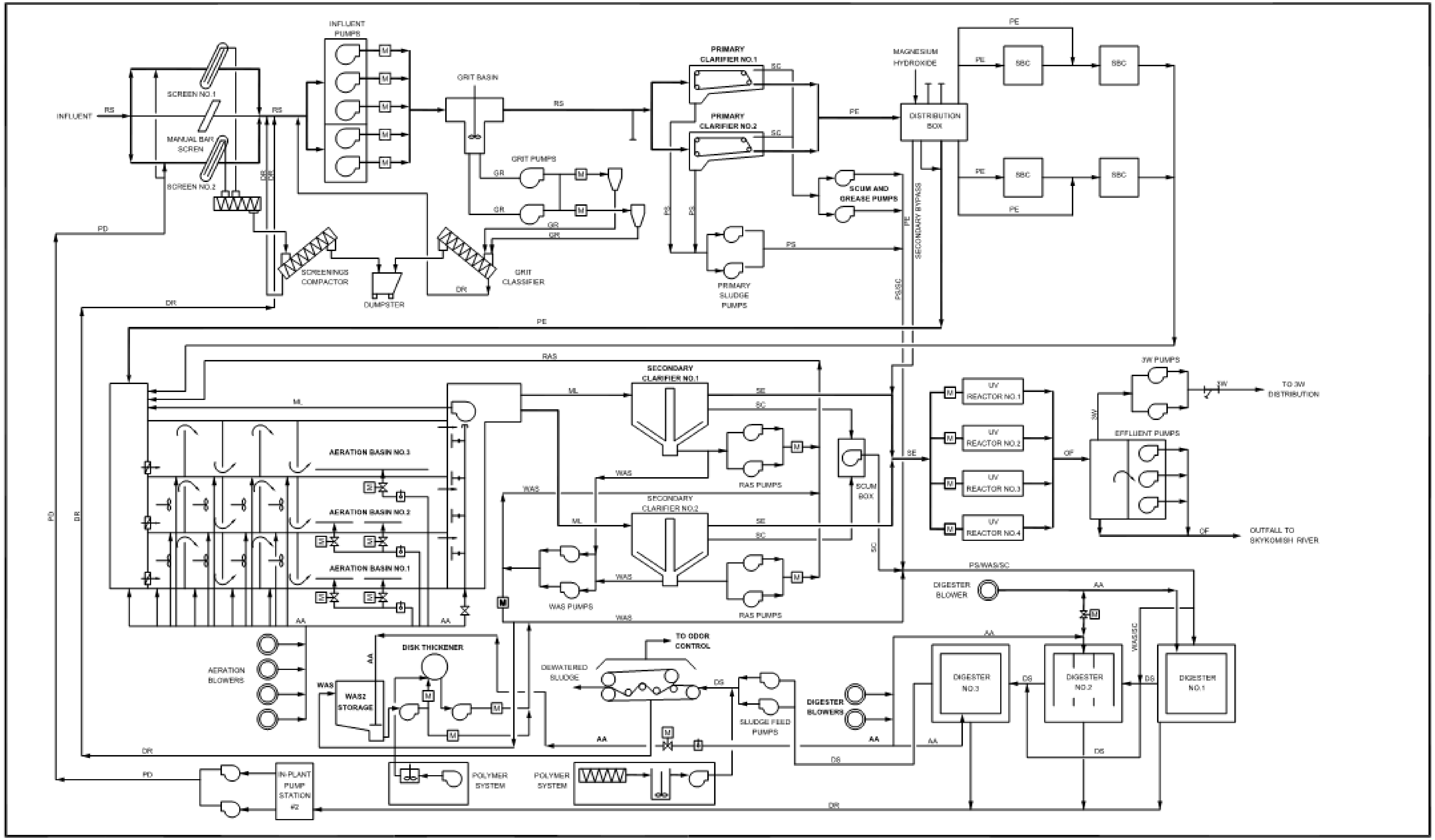
Figure 3-2: Flood Risk Map Generated from FEMA’s Flood Map Service Center to Depict Proximity of City of Monroe’s WWTP (See Red Symbol) to Skykomish River

Figure 3-3: Flood Risk Map Generated from FEMA's Flood Map Service Center to Depict Flood Risk at the City of Monroe's WWTP

3.2.1 Process and Hydraulic Overview

The bold flow lines in the process flow diagram below depict the primary flow path of the liquid treatment process (see Figure 3-4). Flow passes through the mechanical screens and then is lifted by the influent pumps to the grit removal process. After preliminary treatment in the headworks, wastewater flows by gravity through the primary clarifiers, aeration basins, secondary clarifiers, and UV disinfection before being discharge through the outfall. During peak flows and/or high river levels, the effluent pumps will be used to convey effluent through the outfall. Activated sludge settled in the secondary clarifiers is returned to the aeration basins to maintain biomass for treatment. Periodically, a portion of the settled activated sludge is wasted to control the amount of biomass retained for secondary treatment. The waste activated sludge (WAS) is either thickened before being pumped to the aerobic digesters or pumped directly to the aerobic digesters. Sludge settled in the primary clarifiers and scum collected from the secondary and primary clarifiers are pumped directly to the aerobic digesters. Digested sludge is pumped to the belt filter press for dewatering. Dewatered sludge is conveyed into a truck to be hauled off site for beneficial use through application to agricultural land.

Figure 3-5 below depicts the hydraulic profile of the WWTP after completion of the Phase III Improvements described earlier in Section 3.1.



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WWTP Process Flow Diagram

November 2019

Figure 3-4: WWTP Process Flow Diagram

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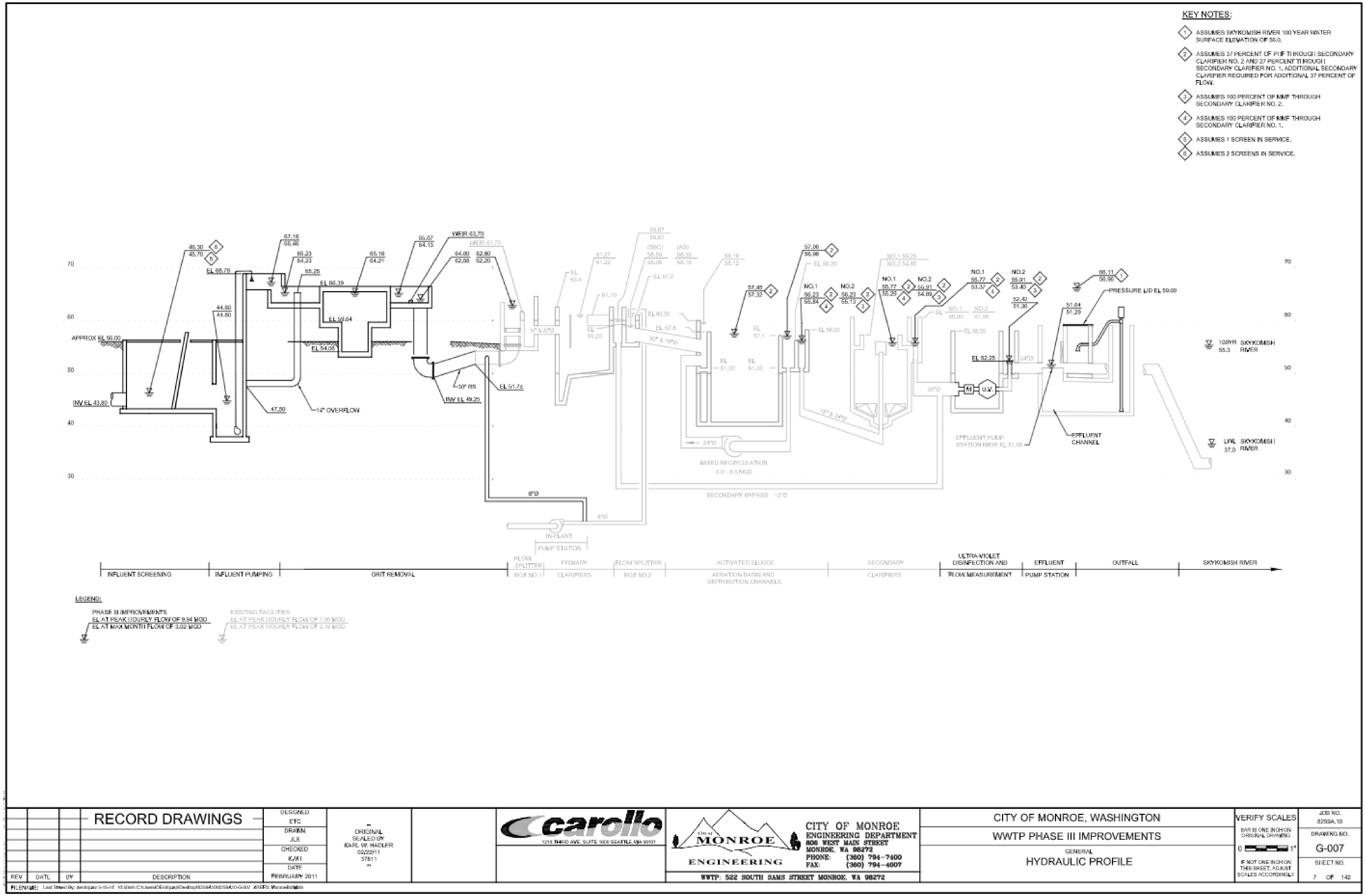

Figure 3-5: WWTP Hydraulic Profile

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3.2.2 Headworks

Influent wastewater enters the WWTP at the headworks via gravity flow. The headworks consists of mechanical bar screens (see Figure 3-6), an influent pump station, and grit removal. The screenings process contains two screens with 1/8-inch [3 millimeter (mm)] openings and a 6.17 MGD capacity each, as well as a backup manual bypass bar screen with openings of 3/8 inch (9 mm). Screenings are conveyed to a washer/compactor and then discharged to a dumpster.

After screening, wastewater enters one of two wet wells. The eastern well contains two larger submersible pumps, each with a capacity of 4.0 MGD. The western well contains three submersible pumps, one larger pump with a capacity of 4.0 MGD and two smaller pumps each with a capacity of 1.0 MGD. The total influent pumping capacity is 14.0 MGD, with a firm capacity (largest pump out of service) of 10.0 MGD. Each pump has a separate discharge pipe with flow meter that flows to a single influent grit channel.

The grit chamber is a single 12-foot diameter vortex basin with a capacity of 12.0 MGD. Grit collected from this basin is pumped to two cyclone washing units, each with a capacity of 250 gallons per minute (gpm), before being sent to a grit classifier.

Figure 3-6: Headworks Mechanical Screens

3.2.3 Primary Clarifiers

After the headworks, wastewater flows by gravity to a splitter box which divides the flow between two identical, rectangular primary clarifiers (see Figure 3-7). Each clarifier is 13 feet wide by 66 feet long, proving a surface area of 858 square feet (ft^2) each or a total of 1,716 ft^2. Based on recent data, it is estimated that the clarifiers are capable of removing nearly 55% of influent TSS based on a typical surface overflow rate of 1,200 gallons per day per square foot (gpd/ft^2). At this overflow rate, the MMF capacity is 2.1 MGD. As the MMF has already exceeded 2.1 MGD and is expected to increase to 3.3 MGD by 2036, it is estimated that TSS removal in the primary clarifiers will decrease to around 45% at the resulting increased overflow rates. Despite the lower TSS removal, the primary clarifiers have sufficient capacity to pass the projected peak flows. Improvement alternatives to be considered must either increase TSS removal at higher flows or account for the resulting increased loading to the secondary treatment process, such that improvements to the primary clarifiers are not needed.

In 2016, the primary clarifier collection mechanisms were replaced, including drives, main and cross collector chains and flights, and the scum skimmers and launders. Primary solids are thickened in-clarifier, producing approximately 3% solids to be sent to digestion. This solids concentration is low for primary sludge and could possibly be increased by reducing the pumping rate/frequency of primary sludge to allow more time for in-clarifier thickening.

Figure 3-7: Primary Clarifiers via a 360-degree View

3.2.4 Aeration Basins

Primary effluent flows into a splitter box that had previously distributed flow among the four SBC tanks and now directs flow to the aeration basin influent channel, which distributes the flow among three identical trains. Each train begins with four small anoxic selector cells, with a total anoxic volume of approximately 102,000 gallons per train. These cells are designed to select against growth of filamentous microorganisms, but also serve to provide some denitrification of the mixed liquor, thereby reducing effluent nitrogen and recovering some alkalinity lost during nitrification.

After the anoxic zone, each train has a single large aeration basin (see Figure 3-8), each with a volume of approximately 368,000 gallons. The solids retention time of the biological process was designed at 9 days with a mixed liquor suspended solids (MLSS) concentration of 3,300 mg/L, which is typically sufficient to maintain nitrification. The nitrification process requires a significant amount of alkalinity; while some of this alkalinity is gained back through denitrification, there is still an insufficient amount to meet the increasingly stringent effluent pH limits of the facility. Currently, the facility doses approximately 120 gpd of magnesium hydroxide to add alkalinity and to maintain effluent pH as required by the NPDES permit.

Two new turbo blowers, each with a capacity of 2,000 standard cubic feet per minute (scfm), were recently installed along with new higher efficiency strip diffusers in two of the three aeration basins. Two older centrifugal blowers, each with a capacity of 1,020 scfm are on standby and serve as a backup. Current operations normally require the use of only one turbo blower. It is expected that within the planning horizon, both turbo blowers will need to be operated normally to maintain treatment. At that time, a third turbo blower should be installed to replace the older centrifugal blowers as backup.

Figure 3-8: Aeration Basin No. 2 (Foreground)

3.2.5 Secondary Clarifiers

Mixed liquor is collected from each aeration basin train in a single mixed liquor channel, where it flows to a distribution box that splits the flow to two secondary clarifiers. Clarifier No. 1 was constructed in 1995 with a 42-foot diameter and 13-foot depth and upgraded in 2017 with a new collector mechanism. Clarifier No. 2 was constructed in 2002 with a 68.7-foot diameter and 16-foot depth (see Figure 3-9). The current flow split between the two clarifiers sends 25% of the flow to Clarifier No. 1, underloading it to allow the activated sludge solids to thicken to approximately 10,000 mg/L prior to wasting. WAS is collected solely from Clarifier No. 1; thus, thicker solids are sent to the disk thickener and/or aerobic digesters to minimize the volume entering the digesters and maximize the retention time for digestion. The remaining flow is sent to Clarifier No. 2, which produces return activated sludge (RAS) at a concentration of around 6,000 mg/L.

Secondary effluent flows by gravity to UV disinfection. Activated sludge solids are collected and returned to the head of the aeration basins using four RAS pumps, two per clarifier (one duty and one standby). Each clarifier has a waste activated sludge pump, though each pump can pull WAS from either clarifier; however, WAS is currently only collected from Clarifier No. 1.

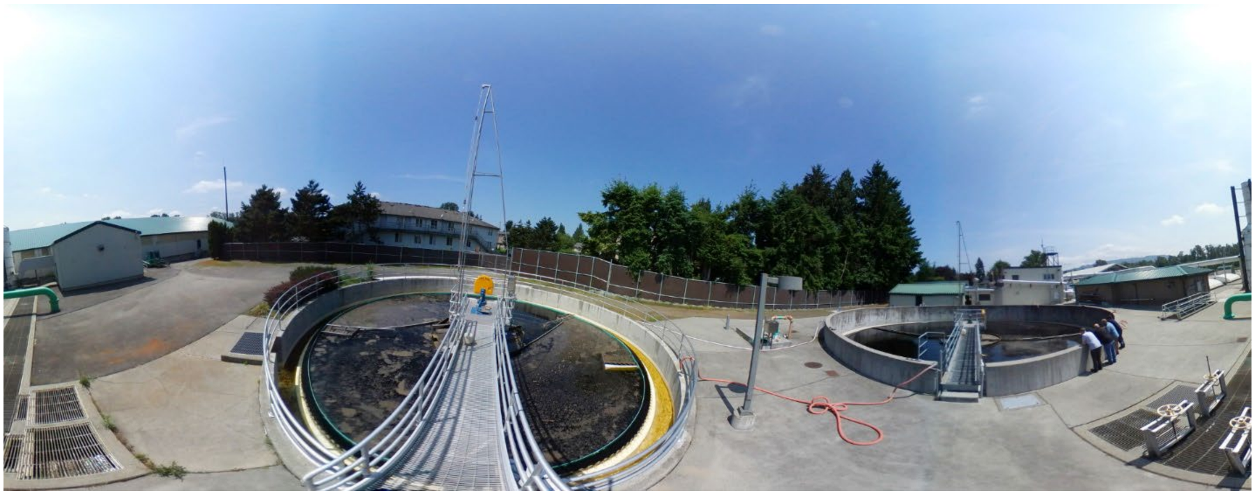


Figure 3-9: Secondary Clarifiers via a 360-degree View

3.2.6 Effluent Disinfection

Secondary effluent flows by gravity to disinfection, which consists of four in-line, closed conduit, low-pressure, high-intensity UV disinfection reactors (see Figure 3-10). The current UV reactors were installed in 2012 as a part of the Phase III upgrades replacing the older and less efficient medium-pressure units. The existing UV reactors have a total capacity of 10 MGD, and a firm capacity of 7.5 MGD based on a capacity of 2.5 MGD per reactor. The UV dose is targeted at 25 millijoules per centimeter squared (mJ/cm^2) at a minimum UV transmittance of 55%.

Figure 3-10: One of Four In-Line UV Reactors

3.2.7 Effluent Pump Station, Outfall, and Receiving Waters

After UV disinfection, treated effluent is discharged to the Skykomish River through an outfall (see Figure 3-11). Outfall piping runs from a 30-inch diameter header, which is connected to four 12-inch diameter high-density polyethylene (HDPE) diffuser lines that extend approximately 50 feet into the river channel from the northern bank. The total length of outfall piping is about 1,500 feet.

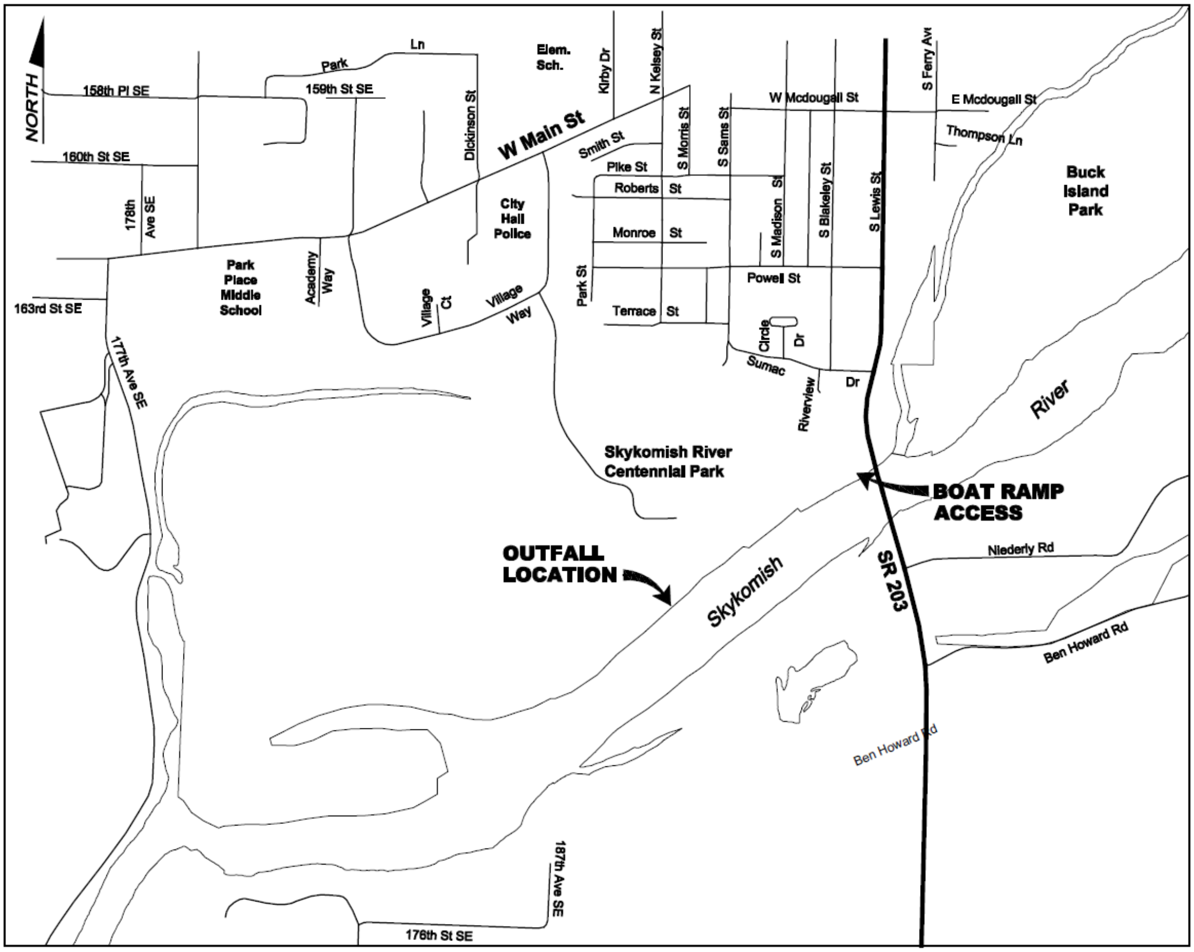


Figure 3-11: Location of the Outfall for the WWTP

Under normal conditions, effluent flows through the outfall by gravity; however, during periods of peak flow and/or high river levels, effluent pumping is required. Three effluent pumps (two duty, one standby), each with a rated capacity of 5.0 MGD at 26.2 feet of head (based on the 100-year flood level), provide a total effluent pumping capacity of 15.0 MGD with a firm capacity (largest pump out of service) of 10.0 MGD. Due to constantly changing conditions in the Skykomish River (see Figure 3-12), the outfall diffuser outlets often transition between being fully unobstructed and partially obstructed. This can result in higher headloss than is factored into the current pump design, which may impact the pumping capacity.

Figure 3-12: View of Outfall from Skykomish Riverbank

3.2.7.1 Existing Condition of Outfall

As required per the NPDES permit, the City conducts annual dye tests to verify the functionality of the individual diffuser lines. In September 2016, the City conducted its annual dye test and subsequently observed that two of the four diffuser pipes (the two upstream-most diffusers) were damaged, which was immediately reported to both Ecology and the Snohomish County Health District. The Monroe Outfall Condition Assessment Technical Memorandum details the damage observed in 2016 and the City's response (BHC 2016). The damaged diffuser pipes were repaired in 2017 to restore full function of the outfall.

The annual dye test conducted in August 2019 showed no signs of concern regarding the functionality of the outfall's diffuser system. However, as mentioned above, dynamic changes to the riverbed and bathymetry can result in partial obstruction of the diffuser outlets.

Under the current NPDES permit (WA0020486), an outfall evaluation is due to be submitted to Ecology by 31 December 2022.

3.2.7.2 Mixing Zone Study

Under the current NPDES permit (WA0020486), an Effluent Mixing Report was due to be submitted to Ecology by 31 December 2021. An updated and DOE approved Effluent Mixing Zone Report is available on Ecology's Permitting and Reporting Information System website. Table 3-1 below provides the dilution factors (S) of the existing NPDES permit, the findings of the 2021 study, and an analysis of projected dilution factors at projected future flows as detailed in Section 2.3. The analysis demonstrates that a reevaluation of the effluent mixing zone may be merited during the 2029-2033 permit cycle.

Table 3-1: Monroe WWTP Effluent Mixing Zone Dilution Factors

Criteria	$S_{ExistingPermit}$	Model Type	$Q_{EMZ2021}$ Formula	Model Input $Q_{EMZ2021}$	$S_{EMZ2022}$	$Q_{EMZDesign}$ Formula [b]	Model Input [e] $Q_{EMZDesign}$	$S_{EMZDesign}$
Acute zone, aquatic life	8.0	Volumetric	Daily Q_{max} (dry weather)	2.58 MGD	4.9	PF*ADWF [b][c]	3.10 MGD	4.26
Chronic zone, aquatic life	16.8	CORMIX	Monthly Q_{max} (dry weather)	1.77 MGD	17.4[a]	ADWF[b]	2.12 MGD	14.7
Human health, non-carcinogens	16.8	CORMIX	Monthly Q_{max} (dry weather)	1.77 MGD	21.7	ADWF[b]	2.12 MGD	18.3
Human health, carcinogens	16.8	CORMIX	AAF	2.07 MGD	84.2	AAF[d]	2.28 MGD	76.5

Notes:

(a) The model for calculating the dilution factor for the chronic zone/aquatic life criterion and as reported in the Final Effluent Mixing Zone Report (dated December 2021) included an input error. The error was addressed in a revised version (Rev01; February 2022) and communicated to Ecology accordingly. The corrected value is 17.4 and the erroneous value of 14.6 is more conservative than the dilution factor within the existing permit as well as the future projected dilution factor at design flows.
(b) Peaking Factor (PF) = Daily Qmax (dry weather) / Monthly Qmax (dry weather) = 2.58/1.77 = 1.46.
(c) The Qdesign values for Average Dry Weather Flow (ADWF) are extracted from record drawings for the Phase III Improvements (2018). To calculate a future ADWF, one utilizes the projected AAF flows included in this Report and adjusts by using the ratio of ADWF/AAF (2.12/2.28=0.93).
(d) The Qdesign value for Annual Average Flow (AAF) is extracted from record drawings for the Phase III Improvements (2018).
(e) The year during which the facility is projected to reach the capacity of the existing design flows (Phase III Improvements [2018]) is 2034.

3.2.8 Solids Treatment and Handling

Currently, WAS is collected from Clarifier No. 1 and either pumped to an aerated sludge holding tank before being pumped to the disk thickener, or it is pumped directly to the aerobic digesters. The disk thickener thickens the WAS to approximately 4.5% solids. Although the thickener is capable of producing higher solids concentrations, the City limits the thickening and the amount of WAS thickened so that the ratio of WAS to primary sludge is not too out of balance, which can impact the sludge dewaterability. The combined WAS, thickened WAS, and primary sludge pumped to the aerobic digesters averages a total solids concentration of approximately 2%. Six different positive displacement blowers were replaced in 2016 and 2018 with three hybrid screw blowers, two of which provide 1,000 scfm each, and one 1,380 scfm unit.

Three digesters are operated in series with maximum volumes of approximately 94,200 gallons, 44,800 gallons, and 101,000 gallons, respectively, for a total maximum volume of about 240,000 gallons. However, the second and third digesters normally average around 60% and 40% full, respectively, to allow attenuation of sludge in between operation of the belt filter press for sludge dewatering. Under design conditions, the solids retention time (SRT) of the digesters is about 16 days; whereas an SRT of 40 days is typically desired to produce Class B biosolids without the need to monitor indicator organisms and ensure sufficient vector attraction reduction (VAR). Currently, the City must test for indicator organisms to ensure pathogen densities meet the requirements for Class B biosolids, due to the short SRT. Because the SRT in the secondary process is significant, the City normally does not have an issue meeting Class B biosolids. VAR requirements are typically met by achieving a 38% volatile solids destruction. Due to the short SRT, the City does not meet this level of volatile solids destruction, but is able to meet VAR requirements by relying on the hauling contractor to incorporate the biosolids beneath the soil at the application site, though at added cost.

After digestion, the sludge is dewatered to 13 to 16% solids (14% average) using a 1.5-meter belt filter press with a hydraulic capacity of 130 gpm (see Figure 3-13). The dewatered sludge cake is hauled to the former composting site of the DOC in a 5-cubic-yard dump truck owned by the City where it is temporarily stored and loaded into larger trucks for transport to the beneficial use site. The existing belt filter press is approximately 20 years old and will need a complete rebuild or replacement within the planning horizon.

Figure 3-13: Belt Filter Press

3.2.9 Odor Control

Foul air generated by the WWTP is treated in order to prevent odor impacts on the adjacent Skykomish River Centennial Park and nearby residences. Two foul air collection and treatment systems exist at the WWTP. One treats foul air from the aerobic digester tanks and the WAS storage tank. This first system uses an engineered media to adsorb hydrogen sulfide, other reduced sulfur compounds and mercaptans. The second treats air from the aeration basins, headworks, primary clarifiers, and sludge dewatering area. This system uses a packed-bed tower with sodium hypochlorite (NaOCl) and sodium hydroxide (NaOH) to remove hydrogen sulfide, ammonia, and other odorous compounds.

3.3 Unit Process Capacity

The individual process capacities are summarized in Table 9. The projected values for 2026 and 2040 from this spreadsheet analysis are compared with typical design values and ranges from "*Wastewater Engineering: Treatment and Resource Recovery*" (5th Ed., 2014, Metcalf & Eddy) and the Orange Book. The shaded cells in Table 9 show processes which exceed the current design capacity and/or do not meet typical design guidelines from Metcalf & Eddy or the Orange Book.

Kennedy Jenks

Table 3-2: Monroe WWTP Process Capacity

Design / Plant Component	Design	Projected			Metcalf and Eddy		Ecology Orange Book
			Year 2026	Year 2040	Typical	Range	Range
Flow, MGD							
Average Annual	2.20		1.99	2.59			
Maximum Month	2.84		2.57	3.34			
Maximum Day	4.55		4.12	5.36			
Peak Hour	9.94		8.50	11.05			
BOD_5, lbs/day (Pretreatment in DOC Lagoon)							
Average Annual	4,710		4,436	5,935			
Maximum Month	6,090		5,495	7,340			
TSS, lbs/day (Pretreatment in DOC Lagoon)							
Average Annual	4,700		4,461	5,972			
Maximum Month	5,940		6,001	8,007			
Total Kjeldahl Nitrogen (TKN), lbs/day (Pretreatment in DOC Lagoon)							
Average annual (43 mg/L)	789		714	929			
Maximum Month (47 mg/L)	1,113		1,007	1,309			
Screening							
Mechanical screens:							
Number, each	2						
Opening size, mm (in)	3 (1/8)						
Capacity, each, MGD	6.17						
Capacity, total, MGD	12.3		8.50	11.05	Manual screen backup also		

Design / Plant	Design	Projected			Metcalf and Eddy		Ecology Orange Book
Component			**Year 2026**	**Year 2040**	**Typical**	**Range**	**Range**
Manual screen:							
Number, each	1	(Allows PHF with one unit out of service)					
Opening size, mm (in)	9 (3/8)						
Influent Pumps							
Type	Submersible centrifugal pumps						
Large pumps:							
Number, each	2 + 1						
Capacity, each, MGD	4.0						
Small pumps:							
Number, each	2						
Capacity, each	1.0						
Total firm capacity, MGD	10.0		8.50	11.05			
Grit Removal							
Type	Mechanical vortex						
Number, each	1						
Diameter, feet	12.0						
Capacity, MGD	12.0		8.50	11.05			
Primary Clarifiers							
Number, each	2				Tables 5-21		
Straight Length, feet	66				80-130	50-300	> 10

Design / Plant	Design	Projected			Metcalf and Eddy		Ecology Orange Book
Component			Year 2026	Year 2040	Typical	Range	Range
Width, feet	13				16-32	10-80	< 24
Side water depth, average, feet	10.0				14	10-16	8-14
Settling Area each, ft^2	858						
Volume/unit, gal	68,671						
Hydraulic Loading/unit, MGD							
@ design avg annual flow	1.10		1.00	1.30			
@ design max month flow	1.42		1.29	1.67			
@ peak hour flow	4.97		4.25	5.53			
Surface loading rate/unit, gpd/sf:					Table 5-20		
@ design avg annual flow	1,282		1,160	1,509	1200	800-1200	800-1200
@ design max month flow	1,655		1,498	1,946	1200	800-1200	800-1200
@ peak hour flow	5,793		4,953	6,439	2500	2000-3000	2000-3000
Detention Time/unit, hour							
@ design avg annual flow	1.50		1.66	1.27	2.0	1.5-2.5	
@ design max month flow	1.16		1.28	0.99			
@ peak hour flow	0.33		0.39	0.30			
Anoxic Tanks							
Number, each	3						
Length, feet	54						
Width, feet	15						
Side water depth, feet	16.33						
Total volume each, cubic feet	13,227						
Volume each, MG	0.10						
Total volume, MG	0.30						

Design / Plant	Design	Projected			Metcalf and Eddy		Ecology Orange Book
Component			Year 2026	Year 2040	Typical	Range	Range
Total Detention Time, hour							
@ design avg flow	3.2		3.6	2.8			
@ design max month flow	2.5		2.8	2.1	0.2 - 2.0		
@ peak flow	0.7		0.8	0.6			
Aeration Basins							
Number, each	3						
Length, feet	57						
Width, feet	54						
Side water depth, feet	16.33						
Total volume each, cubic feet	50,264						
Volume each, MG	0.376						
Total volume, MG	1.13						
Hydraulic loading/unit, MGD							
@ design avg annual flow	0.73		0.66	0.86			
@ design max month flow	0.95		0.86	1.11			
Total Detention Time, hour							
@ design avg flow	12.3		13.6	10.5	Table 8-19		
@ design max month flow	9.5		10.5	8.1		3 - 6	6 - 15
MLSS Conc, mg/L	3,500				2500	1500-4000	1500 - 3500
MLSS mass/basin, lbs	13,863						
MLVSS:MLSS ratio	0.80						
MLVSS mass/basin, lbs	11,090						

Design / Plant	Design	Projected			Metcalf and Eddy		Ecology Orange Book
Component			Year 2026	Year 2040	Typical	Range	Range
BOD loading/ basin, lbs	assumes 25% BOD removal in primary clarifiers						
@ design avg annual BOD	1,178		1,109	1,484			
@ design max month BOD	1,523		1,374	1,835			
F:M Ratio, max mo.	0.14		0.12	0.17		0.2 - 0.6	
Observed Sludge Yield, lbs/lb BOD	0.50		0.50	0.50	(Based on MOP 8 and Monod Curve @ 10+ days)		
SRT, days							
@ average annual BOD	18.0		19.2	14.5	(Assume avg. 10 mg/L effluent TSS)		
@ design max month BOD	13.9		15.4	11.6	10+ days	3-15 days	
Aeration Blowers							
Turbine Blowers							
Number, each	2 duty						
Capacity, each, cfm @8 psi	2,000						
Centrifugal Blowers							
Number, each	2 standby						
Capacity, cfm @8 psi	1,020						
Total firm capacity, cfm	4,040						
Oxygen required, lbs/ day @ max mo.	11,820		10,678	14,096	(Assume 1.1 lbs O2/lb BOD)		
SOTE, %	36%		36%	36%	(Based on 2.5 scfm/sf flux rate)		
AOTE:SOTE ratio	0.44		0.44	0.44	(Based on β=0.95, α=0.6, DO=2 mg/L, T=16 C, sea level)		
Air required, cfm @ max mo.	2,983		2,695	3,557	(Excludes credit for denitrification)		

Design / Plant Component	Design	Projected	Year 2026	Year 2040	Metcalf and Eddy Typical	Metcalf and Eddy Range	Ecology Orange Book Range
Secondary Clarifiers							
Number, each	2						
Number 1:							
Diameter, feet	47.0						
Side water depth, feet	12.0						
Settling area, each, sf	1,735						
Number 2:							
Diameter, feet	68.7						
Side water depth, feet	16.0						
Settling area, each, sf	3,703						
Total surface area, sf	5,438						
Surface loading rate/ gpd/sf	(Based on both clarifiers in service, no redundancy)				Table 8-34		
@ design avg flow	405		366	476			
@ design max month flow	522		473	614		600-800	
@ peak hour flow	1,828		1,563	2,032		1,200-1,600	
Solids loading rate/unit, lb/sf·h	(Both in service, 50% RAS [25% for PHF], no redundancy)						
@ design avg flow	0.74		0.67	0.87			
@ design max month flow	0.95		0.86	1.12		1.0 - 1.5	
@ peak hour flow	2.78		2.38	3.09	2.0		

Design / Plant Component	Design	Projected			Metcalf and Eddy		Ecology Orange Book
			Year 2026	Year 2040	Typical	Range	Range
Surface loading rate/ gpd/sf	(Largest out of service, Reliability Class II)				Table 8-34		
@ design avg flow	634		574	746			
@ design max month flow	818		741	963		600-800	
@ peak hour flow	2,865		2,450	3,185		1,200-1,600	
Solids loading rate/unit, lb/sf·h	(Largest out, Reliability Class II, 50% RAS [25% PHF])						
@ design avg flow	1.16		1.05	1.36			
@ design max month flow	1.49		1.35	1.76		1.0 - 1.5	
@ peak hour flow	4.36		3.72	4.84	2.0		
UV Disinfection							
Type	In-line medium pressure, high intensity UV						
Peak design flow, each, MGD	2.5						
Number of units	4 + 0						
Total firm capacity, MGD	10.0		8.50	11.05	(Appears to meet Reliability Class II @ 50%)		
Design transmittance, %	≥ 55						
Total suspended solids, mg/L	≤45						
UV Dose, mJ/cm^2	25,000						
Effluent Pumps							
Type	Vertical turbine						
Number, each	2 + 1						
Capacity each, MGD:	5.0						
Total firm capacity, MGD	10.0		8.50	11.05			

Design / Plant	Design	Projected			Metcalf and Eddy		Ecology Orange Book
Component			**Year 2026**	**Year 2040**	**Typical**	**Range**	**Range**
Primary Sludge Production	(Based on 45% TSS removal)						
Primary sludge, lbs/day							
@ design avg	2,115		2,007	2,687			
@ design max month	2,673		2,700	3,603			
Primary sludge concentration	3.0%						
Primary sludge, gpd							
@ design avg	8,453		8,023	10,741			
@ design max month	10,683		10,793	14,401			
Secondary Sludge (WAS) Production							
Secondary sludge, lbs/day							
@ design avg	2,355		2,218	2,968			
@ design max month	3,045		2,748	3,670			
Secondary sludge concentration	1.0%						
Secondary sludge, gpd							
@ design avg	28,237		26,595	35,582			
@ design max month	36,511		32,944	44,005			
Rotary Disk WAS Thickening							
Number	1						
Hydraulic Capacity, gpm	100						
Hours/week of Operation @ max mo.	43		39	52			
Solids Capacity, lbs/hr	500						
Loading at max mo., lbs/hr	496		493	494			
Loading at max mo., gpm	99		99	99			

Design / Plant Component	Design	Projected	Year 2026	Year 2040	Metcalf and Eddy Typical	Metcalf and Eddy Range	Ecology Orange Book Range
Thickened Secondary Sludge							
Thickened WAS concentration	4.5%		4.5%	4.5%		4-6%	
Thickened WAS, gpd							
@ design avg	6,275		5,910	7,907			
@ design max month	8,114		7,321	9,779			
Total Sludge, gpd							
@ design avg	14,728		13,933	18,648			
@ design max month	18,797		18,114	24,180			
Aerobic Digesters							
Number, each	3						
Volume, total, cf	32,100						
Volume, total, gallons	240,108						
Retention time, days							
@ design avg	16.3		17.2	12.9	Current secondary SRT ~18 days		
@ design max month	12.8		13.3	9.9	42 d @ 15 C, 28 d @ 20 C		10 - 15
Volatile solids loading, lbs/cf/day	Assumes 85% volatile						
@ design avg	0.12		0.11	0.15			
@ design max month	0.15		0.14	0.19		0.1 - 0.3	0.1 - 0.3
Assumed VSS destruction	40%						
VSS destruction, lbs/day							
@ design avg	1,520		1,437	1,923			
@ design max month	1,944		1,852	2,473			

Design / Plant Component	Design	Projected			Metcalf and Eddy		Ecology Orange Book
			Year 2026	Year 2040	Typical	Range	Range
Total solids from digester, dry lbs/day							
@ design avg	2,950		2,789	3,732			
@ design max month	3,774		3,596	4,800			
Digested sludge concentration	1.5%						
Digested sludge volume, gpd							
@ design avg	23,583		22,293	29,834			
@ design max month	30,167		28,742	38,372			
Digester Blowers							
Primary Digester No. 1 Blower	1						
Capacity, cfm	1,380						
Pri. Dig. No. 2 & Sec. Digester Blower	2						
Capacity, cfm	1,000						
Total capacity, cfm	3,380						
Total firm capacity, cfm	2,000						
Oxygen required, lbs/ day @ max mo.	3,402		3,242	4,328		1.6-1.9	
SOTE, %	12.4%		12.4%	12.4%	(Based on 0.825%/ft per Tideflex)		
AOTE:SOTE ratio	0.40		0.40	0.40	(Based on β=1, α=0.45, DO=1 mg/L, T=25 C, sea level)		
Air required, cfm @ max mo.	2,711		2,583	3,448	(Excludes O_2 for nit. & recovered for denit.)		

Design / Plant Component	Design	Projected			Metcalf and Eddy		Ecology Orange Book
			Year 2026	Year 2040	Typical	Range	Range
Belt Filter Press Dewatering							
Number each	1						
Hydraulic capacity, gpm	130						
Solids capacity, lbs/ hr	1200						
Belt press operation @ max month							
Runtime @ 130 gpm, hrs/week	27		26	34			
Solids Loading, lbs/hr	976		976	976			

Notes:

AOTE = actual oxygen transfer efficiency
SOTE = standard oxygen transfer efficiency
psi = pounds per square inch

3.4 Baseline Performance and Capacity

The BioWin Wastewater Process Simulator by Envirosim was used to simulate the existing WWTP to confirm deficiencies identified in Table 3-2 above and identify additional deficiencies not evident from the spreadsheet analysis. The model was calibrated based on historical conditions and current operations and used to predict performance under projected future conditions. Visual Hydraulics software was used to develop a hydraulic model to identify hydraulic deficiencies. In addition to the modeling, a process audit was conducted on 29 and 30 May 2019 by WSI. A facility walkthrough occurred in conjunction with the process audit and included extensive photo documentation and additional observations of existing conditions.

3.4.1 Process Model Setup

The BioWin process model was set up to represent the existing WWTP processes. City staff provided historical data and conducted supplemental testing to properly characterize the influent wastewater, which is summarized in Table 3-3. Additionally, City staff provided descriptions of current operations so this could be accurately reflected in the model.

Table 3-3: Influent Wastewater Characterization

Date	BOD	fBOD:BOD	COD:BOD	fCOD ratio	ffCOD ratio	Eff fCOD ratio	NH3:TKN	OP:TP	TSS
4/8/2019	234	0.51	2.05	0.48	0.27	0.069	0.68	0.66	170
4/9/2019	215	0.48	2.44						153
4/10/2019	248	0.40	1.84	0.43	0.08	0.049		0.90	169
4/15/2019	230	0.36	2.35						197
4/16/2019	198	0.39	2.12	0.36	0.23	0.074	0.64	0.78	153
4/17/2019	239	0.32	2.36	0.28					174
Average	**227**	**0.41**	**2.19**	**0.39**	**0.19**	**0.06**	**0.63**	**0.78**	**169**

Notes:

fBOD = filtered biochemical oxygen demand
fCOD = filtered chemical oxygen demand
ffCOD = filtered-flocculated chemical oxygen demand
NH3:TKN = ammonia to total Kjeldahl nitrogen ratio
OP:TP = orthophosphate to total phosphorus ratio

3.4.2 Process Model Calibration and Validation

The model predictions for historical conditions and current operations were compared with actual measurements to ensure the model was properly calibrated so predictions of future conditions could be considered sufficiently accurate. Table 3-4 summarizes the process of model calibration. A difference of less than 10% between model predicted values and field collected data is generally considered a good calibration. Highlighted values depict significant deviations in model predictions compared to actual measurements and are discussed below. Actual measurements are based on averages of historical data from 2018.

The model was calibrated to effluent nitrate, which results in the model generally over predicting nitrate concentrations in the anoxic zones. Because the effluent nitrate concentrations are measured based on a composite sample, compared to grab samples from the anoxic zones, the data for effluent nitrate were assumed to be more accurate. The grab samples from the anoxic zones tend to be collected around the same time of day, and so are not representative of the changing concentrations due to diurnal fluctuations.

An important part of model calibration is achieving a representative solids balance. Historical data provided for primary effluent TSS was erratic and indicated significantly lower removal of TSS in the primary clarifiers than expected. The City confirmed that except for more recent primary effluent TSS data, the prior data were not reliable. Therefore, TSS removal in the primary clarifiers was calibrated based on achieving loading to the aeration basins that yielded WAS quantities matching measured quantities. This also resulted in removal rates in the primary clarifiers closer to expectations.

Table 3-4: Model Calibration

Parameter	1/1/18 - 12/31/18	BioWin Values	Δ	Notes
				Effluent
fCOD (mg/L) =	29	27.7	-1.3	
CBOD (mg/L) =	4.2	4.1	-0.1	
TSS (mg/L) =	9.6	10.0	0.4	
pH =	6.8	6.8	0.0	
Ammonia-N (mg/L) =	0.1	0.5	0.4	
Effluent Nitrate-N (mg/L) =	12.7	12.5	-0.2	
Anoxic Zone #1 Nitrate-N (mg/L) =	7.1	9.6	2.5	Calibrated to effluent nitrate instead of anoxic zones
Anoxic Zone #3 Nitrate-N (mg/L) =	4.8	7.9	3.1	Calibrated to effluent nitrate instead of anoxic zones
Anoxic Zone #4 Nitrate-N (mg/L) =	4.8	7.4	2.6	Calibrated to effluent nitrate instead of anoxic zones
Ca (mg/L) =	10	10.0	0.0	Averages from quarterly effluent testing
Mg (mg/L) =	38	38.1	0.1	Averages from quarterly effluent testing
				Solids Balance
Primary Effluent TSS (mg/L) =	145	100	-31.0%	Calibrated to WAS mass instead of primary effluent TSS
MCRT =	UNKNOWN	18		Target mean cell residence time (MCRT) indicated to be 14 days
MLSS =	2,317	2,334	0.7%	
Inventory Mass (lbs) =	24,127	23,860	-1.1%	Adding 650 lbs to mass from model for ML channel
Sec. Clarifier #1 RAS TSS (mg/L) =	9,799	9,770	-0.3%	
Sec. Clarifier #2 RAS TSS (mg/L) =	5,850	5,860	0.2%	
WAS (lbs/d) =	1,285	1,289	0.3%	

Parameter	1/1/18 - 12/31/18	BioWin Values	Δ	Notes
Digester #1 TSS (mg/L) =	14,021	13,340	-4.9%	
Dewatered Sludge (lbs/d) =	1,802	1,740	-3.4%	

To ensure that the model calibration was accurate, a validation was performed. Historical data from March and April of 2019 were used to validate the model calibration under a separate set of conditions. Table 3-5 summarizes the model validation.

Table 3-5: Model Validation

Parameter	3/1/19 - 4/30/19	BioWin Values	Δ	Notes
			Effluent	
CBOD (mg/L) =	4.9	3.6	-1.3	
TSS (mg/L) =	5.8	7.9	2.1	
pH =	7.0	7.0	0.0	
Ammonia-N (mg/L) =	0.5	0.7	0.2	
Effluent Nitrate-N (mg/L) =	11.9	11.8	-0.1	
			Solids Balance	
Primary Effluent TSS (mg/L) =	UNKNOWN	121		Removal rate of 45% to achieve solids balance shown
MCRT =	UNKNOWN	16		Target MCRT indicated to be 14 days
MLSS =	2,384	2,363	-0.9%	
Inventory Mass (lbs) =	23,322	24,190	3.7%	Adding 650 lbs to mass from model for ML channel
Sec. Clarifier #1 RAS TSS (mg/L) =	10,768	10,660	-1.0%	
Sec. Clarifier #2 RAS TSS (mg/L) =	5,719	5,700	-0.3%	
WAS (lbs/d) =	1,459	1,471	0.8%	
Digester #1 TSS (mg/L) =	14,830	12,950	-12.7%	Based on avg. of Jan-Apr 2019, only 1 value after Jan
Dewatered Sludge (lbs/d) =	UNKNOWN	1,632		No biosolids data for 2019 at time of validation

3.4.3 Process Model Evaluation

Following calibration and validation, the BioWin process model was used to model projected future conditions for 2026 and 2040. This included running dynamic simulations to see how capacity requirements of some unit processes and components are affected by diurnal flows.

3.4.3.1 Secondary Clarifier Capacity

Figure 3-14 uses state point analysis diagrams to illustrate clarifier capacity under diurnal flow conditions for Secondary Clarifier Nos. 1 and 2 in 2026. The intersection of the underflow and overflow lines represent the solids loading rate (flux). If this intersection remains below the flux curve, the clarifier should have sufficient capacity for the given conditions. The intersection shown on Figure 3-14 below is based on the condition at the end of the diurnal simulation. The blue squares show how the intersection point varied over the 24-hour simulation period. These points approach but do not exceed the flux curve, suggesting that the clarifiers are essentially at capacity by 2026.

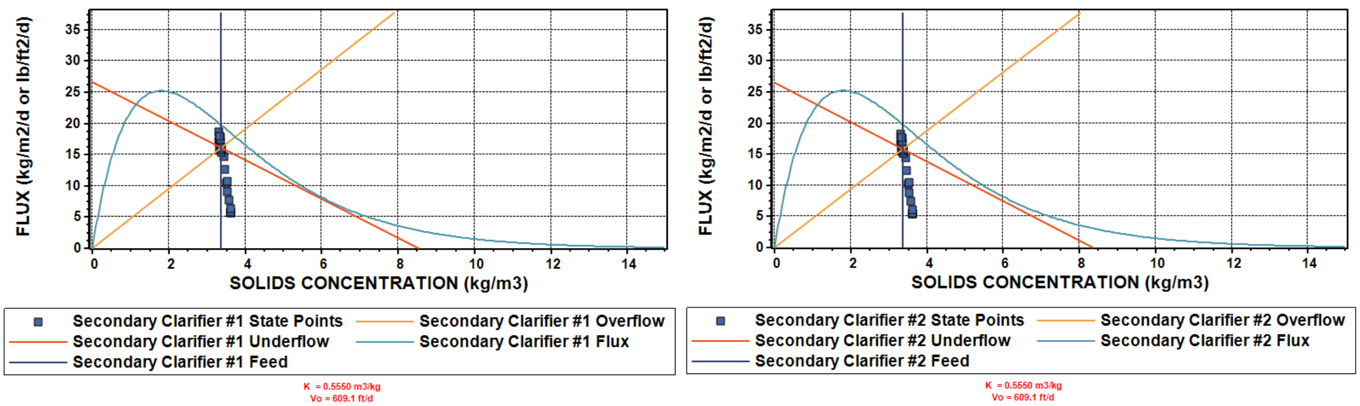


Figure 3-14: 2026 State Point Analysis Diagrams

Similarly, Figure 3-15 illustrates state point analysis diagrams for both clarifiers in 2040. In this scenario, the intersection points for the solids loading rate crosses over the flux curve, indicating the clarifiers are loaded beyond their capacity.

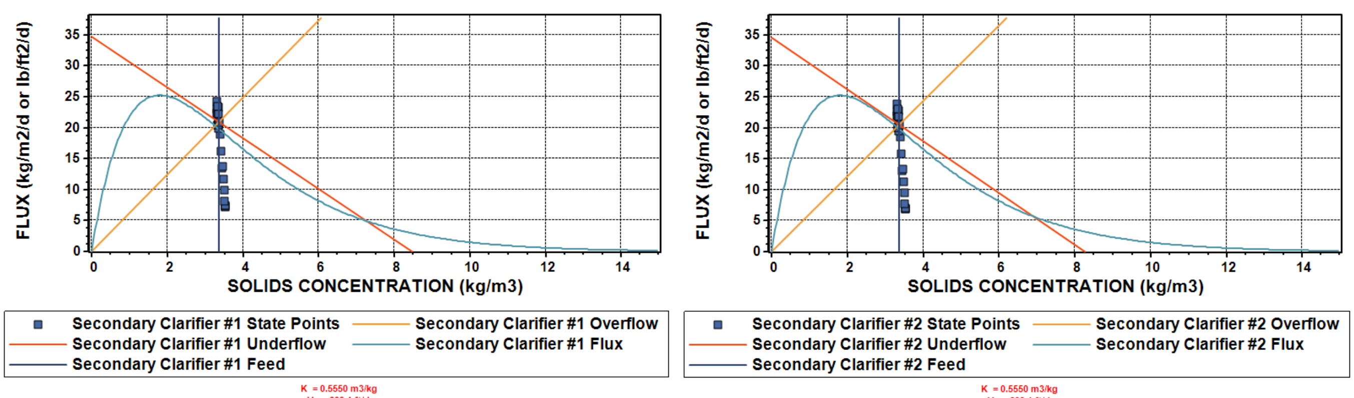


Figure 3-15: 2040 State Point Analysis Diagrams

3.4.3.2 Aeration Basin Blowers

The BioWin process model was also used to estimate aeration needs. The complexity of the model allows it to incorporate denitrification, which will reduce oxygen demand. Oxygen demand also fluctuates as a response to changes in diurnal flows and loads. The typical diurnal pattern referenced in Section 2.2.1 above was applied to the projected maximum month conditions for 2026 and 2040. The airflow necessary to treat the waste load and maintain the dissolved oxygen (DO) setpoint in the aerobic zones under projected maximum month conditions for 2026 is shown on Figure 3-16.

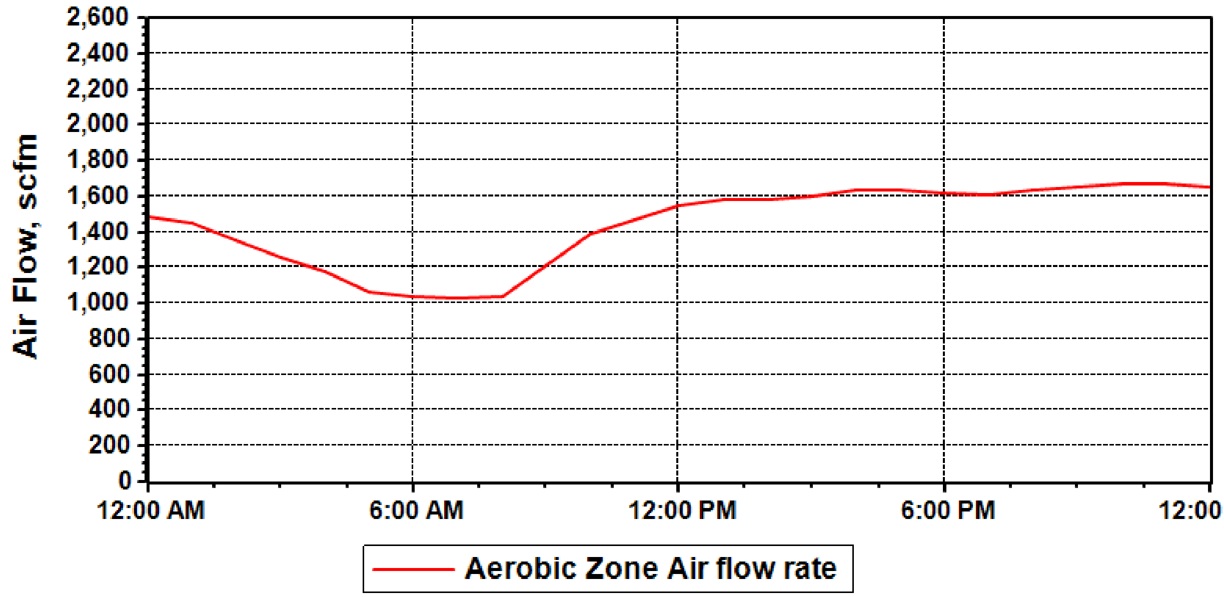


Figure 3-16: 2026 Blower Demand

Similarly, Figure 3-17 represents the necessary airflow under projected maximum month conditions for 2040. The firm capacity (largest blower offline) of the aeration basin blowers is 4,040 scfm. This analysis indicates that in 2040, the blowers are expected to have sufficient firm capacity to maintain adequate treatment.

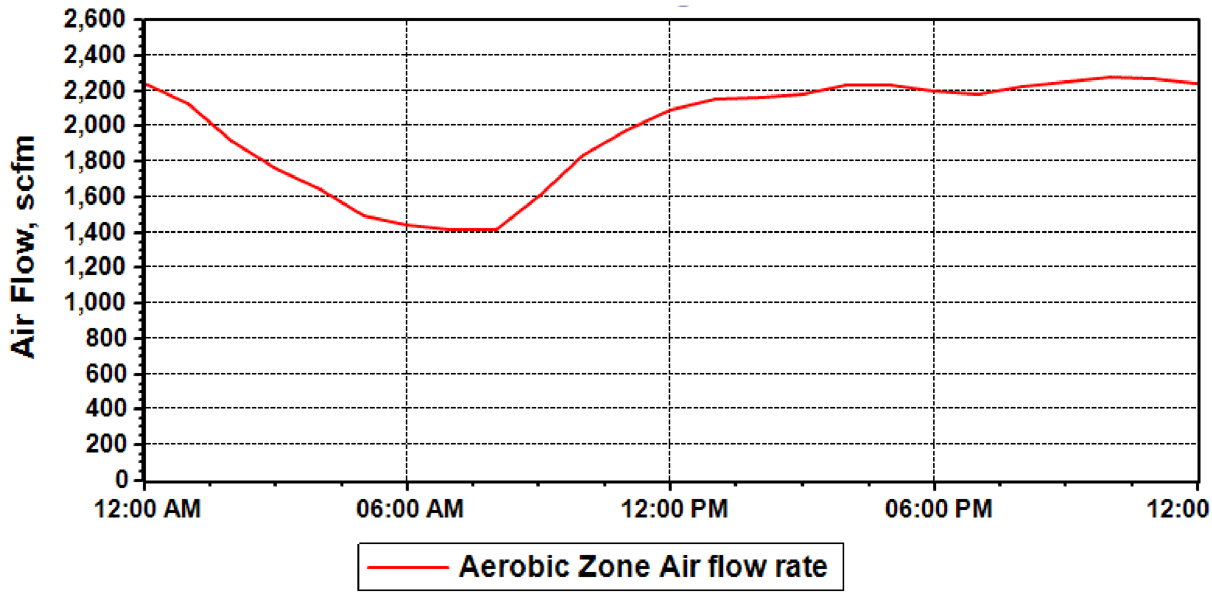


Figure 3-17: 2040 Blower Demand

3.4.3.3 Secondary Treatment

Table 3-6 summarizes effluent quality based on the process model for 2026 and 2040. The 2040 process model utilized all three aeration basins, whereas the 2026 model only used two, which is how the facility currently operates. Significant capacity can be gained by utilizing the third aeration basin, as is also suggested by improved effluent quality predictions despite the increased flow and load. Effluent TSS predictions in the model are based on assuming the same percentage removal as is achieved currently, which as indicated in the state point analyses above is likely not entirely accurate. However, as suggested by the model results, operating three aeration basins at a lower MLSS concentration will reduce solids loading on the secondary clarifiers, which would likely reduce effluent TSS.

Table 3-6: Effluent Quality for 2026 and 2040 Process Model

Year	2026	2040
BOD_5 (mg/L)	7.31	6.53
TSS (mg/L)	18.64	17.10
Ammonia-Nitrogen (NH_3-N) (mg/L)	0.94	0.86
Nitrate + Nitrite-Nitrogen (NO_x-N) (mg/L)	10.14	8.82
TP (mg/L)	2.19	1.99

3.4.3.4 Mass Balance

The BioWin process model was also used to provide a mass balance for the primary components of the WWTP. The mass balance is based on the model calibration representing average conditions for 2018. Figure 3-18 illustrates the model flow diagram with pipe labels that are referenced in the mass balance table (Table 3-7).

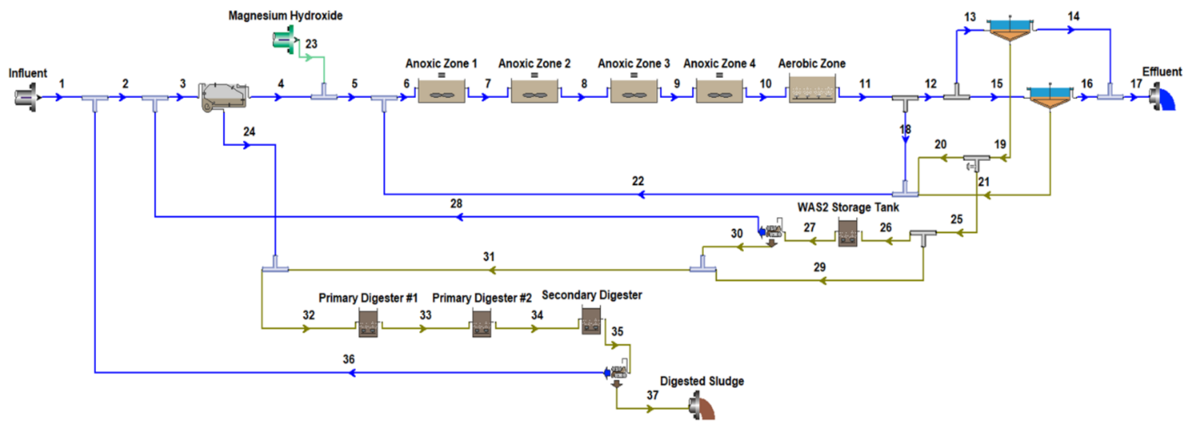


Figure 3-18: Model Flow Diagram

Table 3-7: WWTP Mass Balance (2018 Averages)

Pipe Label	FLOW mgd	COD lbs/d	cBOD lbs/d	TSS lbs/d	VSS lbs/d	TKN lbs/d	NH_4-N lbs/d	NO_X-N lbs/d	TP lbs/d	PO_4-P lbs/d
1	1.7	7,192	3,322	2,759	2,516	616	385	1	71	43
2	1.7	7,594	3,371	3,064	2,765	637	385	1	83	48
3	1.7	7,637	3,380	3,096	2,792	640	385	1	84	49
4	1.7	4,997	2,351	1,452	1,298	552	383	1	65	48
5	1.7	4,997	2,351	1,452	1,298	552	383	1	65	48
6	8.7	226,913	54,731	171,511	144,345	13,239	410	735	4,142	173
7	8.7	226,657	54,510	171,939	144,746	13,223	394	712	4,142	167
8	8.7	226,481	54,362	172,198	144,991	13,222	401	654	4,142	163
9	8.7	226,295	54,216	172,402	145,187	13,222	418	589	4,142	160
10	8.7	226,184	54,137	172,453	145,238	13,222	432	550	4,142	159
11	8.7	224,220	52,842	171,515	144,270	12,822	34	916	4,142	156
12	2.7	68,856	16,227	52,671	44,304	3,938	10	281	1,272	48
13	0.7	17,214	4,057	13,168	11,076	984	3	70	318	12
14	0.5	209	24	66	55	13	2	54	11	9
15	2.0	51,642	12,171	39,503	33,228	2,953	8	211	954	36
16	1.2	395	34	79	66	25	5	127	23	22
17	1.7	603	59	145	122	38	7	181	34	31
18	6.0	155,364	36,615	118,844	99,966	8,885	24	635	2,870	108
19	0.2	17,006	4,032	13,102	11,021	972	1	17	307	3
20	0.1	15,304	3,629	11,791	9,918	874	1	15	277	3
21	0.8	51,248	12,136	39,424	33,162	2,928	3	84	930	14
22	6.9	221,916	52,380	170,060	143,046	12,687	27	734	4,077	125
23	0.0	0	0	0	0	0	0	0	0	0
24	0.0	2,640	1,030	1,670	1,494	88	2	0	19	0
25	0.0	1,701	403	1,311	1,102	97	0	2	31	0
26	0.0	851	202	655	551	49	0	1	15	0
27	0.0	836	191	644	541	48	0	0	15	0
28	0.0	43	10	32	27	2	0	0	1	0
29	0.0	851	202	655	551	49	0	1	15	0

Pipe Label	FLOW mgd	COD lbs/d	cBOD lbs/d	TSS lbs/d	VSS lbs/d	TKN lbs/d	NH_4-N lbs/d	NO_X-N lbs/d	TP lbs/d	PO_4-P lbs/d
30	0.0	793	181	612	514	45	0	0	14	0
31	0.0	1,643	383	1,267	1,065	94	0	1	30	0
32	0.0	4,283	1,413	2,938	2,559	182	2	1	49	1
33	0.0	3,351	845	2,289	1,898	159	0	0	49	0
34	0.0	2,872	483	2,210	1,817	153	0	0	49	1
35	0.0	2,649	325	2,037	1,661	138	0	0	49	6
36	0.0	401	49	306	249	21	0	0	12	5
37	0.0	2,247	276	1,732	1,412	117	0	0	37	0

3.4.4 Hydraulic Model Development and Calibration

A hydraulic model was created using Visual Hydraulics software. The model was compared with several field measurements to check accuracy; it was found that all field measurements were within 2 inches of the model estimates, except in the case of Secondary Clarifier No. 2. It is presumed that this is due to a difference in the weir elevation indicated in the record drawings compared to the actual elevation at which the weir is installed.

At the projected maximum day flow for 2026 (4.12 MGD with RAS flow rate equal to the 2026 MMF) and 2040 (5.36 MGD with RAS flow rate equal to the 2040 MMF), the deficiencies identified by the model are relatively minor. The weirs in the primary clarifier influent splitter box were found to be submerged due to the narrow 2-foot width. This is not a significant concern because the identical size weirs should still achieve a sufficiently even flow split. The primary effluent splitter box weirs were also found to be submerged. This is not a concern as the discharge from both weirs combine into the same pipeline before entering the aeration basin influent channel. The overflow weirs for Anoxic Zones No. 2 and 4 in each aeration basin were found to be submerged as well. This is not a concern as these are designed to operate as overflows rather than weirs and so are submerged under normal conditions. Lastly, the secondary clarifier splitter box weirs were found to be partially submerged. However, because these weirs are only partially submerged, they should still be capable of adequately splitting the flow. There were no additional issues for the 2040 MDF as compared to the 2026 MDF.

At the projected peak hour flow for 2026 (8.50 MGD with RAS flow rate equal to the 2026 MMF), the model indicated two issues. High head loss in the influent grit channel and partial submergence of the UV effluent pipe bellmouth outlets. High headloss in the grit channel is not a concern as it does not generate water levels that would affect performance of the grit removal system or create flooding conditions. Submergence of the UV effluent pipe bellmouth outlets is not a concern because the bellmouth outlets are only needed to ensure the UV reactors are flowing full and are not used for flow splitting.

At the projected peak hour flow for 2040 (11.05 MGD with RAS flow rate equal to the 2040 MMF), the model indicated several additional issues compared to the 2026 PHF. The aeration basin influent and effluent weirs are fully submerged, with flow overtopping the anoxic zone baffle walls. The secondary clarifier splitter box weirs are fully submerged. In both secondary clarifiers, the V-notch weirs and scum baffles were found to be fully submerged. Lastly, the model indicated high headloss in the 10-inch piping just upstream of the UV reactors and full submergence of the UV effluent pipe bellmouth outlets. Upsizing the 10-inch piping will reduce the excessive headloss and help reduce upstream water levels in the secondary clarifiers. The secondary clarifier weirs and scum baffles could also be raised slightly to further mitigate potential submergence. The weirs in the secondary clarifier splitter box need to be enlarged to decrease head over the weirs and reduce water levels in the aeration basins and anoxic zones.

3.4.5 Process Audit

In May 2019, WSI performed a site visit to conduct a process audit at the WWTP. The process audit focused on improving operations and performance through consideration of operational changes and small modifications that could be made in the near term. Many of the observations noted within this section are reinforced by the modeling results presented in the previous sections.

WSI suggested that control of effluent pH could be improved by optimizing use of the anoxic zones, as they are currently not operated under ideal conditions for recovery of alkalinity. If the mixed liquor recycle (MLR) is reduced, the recycle of DO is also reduced, which can increase the portion of the anoxic zones actually operating under anoxic conditions. This will improve the amount of denitrification occurring in the anoxic zones and subsequently increase alkalinity recovery, which will buffer against a drop in pH. The MLR pumping rate is typically about 3.5 times the average flow (about 6 MGD) based on the pump capacity (6,000 gpm) and typical pump speed setting (70% of full speed), which is often higher than required (typically 2 to 3 times the flow). WSI also recommended installing a chemical system as a backup for pH control. Chemical could be introduced just before or after UV disinfection to ensure permit violations do not occur in the event of a process upset or dramatic change in influent wastewater characteristics that resulted in a low pH in the secondary effluent. It was also noted that the MLR could benefit from a flow meter, which could be paced off of plant flow and/or effluent nitrate. In the latter case, a nitrate meter is recommended on final or secondary effluent. Additionally, the two diffuser zones in the aeration basins should be baffled to allow tapered aeration, which will reduce DO recycle to the anoxic zones. These improvements would further optimize denitrification and alkalinity recovery within the existing secondary treatment process.

WSI also investigated foaming issues caused by *Microthrix parvicella* (MP), which is a type of filament that can be overly abundant in the spring due to seasonal changes occurring at the DOC's pretreatment facilities. To control and optimize the filamentous growth, it is recommended to reduce DO in the anoxic selectors, which can be accomplished through the above recommendations, raise the food-to-microorganism ratio (F/M) during the spring warming months, and reduce mixed liquor concentrations during periods of expected MP growth. Additionally, continuation of RAS chlorination as needed is recommended. However, a more permanent system for RAS chlorination could improve control and ease of use. Another consideration mentioned is the injection of polymer into the MLR discharge line to try to keep the MP in solution or employing surface wasting to selectively waste the foam that is predominately comprised of MP.

During the site visit, poor dewatering performance was noted. This is likely due to the short SRT within the aerobic digesters. WSI suggested additional digester capacity and maximizing the DO in the digesters should be considered to gain capacity and enhance performance. To test this, an experiment may be conducted that further digests the sludge for an extra 5 to 10 days to determine whether dewatering is enhanced.

It was noted that the weir in Secondary Clarifier No. 1 is not level around the circumference of the effluent launder. This needs to be fixed as it will result in higher weir overflow rates that will lead to localized velocity currents that could carry solids over the weir.

A few other suggested improvements were noted that are not directly related to process performance:

- Having the odor control fans ramp down at night has potential to save energy.
- The Plant water (3W) pumps often operate at pressures near shutoff (140 psi) due to the pumps being oversized, which causes unnecessary wear on the pumps. If turn down of the pumps can be improved so that they can operate at lower pressures and reduced output, this could reduce energy use and wear.
- The flow meter on the primary sludge line does not work optimally and relocation and replacement are advisable.

3.4.6 Additional Findings from Facility Walkthrough

Personnel from the team conducted walkthroughs on both days of the process audit and photo documented the facility. Photograph documentation included the use of a Samsung Gear 360-degree camera, which allowed for extensive documentation of the existing facility.

Additional observations and input received from the facility's personnel during the walkthrough and beyond the notes captured in the previous sections above are as follows:

- The primary clarifiers were functioning well by physical appearance, did not have malodor, and did not demonstrate signs of sepsis as noted by WSI. See Figure 3-19 below.
- According to operators, the magnesium hydroxide [$Mg(OH)_2$] system for dosing immediately after primary clarification is prone to clogging, especially during cold weather. See Figure 3-20 below.
- According to operators, two of the eight ABS Seltzer mixers within the aeration basins are not working, and the other six mixers are anticipated to only last approximately one more year.
- As noted in Section 3.4.5, the flow meter on the primary sludge line does not work optimally. The Siemens meter is installed on a 6-inch combined line downstream of the primary sludge pumps. The location is not ideal for accurate reading. An option to improve the accuracy of the flowrate readings is to install two separate meters on the individual vertical lines leaving each primary sludge pump. See Figure 3-21.
- The density meter that is located near the sampling point is non-functional and has not worked in over 20 years. See Figure 3-22.
- The end of the skimmer on Secondary Clarifier No. 2 (asset 402) gets clogged during foaming events. See Figure 3-23.

- The Oxidation Reduction Potential (ORP) values across the three aerobic digesters run in series are shown on Figure 3-24 below. The ORP values ranged from -129.6 millivolts (mV) on Digester No. 1 to 70.0 mV on Digester No. 3. Table 3-8 below depicts the biochemical reactions that typically correspond with the respective ORP values.

Figure 3-19: Primary Clarifier No. 1 Without Any Signs of Sepsis

Figure 3-20: Primary Clarifiers (left), Distribution Box with Six Gates (center-foreground), and $Mg(OH)_2$ System (center-background)

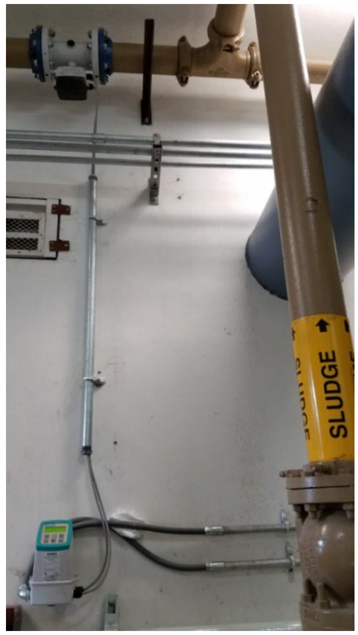


Figure 3-21: Existing Flow Meter on the Combined Horizontal Primary Sludge Line (Upper Left) and Alternative Location for Installation on Individual Vertical Line (Right)

Figure 3-22: Non-Functioning Density Meter (Center) and Sampling Port (Lower Right)

Figure 3-23: End of Skimmer of Secondary Clarifier No. 2 (Asset 402)

Figure 3-24: Hach Meter Displaying Range of Temperature and ORP Values for the Three Aerobic Digesters Run in Series

Table 3-8: Biochemical Reactions and Corresponding ORP Values

Biochemical Reaction	ORP (mV)
Nitrification	+100 to +350
cBOD degradation with free molecular oxygen	+50 to +250
Biological phosphorous removal	+25 to +250

Biochemical Reaction	ORP (mV)
Denitrification	+50 to -50
Sulfide (H2S) formation	-50 to -250
Biological phosphorous release	-100 to -255
Acid formation (fermentation)	-100 to -225
Methane production	-175 to -400

(Source: www.ysi.com)

3.5 Anticipated Deficiencies of Existing WWTP within 20-Year Planning Horizon

Deficiencies and issues were identified based on the spreadsheet analysis, process modeling, hydraulic modeling, and process audit with facility walkthrough. The following narrative summarizes those process deficiencies and issues within the 20-year planning horizon. While a deficiency may be noted within the 20-year planning horizon, the actions to be taken to address the deficiencies within the near-term and with regard to this Report are detailed within Section 6 (Capital Improvement Plan).

3.5.1 pH Control

The need to control pH already exists as influent alkalinity is low, and nitrification uses a significant portion of the available alkalinity. Currently, the facility adds approximately 120 gpd of magnesium hydroxide to supplement the influent alkalinity and help buffer the pH. The current magnesium hydroxide storage and feed system was constructed by the City to meet immediate needs for pH control. Based on the City's experience operating this temporary system, they have identified improvements to controls, durability, and flexibility to be implemented with an upgraded or replacement system for permanent use. The following were recommended in the Engineering Report dated March 2020: flow-pacing and pH monitoring be added to help control dosing of supplemental alkalinity; additional dosing locations could also be provided to ensure that the magnesium hydroxide, a weak base, has sufficient retention time to fully dissociate; and, incorporating carrier water and improving piping could also help with some of the issues associated with handling a slurry such as precipitation and issues with low temperatures.

In addition to improvements for dosing supplemental alkalinity, it was recommended in the Engineering Report dated March 2020 that a backup chemical system also be provided to correct pH in the secondary effluent if there is a significant upset, failure of supplemental alkalinity dosing, or dramatic change in the influent wastewater that would require pH adjustment to maintain compliance with the NPDES permit. This could be accomplished by dosing sodium hydroxide from an existing storage tank (used for one of the odor scrubbers) just before or after UV disinfection to ensure compliance with the pH limit.

It was also recommended in the Engineering Report dated March 2020 that an MLR flow meter and nitrate meter be added to improve control of MLR pumping and the two diffuser zones in the aeration basins be baffled to allow tapered aeration, all of which will maximize denitrification and alkalinity recovery of the existing system.

3.5.2 Filament Control

The growth of filamentous microorganisms is a concern at the facility due to poor settling characteristics. This typically occurs during the shoulder seasons and is not typically a year-round issue. Filaments and associated foaming impact performance of the secondary clarifiers during periods in which they are an issue.

3.5.3 Influent Pumping

The influent pumps have insufficient firm capacity at the projected 2040 peak hour flow. The possible options to increase influent pumping capacity are to add pumps or replace existing pumps with larger capacity units. It appears that the original design left space for replacement of the smaller pumps with larger pumps, which is more cost-effective than reconfiguring the influent pump station to add pumps.

3.5.4 Primary Clarifiers

The primary clarifiers are projected to be hydraulically overloaded under maximum month flow conditions in 2020, 2026, and 2040, and under average annual flow conditions in 2040. The City targets a primary sludge concentration of around 3%, which is within the range for typical values. The model, however, suggests a concentration of less than 2% based on the pumping rate provided by the City. This could be due in part to the non-functioning primary sludge flow meter and limited controls for pumping primary sludge.

3.5.5 Secondary Clarifiers

The analyses herein indicate that the secondary clarifiers are hydraulically overloaded at peak hourly flows in 2020, 2026, and 2040, as well as 2040 maximum month flows. Additionally, the solids loading rate at peak diurnal flows past 2026 exceeds typical design standards, based on a state point analysis. Furthermore, just beyond 2026, there is insufficient redundancy as required by the facility’s permitted Class II reliability requirements.

The existing weirs in the secondary clarifier splitter box are fully submerged under peak hour flow conditions in 2040. Wider weirs are required to reduce headloss and upstream water elevations. Additionally, the weir in Secondary Clarifier No. 1 needs to be leveled to avoid excessive velocity currents.

3.5.6 Aeration Basins

As discussed in Section 1, it is likely that the facility will see nitrogen effluent limits in the future. The current estimate of 8 mg/L of total inorganic nitrogen would require denitrification to be significantly increased. There is currently not enough anoxic volume to achieve the required level of denitrification. Some modifications to the aeration basins would make this possible. For example, converting Aeration Basin No. 3 into pre-anoxic and post-anoxic zones and removing the anoxic volume in the other two aeration basins to make them fully aerobic would allow full nitrification to be maintained and effluent nitrate to be significantly reduced.

Currently, only one turbo blower is required to provide air to the aeration basins. Before 2040, both turbo blowers will need to be utilized on a regular basis. At that time, the old centrifugal blowers should be replaced with a third turbo blower as a more reliable backup.

3.5.7 Solids Treatment and Handling

The aerobic digesters have an insufficient SRT for 2020, 2026, and 2040 flow projections. A thicker primary sludge would increase the solids concentration entering the digester and provide a longer retention time. Additionally, the digesters are currently operated in more of a batch mode, which limits the digester volume that can be regularly utilized. More frequent press operation could allow for higher operating levels in Primary Digester No. 2 and the Secondary Digester.

The BioWin process model has predicted phosphorus limiting conditions and low pH in the digesters – both of which have not been verified by testing. These issues could be fixed by adding phosphorus and a pH buffering chemical, which may help yield greater digestion.

The digester blower capacity is just short of demand in 2040. While its replacement may be necessary in the future to maintain capacity, this is dependent upon the City maintaining its aerobic digestion process.

The existing belt filter press is approximately 20 years old and will need a complete rebuild or replacement within the planning horizon.

3.5.8 Ultraviolet Disinfection

There is insufficient capacity to treat the projected 2040 peak hour flow through the existing UV reactors. There appears to be insufficient space to add a unit; as a result, replacing and upgrading the existing units with higher capacity and efficiency units is an option. Additionally, the 10-inch piping upstream of the UV reactors needs to be upsized to reduce headloss at high flows, which will lower upstream water elevations.

3.5.9 Effluent Pumping

There is insufficient firm capacity for the projected 2040 peak hour flow. There is limited space to add a pump. Additionally, due to the dynamic nature of the riverbed, the actual head at the pumps under design conditions are estimated to be significantly higher. The design flow was 10.0 MGD at 26.2 feet of head. Given the projected 2040 peak hour flow and updated head conditions, this has increased to 11.0 MGD at 38 feet of head. Adding a stage and increasing the motor size will allow for the pumps to maintain flow and head requirements throughout the planning horizon.

3.5.10 3W Pumping

The two existing 3W pumps are sized to provide 105 gpm at 216 feet of head. The high head is used to maintain pressure in the system; however, at low flows, this becomes a challenge. This causes the pump to run near shutoff head due to insufficient turndown. A bladder tank was installed to mitigate this issue but was unsuccessful due to leakage and being insufficiently sized to significantly reduce pump runtime. The bladder tank is no longer functional.

Section 4: Liquids Treatment Alternatives

Section 4 identifies improvements to be made for deficiencies summarized in Section 3.5 above. Where there are viable alternatives to address certain deficiencies, these alternatives are evaluated herein, compared, and an alternative selected for implementation.

4.1 Identification of Potential Liquids Treatment Alternatives

Potential alternatives considered for addressing process deficiencies or issues identified in Section 3 are summarized below. The alternatives for pH and filament control were also presented in the Engineering Report dated March 2020.

4.1.1 pH Control

4.1.1.1 Alkalinity Recovery through Denitrification

Denitrification can be used to recover alkalinity consumed during nitrification. Some denitrification is currently achieved within the existing anoxic zones, which can be further enhanced by limiting the introduction of DO into the anoxic zones to maximize the volume under anoxic conditions. The amount of DO introduced into the anoxic zones can be reduced by utilizing a flow meter and nitrate meter to minimize MLR pumping. Additionally, installing a baffle between the two diffuser zones in the aeration basins will allow tapered aeration, which will reduce DO in the MLR flow. For example, a target DO of 3.0 mg/L in the first zone and 1.5 mg/L in the second zone would focus the air supply where the demand is highest (in the first zone) and allow reduced DO in the second zone so that there is less in the MLR flow back to the anoxic zones.

4.1.1.2 Upgraded Magnesium Hydroxide System

As discussed previously, the current system for adding magnesium hydroxide to the primary effluent must be improved. The new system will replace the bulk storage tank and chemical metering equipment and enhance control to allow flow pacing and automatic adjustment based on effluent pH measurement.

4.1.1.3 Secondary Effluent Sodium Hydroxide Dosing System

To ensure that the pH of the final effluent discharged to the Skykomish River remains within the discharge permit limit range of 6.7 to 9.0 standard units, a sodium hydroxide system (to raise the pH of the secondary effluent prior to discharge) is recommended. This would serve to adjust the pH if required and maintain effluent pH levels within permit requirements. Sodium hydroxide is a strong base and will immediately dissociate to provide prompt pH adjustment in the unlikely event that the dose of magnesium hydroxide is inadequate, there is a secondary process upset, or there are sudden changes in influent wastewater characteristics.

4.1.2 Filament Control

4.1.2.1 RAS Chlorination

RAS chlorination is one of the most commonly employed methods of dealing with filamentous organisms and is particularly effective against MP (Refer to sections 2.5 and 3.4.5). Chlorine is mixed with the RAS at a target dose to kill filaments. At the proper dose, chlorine will kill the filamentous organisms, and flocs of microbes (non-filaments) will have the outer layer damaged, but the floc remains largely intact. The City currently employs RAS chlorination, and it is recommended the City continue this practice as needed; however, the existing temporary chlorination system does not allow for proper control. A new permanent RAS chlorination system with improved control and ease of use is needed. This new system could be located at the Facility Building.

4.1.2.2 Surface Wasting

Surface wasting, also known as a classifying selector, would add equipment to remove foam and floating filamentous organisms from the surface at a select location. This selects against filamentous organisms as they predominately reside in the foam that would be wasted from the system. Surface wasting can be seen as addressing the source of foaming issues but does not guarantee that all foaming issues will be eliminated.

Surface wasting could be achieved by installing a concrete scum box adjacent to the existing mixed liquor channel. An angled scum baffle could be used to trap foam and scum and direct it toward the concrete box. An actuated weir gate could be periodically lowered to waste trapped foam and scum into the box. New piping could be installed to convey the wasted foam and scum to the existing WAS pumps in the Facility Building.

4.1.2.3 Polymer Addition

This alternative could add polymer to the secondary clarifiers to solubilize the foam, putting it back into solution. Polymer addition does not target the source of the foam (filaments), but it does treat the symptom. An emulsion polymer makeup system could be located in the Facility Building and drums or totes of emulsion polymer brought in as needed. The polymer solution could be introduced through the existing spray nozzles at the clarifier feed wells and/or into the MLR piping. From a capital cost standpoint, this is a relatively inexpensive option; however, the high cost of polymer contributes to a relatively high operating cost as compared to surface wasting.

4.1.3 Influent Pumping

As stated in Section 3.5 above, the two smaller influent pumps in the eastern wet well can be replaced with larger pumps. There is sufficient space to replace the existing 1.0 MGD capacity pumps with new 2.0 MGD capacity pumps. This would increase the firm capacity of influent pumping from 10.0 MGD to 12.0 MGD. The higher capacity pumps will require upsizing the individual discharge piping and flow meter from 6-inch diameter to 12-inch diameter to avoid excessive headloss at the higher flow and upsizing the variable frequency drives (VFDs) for the larger motor size.

4.1.4 Primary Clarifiers

Five different alternatives were identified with regard to addressing deficiencies with the existing primary clarifiers. Each is discussed briefly below. Those that were determined not to be viable were not carried forward for further evaluation.

4.1.4.1 Adding a Primary Clarifier

The original design and construction of the two existing primary clarifiers left room for future expansion to include a third primary clarifier to the south of existing Primary Clarifier No. 2. This space is currently occupied by only parking spaces, but the City prefers to reserve it for other potential improvements discussed herein. This option was not considered for further study due to its large footprint, use of limited available space within the current WWTP site, and high capital cost.

4.1.4.2 Chemically Enhanced Primary Treatment

Chemically enhanced primary treatment (CEPT) uses a coagulant, such as alum or ferric, to neutralize charged particles so that they are not repelled from one another and a polymer to promote flocculation of particles, thereby enhancing the removal of TSS and BOD. Removal rates for TSS and BOD in a well operated CEPT system are typically around 85% and 65%, respectively (5th Ed., 2014, Metcalf & Eddy). CEPT installation has a comparatively low capital cost, but costs associated with operations and maintenance are higher due to the need to purchase chemical. The use of chemical does not need to be continuous. Instead, it can be dosed as needed based on flow and loading, which can significantly lower operational costs.

4.1.4.3 Microscreen

Microscreen technology uses a rotating belt or drum to remove 30% to 80% of influent TSS and 20% to 40% of influent BOD. Microscreens have a small footprint, roughly 5% of what is needed for an equivalent conventional primary clarifier. Microscreens as an alternative for primary clarification were not considered for further evaluation due to high capital costs and the desire of the City to avoid technologies that are newer and less proven. Additionally, there are no significant advantages over the more traditional CEPT, which would utilize less footprint, be less operationally complex and likely achieve higher removals compared to microscreens.

4.1.4.4 Primary Filtration

Primary filtration is a form of advanced primary treatment that uses a cloth media to remove solids. It can maintain a solids loading rate of up to 10 lbs/ft^2-day. As with any technology to remove primary solids, primary filtration sees a significant reduction in substrate passing through to secondary treatment. Primary filtration was not considered for further study for similar reasons to the microscreen, largely that it has no major advantages over the more traditional CEPT and is a newer less proven technology.

4.1.4.5 Do Nothing

This alternative would continue operating the existing primary clarifiers without improvements, except for replacement of the primary sludge flow meter. This would result in the clarifiers being normally operated in an "overload" condition compared to typical design criteria. It is anticipated this would reduce the TSS removal rate from the current level of about 55% to around 45%. However, this should be tested during design of improvements to the secondary treatment system by taking measurements with one primary clarifier in operation to confirm this assumption, as this removal rate will impact loading to the aeration basins and secondary clarifiers. Additionally, pending results of that testing, consideration could be given to adding a diffuser on the inlet pipe to the primary clarifier to improve hydraulic conditions for settling of solids. Based on simulation results from the BioWin process model, improvement alternatives for the secondary treatment system should be capable of handling the additional loading but will result in an increase in oxygen demand and energy use from increased blower output. Additionally, higher MLSS concentrations will result from the increased load, which in turn will increase loading to the secondary clarifiers. This is not a concern with all secondary clarifiers in service. With largest secondary clarifier out of service, the SRT may need to be reduced to around 10 days under 2040 maximum month conditions to avoid overloading the clarifiers, though such an operating condition would be short-lived and should still yield adequate treatment. Alternatively, if taking a secondary clarifier out of service can be scheduled during dry weather when flows and loads are lower and/or the City implements CEPT in the future as to allow to reduce loading to the secondary process when needed, a reduction in the SRT may not be needed.

4.1.5 Secondary Clarifiers

Five different alternatives were identified with regard to addressing capacity deficiencies with the existing secondary clarifiers. Each is discussed briefly below. Those that were determined not to be viable were not carried forward for further evaluation.

4.1.5.1 Adding One or More Secondary Clarifiers

One alternative to increase secondary clarifier capacity is adding one or two new secondary clarifiers. This would increase capacity to the required level of redundancy throughout the planning horizon. The major disadvantage to adding secondary clarifiers is the large footprint required. Additionally, new clarifiers would likely be different sizes than the existing ones and would likely not be located in the same general area as the existing clarifiers based on the locations of available space.

4.1.5.2 Sidestream Membrane Bioreactor

Another alternative for solids removal with secondary treatment is a membrane bioreactor (MBR). MBRs have been successfully implemented at several facilities in the area and produce a high-quality effluent with potential for beneficial reuse of the effluent. To reduce the initial cost, a sidestream MBR system would be used in parallel with the existing conventional activated sludge system. Flow would be diverted to the sidestream MBR following grit removal and before the primary clarifiers. This flow split would allow the existing primary clarifiers, aeration basins and secondary clarifiers to operate at or below their current capacity. The MBRs could be located in the existing SBC tanks, which would help reduce the cost associated with a sidestream MBR process. The use of high-capacity membranes, such as ceramic membranes, would also provide the ability to switch over to a fullstream MBR process (i.e., all flow treated through the MBR process) in the future.

Spilt treatment systems using MBRs and conventional activated sludge require two separate mixed liquors, as the concentration and biology of the two will vary significantly. This configuration has been implemented in the Puget Sound region at the South Kitsap Water Reclamation Facility owned by West Sound Utility District.

4.1.5.3 Gravimetric Sludge Selection

Gravimetric sludge selection, such as the inDENSE process, utilizes hydrocyclones to assist in wasting less dense sludge via overflow, and returning more dense sludge via underflow. The sludge volume index (SVI) of sludge processed using this method ranges from the high 70s to the low 80s. Compared to a current average of about 130 for the WWTP, such a reduction in SVI could generate process improvements. However, even with such an improvement in SVI, it is still expected that at least one additional secondary clarifier would be required within the planning horizon to provide the necessary level of redundancy. Additionally, this is a new technology that has seen limited field use; thus, its efficacy is not well known. Therefore, gravimetric sludge selection was not considered for further evaluation as it does not provide a strong benefit such that the City would be willing to consider this newer and less proven technology.

4.1.5.4 Ballasted Activated Sludge

Ballasted activated sludge, such as Biomag, uses inert iron in the form of magnetite (Fe_3O_4) that is fully oxidized to enhance settling. The floc forms around the particle, which has a specific gravity of 5.2, resulting in high floc density and rapid settling. The surface overflow rate with magnetite is 2 to 3 times higher than is achievable with conventional activated sludge, and the solids loading rate is up to 4 times higher than conventional. To prevent loss of magnetite, a magnetic drum recovers the metal from the waste activated sludge resulting in a 96% recovery rate. Similar to gravimetric sludge selection, this alternative does not eliminate the need for a new secondary clarifier within the 20-year planning horizon, it would only defer the addition of a new clarifier. Additionally, it is a newer and less proven technology and would be expensive to implement. For these reasons, this alternative was not considered for further evaluation.

4.1.5.5 Bioaugmentation

The last alternative considered for increasing secondary clarifier capacity was the use of Nuvoda’s mobile organic biofilm. This process introduces organic kenaf particles into the process as carriers to promote biofilm growth and enhance treatment and settleability. As with both the gravimetric sludge selection and ballasted activated sludge alternatives, it is a newer and less proven technology that would not eliminate the need for an additional secondary clarifier within the planning horizon. Although the simplicity of the technology and purported benefits sound promising, there is currently little supporting data available. For these reasons, this alternative was not considered for further evaluation.

4.1.6 Aeration Basins

While the need for enhanced nitrogen removal is not immediate, a potential solution exists with the third aeration basin that is currently unused. Preliminary modeling indicates that splitting this aeration basin into two pre-anoxic zones and one post-anoxic zone would significantly improve denitrification. Both the second pre-anoxic zone and the post-anoxic zone could operate as a swing zone to provide additional aeration capacity if needed during the colder wet weather season. The existing anoxic zones within Aeration Basins No. 1 and 2 would be removed to increase aerobic volume. The mixed liquor would flow through the two pre-anoxic zones before being split between the two aeration basins. Similarly, mixed liquor from the two aeration basins would recombine before entering the post-anoxic zone. Gates would be installed to allow for the isolation of any individual pre-anoxic or post-anoxic zone, as well retaining existing gates allowing isolation of each aeration basin.

4.1.7 Solids Treatment and Handling

See Section 5 for details regarding solids treatment and handling.

4.1.8 Ultraviolet Disinfection

The total capacity of the existing UV system is 10.0 MGD. Based on the projected peak hour flow for 2040, additional capacity will be required. Furthermore, although not required under current reliability criteria, the City would prefer to have a fully redundant UV reactor. As there is insufficient space to add another UV reactor, the existing UV reactors will be replaced with higher capacity units. Consideration was given to possibly re-rating the capacity of the UV reactors based on higher quality effluent if an MBR were implemented. Preliminary investigations suggest a re-rating is not necessarily applicable, so the focus for increasing capacity remains on replacing the existing UV reactors with higher capacity units. Additionally, the 10-inch piping upstream of the UV reactors will be upsized to 14-inch diameter to relieve a hydraulic bottleneck at peak flows.

4.1.9 Effluent Pumping

4.1.9.1 Modify Existing 3W Pumps

One alternative considered to meet effluent pumping requirements for the projected 2040 peak hour flow was to modify the existing 3W pumps for use as effluent pumps. The existing 3W pumps have nine stages and produce 105 GPM at 216 feet of head. Although removing stages to lower the head for pumping effluent is feasible, this does not provide enough additional firm capacity to meet the projected 2040 peak hour flow; thus, this alternative was removed from further consideration.

4.1.9.2 Removal of 3W Pumps and Add a Fourth Effluent Pump

The removal of the two existing 3W pumps and addition of an identical effluent pump was considered. However, the addition of a fourth effluent pump would not provide enough firm capacity to meet the projected 2040 peak hour flow. Because of the increased head conditions that can result from changing conditions in the riverbed, the existing pumps may not always produce their rated flow, so the addition of a fourth pump would still not provide enough firm capacity to meet the projected 2040 peak hour flow. As a result, this alternative was also removed from further consideration.

4.1.9.3 Add Bowl and Replace the Motor on the Existing Pumps

The last alternative investigated is to increase firm capacity by modifying the existing pumps. Discussions with the vendor and manufacturer revealed that it is possible to add a stage to the existing pumps to produce higher flow at a higher head. This will require upgrading the existing pump motors and VFDs from 40 horsepower (HP) to 60 HP. This appears to be the only feasible solution to increase effluent pumping capacity other than a complete pump replacement, which is cost prohibitive.

4.1.10 3W Pumping

The existing 3W pumps will require replacement as they are currently routinely operating near shutoff head, which is known to have caused excessive wear. The existing pumps will be replaced with new pumps that have head and flow characteristics better suited to the application. Additionally, a pressure release valve with recirculation piping will be provided to allow a 3W pump to operate away from shutoff head if flows are very low to avoid the same type of wear that the existing pumps are experiencing.

4.2 Alternatives Selected for Further Evaluation

Some process limitations or issues have one solution that was clearly more viable, and so a detailed evaluation of alternative approaches was not considered. These items are detailed in section 4.2.1 below. Conversely, Section 4.2.2 discusses several improvement alternatives to address certain process deficiencies or issues for which a “preferred alternative” needs to be identified.

4.2.1 CIP Items Not Deemed to Need Further Evaluation

Further evaluation for implementation of the following alternatives was not conducted because either there is only one viable alternative to address the process deficiency or issue, as identified in Section 4.2 above, or in the case of the pH control issue all alternatives identified will be implemented to maximize flexibility and reliability.

4.2.1.1 pH Control

The City prefers to implement the three alternatives identified in Section 4.1.1 above for improving pH control. This includes upgrading the magnesium hydroxide system, adding a backup sodium hydroxide system, and improving denitrification within the existing aeration basins to increase alkalinity recovery. Denitrification improvements will be implemented through two methods: 1) addition of a nitrate meter to minimize MLR pumping and optimize mixed liquor controls; and installation of a baffle between the two diffuser zones in the aeration basins to allow tapered aeration. While installation of a flow meter was deemed desirable as noted in Section 4.1.1.1 and per the Engineering Report (March 2020), design challenges and budget limitations determined that this modification would not be implemented at this time for the upgrades included in the drafted plans and specifications for pH control submitted in November 2020 to Ecology.

4.2.1.2 Filament Control via RAS Chlorination

The City noted a desire to continue periodic RAS chlorination for filament control. Therefore, a new permanent RAS chlorination system with improved control and ease of use will be installed. Moreover, the City's personnel requested additional analysis of the two remaining alternatives for filament control – surface wasting and polymer addition – prior to selecting an additional method of filament control at the WWTP.

4.2.1.3 Influent Pumping

As discussed previously, the existing two smaller pumps each having a capacity of 1.0 MGD will be replaced with larger pumps having a capacity of 2.0 MGD each. This will provide firm pumping capacity of 12.0 MGD, which exceeds the projected 2040 peak hour flow of 11.0 MGD.

4.2.1.4 Ultraviolet Disinfection

The existing UV reactors will be replaced with higher capacity units to provide sufficient firm capacity for the 2040 projected peak hour flow and the 10-inch diameter piping and flow meters upstream of the UV reactors will be upsized to 14-inch diameter to reduce velocities and relieve a hydraulic bottleneck at peak flows. Newer flow meters do not have the higher velocity requirements to retain their accuracy as may be the case with older units. To develop laminar flow through the flow meters, it is typically recommended that the meters be preceded by a straight pipe section five diameters in length and followed by a straight section two or three diameters in length. Sufficient space exists to achieve this with the larger diameter pipe and flow meters, though little space would be left for any further expansion.

4.2.1.5 Modify Effluent Pumps

Improvements to the effluent pumps involve adding a stage to each of the existing pumps and increasing the motor and VFD sizes for each pump from 40 HP to 60 HP. This will provide sufficient firm capacity to convey the projected 2040 peak hour flow under the estimated maximum head conditions due to dynamic changes in the riverbed.

4.2.1.6 3W Pumping

As previously discussed, the 3W pumps require replacement due to excessive wear from running near shutoff head. The pumps will be sized for a smaller flow better suited to actual demands. In addition to the replacement of the pumps, a pipe recirculating discharge to the wet well will be installed with a pressure relief valve to avoid operation of the new pumps near shutoff head.

4.2.2 CIP Items Needing Further Evaluation

Multiple viable alternatives remain for addressing the filament control issue and process deficiencies. The first two alternatives address the filament control issue. The last three alternatives each address the primary clarifier, aeration basin, and secondary clarifier deficiencies through different combinations of the alternatives identified in Section 4.1 above.

4.2.2.1 Filament Control Alternatives

4.2.2.1.1 Filament Control Alternative 1: Surface Wasting

Surface wasting would be achieved by installing a concrete scum box adjacent to the existing mixed liquor channel. An angled scum baffle would be used to trap foam and scum and direct it toward the concrete box. An actuated weir gate would periodically lower to waste trapped foam and scum into the box. New piping would be installed to convey the wasted foam and scum to the existing WAS pumps in the Facility Building.

4.2.2.1.2 Filament Control Alternative 2: Filament Control via Polymer Addition

This alternative would add polymer to the secondary clarifiers to solubilize the foam, putting it back into solution. An emulsion polymer makeup system would be located in the Facility Building and drums or totes of emulsion polymer brought in as needed. The polymer solution would be introduced through the existing spray nozzles at the clarifier feed wells. From a capital cost standpoint, this is a relatively inexpensive option; however, the high cost of polymer contributes to a relatively high operating cost compared to surface wasting.

4.2.2.2 Process Upgrade Alternatives

4.2.2.2.1 Process Upgrade Alternative 1: Sidestream MBR

The sidestream MBR alternative would allow use of the existing infrastructure to be maximized by diverting flow that exceeds capacity of the limiting unit process to the MBR. The existing mainstream conventional activated sludge process could treat approximately 2.0 MGD of flow without exceeding typical loading rates for the primary clarifiers and while providing full redundancy for the secondary clarifiers under most conditions with the largest unit out of service. The sidestream MBR process would be sized to treat at least 1.5 MGD so that the full projected 2040 maximum month flow would be treated through both processes. This would allow implementation of the do nothing alternative for the primary clarifiers.

The existing SBC tanks are a good candidate to be converted to MBR tanks, as they are large and deep enough to be able to fit several different types of membranes. For purposes of maximizing capacity and best available technology, it is assumed ceramic membranes could be utilized for the sidestream MBR. This would allow sufficient membrane capacity to be installed in two of the four existing SBC tanks, such that the remaining two SBC tanks could be retrofitted with membranes in the future if eventually all flow were to be treated with membranes. Advancements in membrane technology will be reviewed further during project implement.

The third aeration basin that is currently unused would be isolated from Aeration Basins No. 1 and 2 and converted into anoxic and aerobic volume for treatment prior to the MBR tanks. A portion of the anoxic zone would be segregated as a de- oxygenation zone to receive oxygenated mixed liquor returned from the MBR tanks. This would allow the dissolved oxygen in the mixed liquor to be consumed before combining with the influent in the anoxic zone. The MBR tanks operate at high DO concentrations (e.g., > 6 mg/L) and so have high DO in the recycled mixed liquor, which would otherwise reduce denitrification in the anoxic zone. Existing Aeration Basins No. 1 and 2 would remain unaltered, except as modified for pH control as discussed in Section 4.1.1.1.

Flow would be split off to the sidestream MBR process following screening and grit removal at the existing headworks. The sidestream flow would then pass through additional fine screening to remove smaller debris (e.g., hair, small plastics, etc.) to the level necessary for protection of the membranes. A new MBR support building would be constructed to house supporting equipment including permeate pumps, scour blowers, and the membrane chemical cleaning systems. This alternative also considered the use of reclaimed water for park irrigation. Use of reclaimed water for irrigation would require a higher level of disinfection, as well as infrastructure for storage and distribution.

4.2.2.2.2 Process Upgrade Alternative 2: Add CEPT and One Secondary Clarifier

This alternative would add CEPT to achieve higher performance in the primary clarifiers, which would result in less loading to the aeration basins and lower MLSS concentrations, such that only one additional secondary clarifier is required to maintain reliability and redundancy. The additional clarifier could be sized to be the same as the larger existing clarifier (Secondary Clarifier No. 2), with a diameter of approximately 69 feet. It was assumed that addition of chemicals for CEPT would be required when flows exceeded approximately 2 MGD. The average number of days throughout the planning horizon that flows would exceed 2 MGD is estimated to be 212 days per year. Polymer makeup and coagulant dosing systems would be installed within the existing headworks structure. Chemical would be delivered and stored in totes.

This alternative also includes retrofit of currently unused Aeration Basin No. 3 to optimize nutrient removal, as described for alternative 1 in Section 4.2.2.2.1 above. Additionally, to allow for a more direct comparison with MBRs, this alternative includes the cost for future addition of tertiary filtration using cloth disk filters to provide a high-quality effluent comparable to that of what is expected with an MBR system. The addition of tertiary filtration factors in the risk of having to produce a higher quality effluent due to the potential for changing permit conditions.

4.2.2.2.3 Process Upgrade Alternative 3: Add Two Secondary Clarifiers

This alternative would forgo any enhancements to the primary clarifiers (i.e., do nothing) and opt to treat the additional load in the secondary treatment process. A higher load in the primary effluent would yield higher MLSS concentrations in the aeration basins, which would require two new secondary clarifiers during the planning horizon to handle the increase solids loading and maintain sufficient reliability and redundancy. The two new clarifiers would both be approximately 59 feet in diameter. An advantage to this alternative is that the construction of the two secondary clarifiers could be phased to spread out the associated capital costs. This alternative also includes the improvements to Aeration Basin No. 3 as described in Section 4.2.2.2.1 and future addition of tertiary filtration.

Adding two clarifiers would take up a significant amount of space, more than what is currently available in any one location at the WWTP site. Two alternate configurations were considered for location of the clarifiers. In one configuration, one secondary clarifier would be constructed in place of the existing SBC tanks and the second clarifier would be constructed further southeast crossing into the adjacent park. The other configuration would involve constructing the new clarifiers west of the aeration basins in the north parking lot of the adjacent park. Either configuration requires some expansion of the WWTP boundaries into the adjacent park. Cost estimates for this alternative assume construction of the clarifiers in the parking lot west of the aeration basins, as this is likely a more desirable location and is more expensive given the larger amount of area impacted.

4.3 Alternatives Evaluation

An alternatives analysis was performed to compare the five alternatives selected for further evaluation based on a variety of metrics.

4.3.1 Basis of Costs

Costs developed for evaluation of alternatives are in 2019 dollars. The capital costs reflect a Class 4 opinion of probable cost as defined by the American Association of Cost Engineers (AACE) and have an expected accuracy range of -20% to +30%. Capital costs were developed using pricing from vendor quotes, comparison to construction cost data for similar project work, and RSMeans online construction cost data, and also include the following markups:

- 10% for mobilization, demobilization, temporary facilities, startup, and testing.
- 2.3% for bonds and insurance.
- 15% for contractor overhead and profit.
- 30% estimate contingency to cover necessary project elements not currently captured in the costs.
- 9.3% sales tax.
- 15% for engineering design, bidding support, and services during construction.
- 10% for construction management.
- 2% for City legal and administrative costs.
- 20% for Owner's contingency to add scope to the project during construction and cover unforeseen conditions (this is reduced to 10% for improvements that were expected to be implemented by 2020).
- 1% for permit, inspection, and review fees.

Annual operation and maintenance (O&M) costs were developed considering the average annual additional labor to operate and monitor the process improvements, electricity, and chemicals necessary to run the process improvements, and associated maintenance (primarily replacement of parts). The annual O&M costs were converted to a 20-year net present value in 2019 dollars based on an assumed interest rate of 5% and inflation rate of 3% for an effective interest rate of 2%. The following assumptions were used to develop the O&M costs:

- Labor rate of $50 per hour.

- Electricity rate of $0.07 per kilowatt-hour.
- Maintenance cost at 2% per year of the equipment purchase price.
- Liquid alum cost of $0.30 per pound.
- Emulsion polymer cost of $8.00 per pound.
- 12.5% liquid sodium hypochlorite solution cost of $10.00 per gallon.
- 50% Citric acid cost of $8.10 per gallon.

4.3.2 Criteria

Eight different criteria were used as metrics to compare the different alternatives: performance, reliability, proven technology, future expandability and flexibility, footprint, public perception, operations and maintenance cost, and capital costs. Different weights were applied to each category based on the importance of the criteria in decision making for the City.

4.3.2.1 Performance

This criterion considers if the improvement meets or exceeds the performance requirements and if there are performance benefits to other processes. A weight of 8% was applied to performance.

4.3.2.2 Reliability

Reliability considers redundancy, complexity, points-of-failure, and any known or historical issues. A weight of 12% was applied to this criterion.

4.3.2.3 Proven Technology

The City has expressed that it does not want to be a “guinea pig” in the implementation of new or less proven technologies. This criterion considers maturity of technology, number of installations, and any local track record. A 6% weight was used for this criterion.

4.3.2.4 Future Expandability and Flexibility

Future expandability and flexibility encompass how an improvement might serve the facility with regards to further expansion, modularity, and ability to meet future changes in projections and/or permit limits. The City does not want to select a technology or alternative that unnecessarily limits future potential treatment modifications in the long run. This criterion was weighted at 15%.

4.3.2.5 Footprint

The existing site is space constrained, with a parking lot and apartments to the east, housing to the north and the west, and a park to the south. By minimizing footprint of improvements, there will be more space for other needs further down the road. This criterion is weighted at 8%.

4.3.2.6 Public Perception

Implementation of certain alternatives could negatively impact public perception, such as requiring use of space in the adjacent park, having greater odor potential than existing processes, increasing noise, or anything else that might be viewed negatively by the public. Conversely, some alternatives could positively impact public perception, such as higher effluent quality or availability of reclaimed water. This criterion was weighted at 7%.

4.3.2.7 Capital Costs

With any capital improvement, cost is one of the most important factors in decision making and capital costs were weighted at 22%. For the third alternative for process upgrades (Aeration Basin Improvements and Two Secondaries), construction of the second new clarifier and associated improvements would occur on an “as-needed” basis as part of a second phase to spread out the capital expenditures. A summary of the capital costs associated with each alternative is provided in Table 4-1. Of note, the capital costs for the alternatives for additional filament control are the same as those presented in the Engineering Report (dated March 2020).

Table 4-1: Alternative CIP Capital Costs

	Process Upgrades			Additional Filament Control	
	Sidestream MBR	Aeration Basin Improvements, CEPT, Single Secondary	Aeration Basin Improvements and Two Secondaries	Surface Wasting	Polymer Addition
Initial Capital Cost	$19,360,000	$9,080,000	$7,750,000	$400,000	$330,000
Phased Capital Cost	N/A	N/A	$4,000,000	N/A	N/A
Future addition of Tertiary Filtration	$0	$3,490,000	$3,490,000	N/A	N/A
Property Acquisition & Site Preparation	$0	$0	$980,000	N/A	N/A
Reclaimed Water	$2,620,000	$0	$0	N/A	N/A
Total Capital Cost	$21,980,000	$12,570,000	$16,220,000	$400,000	$330,000

4.3.2.8 Operational Costs

Operational expenses are those incurred during the life of the improvement related to operation and maintenance. As shown in the summary of operational costs in Table 4-2 below, some of the alternatives evaluated are significantly more expensive to operate than others. Of note, the net present values (NPV) were calculated assuming a 20-year life cycle, and a 2% effective interest rate. The NPV for reclaimed water applicable to the Sidestream MBR is based on the additional cost of $4,500 annually to produce reclaimed water for irrigation of the park compared to purchasing City potable water for irrigation. The total NPV is the sum of the total capital cost from Table 4-1 and the total O&M NPV. Of note, the operational costs for the alternatives for additional filament control are the same as those presented in the Engineering Report (dated March 2020).

Table 4-2: Alternative CIP Operational Costs

	Process Upgrades			Additional Filament Control	
	Sidestream MBR	Aeration Basin Improvements, CEPT, Single Secondary	Aeration Basin Improvements and Two Secondaries	Surface Wasting	Polymer Addition
Annual O&M Cost	$252,841	$213,434	$60,430	$640	$30,264
Annual O&M Cost NPV	$4,134,000	$3,490,000	$988,000	$10,000	$495,000
Reclaimed Water NPV	$33,000	$0	$0	N/A	N/A
Total O&M NPV	$4,167,00	$3,490,000	$988,000	$10,000	$495,000
Total NPV	$26,147,000	$16,060,000	$17,208,000	$410,000	$825,000

4.3.3 Non-Cost Criteria Ratings

The following tables provide commentary on each of the non-cost criteria for each alternative evaluated, along with representative scoring that is reflective of the commentary with 1 being the worst score and 5 being the best possible score. Of note, the non-cost ratings for the alternatives for additional filament control are the same as those presented in the Engineering Report (dated March 2020).

4.3.3.1 Alternatives for Additional Filament Control

Table 4-3: Additional Filament Control Alternative 1, Surface Wasting

Category	Rating	Comment
Performance	3	Physically captures and removes scum and foam, which yields removal of problematic bacteria, but limited to the one location at the mixed liquor channel. Could still see foam/scum in the clarifier due to biological activity. This process would be continuous. Should not have any adverse impact on thickening or dewatering processes.
Reliability	4	Simple physical process with no chemicals and limited moving parts (just the actuated gate).
Proven Technology	3	Has been proven to be effective at removing foam from locations where installed.
Future Expandability and Flexibility	4	Additional surface wasting locations could be added, such as in the aeration basins to deflect and capture foam in front of the effluent weirs.
Footprint	5	Small footprint and located below grade in an area that would likely not conflict with other current or potential future improvements.
Public Perception	4	Reduction in foam and scum would improve aesthetics of open clarifier tanks and may yield some minor reduction in odor.

Table 4-4: Additional Filament Control Alternative 2, Polymer Addition

Category	Rating	Comment
Performance	3	Reduces foam at the location it is of greatest concern (secondary clarifiers), but does not physically remove problematic bacteria and performance is dependent on selection of the right polymer, providing the correct dose, and beginning dosing at the correct time. Impact on dewaterability of sludge is unknown. Does not impact scum. This process would be implemented as needed.
Reliability	3	Relatively simple process. Chemical reaction kinetics can change with weather, flow, and sludge quality. If not dosed continuously, operator must be well aware as to when dosing will be necessary.
Proven Technology	3	Has been proven to be effective at controlling foam when using correct polymer type and dose.
Future Expandability and Flexibility	4	Can be expanded to additional clarifiers.
Footprint	4	Small footprint but would take up some space in the Facility Building that could otherwise be used for other process equipment or as shop space.

Category	Rating	Comment
Public Perception	5	Reduction in foam would improve aesthetics of open clarifier tanks and may yield some minor reduction in odor.

4.3.3.2 Alternatives for Process Upgrades

Table 4-5: Process Upgrade Alternative 1, Sidestream MBR

Category	Rating	Comment
Performance	5	A sidestream MBR will produce high quality effluent, reduce loading on both the primary clarifiers to within typical operating criteria and allow the existing secondary clarifiers to meet the desired level of redundancy, which exceeds Class II reliability requirements. High TSS removal through the MBR would yield lower effluent BOD also. If phosphorus removal is required, an MBR likely would require lower dose of chemical to remove ortho-phosphorus and would filter all organic phosphorus. It may also increase capacity of UV units due to cleaner effluent and enhance thickener performance due to the higher MLSS concentration from the MBR.
Reliability	4	Membrane treatment systems are more complex with more automated equipment and controls, and thus, more potential points of failure. If ceramic plate membranes are used, enough membranes can fit in the 4 SBC tanks to provide full facility capacity for the 20-year planning period, allowing for expansion of the MBR from sidestream to full stream. With polymeric membranes, additional MBR tanks would need to be constructed for future full flow capacity. This alternative allows for sufficient redundancy with primary and secondary clarifiers, as well as within the MBR system.
Proven Technology	3	MBRs are proven successful technologies. The City has no experience with MBRs, as opposed to conventional activated sludge with secondary clarifiers. A particular challenge in this application is operating a sidestream process, such that staff are running two different biological treatment technologies and types of biomass at the facility. Ceramic membranes have been in use for a while, but they are newer than polymeric membranes to municipal wastewater treatment.
Future Expandability and Flexibility	4	The sidestream MBR would be able to utilize existing tankage, without the need to construct new tanks. This would remain true even if the MBR is expanded to treat full flow for the 20-year planning horizon with the use of ceramic plate membranes. In this case, the facility could also regain space occupied by the existing secondary clarifiers, which would no longer be needed if the MBR is treating full flow. As MBRs operate at high MLSS concentrations, existing aeration basin volume should be sufficient for full flow.
Footprint	5	Provides the greatest capacity in the smallest footprint. Although space will be needed for a new building to house support equipment such as blowers and permeate pumps, the secondary clarifiers could eventually be removed resulting in essentially not net change in availability of space. No new tankage would be required. Least potential for future incursion into park. Additionally, could convert the clarifier tanks to aerobic digesters.
Public Perception	5	MBRs are covered, which assists with odor control. The footprint is small, meaning park space would not be encroached upon. Existing tankage would be utilized, but a new building for support equipment would be necessary. High quality effluent for greater perceived environmental benefit.

Table 4-6: Process Upgrade Alternative 2, Aeration Basin Enhancements, CEPT, One Secondary Clarifier

Category	Rating	Comment
Performance	4	Conventional activated sludge with secondary clarification does not produce effluent as clean as an MBR, but it is sufficient to meet permit requirements and anticipated future nitrogen limits. Increased denitrification will likely yield some reduction in aeration demand and supplemental alkalinity.
Reliability	3	Adding CEPT and a third secondary clarifier achieves the desired level of redundancy and reliability, which exceeds Class II reliability requirements. Unlike membranes, performance of secondary clarifiers is dependent on sludge quality and subject to solids being carried over the weir in the case of high SVI or other process upsets. This alternative will reduce the number of aeration basin trains from 3 to 2, as the third basin will be converted to anoxic/swing zone volume. New anoxic/swing zones will be configured to allow isolation of any zone for maintenance.
Proven Technology	5	The facility currently operates a similar process using conventional activated sludge and secondary clarifiers. Adding an additional secondary clarifier and continuing with the Modified Ludzack Ettinger (MLE) process maintains the modus operandi of the current process.
Future Expandability and Flexibility	3	Adding CEPT, modifying existing aeration basins, and adding a third secondary clarifier should provide sufficient treatment and capacity through the 20-year planning period. This process could be expanded further, but at that point would likely require new tankage encroaching on the park.
Footprint	3	Activated sludge process would be contained within existing aeration basins. Using CEPT allows addition of just one more secondary clarifier; however, the facility is space limited and future expansion past the 20-year planning horizon would likely encroach into the park.
Public Perception	3	Odor and noise are not expected to change. There is sufficient space between the aeration basins and primary clarifiers to locate the new secondary clarifier, but any further expansion would likely encroach into the park. Nitrogen removal is a positive environmental benefit.

Table 4-7: Process Upgrade Alternative 3, Aeration Basin Enhancements, Two Secondary Clarifiers

Category	Rating	Comment
Performance	3.5	Conventional activated sludge with secondary clarification does not produce effluent as clean as an MBR, but it is sufficient to meet permit requirements and anticipated future nitrogen limits. Performance of the primary clarifiers would be poorer without CEPT, but this would be offset by adding two new secondary clarifiers. However, this would yield less primary sludge and more load to the aeration basins. Increased denitrification will likely yield some reduction in aeration demand and supplemental alkalinity.

Category	Rating	Comment
Reliability	3	Adding two secondary clarifiers achieves the desired level of redundancy and reliability, which exceeds Class II reliability requirements. Unlike membranes, performance of secondary clarifiers is dependent on sludge quality and subject to solids being carried over the weir in the case of high SVI or other process upsets. This alternative will reduce the number of aeration basin trains from 3 to 2, as the third basin will be converted to anoxic/swing zone volume. New anoxic/swing zones will be configured to allow isolation of any zone for maintenance.
Proven Technology	5	The facility currently operates a similar process using conventional activated sludge and secondary clarifiers. Adding secondary clarifiers and continuing with the MLE process maintains the modus operandi of the current process.
Future Expandability and Flexibility	2	Modifying existing aeration basins and adding two new secondary clarifiers should provide sufficient capacity and treatment through the 20-year planning period, but it would take up essentially all remaining space and require some encroachment into the adjacent park. CEPT could be employed in the future to gain some capacity, otherwise new tankage would be required for further expansion.
Footprint	2	Activated sludge process would be contained within existing aeration basins. Doing nothing with primary treatment requires the addition of two new secondary clarifiers, which would require encroaching into the park, though the second clarifier could be phased to possibly defer encroachment into the park to later in the planning horizon, depending on location of the new clarifiers. Any future expansion beyond the planning horizon would require further encroachment into the park.
Public Perception	2	Two new secondary clarifiers require some encroachment into the park. Odor and noise are not expected to change. Nitrogen removal is a positive environmental benefit.

4.3.4 Final Alternative Scores

The final score for each alternative was based on the sum of the weighted scores. A summary of the scoring is provided in Table 4-8. The highest scoring alternative is the most favorable. For scoring costs, the lowest capital and O&M costs were given a score of 5 and the highest costs were given a score of 1 for each group of alternatives. For an alternative that fell between the highest and lowest costs, its score was based on its proximity to the lowest and highest costs.

Table 4-8: Alternatives Matrix

Category	Weight	Process Upgrades			Additional Filament Control	
		Sidestream MBR	Aeration Basin Improvements, CEPT, Single Secondary	Aeration Basin Improvements and Two Secondaries	Surface Wasting	Polymer Addition
Performance	8.0%	5.0	4.0	3.5	4.0	3.0
Reliability	12.0%	4.0	3.0	3.0	4.0	3.0
Proven Technology	6.0%	3.0	5.0	5.0	3.0	3.0
Future Expandability and Flexibility	15.0%	4.0	3.0	2.0	4.0	4.0
Footprint	8.0%	5.0	3.0	2.0	5.0	4.0
Public Perception	7.0%	5.0	3.0	2.0	4.0	5.0
O&M Cost	22.0%	1.00	1.85	5.00	5.00	1.00
Capital Cost	22.0%	2.01	5.00	3.84	5.00	4.15
Total	**100.0%**	**3.07**	**3.39**	**3.48**	**4.27**	**3.37**

4.3.5 Selected Alternatives

4.3.5.1 Additional Filament Control

Surface Wasting has the highest score between the two additional filament control alternatives. It should be noted that these two alternatives are not exclusive of each other, meaning that both could be installed if desired. The City initially elected surface wasting as it has a much lower O&M cost because it does not require chemicals and is simpler and more reliable. The capital costs of the two alternatives are comparable. Another reason for this is that polymer addition would only treat the symptom of the problem, and the problematic filaments would remain in the system. However, upon review of available budgets for improvements included in the drafted plans and specifications of the CIP1 design package for pH and filament control (dated November 2020), filament control via surface wasting will not be included in the near term. The City may elect to include additional filament control via surface wasting in future upgrades if still merited after completion of construction and commissioning of the five upgrades detailed in the CIP1 design package. The City may elect to include the surface wasting if the upgraded RAS chlorination system does not provide sufficient improvement to comply with TSS limits.

4.3.5.2 Process Upgrades

Alternative 2 (Aeration Basin Improvements, CEPT, Single Secondary) was excluded, as it was the lowest scoring between the two conventional activated sludge alternatives. The City agreed with discontinuing this alternative due to the high chemical cost, a preference not to rely on chemicals and having more physical clarifier capacity. Alternative 3 (Aeration Basin Improvements, Two Secondaries) was kept in consideration, as it scored the highest of all the process upgrade alternatives. Alternative 1 (Sidestream MBR) was kept in consideration as it maintains the highest flexibility for a changing regulatory environment, avoids the expansion outside the current WWTP boundaries, is currently considered the best available technology for wastewater treatment, and it provides potential for effluent reuse. As a result, the City believes that public perception, footprint, and future expandability are better with a sidestream MBR and would like to consider this alternative further to determine if it might be worth the added expense. Additionally, if the WWTP was eventually fully converted to an MBR process, the secondary clarifier tanks could be repurposed or removed to free up additional space, the higher clarity effluent may increase capacity of the UV disinfection process, and the more concentrated WAS would improve sludge thickening.

Alternative 3 (Aeration Basin Enhancements, Two Secondary Clarifiers) does have some advantages over Alternative 1 (Sidestream MBR). City staff already has familiarity with the conventional activated sludge process, it does not require operating parallel treatment processes, it has fewer equipment and controls to maintain, it has a lower capital and O&M cost, and Alternative 3 has the ability to phase construction of the second additional clarifier. However, it has a larger footprint that would require construction outside current boundaries of the WWTP and does not produce effluent as high in quality as an MBR. While Alternative 1 was preferred by the City for planning purposes, Alternative 3 remained as a viable option for further consideration.

4.3.6 Comparison of Nitrogen Removal Potential for Preferred Process Upgrade Alternatives

As future limits on effluent nitrogen are unknown, BioWin process modeling was used to evaluate nitrogen removal potential for Process Upgrade Alternatives 1 and 3, which are focused on upgrading the secondary treatment process. The process models used were considered somewhat conservative in their predictions, since they did not account for improvements to the solids handling and treatment processes. The models only accounted for the current aerobic digester tanks and associated controls and equipment. Proposed solids improvements discussed in Chapter 5, which could include expanded digester volume and/or addition of equipment and controls to enhance denitrification in the digesters, would likely result in less nitrogen returned to the process through filtrate from the dewatering process. A reduction in the returned nitrogen would be expected to yield lower effluent nitrogen concentrations.

The nitrogen limits considered in this evaluation are based on potential concentration limits that Ecology has suggested for consideration. These limits are effluent TIN of 3 mg/L or 8 mg/L. For both Alternatives 1 and 3, consideration was given to use of supplemental carbon to achieve these limits. Additionally, consideration was given to achieving these limits under maximum month conditions (if limits are year-round) and annual average conditions (if limits are seasonal). Furthermore, future expansion of Alternative 1 from a sidestream to full stream MBR to treat all the flow was also considered.

A summary of the evaluation is shown in Table 4-9. Micro C was assumed to be the source of supplemental carbon used to enhance denitrification, with estimated dosing rates shown in parenthesis. At a cost of around $3.50 per gallon, an average use of 50 gallons per day would equate to approximately $63,000 per year and $1.04 million over 20 years at a 2% effective interest rate. The target effluent TIN is shown for each condition with the model predicted effluent TIN shown in parenthesis. The effluent TIN predicted by the model illustrates the potential nitrogen removal capabilities of each alternative under the conditions noted. However, these predictions are not final, and will be ultimately dependent on actual design of the improvements.

Table 4-9: Nutrient Removal Evaluation of Selected Alternatives

Alternative	Flow Condition	Supplemental Carbon Addition	Effluent TIN
1 (Sidestream MBR)	2040 Max Month	Yes (100 gpd)	<8 (5.8)
1 (Sidestream MBR)	2040 Max Month	No	<8 (7.4)
1 (Sidestream MBR)	2040 Average Annual	Yes (50 gpd)	<8 (4.8)
1 (Sidestream MBR)	2040 Average Annual	No	<8 (6.7)
1 (Full Stream MBR)	2040 Max Month	Yes (50 gpd)	<3 (1.0)
1 (Full Stream MBR)	2040 Max Month	No	<3 (1.5)
1 (Full Stream MBR)	2040 Average Annual	Yes (50 gpd)	<3 (1.2)
1 (Full Stream MBR)	2040 Average Annual	No	<3 (2.8)
3	2040 Max Month	Yes (100 gpd)	<3 (1.6)
3	2040 Max Month	No	<8 (6.3)
3	2040 Average Annual	Yes (50 gpd)	<3 (1.8)
3	2040 Average Annual	No	<8 (5.3)

In Alternative 1 (Sidestream MBR), Aeration Basin No. 3 will be retrofitted as process basins for the MBR stream. Aeration Basins No. 1 and 2 will be kept in their current configuration, except a baffle will be added to provide two separate aerobic zones. No supplemental carbon addition is required to achieve effluent TIN of 8.0 mg/L. However, supplemental carbon addition will not achieve effluent TIN of 3.0 mg/L, due to a lack of post-anoxic zones and limited anoxic volume within Aeration Basins No. 1 and 2. The BioWin schematic for the sidestream MBR is illustrated on Figure 4-1.

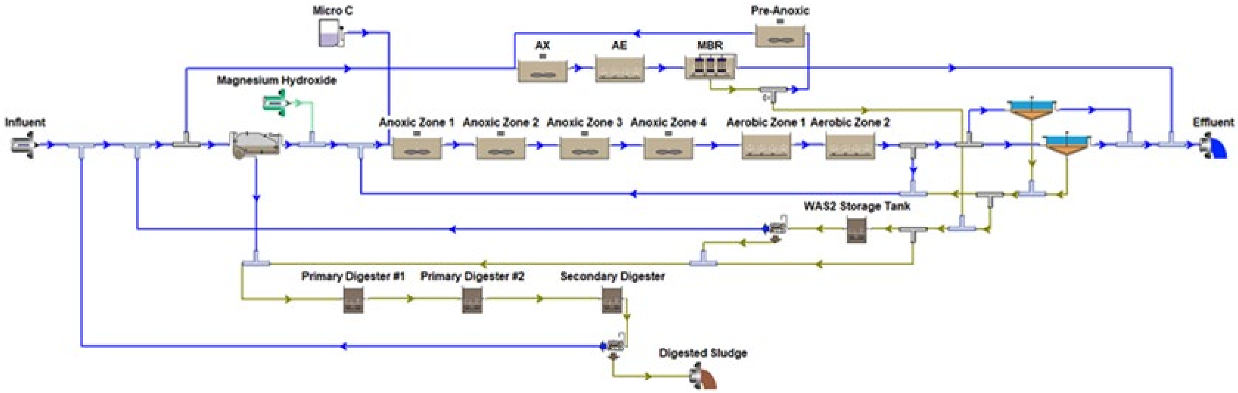


Figure 4-1: Biowin Model for Alternative 1 (Sidestream MBR)

A full stream MBR will create three identical treatment trains in the three existing aeration basins, which would follow a 4-stage Bardenpho process. This entails a pre-anoxic zone, where internal mixed liquor recycle, activated sludge returned from the MBR tanks, and influent wastewater combine. This is followed by an aerobic zone to drive nitrification. The internal mixed liquor recycle returns nitrified mixed liquor to the pre-anoxic zone for denitrification. The final zone in the aeration basins is a post anoxic zone, which is where supplemental carbon can be added. The last zone is the MBR tank, which serves as a post-aerobic zone. The high DO that exists in these tanks due to air scouring for cleaning of the membranes also serves to nitrify remaining ammonia and oxidize remaining BOD. Figure 4-2 illustrates the BioWin schematic of how the 4-stage Bardenpho process would be implemented. While three basins will be available to operate as process basins, only two are necessary to treat the projected 2040 maximum month flows and loads. Effluent TIN of 3.0 mg/L appears possible without the addition of Micro C; however, it would still be beneficial to maintain a supply of the chemical on-site and dosing equipment in the event of process upsets or periods of high loading.

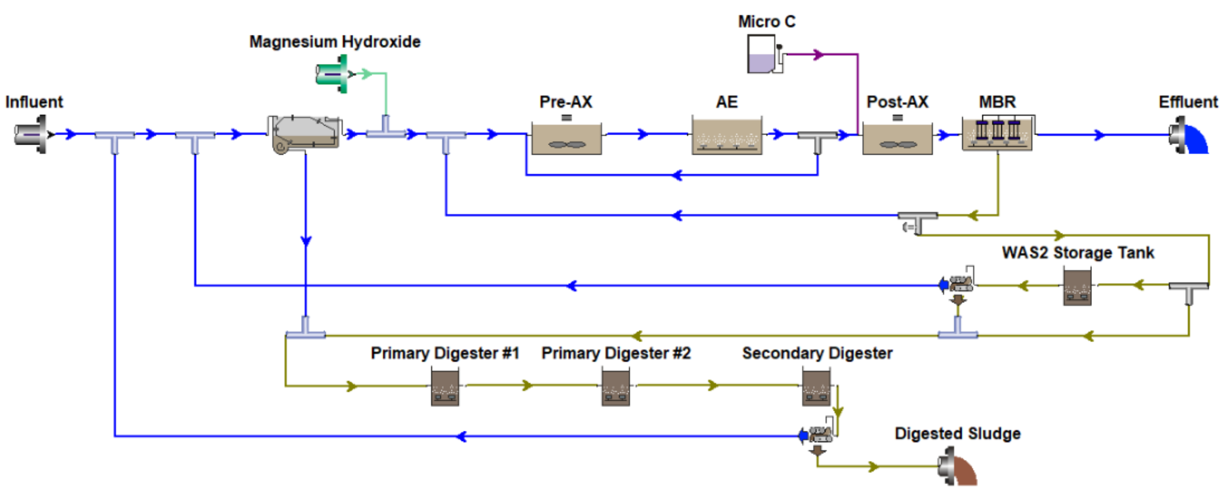


Figure 4-2: Biowin Model for Alternative 1 (Full Stream MBR)

For Alternative 3 (Aeration Basin Improvements, Two Secondaries), supplemental carbon addition would occur solely in the post-anoxic zone as there appears to be sufficient BOD in the influent to drive denitrification in the pre-anoxic zones. Figure 4-3 illustrates the BioWin schematic of this alternative. A TIN level of 8.0 mg/L is achievable without supplemental carbon addition, and a level of 3.0 mg/L is achievable only with supplemental carbon addition.

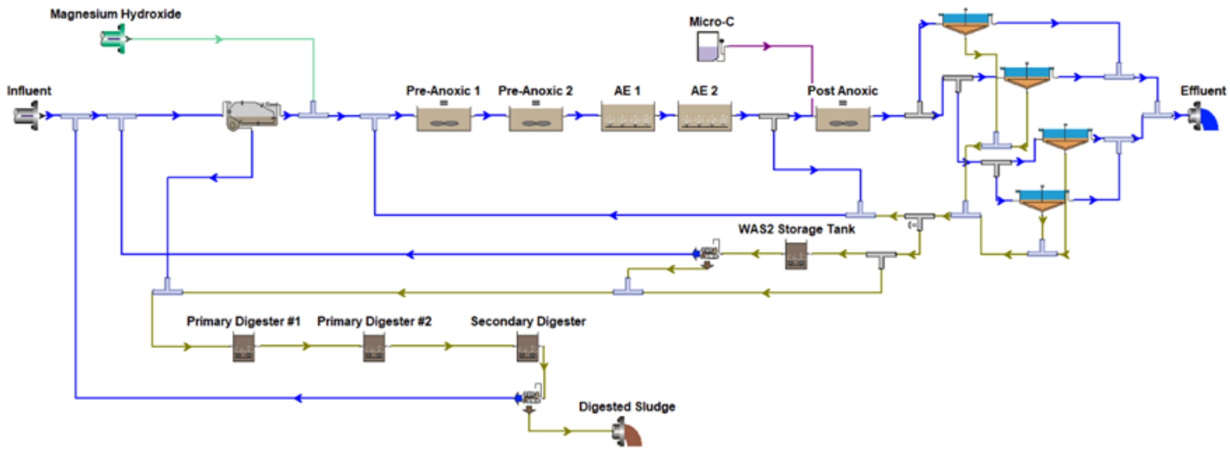


Figure 4-3: Biowin Schematic for Alternative 3 (Aeration Basin Improvements, Two Secondaries)

4.4 Evaluation of Secondary Treatment Capital Improvement Alternatives

Upon review of the three alternatives for liquid process upgrades detailed in Section 4.3 above by City personnel, the City requested a comprehensive evaluation of capital improvement costs and layouts for the two preferred alternatives to be presented to the City's leadership. The two preferred alternatives included: 1) the Sidestream MBR; and 2) the Aeration Basins Improvements with Two Secondaries (later referred to as "Expanded Conventional Activated Sludge"). Both alternatives for liquid process upgrades focused on the secondary treatment process. This section includes the information presented to the City's leadership. The presentations to finance personnel and the Transportation/Planning, Parks & Recreation, and Public Works (P3) Committee occurred in Q1 of 2020. The presentation to the City's Council was delayed by the COVID-19 virus and subsequent restrictions regarding in-person meetings. Hence, the presentation to the City's Council occurred virtually in third quarter (Q3) of 2020.

4.4.1 Secondary Treatment Capital Improvements – Sidestream Membrane Bioreactor Alternative

As detailed in Section 4.3.5.2, the Sidestream Membrane Bioreactor was deemed as one of the two preferred options for process upgrades. This alternative could utilize the existing SBC tanks and existing Aeration Basin No. 3 for construction of a sidestream MBR. Implementation of a sidestream MBR is illustrated on a site plan on Figure 4-4. The membranes would be retrofitted into the existing SBC tanks, allowing them to be repurposed. A new MBR support building would be required to house permeate pumps, membrane blowers and chemical cleaning systems for the membranes. This building would be placed to the south of the MBR tanks and arranged to maintain as much room as is feasible where the existing parking is located just south of the primary clarifiers. MBR permeate will combine with secondary effluent from the parallel existing conventional activated sludge process in the existing secondary effluent pipeline before being sent to UV disinfection. Figure 4-4 illustrates the site plan, while Figure 4-5 depicts the process flow and how the sidestream MBR would be integrated with the existing mainstream conventional activated sludge system.

The hydraulics of these improvements were investigated using Visual Hydraulics software. There appear to be no issues hydraulically at the projected 2040 peak flow, with the exception of the secondary clarifier weirs being partially submerged and the primary clarifier influent weirs being fully submerged. Although the hydraulic model indicates that the weirs in both the new and existing clarifiers are partially submerged at the projected 2040 peak hour flow, this assumes effluent is being pumped to the river and the water level in the effluent pump wet well is at the maximum operating level. These conditions may exist for only a short period of time and even so an adequate flow split could likely still be maintained with partial submergence. The hydraulic model also indicates that the primary clarifier influent weirs are fully submerged. However, because the weirs and clarifiers are identical in size, an adequate flow split should still be attainable even when the weirs are completely submerged.

The effluent of the sidestream MBR is expected to be essentially free of solids and have high potential for reuse if treated to Class A reclaimed water standards. High quality effluent from an MBR is also typically lower in total phosphorus compared to conventional activated sludge, as a portion of effluent phosphorus is often bound in TSS that can overflow secondary clarifiers. When combined with effluent from the conventional activated sludge process, the resulting effluent quality will be better than that from the conventional activated sludge process alone, but not as high of quality as effluent directly from the sidestream MBR.

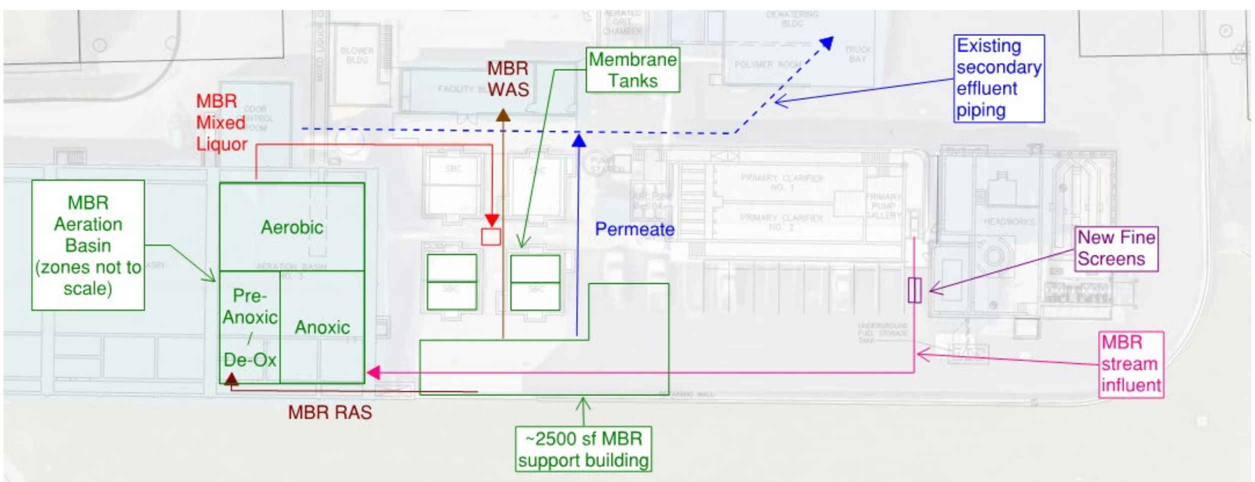


Figure 4-4: Site Plan for Sidestream MBR

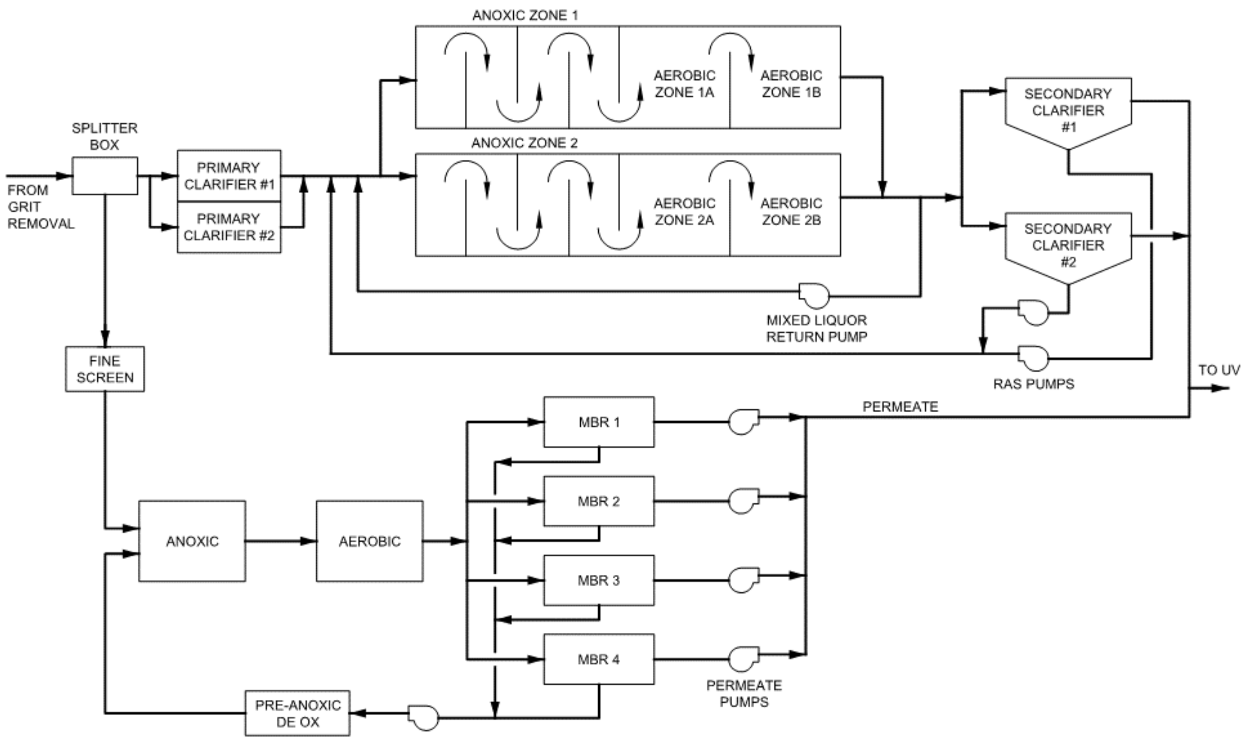


Figure 4-5: Process Schematic for Sidestream MBR

The project element for the Sidestream MBR upgrades is detailed in Table 4-10 below, which includes a description of each project element, as well as the associated project cost and operations and maintenance cost. The pros and cons of Sidestream MBR are detailed in Table 4-11 below.

Table 4-10: Project and O&M Costs for Sidestream MBR

Project Element	Description of Improvements	Project Cost (2020 Dollars)	Operations and Maintenance Cost ($/yr, 2020 Dollars)
Add a Sidestream MBR	Convert the existing SBC tanks into membrane bioreactors (MBRs). Aeration Basin 3 will be converted to pre-anoxic and aerobic zones for treatment prior to the MBRs. The MBRs will be operated in parallel with the existing conventional activated sludge (CAS) process utilizing Aeration Basins 1 and 2 and the existing clarifiers. This will prevent the CAS process from becoming overloaded but will yield two different microbial populations at the facility. This project also includes some minor improvements to Aeration Basins 1 and 2 for the conventional activated sludge system and replacement of the weir in Secondary Clarifier #1.	$20,030,000	$262,000

Table 4-11: Comparison of Pros and Cons for Sidestream MBR

Pros	Cons
• Small footprint • Improvements fit within the existing WWTP site • No need for property acquisition or park encroachment • High quality effluent • Adequate denitrification • Potential for effluent reuse • Ability to repurpose secondary clarifier tanks if conversion of full plant to MBR is need in the future to meet regulations • Improves efficiency of UV disinfection • Thicker WAS • More efficient phosphorus removal if required in the future • Best available technology may reduce additional investment to comply with future NPDES permit limits	• High capital and operating expenses • Operational complexities with two treatment streams • Amount of equipment and instruments to maintain • City has no experience with MBRs

4.4.2 Secondary Treatment Capital Improvements – Expanded Conventional Activated Sludge Alternative

As discussed in Section 4.3.5.2, one of the preferred alternatives (Aeration Basin Improvements, Two Secondaries) allows the City to expand the conventional activated sludge process for improved secondary treatment. For simplicity for the remainder of this Report, this alternative is referred to as “Expanded Conventional Activated Sludge.” This alternative could be constructed in two phases. In the first phase, improvements would be made to the existing aeration basins to enhance nitrogen removal and a third secondary clarifier would be constructed on the property to the south or west in the adjacent park. Improvements would be made to the park land to facilitate this expansion, as well as the construction of a fourth clarifier in the second phase. Although two additional secondary clarifiers will be needed to maintain adequate reliability and redundancy of treatment within the planning horizon, the second additional clarifier can be constructed on an “as-needed” basis, meaning cost savings can be achieved by only constructing one initially in Phase 1.

The hydraulics of this alternative were investigated using Visual Hydraulics software. The two new clarifiers (one from Phase 1; one from Phase 2) would be in parallel to the existing two, and all discharge into the existing secondary effluent pipeline. Although the hydraulic model indicates that the weirs in both the new and existing clarifiers are partially submerged at the projected 2040 peak hour flow, this assumes effluent is being pumped to the river and the water level in the effluent pump wet well is at the maximum operating level. These conditions may exist for only a short period of time and even so an adequate flow split could likely still be maintained with partial submergence. The hydraulic model also indicates that the primary clarifier influent weirs are fully submerged. However, as discussed under the Sidestream MBR alternative, neither of these issues are of significant concern and should still yield adequate flow splitting under these short duration conditions.

4.4.2.1 Expanded Conventional Activated Sludge Phase 1

As discussed in Section 4 and above, the initial phase of conventional activated sludge improvements includes the construction of anoxic/swing zones in existing Aeration Basin No. 3, removal of the anoxic zones in Aeration Basin No. 1 and 2 to expand aerobic volume, and construction for a third secondary clarifier. The final location of the additional clarifier is yet to be determined, but two alternative locations are represented in the site plan (Figure 4-6). In one case, the clarifier could be located to the west of the aeration basins, in an area that is currently used for vehicle parking at the park. One advantage to this location is that there would be no disruption to the baseball fields at the park. Additionally, there is sufficient space to add the second new clarifier in Phase 2. The other location would require demolition of the existing SBC tanks for construction of the first new clarifier. Some of the park space would need to be taken with the construction of the second new clarifier in Phase 2. The location of the new clarifiers in either location would be some distance from the existing clarifiers, but no additional land would need to be purchased, as the City already owns the park. However, for either location, it is assumed some improvements will be made to the park to integrate the new structures and mitigate their impacts.

A process schematic for Phase 1 is illustrated on Figure 4-7.

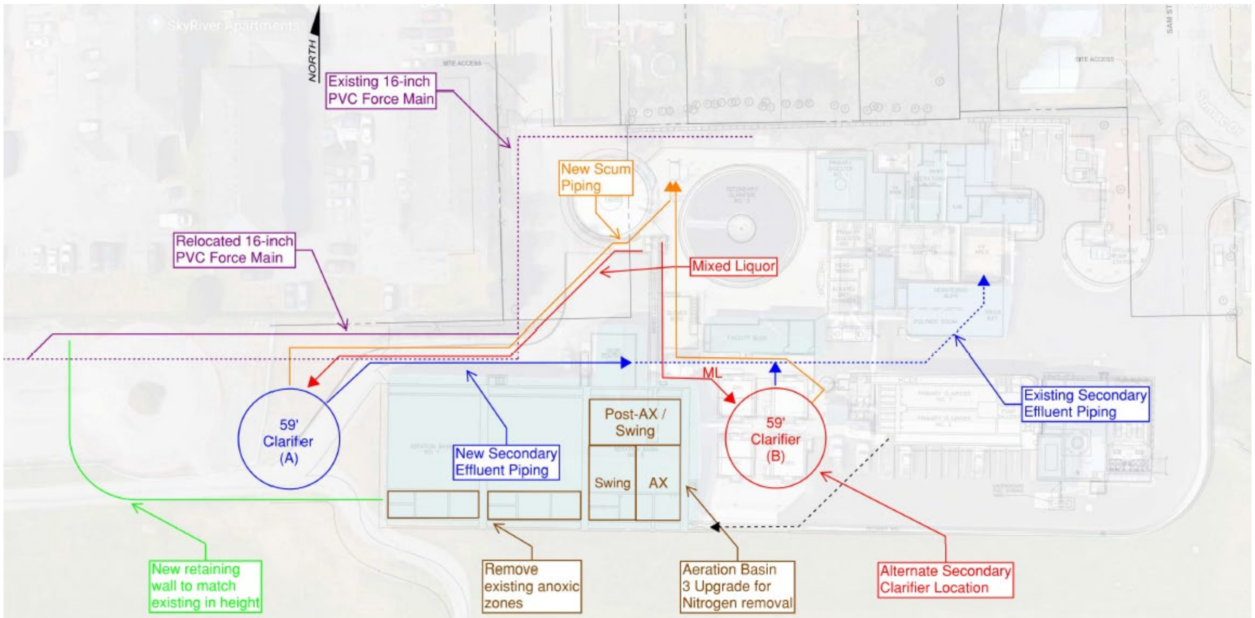


Figure 4-6: Site Plan for Expanded Conventional Activated Sludge Phase 1

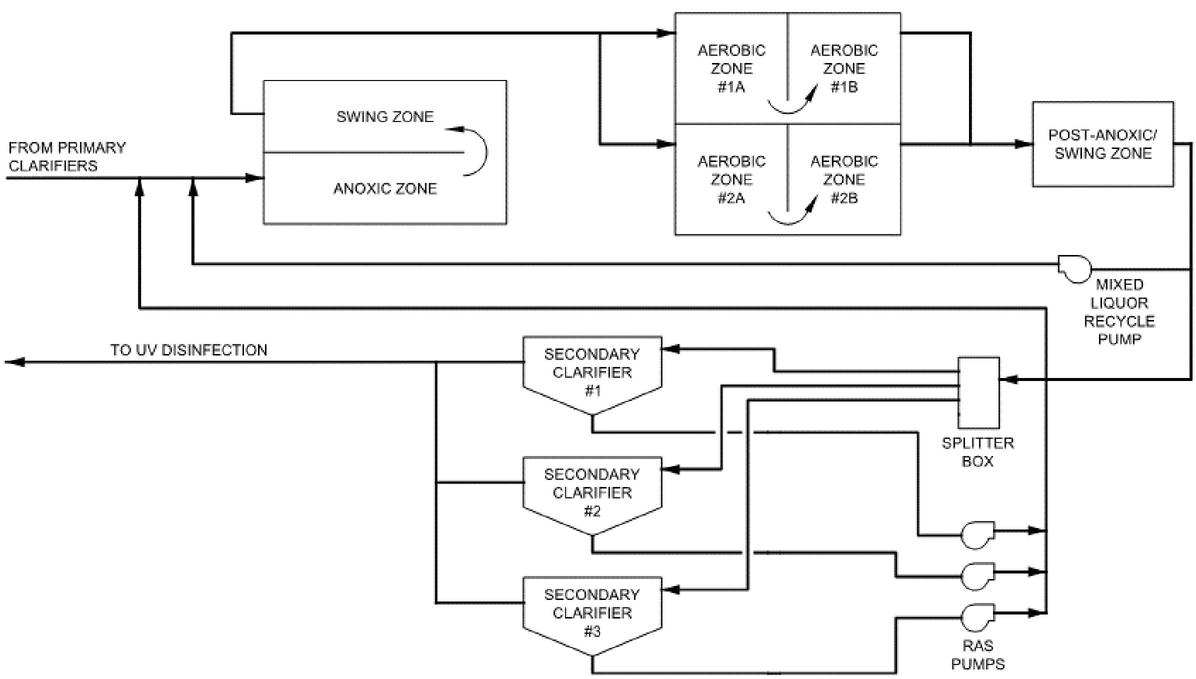


Figure 4-7: Process Schematic for Expanded Conventional Activated Sludge Phase 1

The three project elements for the Phase 1 upgrades are detailed in Table 4-12 below, which includes description of each project element as well as the associated project cost and operations and maintenance cost. The pros and cons of Phase 1 are detailed in Table 4-13 below.

Table 4-12: Project and O&M Costs for Expanded Conventional Activated Sludge Phase 1

Project Element	Description of Improvements	Project Cost (2020 Dollars)	Operations and Maintenance Cost ($/yr, 2020 Dollars)
1. Add 3rd Secondary Clarifier	Add a single 59' secondary clarifier. An additional clarifier will be constructed as part of a separate phase (see Phase 2). Includes Secondary Clarifier #1 weir replacement. Two possible locations [denoted as "(A)" and "(B)"] for the new clarifiers are shown above on Figure 4-8.	$4,240,000	$18,000
2. Aeration Basin Upgrades	Convert Aeration Basin 3 into two pre-anoxic/swing zones, and one post-anoxic swing zone. Aeration Basins 1 and 2 will have existing anoxic zones demolished. The existing baffles, installed as a part of the CIP for pH and filament control, may require adjustment to ensure the two zones are equally sized after the demolition of the anoxic zones. These two aerobic zones will allow for tapered aeration (e.g., 3.0 mg/L target in the first zone and 1.5 mg/L target in the second zone) to lower the recycle of DO.	$3,780,000	$28,000
3. Site Prep, Retaining Wall, and Force Main relocation[(a)]	Removal of asphalt, addition of retaining wall and fill to bring up to the same grade as existing WWTP facility. An allowance for park improvements is included.	$1,010,000	$0

Note:

(a) Project Element 3 and the associated costs are reflective of the option to locate the 3rd secondary clarifier at the site labeled as "A", which is west of the existing aeration basins and outside of the existing WWTP.

Table 4-13: Comparison of Pros and Cons for Expanded Conventional Activated Sludge Phase 1

Pros	Cons
• Familiarity with this process • Improves performance and solids capture • Adds redundancy • Allows for phasing of new clarifiers • Optimizes denitrification and increases nitrogen removal • Gain secondary treatment capacity • Relatively high levels of denitrification would likely meet potential nitrogen limits • SBC tanks location prevents encroachment of WWTP into park parking lot. Parking lot location reserves SBC tanks for other use.	• Large footprint • May require construction outside current WWTP boundaries during Phase 1 if location A is preferred • More challenges regarding floodplain permitting if location A is preferred • Further expansion would require additional property and tankage • Loss of parking at park or loss of SBC tanks for future use. • Cost for park improvements for parking lot location

4.4.2.2 Expanded Conventional Activated Sludge Phase 2

As discussed in the previous section, Phase 2 involves construction of a fourth secondary clarifier, identical to the one constructed as a part of Phase 1. Figure 4-8 illustrates the site plan with both new clarifiers, with potential siting including the clarifier installed with Phase 1. As previously discussed, this second new clarifier can be constructed on an “as-needed” basis. As illustrated on Figure 4-9, the process would not see any major changes compared to Phase 1. Some improvements, such as improvements to the existing clarifier splitter box and some underground piping, can be completed during Phase 1 to simplify and ease construction and costs of Phase 2.

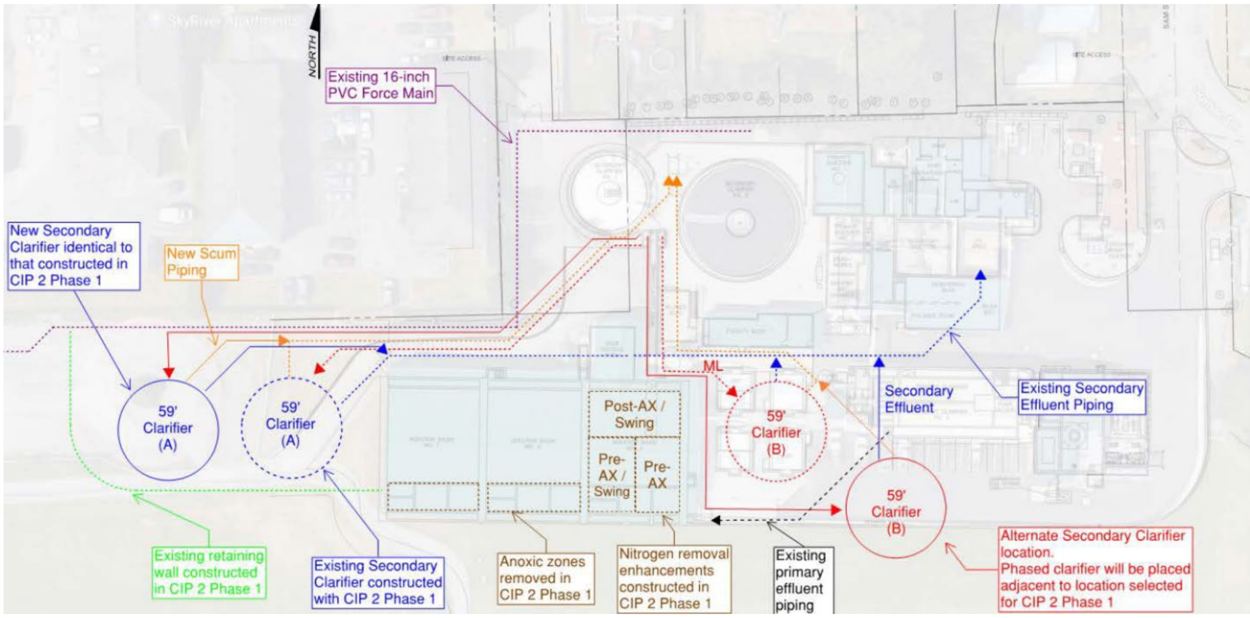


Figure 4-8: Site Plan for Expanded Conventional Activated Sludge Phase 2 Site Plan

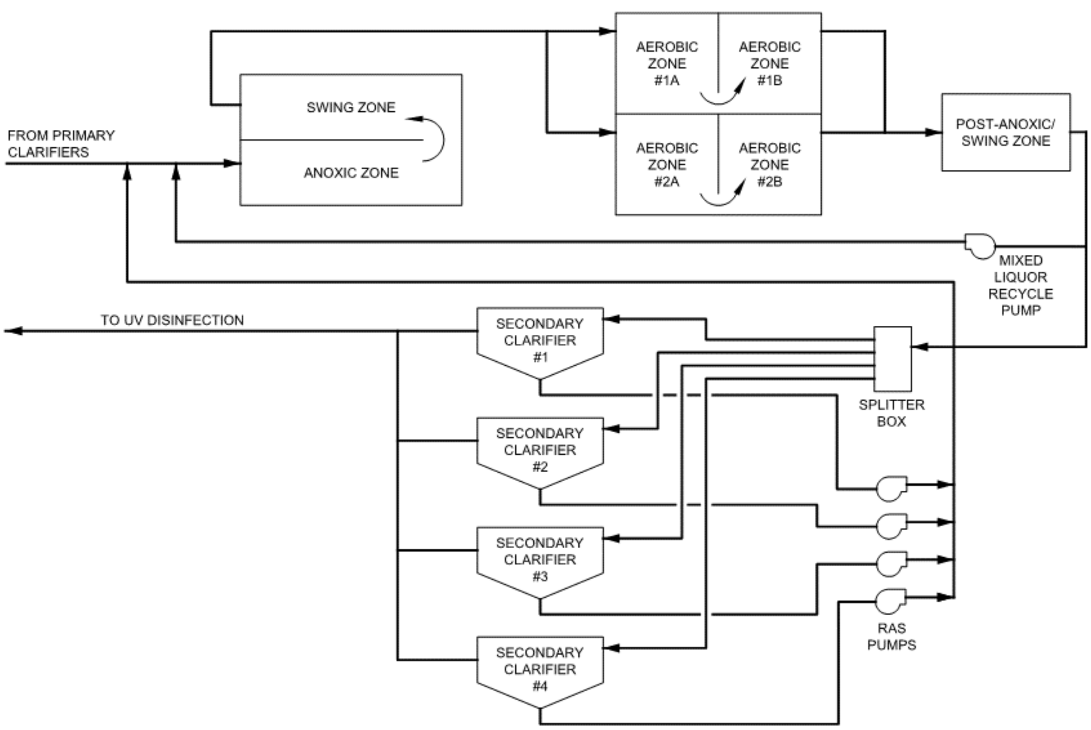


Figure 4-9: Process Schematic Expanded Conventional Activated Sludge Phase 2

The project element for the Phase 2 upgrades is detailed in Table 4-14 below, which includes description of each project element as well as the associated project cost and operations and maintenance cost. The pros and cons of Phase 2 are detailed in Table 4-15 below.

Table 4-14: Project and O&M Costs for Expanded Conventional Activated Sludge Phase 2

Project Element	Description of Improvements	Project Cost (2020 Dollars)	Operations and Maintenance Cost ($/yr, 2020 Dollars)
Add 4th Secondary Clarifier	Add another identical 59' secondary clarifier as a second phase to Phase 1. The location of the fourth clarifier is dependent upon the location selected for the third clarifier in Phase 1. This cost assumes most of the piping for this additional clarifier is installed and the splitter box improvements are constructed as part of Phase 1.	$4,140,000	$18,000

Table 4-15: Comparison of Pros and Cons for Expanded Conventional Activated Sludge Phase 2

Pros	Cons
• Familiarity with this process • Further improves performance and solids capture • Adds further redundancy • Phasing of new clarifiers allows smaller capital outlay for Phase 1	• Large footprint • Requires construction outside current site boundaries and encroachment into park area or parking lot • Challenges regarding floodplain permitting when working outside of the current site and within the flood zone

4.4.3 Secondary Treatment Capital Improvements – Engineer's Recommendation

The Team recommends the Sidestream MBR Alternative for the following reasons:

- The proposed improvements would remain within the boundaries of the existing WWTP site.
- Membranes, typically considered "best available technology," would not only meet projected demands and effluent limits, but could also more efficiently address potential future regulatory requirements (e.g., phosphorus, emerging contaminants of concern, etc.) with the option of converting the entire plant to MBR technology.

- The ability to repurpose the secondary clarifier tanks or the space they occupy for future needs if the entire plant is converted to MBR technology.

- Improved effluent clarity and higher effectiveness and efficiency of UV disinfection.

The selection of the Sidestream MBR alternative may be reevaluated if the above reasons for driving the decision alter substantially.

Section 5: Biosolids Management Study

The alternatives for solids treatment, handling, and end-use are further described in this section.

5.1 Biosolids Management Program Evaluation

5.1.1 Introduction

A component of the Project includes the development of a Biosolids Management Study (Study). The overall purpose of the Study was to evaluate short-term and long-term approaches for improving the treatment, handling, and beneficial use or disposal of biosolids generated at the WWTP.

The Study included the following elements, as follows:

- A definition of biosolids and the overall regulatory requirements regarding this important resource.
- Description of opportunities and challenges of the City's current biosolids management program.
- Developed economic and non-economic criteria and goals for the City's biosolids used to assess and rank potential biosolids treatment, handling and beneficial use or disposal short-term and long-term alternatives.
- Described potential local markets and customers that may have an interest in the City's biosolids product(s). This includes the product(s) that are produced from the selected treatment alternatives (e.g., Class A) and not those products derived from options that were not chosen (e.g., Class B).
- Based on the non-economic and economic criteria and market assessment, seven alternatives were developed for consideration by the City. These alternatives were ranked and resulted in three preferred options for further analysis.
- A more detailed comparison of the preferred three alternatives included: conceptual level costs (AACE Class 4 construction cost estimates) with 20-year net present worth analysis of operational and maintenance costs; schematic layouts for each of the three preferred alternatives; a description of any permit modifications to the City's NPDES and/or Ecology approved Biosolids Management Plan for the three preferred alternatives.

5.1.2 Study Nomenclature

There are several key terms used in the literature and industry pertaining to biosolids management. These terms are used in this Study to be consistent with what is commonly used.

The definitions below do not replace those definitions used by federal or state regulatory authorities.

1. "Sewage Sludge" or "Solids" refer to the residual material produced by a treatment works treating domestic sewage that does not meet the standards to be classified as biosolids.

2. "Biosolids" refers to sewage sludge that has been or is being treated to meet standards so that it can be applied to the land, given away or sold.

3. "Beneficial Use" refers to the application of biosolids to the land for the purposes of improving soil characteristics to enhance the growth of vegetation or crops.

5.1.3 Study Methodology and Program Goals

The City and the Tea, developed overall biosolids management program goals that were used to guide the biosolids work, as follows:

- Long-term reliability for the treatment, handling and end-use of the product.
- Cost effective operations.
- Continue to beneficially use the product.
- Integration with the liquid stream processes.

Following the development of the goals, the City and the Team established weighted criteria that were aligned with the goals and used to examine five overall Biosolids Process Alternatives. These alternatives included: stabilization, dewatering, additional treatment for producing Class A biosolids, storage and beneficial use or disposal. There was a total of 22 sub-alternatives that were included under the five overall alternatives.

During a Biosolids Workshop on 25 June 2019, the City and Team confirmed the criteria and alternatives to be evaluated. At the workshop, the City and the Team carefully discussed and scored the alternatives, and then chose six Biosolids Process Alternative Treatment Trains for further consideration. Capital and O&M costs were developed for these alternatives and subsequent recommendations for implementation. Appendix F presents the detailed list of Biosolids Process Alternatives and Biosolids Process Alternative Treatment Trains.

Table 5-1 presents the projected solids production from the City's WWTP. This data accounts for the solids being generated from the digesters prior to dewatering. They also account for solids reduction as a result of the WAS and MBR sludge going through the thickener, solids recycled into the process and solids volatilized from the digestion process.

Table 5-1: Projected Solids Production

Year	Solids Production	
	lbs/day	tons/day
2020 (baseline)	2950	1.48
2026 (sidestream MBR)	4800	2.4
2040 (sidestream MBR)	6400	3.2

5.1.4 Biosolids Overview

Biosolids are the nutrient-rich organic material resulting from the treatment of sewage at domestic wastewater treatment plants. Through biosolids management, solid residue from the wastewater treatment process is treated to reduce or eliminate pathogens and minimize odors, forming a safe, beneficial product for land application or disposal.

5.1.4.1 Federal Regulations

Biosolids treatment for disposal and beneficial use is regulated at the federal level by the EPA to ensure quality standards are met. Promulgated in 1993, Title 40 Code of Federal Regulations (CFR) Part 503 (40 CFR Part 503) set forth quality standards so that biosolids are protective of human health and the environment. Under these regulations, biosolids must meet risk based-pollutant limits and controls for pathogen reduction and vector attraction reduction. The rules also describe the requirements for land application, monitoring, testing, and reporting.

The federal regulations define two classes of biosolids based on pathogen reduction: Class B and Class A. Class B biosolids are treated but still contain detectable levels of pathogens. When utilizing Class B biosolids for land application, the site must be permitted. Agronomic application rates are specified and buffer requirements, public access restrictions, and crop harvesting restrictions must be met. This allows time for any pathogens that are present to be destroyed by environmental exposures to temperature changes, sunlight, drying, and competing soil microorganisms. Class A biosolids receive additional treatment and contain insignificant levels of pathogens. Class A biosolids have no restrictions on their use or sale to the public. A third category of biosolids is called Exceptional Quality (EQ) biosolids. Class A EQ biosolids meet the most stringent requirement for pathogens (Class A), vector control, pollutant concentrations, and are safe for unregulated use. In most cases when a facility refers to producing a “Class A biosolids product,” they meet the EQ designation as well.

The following sections describe requirements for treating biosolids to reduce pathogens, vector attraction reduction, pollutant concentrations (metals), as well as requirements for sampling and monitoring.

5.1.4.2 Class A Pathogen Reduction Requirements

Pathogen reduction can be achieved by treating solids prior to beneficial use or disposal and through environmental attenuation. Treatment processes are available that use a variety of approaches to reduce pathogens and alter the solids so that it is a less effective medium for microbial growth (EPA 2003). The 40 CFR Part 503 lists treatment technologies that are judged to produce biosolids with pathogens sufficiently reduced to protect public health and the environment. The regulation also allows the use of any other technologies that produce biosolids with adequately reduced pathogens as demonstrated through microbiological monitoring.

There are six alternative methods for demonstrating Class A pathogen reduction. The objective of all these requirements is to reduce pathogen densities to below detectable limits. In addition to undergoing a treatment process Class A biosolids must also be tested for bacteria.

Class A biosolids must meet one of the following bacteria limits and one of the process treatment alternatives:

Biosolids must comply with one of the following bacteria limits:

- Fecal coliform is less than 1,000 Most Probable Number (MPN) per gram of total solids (dry weight).
- *Salmonella sp*. bacteria density is less than 3 MPN per 4 grams total solids (dry weight).

Biosolids must meet one of the following treatment alternatives:

- Maintain the sludge at the time, temperature and percent solids determined by using the formula in [(EPA Class A alternative 1, per 503.32(a)(3)].
- Maintain the temperature of the sludge above 52 degrees Celsius (ºC) [(126 degrees Fahrenheit (ºF)] for 72 hours. The sludge must be above pH 12. Air dry the sludge to 50% solids or higher [(EPA Class A alternative 2, per 503.32(a)(4)].
- Use other treatment process to achieve the following: Enteric virus density must be less than 1 Plaque Forming Unit (PFU) per 4 grams of total solids (dray weight). Viable helminth ova density must be less than 1 per 4 grams of total solids (dry weight), [EPA Class A alternatives 3 or 4, per 503.32(a)(5) and (6)].
- Use a Process to Further Reduce Pathogens (PFRP) or equivalent treatment process approved by the permitting authority, [EPA Class A Alternative 5 or 6, per 503.32(a)(7) and (8)] (Table 5-2).

Table 5-2: Processes to Further Reduce Pathogens

Process	Requirement
Composting	Using either the within-vessel composting method or the static aerated pile composting method, the temperature of sewage sludge is maintained at 55ºC (131ºF) or higher for 3 consecutive days. Using the windrow composting method, the temperature of the sewage sludge is maintained at 55ºC (131ºF) or higher for 15 consecutive days or longer. During the period when the compost is maintained at 55ºC (131ºF) or higher, there shall be a minimum of five turnings of the windrow.
Heat Drying	Sewage sludge is dried by direct or indirect contact with hot gases to reduce the moisture content of the sewage sludge to 10% or lower. Either the temperature of the sewage sludge particles exceeds 80ºC (176ºF) or the wet bulb temperature of the gas in contact with the sewage sludge as the sewage sludge leaves the dryer exceeds 80ºC (176ºF).
Heat Treatment	Liquid sewage sludge is heated to a temperature of 180ºC (356ºF) or higher for 30 minutes.
Thermophilic Aerobic Digestion	Liquid sewage sludge is agitated with air or oxygen to maintain aerobic conditions and the mean cell residence time (i.e., the solids retention time) of the sewage sludge is 10 days at 55ºC (131ºF) to 60ºC (140ºF).
Beta Ray Irradiation	Sewage sludge is irradiated with beta rays from an electron accelerator at dosages of at least 1.0 megarad at room temperature (ca. 20ºC [68ºF]).
Gamma Ray Irradiation	Sewage sludge is irradiated with gamma rays from certain isotopes, such as Cobalt 60 and Cesium 137, at dosages of at least 1.0 megarad at room temperature (ca. 20ºC [68ºF]).
Pasteurization	The temperature of the sewage sludge is maintained at 70ºC (158ºF) or higher for 30 minutes or longer.

5.1.4.3 Class B Pathogen Reduction Requirements

The alternatives for Class B biosolids consist of either a treatment process, such as a Process to Significantly Reduce Pathogens (PSRP) or a fecal coliform bacteria limit, as follows:

Biosolids must comply with the following bacteria limit:

- The geometric mean of the density of fecal coliform must be less than 2,000,000 MPN, per gram of total solids (dry weight).

Biosolids must undergo one of the following PSRP's Listed in Appendix B of 40 CFR Part 503 or an equivalent treatment method approved by the permitting authority (Table 5-3).

Table 5-3: Process to Significantly Reduce Pathogens

Process	Requirement
Aerobic Digestion	Sewage sludge is agitated with air or oxygen to maintain aerobic conditions for a specific mean cell residence time (i.e., solids retention time) at a specific temperature. Values for the mean cell residence time and temperature shall be between 40 days at 20ºC (68ºF) and 60 days at 15ºC (59ºF).
Air Drying	Sewage sludge is dried on sand beds or on paved or unpaved basins. The sewage sludge dries for a minimum of 3 months. During 2 of the 3 months, the ambient average daily temperature is above 0ºC (23ºF).
Anaerobic Digestion	Sewage sludge is treated in the absence of air for a specific mean cell residence time (i.e., solids retention time) at a specific temperature. Values for the mean cell residence time and temperature shall be between 15 days at 35ºC to 55ºC (131ºF) and 60 days at 20ºC (68ºF).
Composting	Using either the within-vessel, static aerated pile, or windrow composting methods, the temperature of the sewage sludge is raised to 40ºC (104ºF) or higher and remains at 40ºC (104ºF) or higher for 5 days. For 4 hours during the 5-day period, the temperature in the compost pile exceeds 55ºC (131ºF).
Lime Stabilization	Sufficient lime is added to the sewage sludge to raise the pH of the sewage sludge to 12 for ≥2 hours of contact.

5.1.4.4 Vector Attraction Reduction Requirements

The pathogens in biosolids may pose a disease risk only if there are routes by which the pathogens are brought into contact with humans or animals (EPA 2003). A primary route for transport of pathogens is vector transmission. Vectors are any living organism capable of transmitting a pathogen from one organism to another either mechanically or biologically by playing a specific role in the life cycle of the pathogen. Vectors for pathogens would most likely include insects, rodents, and birds.

Vector attraction reduction is accomplished by implementing one of the following:

- Biological processes which breakdown volatile solids, reducing the available nutrients for microbial activities and odor producing potential
- Chemical or physical conditions which stop microbial activity
- Physical barriers between vectors and volatile solids in the solids.

The term “stability” is often used to describe sewage sludge or biosolids. Although it is associated with vector attraction reduction, stability is not regulated by 40 CFR Part 503. Stability is generally defined as the point at which food for microbial activity is no longer available (EPA 2003). Solids which are stable will generally meet vector attraction reduction but does not ensure they are stable. Because stability is also related to odor generation and the continued degradation of solids, it is often considered an important parameter when producing Class A biosolids for sale or distribution.

Biosolids must undergo one of the vector attraction reduction options set forth in 40 CFR Part 503, shown in Table 5-4 below.

Table 5-4: Vector Attraction Reduction Options

VAR Option	Requirement	Most Appropriate for the Following
Option 1 503.33(b)(1)	At least 38% reduction in volatile solids during sewage sludge treatment	Sewage sludge processed by: anaerobic or aerobic biological treatment
Option 2 503.33(b)(2)	Less than 17% additional volatile solids loss during bench-scale anaerobic batch digestion of the sewage sludge for 40 additional days at 30ºC to 37ºC (86ºF to 99ºF)	Only for anaerobically digested sewage sludge that cannot meet the requirements of Option 1
Option 3 503.33(b)(3)	Less than 15% additional volatile solids reduction during bench-scale aerobic batch digestion for 30 additional days at 20ºC (68ºF)	Only for aerobically digested liquid sewage sludge with 2% or less solids that cannot meet the requirements of Option 1 – e.g., sewage sludges treated in extended aeration plants. Sludges with 2% or greater solids must be diluted.
Option 4 503.33(b)(4)	SOUR at 20ºC (68ºF) is ≤ 1.5 mg oxygen/hr/g total sewage sludge solids	Liquid sewage sludges (2% or less solids) from aerobic processes run at temperatures between 10 to 30ºC (should not be used for composted sewage sludges)
Option 5 503.33(b)(5)	Aerobic treatment of the sewage sludge for at least 14 days at over 40ºC (104ºF) with an average temperature of over 45ºC (113ºF)	Composted sewage sludge (For sewage sludges from other aerobic processes, it will likely be easier to meet option 3 or 4)
Option 6 503.33(b)(6)	Addition of sufficient alkali to raise the pH to at least 12 at 25ºC (77ºF) and maintain a pH ≥ 12 for 2 hours and a pH ≥ 11.5 for 22 more hours	Alkali-treated sewage sludge (alkaline materials include lime, fly ash, kiln dust, and wood ash)
Option 7 503.33(b)(7)	Percent solids ≥ 75% prior to mixing with other materials	Sewage sludges treated by an aerobic or anaerobic process (i.e., sewage sludges that do not contain unstabilized solids generated in primary wastewater treatment)
Option 8 503.33(b)(8)	Percent solids ≥ 90% prior to mixing with other materials	Sewage sludges that contain unstabilized solids generated in primary wastewater treatment (e.g., heat-dried sewage sludges)

VAR Option	Requirement	Most Appropriate for the Following
Option 9 503.33(b)(9)	Sewage sludge is injected into soil so that no significant amount of sewage sludge is present on the land surface 1 hour after injection, except Class A sewage sludge which must be injected within 8 hours after the pathogen reduction process	Sewage sludge applied to the land or placed on a surface disposal site. Domestic septage applied to agricultural land, a forest, or a reclamation site, or placed on a surface disposal site
Option 10 503.33(b)(10)	Sewage sludge is incorporated into the soil within 6 hours after application to land or placement on a surface disposal site, except Class A sewage sludge which must be applied to or placed on the land surface within 8 hours after the pathogen reduction process	Sewage sludge applied to the land or placed on a surface disposal site. Domestic septage applied to agricultural land, forest, or a reclamation site, or placed on a surface disposal site

5.1.4.5 Pollutant Concentration Requirements

Biosolids for beneficial use must meet risk-based pollutant limits to protect public health and the environment. The 40 CFR Part 503 rules (section 503.13) set regulatory limits for certain pollutants (metals) and requires biosolids be used in accordance with approved management practices including operational standards, monitoring, recordkeeping, and reporting.

The nine pollutants regulated are: arsenic, cadmium, copper, lead, mercury, molybdenum, nickel, selenium, and zinc. These limits determine whether a permit is needed for land application. The regulatory limits include the following:

Ceiling Concentration Limits

This is the maximum concentration of each pollutant allowed in biosolids for beneficial use. According to 40 CFR Part 503, biosolids containing any pollutant that exceeds the Ceiling Concentration Limits (CCLs) cannot be beneficially used. This is also known as EPA Table 1, which is shown in the second column of Table 5-5 below.

Cumulative Pollutant Loading Rate

The Cumulative Pollutant Loading Rate (CPLR) is the maximum amount of a pollutant that can be applied to a site over its lifetime by all biosolids applications meeting ceiling concentration limits. Biosolids applications must be discontinued when any one of the pollutants reaches its maximum CPLR. This is also known as EPA Table 2, which is shown in the third column of Table 5-5 below.

Pollutant Concentration Limits

The Pollutant Concentration Limits (PCLs) are used along with the pathogen reduction and vector attraction reduction requirements as quality standards for EQ biosolids. Biosolids with pollutant concentrations below the PCLs can be sold or given away without a permit from EPA or Ecology. Biosolids with pollutant concentrations above the PCL require a permit, applied at agronomic rate, and the cumulative amounts of pollutants must be tracked. This is also known as EPA Table 3, which is shown in the fourth column of Table 5-5 below.

Annual Pollutant Loading Rate

The Annual Pollutant Loading Rate (APLR) sets the maximum amount of a pollutant that can be applied during a 365-day period. These rates apply to non-EQ biosolids. This is also known as EPA Table 4, which is shown in column 5 of Table 5-5 below.

Table 5-5: Pollutant Limits and Loading Rates for Biosolids

Pollutant[a]	Ceiling Concentration Limits, EPA Table 1 (mg/kg) [b]	Cumulative Pollutant Loading Rate Limits, EPA Table 2 (mg/kg)[b]	Pollutant Concentration Limits, EPA Table 3 (mg/kg)[b]	Annual Pollutant Loading Rate Limits, EPA Table 4 (mg/kg/365-d-period)[b]
Arsenic	75	41	41	2.0
Cadmium	85	39	39	1.9
Copper	4,300	1,500	1,500	75
Lead	840	300	300	15
Mercury	57	17	17	0.85
Molybdenum	75	(c)	(c)	(c)
Nickel	420	420	420	21
Selenium	100	100	100	5.0
Zinc	7,500	2,800	2,800	140

Notes:

(a) Source: EPA 40 CFR part 503; University of Georgia Extension (March 2017).
(b) Dry-weight basis: mg/kg - milligrams per kilogram; kg/ha - kilograms per hectare.
(c) February 25, 1994, 40 CFR Part 503 Rule Amendment deleted the molybdenum limits but retained the molybdenum CCL.

5.1.4.6 State Regulations

In addition to federal requirements, Washington State also implements regulations overseeing the production and use of biosolids. Ecology developed its own biosolids regulations in 1998 and updated them in 2007. The state rule, Chapter 173-308 WAC incorporates all the legal requirements in 40 CFR Part 503 but goes further to require specific plans for land application and additional public notice requirements.

Chapter 70.95J RCW, recognizes biosolids as a valuable commodity and directs Ecology to implement a program that maximizes beneficial use. Ecology regulates biosolids programs by issuing permits, requiring mandatory reporting, tracking biosolids quality, and conducting enforcement activities, if required.

When evaluating biosolids program alternatives it is important that all end uses meet the federal and state regulatory requirements. WAC 173-308-080 defines the beneficial use of biosolids as "application to land for the purposes of improving soil characteristics including tilth, fertility, and stability, and enhancing the growth of vegetation consistent with protecting human health and the environment." The state does not allow landfilling of biosolids except as an emergency practice. Class B land application and Class A product giveaway and sale both are considered beneficial use.

5.1.4.7 Future Biosolids Regulations

As part of this Study, the City and the Team contacted Ecology biosolids program staff to discuss their opinion regarding current and future trends in biosolids management. The staff at Ecology mentioned there is a general trend of moving from Class B to Class A or EQ programs in Washington. The trend allows more flexibility in biosolids product use, protects against any unforeseen regulatory changes and common public perception issues encountered with Class B land application. Also, there is continued public perception challenges in Western and Central Washington. Concerns are focused on odor, emerging contaminants, and lack of regulatory oversight.

When discussing potential future regulatory requirements, Ecology staff stated they did not foresee any immediate changes to the state rules. They believe that much of the challenges associated with managing biosolids is the result of increased growth in rural areas. The urbanization of Western Washington will continue to result in less local Class B land application sites and thus, more reliance on distant land application or Class A options for municipalities. On a federal level, new requirements will be implemented requiring utilities to test for Per- and polyfluoroalkyl substances (PFAS). The EPA, however, has yet to choose an approved method for sampling for this compound. In October 2020, Ecology issued *"Per- and Polyfluoroalkyl Substances Draft Chemical Action Plan"* which describes recommendations for the agency to complete gaps associated with biosolids data. The document discusses nine recommendations for Ecology in order to obtain additional data. A few examples include working with municipalities to sample and test PFAS, develop appropriate soil testing methodologies, and evaluate the existing risk assessment approach. Presumably, Ecology will be proactively reaching out to the City to coordinate potential sampling and testing for PFAS.

It is important to note that in 2002 the EPA took a mostly neutral position on beneficial use of biosolids and now equally promotes other end uses such as landfilling and incineration *(Office of Inspector General, Status Report, Land Application of Biosolids, 2002-S-000004, March 2002)*. This policy position has resulted in a visibly lower level of support to states and municipalities engaged in beneficial use.

5.1.5 City of Monroe's Existing Biosolids Program

The City currently generates a Class B biosolids dewatered cake product. The primary and secondary solids are thickened via a disc thickener prior to stabilization in three aerobic digesters. Two primary digesters are operated in parallel followed by one secondary digester in series. This provides an aerobic treatment volume of approximately 240,000 gallons. The retention time of the digesters is less than the 40 days required to achieve the 40 CFR Part 503 pathogen destruction and the minimum 38% volatile solids destruction requirement to meet EPA's VAR standard. However, significant solids stabilization is occurring in the aeration basins. The City meets Class B requirements by testing the biosolids for pathogen reduction. After the digesters, the solids are dewatered using a Belt Filter Press to produce a dewatered cake with

12 to 16% solids content. Once dewatered, the solids are transported offsite and stored at the former compost facility located at the Washington State DOC's Monroe Correctional Complex or maintained at the WWTP. A third-party contractor hauls the stored biosolids to Central Washington and are land applied at an Ecology permitted Beneficial Use Facility. The VAR requirements are met by incorporating the biosolids into the soil and the land application site. Relying on soil incorporation presents a significant regulatory and potential public perception issue for the City. The City produced and land applied 343 and 396 dry tons (DT) of Class B biosolids in 2019 and 2020, respectively.

5.1.6 Biosolids Program Issues and Risks

The City has identified several areas of concern within their current biosolids program, as follows:

1) As stated in the previous section of this report, the current capacity of the aerobic digesters achieves an insufficient hydraulic retention time (HRT) to completely stabilize the biosolids. This lack of capacity results in the City having to solely rely on a third-party contractor to properly incorporate the unstabilized solids at the land application site in order to meet federal and state VAR requirements for Class B biosolids. This poses significant risk to the City for several reasons:

    a) If there was a spill the resultant clean-up would be problematic from a public health and environmental protection (e.g., water quality) perspective.

    b) Handling of the unstabilized solids poses a greater risk to human health because the material has a greater density of volatile solids and adequately digested biosolids.

    c) Incorporation of solids requires more resources (i.e., fuel and labor) than land applying a stabilized biosolids product.

    d) Solids that do not meet VAR requirements and thus, must be incorporated into the soil, limit the number and types of crops that can receive the City's biosolids. This narrows the marketability for the Class B biosolids and poses a public acceptance risk for this practice.

    e) There are concerns about the viability and performance of soil incorporation at the land application site. For example, incorporation may not occur when there are equipment failures or weather issues; thus, resulting in federal and state regulatory compliance issues and additional risk to human health and the environment.

    f) To meet Class B requirements by aerobic digestion, additional treatment volume is required to treat current flows.

2) The City has been utilizing a third-party contractor to transport dewatered Class B biosolids to Central Washington for land application for many years. This has been relatively successful process; however, there are existing issues and concerns impacting this

approach for long-term biosolids management. The following are some of the specific issues and concerns:

a) The largest markets for Class B biosolids are in Douglas and Yakima Counties, where farmer-owned companies receive and manage the application of biosolids on their own farmland to primarily grow wheat crops. The Central Washington market for biosolids has been reliable and stable for more than 20 years; however, the location requires regular truck deliveries across the mountain passes year-round. Fluctuating fuel costs will continue to impact costs for the City's program.

b) Each winter mountain passes are closed due to inclement weather. During these periods the City's biosolids are diverted to Republic Services' Roosevelt Regional Municipal Solid Waste Landfill in Klickitat County. These diversions can occur anytime the passes are closed and result in unplanned costs the City.

c) Many farmers in Central Washington are converting to organic practices; thus, preventing the use of biosolids under the national Organic Food Production Act.

d) The price of wheat is declining coupled with an increase (i.e., 3%) in wheat production. This indicates there may be a decreased demand for biosolids use on these crops.

e) Precipitation levels in the Central Washington area is decreasing which results in the build-up of phosphorus in the soil over time. Accumulation of phosphorous requires farmers to rotate fields more often, potentially eliminating the use of biosolids on some fields and moving operations further east (e.g., Lincoln County).

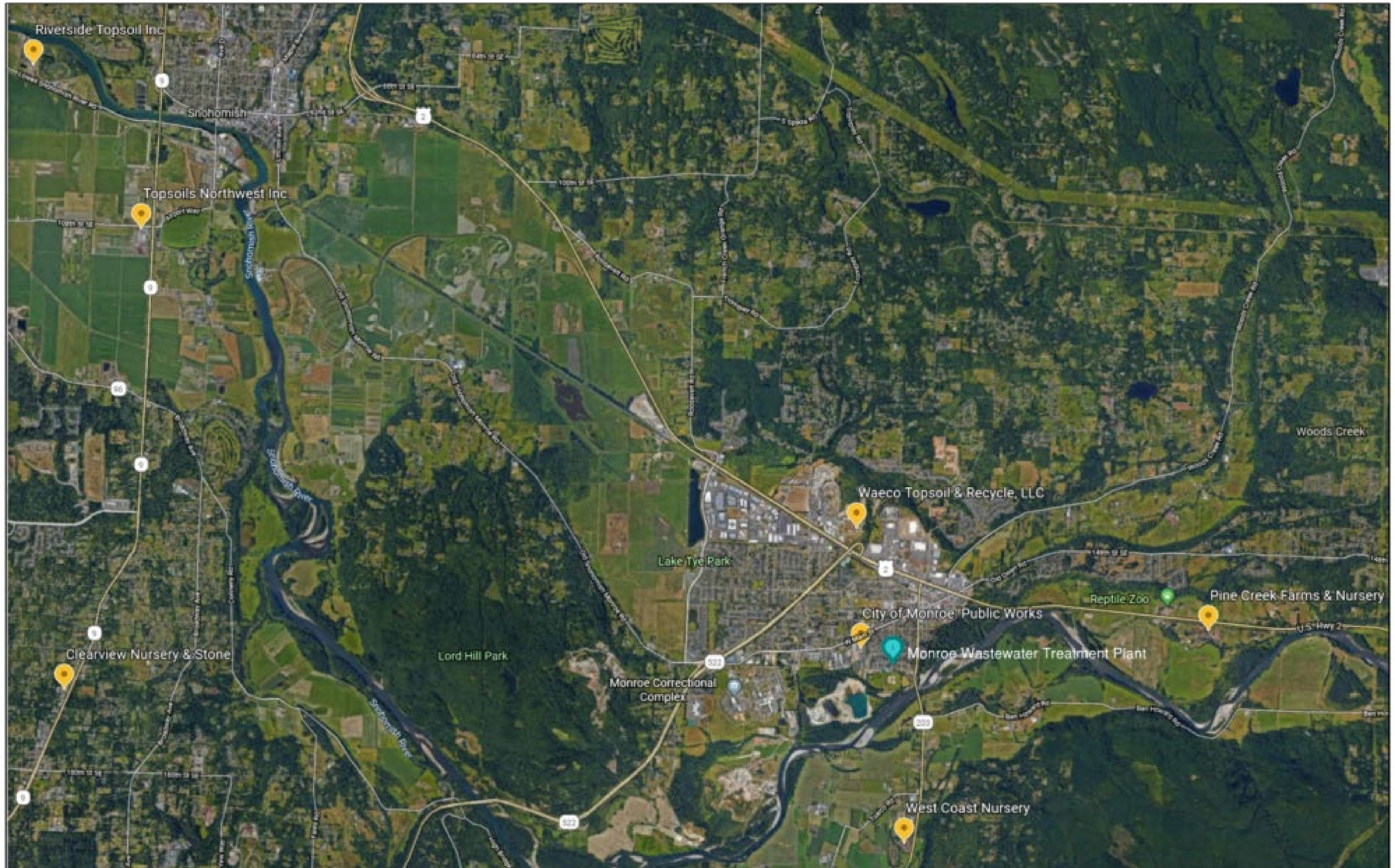
5.2 Biosolids Market Assessment

It was determined that conducting an extensive Class A biosolids market study was not necessary at this time. The multiple examples of successful Class A biosolids programs throughout the Pacific Northwest is evident of the likely demand for a quality biosolids product and future demand for soil amendments.

To understand the potential market for a Class A dried biosolids product (preferred alternative) the Team conducted a search for existing businesses and government agencies that may be interested in using the City's product (see Figure 5-1 below). The Team recommends the City elaborate on this work prior to a preliminary design phase for the installation of a Class A biosolids facility (i.e., dryer). This elaboration will allow the City to contact the entities listed within the market assessment to determine specific interest in using Class A biosolids.

The market assessment included potential biosolids markets such as local nurseries, soil manufacturing companies, and government organizations within approximately 20 miles from the City's WWTP. The distance was selected because it is a short drive to-and-from the WWTP. Within the 20-mile radius of the WWTP there are currently seven established commercial nurseries and topsoil manufacturers that use soil amendments in some manner at their respective business. This includes as potting soil to grow plants, trees, and shrubs, or in the production of topsoil blends for commercial and residential applications throughout Snohomish County.

In addition, the Washington DOC owns and operates the Monroe Correctional Complex which maintains several acres of landscaped ground and is familiar with the City's former biosolids compost operation and product. Other potential government partners may include the City's own parks department which owns and operates 14 parks within the City limits. The Washington Department of Transportation owns and operates over 1,650 miles of roads and is a large user of soil amendments for its landscaped facilities (e.g., highway interchanges, and rest stops).



Potential Biosolids Markets	
Nursery or Soil Manufacturers	Approximate driving distance from WWTP (in miles)
West Coast Nursery	2
WAECO Topsoil & Recycle	2
Pine Creek Farm & Nursery	4
Riverside Topsoil (Snohomish)	10
Topsoil Northwest (Snohomish)	10
Pacific Topsoils (Snohomish)	10
Clearview Nursery & Stone	11
Intergovernmental Coordination	Potential End Uses
Department of Corrections	Landscape use onsite
Monroe Public Works	14 Public Parks
WSDOT	1,650 miles or roadways in Snohomish County

Kennedy/Jenks Consultants

City of Monroe

N

Class A Biosolids Market Assessment

Project Number: 1997002*00
November 2019

Figure 5-1: Class A Biosolids Market Assessment

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5.3 Biosolids Management Alternatives

National, regional, and local wastewater management is shifting to manage residuals derived from treatment facilities as a commodity to be beneficially used rather than as a liability to be disposed. Examples of this include nutrient removal systems for phosphorus, an increase in Class A biosolids products, gas recovery systems, and recycled water programs. A biosolids program can provide multiple benefits to a utility including revenue from the biosolids product and additional resource recovery.

The following section is a discussion of different biosolids treatment options and management alternatives. Each treatment technology and biosolids end use were evaluated to identify a biosolids program that is cost-effective, sustainable, and in alignment with the City's goals. As directed by the City, we have focused on treatment and management alternatives that beneficially use biosolids rather than disposal via landfilling or incineration.

5.3.1 Stabilization Technology – Digestion

Digestion is a process technology utilizing microbes for stabilizing wastewater solids, so the biosolids are safe for use. The benefits of digestion include pathogen reduction, volatile solids destruction, solids volume reduction, and odors. There are two types of digestion used within the wastewater industry including: aerobic and anaerobic. The primary difference between the two technologies is the type of microbial organisms utilized for stabilizing the wastewater solids, as discussed further below.

Although there was specific interest by the City in maintaining focus on the existing aerobic conventional digestion process, there was an agreement to evaluate other stabilization processes to ensure that other opportunities were not overlooked. Five stabilization processes were considered including two that can produce Class B biosolids and three that can achieve Class A biosolids standards. These technologies included: Conventional Aerobic Digestion (City's existing process), Conventional Anaerobic Digestion, Thermophilic Anaerobic Digestion, Acid Phase Anerobic Digestion, and Autothermic Anaerobic Digestion. The following is a discussion of these stabilization technologies.

5.3.1.1 Conventional Aerobic Digestion

Aerobic digestion is defined as the biological conversion of organic matter in the presence of air (or oxygen). During Aerobic Digestion, bacteria convert organic matter to carbon dioxide, water, ammonia, new cellular biomass, and energy through oxidation.

Advantages of aerobic treatment include simpler operational requirements compared to the anaerobic treatment process. An aerobic system, however, produces no usable gas and is energy intensive due to the power requirements for mixing and oxygen transfer. Furthermore, the retention time required to stabilize the biosolids using Aerobic Digestion is approximately double the retention time required for biosolids stabilization anaerobically. Conventional Aerobic Digestion produces a Class B biosolids product.

The advantages of Aerobic Digestion include:

- Simpler operation requirements
- City currently utilizes this technology
- Supernatant BOD concentrations are lower relative to anerobic digestion.

The disadvantages of Aerobic Digestion include:

- Requires a larger treatment footprint to achieve a hydraulic retention time of over 40 days to meet Class B biosolids requirements
- Relatively inferior dewatering characteristics
- High energy usage rates due to operation of mixers and blowers.

5.3.1.2 Conventional Anaerobic Digestion

Anaerobic Digestion is a biological process in which anaerobic bacteria convert organic matter into biogas, containing methane and carbon dioxide, in the absence of oxygen. The process stabilizes the organic matter in wastewater solids, reduces pathogens and odors and reduces total solids quantity. Solids are reduced by converting the volatile solids fraction of the wastewater into biogas. Anaerobic digesters for the City's WWTP would likely be operated in the mesophilic temperature range between 95 and 104°F, producing Class B biosolids.

The advantages of Anaerobic Digestion include:

- Lower retention times of 15 to 20 days to meet stabilization requirements using the existing aerobic tankage volume
- Offsets plant energy use by generating biogas which can be used instead of purchasing fossil fuel
- Could potentially allow acceptance of outside feedstocks for co-digestion [e.g., fats, oils, and grease (FOG) and Food Waste] that would provide additional tipping fees and increase gas production.

The disadvantages of Anaerobic Digestion include:

- More operationally complex relative to aerobic digestion
- Upgrading to anaerobic digestion can be costly and the payback in resource recovery is typically achieved for flows greater than 5 MGD
- Requires additional equipment.

5.3.1.3 Advanced Anaerobic Digestion

The other digestion processes, Thermophilic Anaerobic Digestion, Acid Phase Anerobic Digestion, and Autothermic Anaerobic Digestion can produce Class A biosolids. In general, this is achieved through modifying the digesters to operate in multiple stages optimizing the digestion process. These technologies use higher temperatures and/or acidic conditions at different stages to vary the microbial communities and achieve a higher level of stabilization.

The advantages of Advanced Anaerobic Digestion include:

- Produces a Class A biosolids product
- Some systems can produce Class B or Class A biosolids
- Can produce more energy (i.e., methane) than conventional anaerobic process.

The disadvantages of Advanced Anaerobic Digestion include:

- Significant capital investment to install these technologies
- Even more complex operation and maintenance than conventional anaerobic digestion
- Most require extra tanks; thus, having larger footprints
- Applicable only for wastewater plants treating higher flows.

5.3.2 Dewatering Technologies

After the stabilization process, the water content in the solids is reduced by a dewatering process. During dewatering, the water content is mechanically decreased, and the solids concentration increases from approximately 4% to between 16 and 22%, by weight, depending on the dewatering process selected. At this point, the biosolids product is a black, semisolid, soil-like, carbon- and nutrient rich material generally referred to as “dewatered biosolids cake.”

Five dewatering technologies were considered in this Study including: rehabilitation of the existing Belt Filter Press, new Belt Filter Press, Centrifuge, Fan Press, and Screw Press. All these technologies are used in the municipal wastewater industry and have a track record of operation. Two of the technologies were included for further evaluation including a new Belt Filter Press and Screw Press.

5.3.2.1 Belt Filter Presses

Belt Filter Presses are dewatering devices that use the principles of chemical conditioning, gravity drainage, and mechanically applied pressure to dewater solids. In a dewatering process, polymer is added to flocculate the solids. The flocculated solids are then distributed on a gravity belt section where the free water drains through a moving, porous fabric belt (like gravity belt thickeners). The solids are then pressed between two belts as the belts move in a serpentine pattern over a series of rollers. Each pass over a roller provides additional pressing force and removes additional water. A scraper blade removes the final dewatered cake from the belts.

Filtrate is returned to the liquid treatment process and the dewatered solids are conveyed to storage. When using polymer, typically belt filter presses can produce cake with approximately 16 to 18% solids content and can usually capture more than 95% of the solids. An example of a Belt Filter Press is shown on Figure 5-2 below.

Figure 5-2: Belt Filter Press

The advantages of Belt Filter Presses include:

- City currently utilizes this technology
- Operation and maintenance are simple, and adjustments can be made to the process as the solids are visible on the belt
- Fits within their current building footprint.

The disadvantages of Belt Filter Presses include:

- It is an open-air process that generates significant odors
- Requires daily washdown
- Generally, produces a dewatered cake with lower solids content (e.g., 16 to 18%) relative to other technologies.

5.3.2.2 Screw Presses

Screw Presses consist of a tapered screw with a surrounding screen. Solids are conveyed down the length of the screw and dewatered through compression between the tapered screw and the reducing diameter of the surrounding screen. In a Screw Press operation, just as in a Belt Filter

Press, polymer is added to flocculate the solids just prior to entering the screw press. The polymer feed rate is set proportional to the speed of the solids feed to maintain the proper polymer ratio. Typical polymer requirements are like those of a Belt Filter Press. The flocculated solids overflow the flow-through process and drop into the head box on the top of the unit. If the head box fills too high, the feed rate is cut back. Solids move through the unit along the length of a tapered screw enclosed by an outer screen with a reducing diameter. The dewatering is accomplished as gravity drainage allows the filtrate to fall out of solution. As solids moves along the screw, the internal pressure increases, forcing water to drain out through the outer screen. The typical dewatering performance of a Screw Press ranges from 16 to 20% total solids. An example of a Screw Press is shown on Figure 5-3 below.

Figure 5-3: Screw Press (Source: FKC)

The advantages of Screw Presses include:

- The speed of the screw is slow and consequently the units experience low wear and require minimal maintenance
- Requires lower energy than other dewatering technologies
- Operation can be automated
- Minimal cleanup, washdown can be as infrequent as once a week.

The disadvantages of Screw Presses include:

- Slightly larger footprint than Belt Filter Presses
- Lower solids capture efficiency (less than 95%)
- Potentially slightly higher polymer use relative to belt filter presses.

5.3.3 Additional Treatment: Class A Products

Class A biosolids treatment processes can be added to the existing solids treatment system at the City's WWTP to further reduce pathogens and thus, further stabilize the biosolids. Class A biosolids can be land applied without restriction or can be distributed directly to the public for use in landscaping, gardens, and other applications. Class A biosolids provide the City with significantly more flexibility in how to manage its solids program and provides the potential to obtain revenue from the distribution or sale of the final product.

Three Class A biosolids treatment alternatives were considered in this Study. They include Composting, Heat Drying (dryers), and Lime-Heat Pasteurization.

5.3.3.1 Class A Biosolids Composting – Aerated Static Pile

Composting is one of several methods for treating biosolids to create a marketable product that can be applied as a soil amendment and fertilizer to gardens and crops of all varieties. Biosolids compost is safe to use and generally has a high degree of acceptability by the public. Thus, it competes well with other bulk and bagged products available to homeowners and the marketplace.

Composting typically requires mixing biosolids with a carbonaceous bulking agent such as sawdust, wood chips, or ground woody yard debris. Composting is a treatment process that uses time and temperature to produce a final product that meets Class A pathogen reduction criteria.

For the purposes of this study, we have chosen to focus on the ASP composting process because it is a well-established and applicable method used for biosolids. The ASP process maintains aerobic conditions by blowing air through the piled media instead of physical manipulation of the material. Compost can be distributed in bulk for commercial use or bagged and sold in smaller quantities directly to the public. The beneficial use of Class A biosolids compost is relatively well known in the marketplace with several utilities nationwide relying on this process for treating biosolids. Costs for producing biosolids compost can be variable. For example, costs can be significantly higher if bulking material (e.g., wood chips, yard debris, etc.) must be purchased. An example of the ECS composting system is shown on Figure 5-4 below.

(Source: ECS)

Figure 5-4: ECS Composting System

Advantages of composting include the following:

- Composting biosolids is a relatively simple reliable technology
- Composting produces a highly marketable Class A product that is typically well accepted by the public
- Composting can be gradually phased-in with additional compost piles added over time
- The City could generate the biosolids product close to the intended market reducing annual hauling costs.

Disadvantages of composting include the following:

- Total volume of material will be greater than other alternatives because of the addition of bulking material (e.g., wood chips or yard debris) needed for the composting process
- Operations typically require additional well-trained staff
- Odor management, material management, and product distribution requirements must be considered among other criteria
- Additional land may need to be purchased for construction of a composting facility depending on overall goals for this type of treatment process.

5.3.3.2 Class A Heat Drying

Thermal drying technology removes water via evaporation from dewatered biosolids, reducing the volume and weight. The thermal energy used for drying is generated by combustion of natural gas but can be offset using waste heat from combustion of digester gas. The high temperatures utilized by a dryer ensure the EPA's time and temperature requirements for Class A biosolids are met. Thermal drying results in a material with a solids content greater than 90%.

A thermally dried Class A biosolids product has universal applications. The dried biosolids can be supplemented for fuel, land-applied for reclamation and other soil improvement projects or blended with other materials to create topsoil. Heat drying can be accomplished by one of two main drying technologies: direct or indirect dryers.

Direct Belt Dryer

Based on market performance and hazards associated with other types of direct drying, we have focused our discussion on direct drying to belt dryers. A belt dryer is a direct dryer that drives heated air directly over and around digested dewatered solids. The belt drying system distributes dewatered cake onto a slow-moving belt, allowing for high surface area exposure to the hot air. The circulation of the heated air around the biosolids evaporates the water. A portion of the air (70 to 90%) is recycled back through the process. The remainder is discharged via exhaust which requires treatment with air pollution control equipment to remove odors and destroy volatile organic compounds (VOCs). Belt dryers utilize multiple stacked belts to minimize the size of the unit. This convective dryer operates on a continuous or flow through basis. Belt dryers typically produce a product with a solids content of greater than 90%. The heating chamber requires temperatures around 150 to 200°F compared to other direct dryer counterparts that can exceed 750°F.

Indirect Dryer

The heat in indirect dryers does not come into direct contact with the biosolids. Instead, a mixing element is used to transfer heat. In a paddle dryer, hollow metal paddles are used to dry the biosolids. Operation of a paddle-dryer requires startup prior to drying of the feed solids, to allow the paddles to come up to temperature. Dewatered biosolids are fed to the dryer shaft and pass in a helical pattern through the dryer. Drying occurs as the biosolids particles are broken-up through agitation and contact the heated metal surfaces in the dryer. These dryers are fueled by fossil fuels, natural gas, or biogas. The product is typically granular and varies in size. The exhaust from the dryer is sent to a condenser where water vapor is removed and sent back to the wastewater treatment plant. The small amount of air flow (containing some odors and VOCs) is sent to the furnace for use as combustion air. An example of a Sülzle Klein belt dryer is shown on Figure 5-5 below.

(Source: Centrisys/TEC)

Figure 5-5: Sülzle-Klein Belt Dryer

Advantages of dryers include the following:

- The dry product onsite storage footprint is very small (approximately 4% compared to a composting process)
- The cost of transporting is significantly reduced due to the volume reduction of the final biosolids product

- Relatively low energy demand of belt dryers
- Dryer facilities could be located onsite at the WWTP eliminating the need for acquisition or lease of additional land
- The City could generate the biosolids product close to the intended market reducing the risks associated with hauling over mountain passes
- The final biosolids product can be marketed for use as a soil amendment, fertilizer, or as an additive to topsoil blends.

Disadvantages of dryers include the following:

- Odor management requirements must be considered among other criteria
- Some solids treatment processes are not conducive to drying applications (e.g., can result in an odorous biosolids product).

5.3.3.3 Lime Heat Pasteurization

The combination of elevated pH coupled with high temperatures in a solids mixture creates an inhospitable environment that desiccates pathogenic organisms. This process is often referred to as lime stabilization or lime pasteurization. Lime stabilization is carried-out by mixing lime [quick lime, CaO or hydrated lime, Ca(OH)2] with dewatered solids/sludge. The pathogenic organisms in the solids die due to the high pH (12 or higher) assisted by the pasteurizing temperatures achieved by the exothermic nature of the reaction of lime with the water in the solids/sludge mixture.

Lime stabilized biosolids are suitable for application to agricultural land because of their liming value, although application rates may be limited by the lime content. The optimum application rate is site specific. The optimum lime to biosolids ratio needs to be determined for each specific facility. The lime requirement will depend on the type of solids/sludge, organic composition, and solids concentration. Odor can be an issue if the high pH is not maintained and septic conditions exist. An example of a lime-heat pasteurization system is shown on Figure 5-6 below.

(Source: RDP Technologies)

Figure 5-6: Lime-Heat Pasteurization System

Advantages of lime heat pasteurization include the following:

- Lime heat pasteurization facilities could be located onsite at the WWTP eliminating the need for acquisition of additional land
- Lime heat pasteurization produces Class A biosolids with a significant lime content that is desirable for agricultural land application.

Disadvantages of lime heat pasteurization include the following:

- Although less than composting, lime heat pasteurization produces significantly more solids than drying. This is because of the addition of lime (e.g., 40% by weight) and because the process removes little water from the biosolids
- The end-product can have increased odors when wetted.
- Lime costs can be extremely volatile and have increased significantly over time. This leads to greater uncertainty in terms of future operating costs
- Lime heat pasteurization is a mechanically intensive process with increased potential for failure
- Lime handling can pose worker safety risks.

5.3.4 Biosolids End Use

The following is a discussion of biosolids markets or end uses.

5.3.4.1 Class B Land Application

The land application of Class B biosolids has occurred in Washington for decades and over 85% of the biosolids produced in the state is used as a fertilizer or soil amendment (Ecology 2019). The practice typically involves farmers or a beneficial use facility contracting with a municipality that produces the biosolids to receive, and, in some cases, manage the material once it has been delivered to the property. Farms benefit from the nutrients and carbon from the biosolids, as well as the increased soil moisture holding capacity realized by the addition of biosolids.

The largest markets for Class B biosolids are in Douglas and Lincoln Counties, where farmer-owned companies receive and manage the application of biosolids on their own farmland to primarily grow wheat crops. The Central Washington market for biosolids has been reliable and stable for more than 15 years; however, the location requires regular truck deliveries across the mountain passes year-round. Fluctuating fuel costs and winter closures of the mountain passes has significant impacts on the program. The future of biosolids application in these counties is less certain. Many farmers are converting to organic practices and the price of wheat is declining indicating that demand for biosolids may decrease in the immediate future. In addition, it has been recently discovered that phosphorus is accumulating in the soil following repeated biosolids applications. To prevent phosphorus buildup, farmers will require a longer fallow period between repeat applications on land.

Advantages of a Class B land application include:

- Commonly a least cost option for beneficial use of biosolids
- A historically acceptable nutrient and amendment source for farmers.

Disadvantages of a Class B land application include:

- Public perception of Class B land application has significantly decreased over the past 20 years and has resulted in the reduction of sites available in Western Washington
- Urban sprawl has resulted in the reduction of sites available in Western Washington
- Hauling distances have increased over the years (e.g., Western to Eastern Washington)
- Limitations from inclement weather and transportation route policies have resulted in the lack of transportation routes during winter months
- Regulatory monitoring requirements for land application sites

- Continued need for application sites and ongoing public outreach with farmers and neighboring property owners
- Reliance on third-party contract haulers.

5.3.4.2 Class A Product for Community Giveaway or Local Sale

Class A biosolids can be land applied without restriction or can be distributed directly to the public for use in landscaping and gardens. Class A biosolids provide the City with significantly more flexibility in how to manage the solids program and provides the potential to obtain revenue from the distribution or sale of the final product. In addition, the City would remain in control of the product quality as they will not have to rely on a third-party contractor to generate the product. The City would be generating the biosolids product close to the intended market, reducing annual hauling costs.

Advantages of a Class A program include:

- Class A biosolids products are widely produced and marketed in the U.S.
- Multiple markets for end-use available in Western Washington
- No restrictions on end-product use (e.g., landscapes, gardens, soil manufacturers, or farming)
- Potential revenue source for the City (i.e., end-product may be sold).
- City remains in control of all aspects of biosolids production and end-use.

Disadvantages of a Class A program include:

- Requires building a market for the product
- Typically requires some storage of product onsite
- Capital investment in treatment technology.

5.3.4.3 Landfill

Landfill of biosolids does not qualify as a beneficial use under the CFR or the WAC. However, landfilling is a backup or contingency option for many utilities. Roosevelt landfill, located in Klickitat County Washington, receives the majority of solid waste and recycling streams in Washington. The landfill is one of the few landfills in Washington that accepts biosolids. The landfill is setup to receive waste via trucks or via rail cars. Moving biosolids cross state via rail provides the benefit of reduced hauling costs. Roosevelt landfill operates a gas capture facility and generates electricity. However, the landfill has limited space and will eventually be capped.

5.4 Biosolids Process Alternatives Evaluation

Each of the biosolids treatment technologies and end uses were evaluated in a workshop with the City on June 25, 2019. Appendix F provides the detailed biosolids process alternatives assessment. The process by which this evaluation occurred is discussed below.

5.4.1 Alternatives Evaluation Procedure

Alternatives were evaluated using a matrix-based approach incorporating quantitative criteria related to capital and O&M costs, as well as qualitative criteria (non-economic) related to criteria meaningful to the City (e.g., technology maturity, regulatory certainty, etc.). Non-economic criteria are quantified based on the relevant advantages and disadvantages for each alternative. The “no change” alternative was not an element in this evaluation process because the goal of this analysis was comparing Class A and B biosolids options. Alternatives ratings were calculated providing an independent score for each of the stated evaluation criteria multiplied by a relative importance, or weighting, to each criterion according to the following formula:

$$AlternativeRating = \sum_{Criteria} Score \times Weighting$$

Score and Weighting

Alternatives were scored for each criterion on a scale of one (1) to five (5), with 1 being lowest and 5 being highest. The weighting factor is a percentage-based multiplier that places greater emphasis on specific criteria deemed to be of higher value, allowing economic criteria (capital and O&M costs) to be considered along with more qualitative criteria.

Evaluation Criteria

Evaluation criteria used in the alternative evaluation along with weighting factors and the total criteria weight are summarized in Appendix F. Each criterion was assigned a weighting factor to indicate overall importance in the alternative evaluation. The alternatives were evaluated based on two economic and seven non-economic factors. These factors were identified by City staff as being important considerations for the long-term success of any potential improvement to the City’s biosolids management program. The following nine evaluation criteria were used in the Study:

- **Phasing Potential:** Ability to expand wastewater treatment plant facilities (e.g., capacity, moving from Class B to Class A, etc.) in the future without a high degree of design, modification, or construction.

- **Technological Maturity and Performance:** Use of proven technologies with a track record at domestic wastewater treatment plants. Number, size, and longevity of similar facilities operating under similar circumstances. Ability to consistently meet treatment objectives while handling both flow and load variability.

- **Footprint:** Ability to convert existing facilities (e.g., tanks, buildings, etc.) to implement the alternative.

- **Odor Potential:** Potential for presence of nuisance odors and ease with which potential odor sources can be mitigated at the treatment plant.
- **Capital Costs:** Relative capital costs of alternatives.
- **Operation and Maintenance Costs:** Relative annual O&M costs of alternatives including staffing.
- **Operational Complexity:** Degree of complexity required to operate and maintain the treatment units. Includes both number of systems and mechanical complexity.
- **Regulatory Certainty:** The ability for the alternative to have a relatively greater regulatory acceptance and reduced risk from uncertainty due to changes in federal or state regulations.
- **Long Term Reliability of Beneficial Use:** The acceptability and value of the Class A or B biosolids product to be resilient and provide low risk to the City.

5.4.2 Biosolids Process Alternatives Selection

Each biosolids treatment technology and end use were ranked during the biosolids workshop with the City. The following ranked the highest of all the process alternatives:

- **Stabilization**: Aerobic Digestion
- **Dewatering**: Belt Filter Press, Screw Press
- **Additional Treatment (Class A)**: Indirect Belt Drying
- **Storage**: Onsite
- **Biosolids End Use**: Class B Land Application and Class A giveaway/sale.

The highest-ranking processes were then combined into six Biosolids Process Alternative Treatment Trains. Each treatment train includes a stabilization, dewatering, storage, and beneficial use process. Additional treatment for Class A was included in three of the six treatment train alternatives. The rankings assigned in the workshop were totaled to identify four Preferred Biosolids Management Alternatives for further evaluation. These rankings are also included in Appendix F.

5.5 Preferred Biosolids Management Alternatives

Four preferred alternatives were selected for further evaluation. The capital and O&M costs were evaluated for these four preferred alternatives and include:

1. Status Quo: Aerobic Digestion with BFP dewatering and Class B Land Application

2. Baseline: Expanded aerobic digestion with BFP dewatering and Class B Land Application

3. Class A Facility: Aerobic Digestion with Screw Press (SP) dewatering, Dryer, Class A Giveaway or Sale

4. Class A and B Facility: Aerobic Digestion with SP dewatering, Dryer, Class A Giveaway/Sale or Class B Land Application.

Upon preliminary analysis cost analysis, Alternative 4 (Class A and B Facility) was screened out. This was due to higher cost associated with maintaining both Class A and B production and insignificant increase in benefit with both systems.

5.5.1 20-Year Lifecycle Cost Estimating Methodology

An economic model was developed that considered a 20-year planning horizon through 2040, considering capital, O&M costs, and monetized risk for each of the three preferred alternatives.

The O&M costs include estimated annual costs for City staff to operate and maintain the solids process equipment, energy costs to run equipment, and chemical costs.

The foundation of any cost model is comprised of the assumptions and data used as a basis for calculations. Following is a list of the economic assumptions used to develop the annual O&M costs that were common to all alternatives:

- Biosolids Total Solids: 16%
- Sale of a Class A biosolids product: conservatively the Class A product is assumed to be given away (no revenue at this time)
- Contingency Costs: 30%
- Evaluation Period: 20 years
- Escalation Rate: 4%
- Discount Rate: 6%
- Biosolids Hauling Cost Escalation: 5%
- Equipment power and chemical use was based on vendor supplied data.

Operation of a biosolids program is subject to biosolids program issues and risks as discussed in Section 5.1.6. Furthermore, these risks can have monetary impacts on the future biosolids program. Four risk scenarios were considered in this analysis as follows:

- **Ecology Regulatory Change:** A regulatory change triggers an emergency upgrade to increase the aerobic digester capacity. In the meantime, all solids are hauled to the landfill for 6 months. This only affects the status quo alternative.

- **Loss of Storage at Washington Department of Corrections:** The contract for offsite storage at the DOC is canceled. This would require more frequent hauling due to space limitations at the plant and an increase in contract hauling costs This affects all alternatives with Class B land application.
- **Emergency Landfill:** Mountain passes are closed and biosolids are hauled to Republic Services' Roosevelt Regional Municipal Solid Waste Landfill in Klickitat County for 7 days. This affects all alternatives with Class B land application.
- **Reliance on a Third-Party Contract Hauler**: Trucks are inoperable, permits are lost at field sites due to misapplication or other unforeseen risks associated with dependency on a third-party hauler. In this scenario biosolids are landfilled for 3 weeks. This affects all scenarios with Class B land application.

To monetize the risks, a capital or operation cost is developed for each scenario. This is then multiplied by the likelihood of occurrence in any year for each of the four preferred alternatives.

The 20-year life cycle cost estimating was conducted for the three preferred alternatives listed in Section 5.5 above. The results of the analysis are shown on Table 5-6 and Figure 5-7 below and included in Appendix F.

Table 5-6: Anticipated Permit Modifications, Approvals and Agreements

Alternative	Description	Capital Costs	Annual O&M: yr 1	Cumulative 20-yr NPV
Alt 1	Status Quo, BFP Rehabilitation	$1,510,000	$1,127,000	(23,630,000)
Alt 2	Expanded Aerobic, Screw Press, Class B	$9,360,000	$587,000	(22,100,000)
Alt 3	Screw Press, Dryer, Class A	$14,900,000	$314,000	(20,390,000)

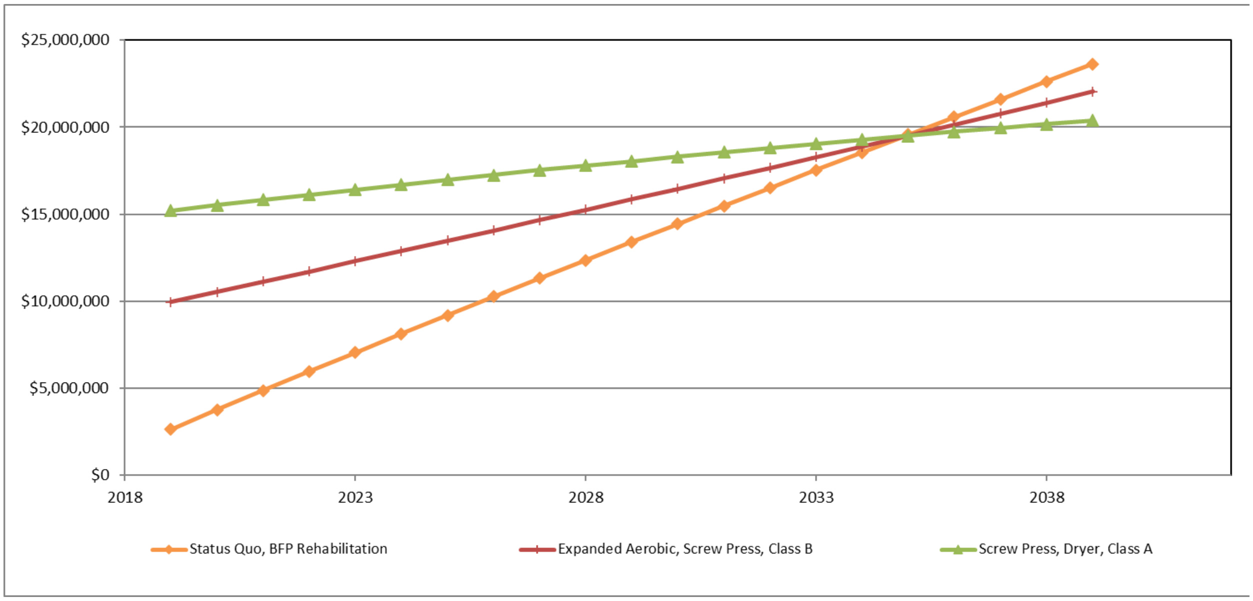


Figure 5-7: Lifecycle Costs by Year for the Preferred Biosolids Management Alternatives

5.5.2 Anticipated Permit Modifications of Preferred Alternatives

The following table lists the anticipated non-construction related permit modifications, approvals, and contract agreements associated with the three preferred alternatives by permitting authority.

Table 5-7: Anticipated Permit Modifications, Approvals, and Agreements

Preferred Alternative	Local	State	Federal
Status Quo	Snohomish Health District: • Land Application solid waste facility permit (local land application) Republic Services Roosevelt Regional Municipal Solid Waste Landfill: • Contract agreement for emergency landfilling of biosolids Third-Party Contract Hauler Agreement	Ecology Biosolids General Permit: • Application for Coverage • General Land Application Plan • Site Specific Land Application Plan • Sampling plan • Spill Prevention Plan	None
Baseline	Snohomish Health District: • Local land Application solid waste facility permit Republic Services Roosevelt Regional Municipal Solid Waste Landfill: • Contract agreement for emergency landfilling of biosolids Third-Party Contract Hauler Agreement	Ecology Biosolids General Permit: • Application for Coverage • General Land Application Plan • Site Specific Land Application Plan • Sampling plan • Spill Prevention Plan	None
Class A Facility	None	Ecology Biosolids General Permit: • Application for Coverage • Sampling plan • Spill Prevention Plan	None

5.6 Evaluation of Solids Treatment and Handling Capital Improvement Alternatives

Upon review of the alternatives for solids treatment and handling detailed in Section 5.5 by City personnel, the City requested a comprehensive evaluation of capital improvement costs and layouts for the two, non-status quo alternatives for upgrading solids treatment and handling to be presented to the City's leadership. The two preferred alternatives for solids treatment and handling included: 1) upgrades to the existing Class B facility and 2) upgrades to become a Class A facility. This section includes the information presented to the City's leadership. The presentations to finance personnel and the P3 Committee occurred in Q1 of 2020. The presentation to the City's Council was delayed by the COVID-19 virus and subsequent restrictions regarding in-person meetings. Hence, the presentation to the City's Council occurred virtually in Q3 of 2020.

5.6.1 Solids Treatment and Handling Capital Improvements – Class B Upgrades Alternative

Improvements to the City's Class B biosolids facilities are necessary in order to meet solids capacity demands, replace existing end-of-life dewatering facilities, improve measuring equipment for flow and other metrics, and maximize the potential for beneficial use regulatory compliance.

Upgrades to the existing Class B facility would consist of several elements including: 1) construction of a new aerobic digester, 2) installation of a new dewatering screw press and 3) replacement of the existing Primary Effluent (PE) Sludge Flow Meter and TSS Meter, and 4) construction of a new below-grade blower and sludge pump room. Figure 5-9 is a site layout illustrating the approximate location of the Class B facility upgrades.

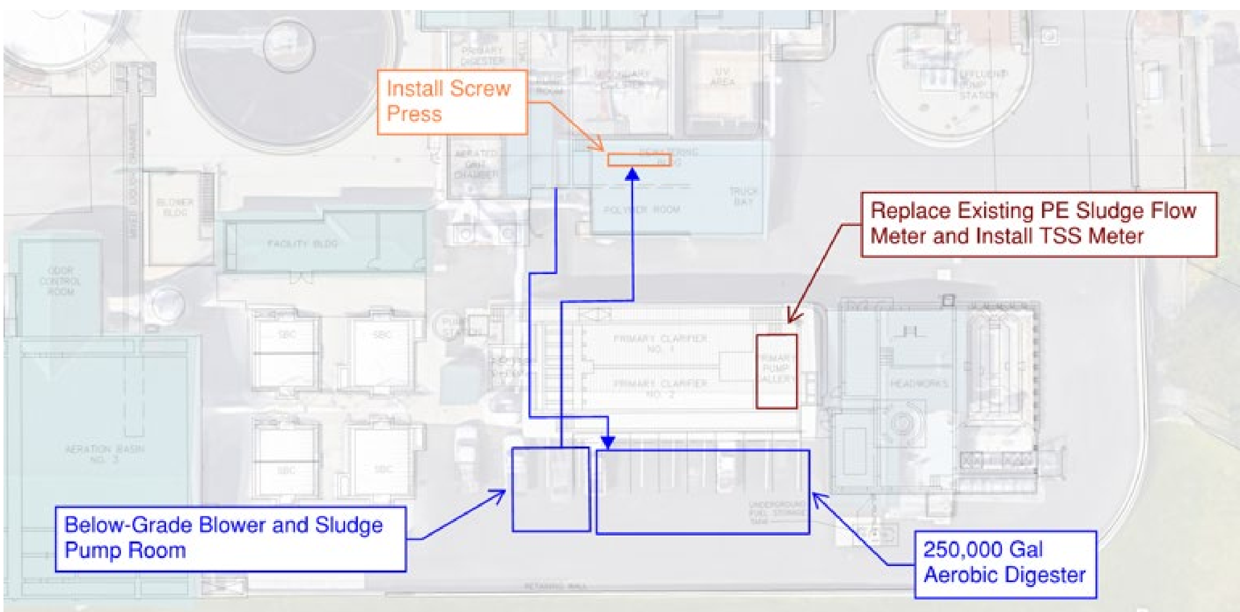


Figure 5-8: Site Plan for Class B Solids Treatment and Handling Upgrades

The three project elements for the Class B Solids Treatment and Handling Upgrades are detailed in Table 5-8 below, which includes a description of each project element, as well as the associated project cost and O&M cost. The pros and cons of Class B Solids Treatment and Handling Upgrades are detailed in Table 5-9 below.

Table 5-8: Project and O&M Costs for Class B Solids Treatment and Handling Upgrades

Project Element	Description of Improvements	Project Cost (2020 Dollars)	Additional Operations and Maintenance Cost ($/yr, 2020 Dollars)
Construct New Digester Next to Primary Clarifiers	Increase total aerobic digester volume at the Plant by constructing a new digester (~250,000 gallons) below the parking area south of the Primary Clarifiers. A new digester could be operated either in series or in parallel with existing digesters tanks. A new blower and digested sludge pump room would be constructed beneath the parking lot south of the primary clarifiers.	$6,310,000	$42,300
Install Screw Press	Installation of a dewatering screw press in the space currently occupied by the Belt Filter Press. This project would entail the demolition of the existing Belt Filter Press prior to installation of a screw press.	$3,310,000	
PE Sludge Flow Meter and TSS Meter	Replace the existing PE sludge flow meter and install a TSS meter downstream of PE sludge pumps.	$70,000	

Table 5-9: Comparison of Pros and Cons for Class B Solids Treatment and Handling Upgrades

Pros	Cons
• Existing SBC tanks remain available to be retrofitted to MBR tanks for liquid stream process upgrades • Can meet full SRT requirements for solids stabilization • Smaller footprint • New equipment with new equipment warranty • Increased PE sludge monitoring capabilities	• Additional pumping and blower electricity cost • Very limited end use applications for Class B Biosolids product • Higher financial cost over refurbishment of existing Belt Filter Press

5.6.2 Solids Treatment and Handling Capital Improvements – Class A Upgrades Alternative

Improvements to the City's biosolids facilities are necessary in order to meet solids capacity demands, replace existing end-of-life dewatering facilities, improve measuring equipment for flow and other metrics, and maximize the potential for beneficial use regulatory compliance. The implementation of Class A facilities would be the most effective means in which to ensure long-term biosolids compliance and minimize the amount of material required for disposal or beneficial use.

Upgrades to a Class A facility would consist of several elements including: 1) installation of a new biosolids dryer and odor control system, 2) installation of a new dewatering screw press, 3) construction of a new two-story steel building for the dryer, screw press, and ancillary equipment, and 4) replacement of the existing PE Sludge Flow Meter and TSS Meter. Figure 5-12 is a site layout illustrating the approximate location of the Class A facility upgrades. Figure 5-13 illustrates the first and second floor layouts of equipment for the Class A solids facility and handling equipment.

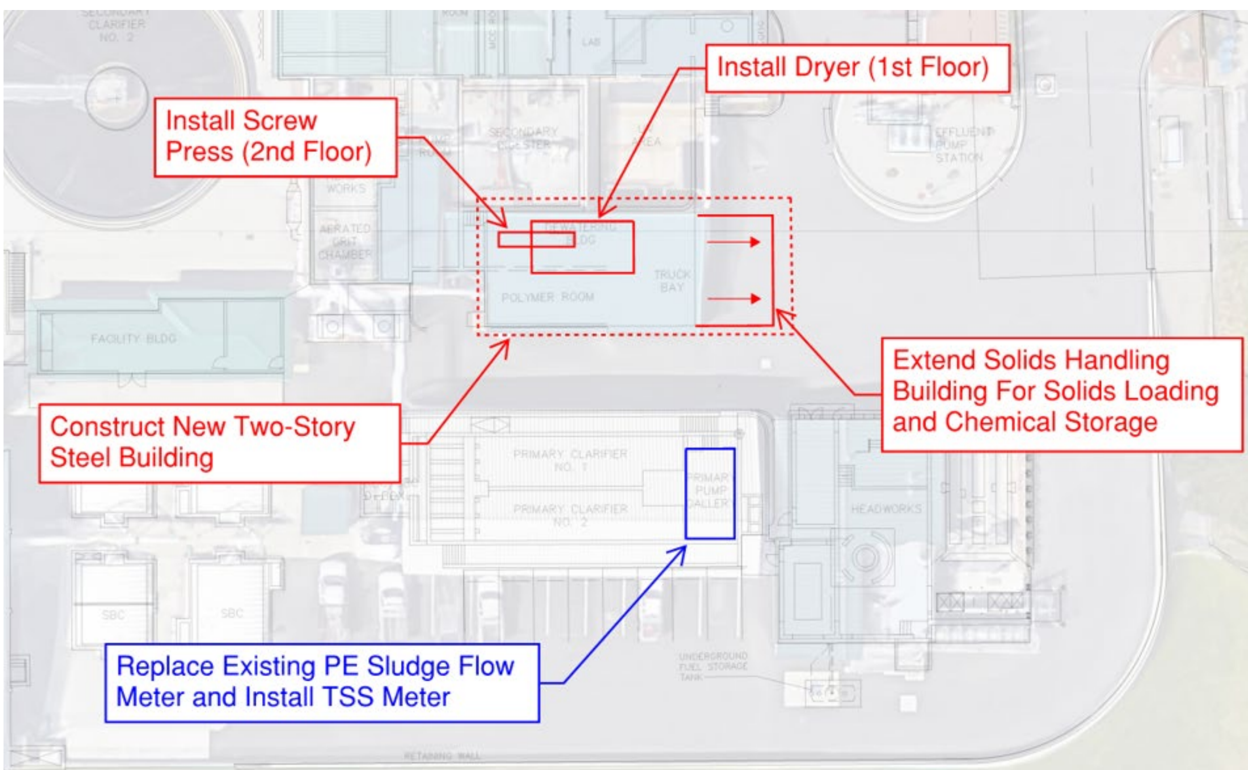


Figure 5-9: Site Plan for Class A Solids Treatment and Handling Upgrades

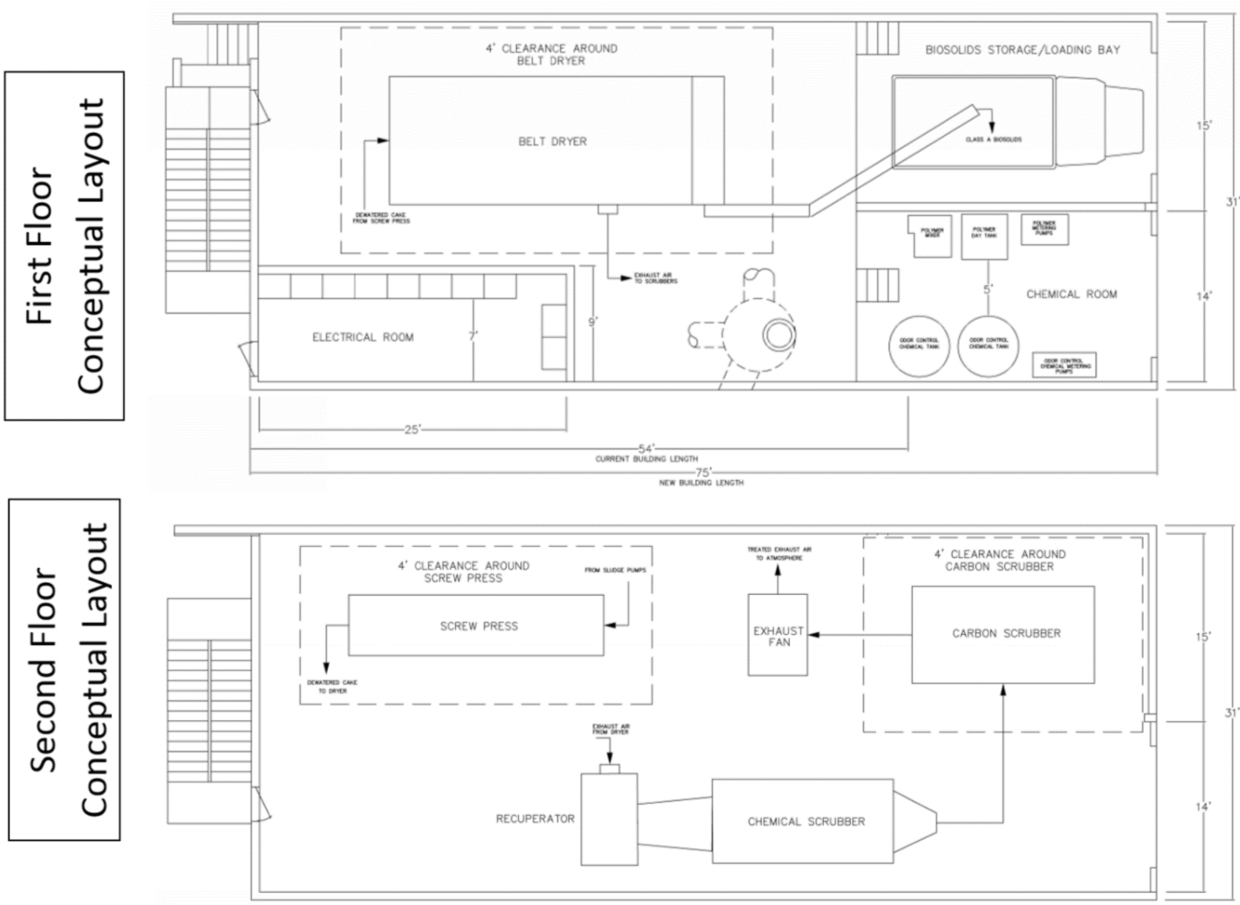


Figure 5-10: First and Second Floor Conceptual Layouts of Equipment for Class A Solids Treatment and Handling Upgrades

The three project elements for the Class A Solids Treatment and Handling Upgrades are detailed in Table 5-10 below, which includes a description of each project element, as well as the associated project cost and O&M cost. The pros and cons of Class A Solids Treatment and Handling Upgrades are detailed in Table 5-11 below.

Table 5-10: Project and O&M Costs for Class A Solids Treatment and Handling Upgrades

Project Element	Description of Improvements	Project Cost (2020 Dollars)	Additional Operations and Maintenance Cost ($/yr, 2020 Dollars)
Class A Biosolids Dryer	Install Class A biosolids dryer and odor control system. The existing solids handling building, and the belt filter press could be left in place and operational as a two-story steel frame building is constructed around the exterior of the existing building. A dryer could be installed on the first floor in the space occupied by the existing belt filter press.	$12,040,000	-$139,500
Install New Screw Press	Install a dewatering screw press on the second floor of the modified two-story solids handling building	$3,310,000	
PE Sludge Flow Meter and TSS Meter	Replace the existing PE sludge flow meter and install a TSS meter downstream of PE sludge pumps.	$70,000	

Table 5-11: Comparison of Pros and Cons for Class A Solids Treatment and Handling Upgrades

Pros	Cons
• Upgrades do not spatially conflict with future liquid stream upgrades • Produces Class A biosolids product which could be used directly by the local community • No hauling costs • Lower risk for Ecology biosolids compliance • Reduction in volume of biosolids at the Plant • Complete Aerobic Digestion would not be needed, and no future expansion of aerobic digesters would be needed • Existing Digesters can be used as upstream equalization tanks which improves operational flexibility for the solids handling system • Smaller footprint than belt press • New equipment with new equipment warranty • Increased PE sludge monitoring capabilities	• Higher capital cost • Uses natural gas • Extensive structural modifications/construction needed • Higher financial cost over refurbishment of existing Belt Filter Press

5.6.3 Solids Upgrade Capital Improvements – Engineer's Recommendation

The Team recommends the Class A Solids Treatment and Handling Alternative for the following reasons:

- The current capacity of the aerobic digesters achieves an insufficient hydraulic retention time to completely stabilize the biosolids. This lack of capacity results in the City having to solely rely on a third-party contractor to properly incorporate the unstabilized solids at the land application site to meet federal and state VAR requirements for Class B biosolids. This poses significant risk to the City for several reasons as described below. Installation of a Class A biosolids dryer facility would eliminate these issues:
    - If there were a spill, the resultant clean-up would be problematic from a public health and environmental protection (e.g., water quality) perspective.
    - Handling of the unstabilized solids poses a greater risk to human health because the material has a greater density of volatile solids and adequately digested biosolids.
    - Incorporation of solids requires more resources (i.e., fuel and labor) than land applying a stabilized biosolids product.
    - Solids that do not meet VAR requirements and thus, must be incorporated into the soil, limit the number and types of crops that can receive the City's biosolids. This narrows the marketability for the Class B biosolids and poses a public acceptance risk for this practice.
    - There are concerns about the viability and performance of soil incorporation at the land application site. For example, incorporation may not occur when there are equipment failures or weather issues; thus, resulting in federal and state regulatory compliance issues and additional risk to human health and the environment.
    - To meet Class B requirements by aerobic digestion, additional treatment volume is required to treat current flows.
- The City has been utilizing a third-party contractor to transport dewatered Class B biosolids to Central Washington for land application for many years. This has been relatively successful process; however, there are existing issues and concerns impacting this approach for long-term biosolids management. Some of the specific issues and concerns are listed below. Installation of a Class A biosolids dryer facility would eliminate these concerns:
    - The largest markets for Class B biosolids are in Douglas and Yakima Counties, where farmer-owned companies receive and manage the application of biosolids on their own farmland to primarily grow wheat crops. The Central Washington market for biosolids has been reliable and stable for more than 20 years; however, the location requires regular truck deliveries across the mountain

passes year-round. Fluctuating fuel costs will continue to impact costs for the City's program.

  - Each winter mountain passes are closed due to inclement weather. During these periods, the City's biosolids are diverted to Republic Services' Roosevelt Regional Municipal Solid Waste Landfill in Klickitat County. These diversions can occur anytime the passes are closed and result in unplanned costs the City.
  - Many farmers in Central Washington are converting to organic practices; thus, preventing the use of biosolids under the national Organic Food Production Act.
  - The price of wheat is declining coupled with an increase (i.e., 3%) in wheat production. This indicates there may be a decreased demand for biosolids use on these crops.
  - Precipitation levels in the Central Washington area are decreasing which results in the build-up of phosphorus in the soil over time. Accumulation of phosphorous requires farmers to rotate fields more often, potentially eliminating the use of biosolids on some fields and moving operations further east (e.g., Lincoln County).

- A Class A biosolids facility not only eliminates the risks described above with the City's current system, but provides the follow benefits:
  - Class A biosolids products are widely produced and marketed in the U.S.
  - There are multiple successful Class A biosolids programs in Washington.
  - Multiple markets for Class A biosolids end-use available in Western Washington.
  - No restrictions on end-product use (e.g., landscapes, gardens, soil manufacturers, or farming).
  - Potential revenue source for the City (i.e., end-product may be sold).
  - City remains in control of all aspects of biosolids production and end-use.
  - Reduced risk regarding potential new Ecology or EPA regulatory restrictions.
  - Eliminate reliance on Washington DOC for biosolids treatment or storage.
  - Greatly reduce or eliminate reliance on emergency landfilling due to truck breakdowns or inclement weather on mountain passes.

Section 6: Capital Improvement Plan

Upon review of the findings detailed in Section 4 and Section 5 of this Report, the City Council approved the Capital Improvement Plan (Plan) detailed in this section on 14 July 2020. The Plan approved by City Council focused on retaining reliable performance of the treatment systems, ensuring compliance with regulatory requirements, maintaining safe conditions at the facility per code requirements in enforce in 2020, and serving as good stewards of rate-payer funds.

6.1 Selected Improvements

Both the P3 Committee and the City Council approved the recommendations for liquids and solids upgrades upon review of the costs of each project (total project costs; total lifecycle costs; lifecycle of risk costs; total lifecycle costs plus lifecycle of risks costs), as well as for the four potential combinations as detailed in the cost analysis included as Appendix G. A summary of the total project costs for the projects included in the City's Plan is detailed in Table 6-1 below.

The detailed cost analysis includes life-cycle costs (where applicable) and operations and maintenance costs. The City's decision to select the combination of projects detailed in the table below included the considerations of savings from risk reduction pertaining to solids upgrades. The combination of improvements selected by the City results in cost savings when annualized through the end of the planning period.

Table 6-1: CIP Cost Summary

Capital Improvement Project	Estimated Total Project Cost (2020 Dollars)[a][b]
pH and Filament Control	$2.79M[c]
Secondary Treatment Upgrades	$20.03M
Solids Treatment and Handling Upgrades	$15.42M
Plantwide Pump & UV Disinfection Upgrades	$5.13M

Notes:

(a) Operation and maintenance costs for the life of the projects are presented in Appendix G.
(b) Cost estimating was conducted in 2020. Dollar figures are in 2020 dollars to be consistent with the values as presented to the City Council for review and approval on 14 July 2020, with the exception of the pH and Filament Control project. The submission of this report in 2022 reflects delays experienced due to the COVID-19 pandemic and development of the Effluent Mixing Zone Study.
(c) The original estimate for the pH and Filament Control project was $1.76M (2020 Dollars). The costs shown reflect the anticipated costs at the completion of the project as reported by the City. It is noted that the increase of costs are a product of the market volatility and supply chain issues pervasive during the COVID-19 pandemic.

The following sub-sections include an overview of the four capital improvement projects approved by the City Council on 14 July 2020.

6.1.1 CIP – pH Control and Filamentous Control

The modifications included in the design package of plans and specifications submitted to Ecology in December 2020 included:

- replacement of the magnesium hydroxide storage tank and dosing system with new piping, heat tracing, insulation, and controls;
- installation of a backup NaOH feed system with storage in the odor control building and fed into the secondary effluent upstream of UV disinfection;
- optimization of the mixed liquor return (MLR) controls with the installation of new nitrate sensors to improve the controls;
- baffling of aeration basins 1 and 2; and
- installation of a permanent sodium hypochlorite chemical dosing system with storage in the odor control building and fed into the RAS line.

The modifications do not include installation of a MLR flow meter or surface wasting of the mixed liquor as originally proposed in the March 2020 Engineering Report because of conflicts with existing infrastructure and constraints with available budget for pH modifications. Construction of the pH control and filamentous control upgrades began in the Q3 2021 and are scheduled for completion in Q2 2022.

6.1.2 CIP – Secondary Treatment Upgrades via Sidestream Membrane Bioreactor (MBR)

As detailed in Section 4.4, the membranes for the preferred sidestream MBR upgrades would be retrofitted into the existing submerged biological contactor (SBC) tanks that are no longer in service, allowing them to be repurposed. A new MBR support building would be required to house permeate pumps, membrane blowers and chemical cleaning systems for the membranes. MBR permeate will combine with secondary effluent from the parallel existing conventional activated sludge process in the existing secondary effluent pipeline before being sent to UV disinfection.

6.1.3 CIP - Solids Handling and Treatment Upgrades to a Class A Facility

As detailed in Section 5.6, the upgrades to produce Class A biosolids would consist of several elements including: 1) installation of a new biosolids dryer and odor control system, 2) installation of a new dewatering screw press, 3) construction of a new two-story steel building for the dryer, screw press, and ancillary equipment, and 4) replacement of the existing PE Sludge Flow Meter and TSS Meter.

6.1.4 CIP – Plantwide Pump and Ultraviolet Disinfection Upgrades

This CIP group serves to upgrade the hydraulic capacity of various processes at the WWTP. This is expected to occur about midway through the 20-year planning horizon when it is presumed the existing 3W pumps will require replacement due to their age and wear.

6.1.4.1 Ultraviolet (UV) Disinfection

The UV disinfection units are not rated to treat the projected 2040 peak hour flow. The units are currently operating with the maximum number of lamps, meaning more lamps cannot be added to gain treatment capacity. Re-rating the units could be a potential option with a major process change that resulted in substantially higher effluent clarity, such as the case with full conversion to MBR. As a result, the most reliable option to increase capacity within the existing space allotted is replacement of the units. Wedeco LBX units similar to the existing ones could be installed in the footprint of the existing UV disinfection system and deliver greater treatment capacity.

Also included in this project would be increasing the 10-inch piping which contains the effluent flow meters to 14-inch diameter pipe. This would reduce headloss through the UV disinfection system.

6.1.4.1.1 Effluent Pumping

The three Peerless 16HH effluent pumps will require a retrofit to meet the new flow condition. An additional bowl would be installed along with a new motor and VFD for each pump to meet the increase in projected flows and increased head condition. The effluent pumps can stay in the existing effluent pump wet well.

6.1.4.1.2 Influent Pumping

There are five existing influent pumps, three of which are sized at 4.0 MGD. The two smaller pumps are currently sized at 1.0 MGD and would be replaced by Flygt NP3153 (for example) units sized for 2 MGD. Additionally, the discharge piping and flow meters for these new pumps would I be upsized to 12 inches in diameter to reduce velocities and headloss at the higher flows.

6.1.4.1.3 3W Pumps

The existing 3W pumps are oversized and will be replaced with units more adequately sized for the existing purpose. To maintain pressure in the 3W system and prevent wear on the pumps, a recycle line will be installed back into the wet well along with a pressure relief valve to prevent operating near the shutoff head, which has caused substantial wear on the existing pumps.

6.2 Implementation Schedule

A trigger chart (Figure 6-2) was developed to illustrate to the City the timeline in which the Plan's projects are scheduled to be implemented based on projected maximum month flow (MMF). Table 6-2 provides descriptions of the event(s) that triggers the need for each capital improvement at the specified mid-point of construction. The trigger points are based on meeting the Class II redundancy requirements for the treatment facility and maintaining adequate capacity to meet the projected flows and loads.

- The trigger for pH and filament control is based on requirements in the current NPDES permit to have improvements for pH control implemented before the end of 2022.
- The trigger for solids upgrades is risk-based and hence, reduces the risks pertaining to solids handling, storage, and disposal. Unlike the Plan's projects based on MMF at the facility, timing of the solids upgrades are based upon mitigating existing risks related to solids handling and treatment. The estimated timing is based upon the intention to include within the 6-year planning horizon but after the imminently needed upgrades to address pH per regulatory requirements.
- The trigger for implementing sidestream MBR treatment in 2027 is secondary clarifier capacity due to high solids loading on those units.
- The trigger for plantwide pumps and UV disinfection upgrades is based on the anticipated need to replace the worn 3W pumps by about the midpoint of the planning horizon.

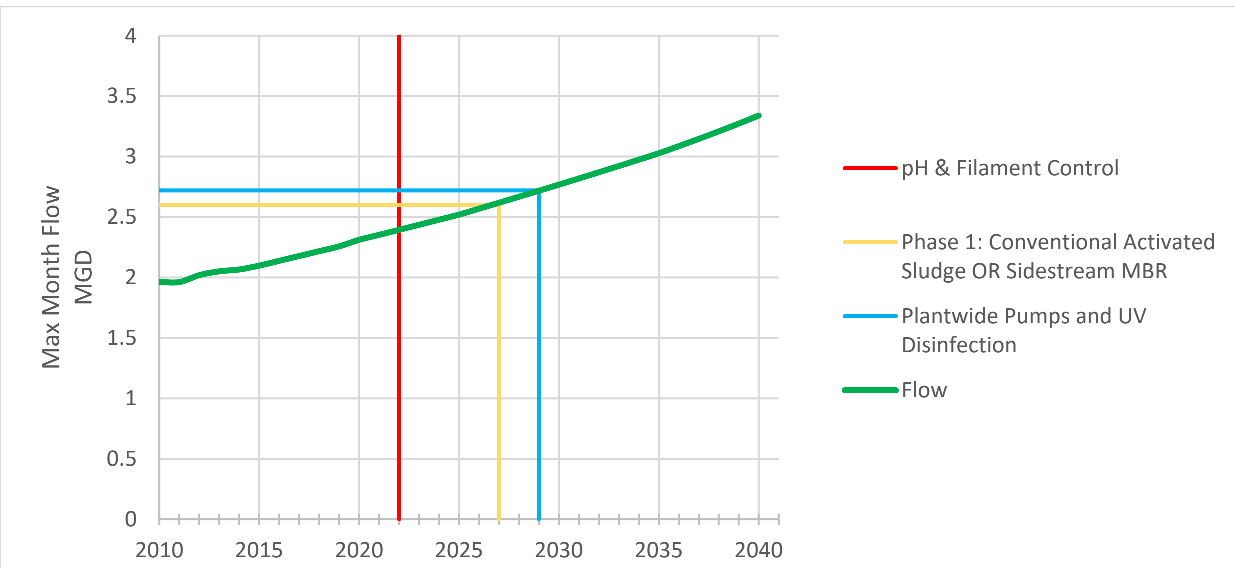


Figure 6-1: CIP Trigger Chart

Table 6-2: CIP Trigger Summary

WWTP CIP Description	Anticipated Mid-point of Construction	Trigger(s)
pH and Filament Control	In-construction	NPDES permit requires pH control implemented by 31 December 2022
Class A Solids Upgrades	2023	Risk related triggers, which include currently not meeting regulatory minimum digestion time; and several Class B disposal risks (disk-in-solids, solids transport, contractual agreements)
Sidestream Membrane Bioreactor	2027	Class II reliability criteria exceeded for secondary clarifier capacity (2.6 MGD at MMF)
Plantwide Pumps and Ultraviolet Disinfection Upgrades	2029	3W pump replacement (capacity) needed; effluent pumps and UV capacity exceeded in 2034 at 10 MGD at PHF

6.3 Funding Sources and Other Economic Considerations

This Section identifies potential funding sources and other economic considerations.

6.3.1 Overview of Funding Sources

The three funding mechanisms discussed in this section include: bonds, loans, and grants.

6.3.1.1 Bonds and CWSRF Loans Overview

Table 6-3 summarizes considerations of a municipal bond compared to a Clean Water State Revolving Fund (CWSRF) loan. Detailed funding considerations are not included in the scope of this report.

Table 6-3: Typical Bond and CWSRF Loan Summary

Municipal Bond	CWSRF Loan
• Higher interest rate • Less administrative effort • Optional payback periods • Less time required to get loan • Funds likely available, which decreases risk • Funds can be used to match grant money • Immediate repayment • Potential for prepayment penalties.	• Lower interest rate • More administrative effort • 20-year payback • Increased time to get loan • Funds may not be available, which increases risk • Funds cannot be used for grant matching money • Repayment does not start until construction begins • Source requirements, such as “Buy American Steel” • Debt service ratio requirement of 1:1 • Cannot be junior to any other debt

6.3.1.2 Grant Funding

Pursuing and implementing grants could be part of a long-term financial strategy for the City to fund the future work. It is important to recognize that (1) grants are competitive and are therefore not guaranteed to be awarded, (2) the City may have to demonstrate that they have matching funds in place to secure the grant award, and (3) the City may have to accept or adopt grant related requirements that are included with grant approval.

Coordinating grant requests with other project funding options is important to identify anticipated expense and effort compared to the grant award possibilities. Grant funding tied to federal programs may include contract provisions that are federally mandated and, in some cases, may need City Council approval.

The true costs of grants include costs associated with applying for and managing grants, city agencies may be asked to commit internal resources or bring in outside consultants to prepare the applications to be competitive.

6.3.1.3 Summary of Loan and Grant Opportunities

The table below provides a summary of potential funding sources, which are detailed by geography, type, eligibility, funding level, and agency. The table is illustrative and does not include funding sources for which the City was deemed not eligible. Funding sources were excluded from the below list if the eligibility requirements were not met (e.g., population requirements) and/or if the projects did not align to the funder's description and objectives (e.g., type of infrastructure improvements allowed). In particular, the City may consider the opportunities pertaining to loans available through the Clean Water State Revolving Fund (CWSRF), as the funding levels are projected to significantly increase through the recently executed Infrastructure and Investment Jobs Act (passed by Congress on 02 December 2021).

Table 6-4: Potential Loan and Grant Opportunities

Geography	Program	Type	Description	Eligible Applicants	Agency
National	Water Infrastructure Finance and Innovation Act of 2014 (WIFIA)	Loan	The WIFIA established the WIFIA program, a federal credit program administered by EPA for eligible water and *wastewater infrastructure projects*. WIFIA and the WIFIA implementation rule outline the eligibility and other requirements for prospective borrowers.	Local, state, tribal, and federal government entities Partnerships and joint ventures Corporations and trusts Clean Water and Drinking Water State Revolving Fund (SRF) programs	USEPA
National	United States Department of Agriculture (USDA) Water and Waste Disposal Loan and Grant Program	Loan and Grant	Provides funding for clean and reliable drinking water systems, *sanitary sewage disposal*, sanitary solid waste disposal, and stormwater drainage to households and businesses in eligible rural areas.	Most state and local governmental entities, private non-profits, and federally-recognized Tribes- Rural areas and towns with fewer than 10,000 people Tribal lands in rural areas	USDA
WA	Rural Community Assistance Corporation (RCAC) Feasibility and Pre-Development Loans	Loan	RCAC offers loans to finance water and waste facility projects. RCAC's loan program is unique — it provides the early funds small rural communities need to determine project feasibility and to *pay pre-development costs prior to receiving state and federal funding*. Eligible projects include water, wastewater, stormwater, and solid waste planning; environmental work; and *other work to assist in developing an application for infrastructure improvements*.	Non-profit organizations, public agencies, tribes, and low-income rural communities with a 50,000 population or less, or 10,000 or less if proposed permanent financing is through USDA Rural Development	RCAC

Geography	Program	Type	Description	Eligible Applicants	Agency
WA	Rural Community Assistance Corporation (RCAC) Construction Loans	Loan	RCAC offers loans to finance water and *waste facility projects*. RCAC's loan program is unique — it provides the early funds small rural communities need to determine project feasibility and to pay pre-development costs prior to receiving state and federal funding. Eligible projects include water, *wastewater*, solid waste, and stormwater facilities that *primarily serve low-income rural communities*. *Can include pre-development costs*.	Non-profit organizations, public agencies, tribes, and low-income rural communities with a 50,000 population or less, or 10,000 populations or less if using USDA Rural Development financing as the takeout.	RCAC
WA	Rural Community Assistance Corporation (RCAC) Intermediate Term Loan	Loan	RCAC offers loans to finance water and waste facility projects. RCAC's loan program is unique — it provides the early funds small rural communities need to determine project feasibility and to pay pre-development costs prior to receiving state and federal funding. Eligible projects include water, *wastewater*, solid waste, and stormwater facilities that primarily serve low-income rural communities.	Non-profit organizations, public agencies, tribes, and low-income rural communities with a 50,000 population or less	RCAC

Geography	Program	Type	Description	Eligible Applicants	Agency
WA	Community Economic Revitalization Board (CERB) Construction Program	Loans Grants	The CERB was formed in 1982 to respond to local economic development in Washington communities. CERB provides funding to local governments and federally-recognized tribes *for public infrastructure which supports private business growth and expansion*. Eligible projects include public facility projects required by private sector expansion and job creation. Projects must support significant job creation or significant private investment in the state. • Bridges, roads and railroad spurs, domestic and industrial water, sanitary and storm sewers. • Electricity, natural gas, and telecommunications • General purpose industrial buildings, port facilities. • Acquisition, construction, repair, reconstruction, replacement, rehabilitation.	Counties, cities, towns, port districts, special districts. Federally recognized tribes Municipal corporations, quasi-municipal corporations with economic development purposes	WA DOC
WA	Public Works Board (PWB) Construction Program	Loan	New construction, replacement, and repair of existing infrastructure for stormwater, solid waste, recycling, road or bridge projects. *Eligibility restrictions applied to domestic water, sanitary sewer projects.* Please contact Board staff for eligibility.	Counties, cities, special purpose districts, and quasi-municipal organizations that meet certain requirements. School districts, tribes and port districts are not eligible.	PWB

6.3.2 Assessment of Potential Impacts to City's Sewer Rates

The City's financial committee utilized the findings of the detailed cost analysis (Appendix G) of the preferred combination of upgrades at the facility to assess impacts upon the City's sewer rates. The City's financial analysis confirmed that the current sewer rates can support the Plan's recommendations through 2026 and did not identify any concerns regarding the affordability criterion as detailed in Section 12.6.5 of 2015 Utility Plan and pertaining to the recommendations of the Washington State Department of Health and the State Public Works Board for rates to not exceed 1.5-2.0% of the median household income.

6.4 Other Considerations and/or Restrictions

This section summarizes other potential regulatory, economic, and operational considerations or restrictions. as follows:

- Regulatory: The proposed projects will need to comply with applicable state or local water quality management plans, or plans adopted pursuant to the federal Water Pollution Control Act as amended. As noted in Section 1.5, a SEPA checklist is included as Appendix B. The City does not presently intend to seek EPA funding for these projects; however, the City shall further review the CWSRF mechanism identified in Section 6.3 and pertaining to the secondary treatment upgrades. The City acknowledges that pursuit of CWSRF funds includes special requirements which would need to be assessed prior. SERP requirements would need to be satisfied and this Report would need to be amended to accommodate SERP if EPA funds were sought by the City.

- Economic: The City intends to fund these projects primarily through existing reserves and revenue generated from the rates and fees. The City does not presently intend to seek grants, federal loans, or state loans for these projects. However, the City shall further review the CWSRF mechanism identified in Section 6.3 and pertaining to the secondary treatment upgrades.

- Operational: Implementation of the Plan will add complexity to the operation of the WWTP. As the City continues to implement the CIP projects, thought should be given to improving staff capabilities through training, hiring of staff members familiar with the operation of similar facilities contemplated in the Plan and promoting staff members to take on more responsibility as it relates to the WWTP. Developing staff in operations, maintenance, engineering and management of the WWTP will help the City in maintaining a reliable WWTP.

6.5 Project Delivery Methods

A summary of project delivery methods utilized in Washington State and by the City are as follows:

- Design-Bid-Build (DBB) is a method for which the owner contracts with separate entities for design and construction of improvements.

- General Contractor/Construction Manager (GC/CM) is a method for which the owner contracts with a contractor during the design process to provide input prior to bidding. The selected contractor can self-perform a portion of the work but must also competitively bid portions of the work.

- Design-Build (DB) is a method for which the owner contracts with a single entity for design and construction of improvements. Design-Build is also referred to as an alternative delivery method to the more historically prevalent DBB method. DB includes Progressive Design-Build.

- Energy Savings Performance Contracting (ESPC), which is a mechanism that allows entities to identify and install energy and utility improvements. The Washington State Energy Program provides guidance on this process.

Table 6-5: Potential Delivery Methods for Program's Capital Improvement Projects

Capital Improvement Project	Preferred Delivery Method(s)	Rationale
Secondary Treatment Upgrades	• DBB: OR • GC/CM; OR • DB	• City's contracting personnel are most familiar with the DBB method. • Project is large enough and invasive enough to warrant contractor input early with the design team to reduce risk. • DB should be considered if a schedule driver were to emerge for implementation of this large capital project.
Solids Treatment and Handling Upgrades	• DBB; OR • ESPC	• City's contracting personnel are most familiar with the DBB method and DBB may have cost savings. • City's established familiarity with the ESPC method at the WWTP in past 10 years. Historical ESPC projects at the WWTP demonstrated minimal demands upon WWTP personnel. Historical ESCO projects at the WWTP have increased cost certainty. • Performance of the solids handling system are critical to reduce risk and cost for the City and the ESPC method would allow for more efficient pre-selection of equipment to capture performance needs
Plantwide Pump & UV Disinfection Upgrades	• DBB	• City's contracting personnel are most familiar with the DBB method. • Project is straight forward and can be conveyed in design documents

The Team recommends the City confirm their preferred project delivery method prior to implementing each project.

References

BHC Consultants. 2015. *City of Monroe Utility Systems Plan: Sanitary Sewer, Water and Stormwater*. 2 April (Draft).

BHC Consultants. 2016. *Technical Memorandum: Monroe Outfall Condition Assessment*. 4 November.

Richard, Michael. *Microbial and Chemical Testing for Troubleshooting Lagoons*, Available at: http://www.lagoonsonline.com/trouble-shooting-wastewater-lagoons.htm. Accessed on 10 March 2020 at 2:53 pm PDT.

State of Washington Department of Ecology. 2008. *Criteria for Sewage Works Design (Orange Book).* Olympia, Washington: Water Quality Program, Department of Ecology.

United States Environmental Protection Agency. 1974. *Design Criteria for Mechanical, Electric, and Fluid System and Component Reliability* [EPA-430-99-74-001]. Washington, D.C.: Office of Water Program Operations, United States Environmental Protection Agency.

United States Environmental Protection Agency. 2002. *Wastewater Technology Fact Sheet: Facultative Lagoons* [EPA-832-F-02-014]. Washington, D.C.: Office of Water, United States Environmental Protection Agency. Available at: https://www3.epa.gov/npdes/pubs/faclagon.pdf. Accessed on 10 March 2020 at 2:59 pm PDT.

Appendix A

Monroe WWTP NPDES WA0020486 Final Permit (20181128)

Issuance Date:	November 28, 2018
Effective Date:	December 1, 2018
Expiration Date:	November 30, 2023

National Pollutant Discharge Elimination System
Waste Discharge Permit No. WA0020486

State of Washington
DEPARTMENT OF ECOLOGY
Northwest Regional Office
3190 160th Avenue SE
Bellevue, WA 98008-5452

In compliance with the provisions of
The State of Washington Water Pollution Control Law
Chapter 90.48 Revised Code of Washington
and
The Federal Water Pollution Control Act
(The Clean Water Act)
Title 33 United States Code, Section 1342 et seq.

CITY OF MONROE
806 West Main Street
Monroe, WA 98272

is authorized to discharge in accordance with the Special and General Conditions that follow.

Plant Location: 522 South Sams Street Monroe, WA 98272	**Receiving Water:** Skykomish River
Treatment Type: Activated Sludge	**Discharge Location:** Latitude: 47.844501 Longitude: -121.974614

Rachel McCrea
Water Quality Section Manager
Northwest Regional Office
Washington State Department of Ecology

Table of Contents

Summary of Permit Report Submittals

Refer to the Special and General Conditions of this permit for additional submittal requirements.

Permit Section	Submittal	Frequency	First Submittal Date
S3.A	Discharge Monitoring Report (DMR)	Monthly	January 15, 2019
S3.A	Discharge Monitoring Report (DMR)	Quarterly	April 15, 2019
S3.A	Permit Renewal Application Monitoring Data	Annual	January 15, 2020
S3.A	DMR - Priority Pollutant Data - Single Sample Data	Annual	January 15, 2020
S3.F	Reporting Permit Violations	As necessary	
S4.B	Plans for Maintaining Adequate Capacity	As necessary	
S4.D	Notification of New or Altered Sources	As necessary	
S5.F	Bypass Notification	As necessary	
S5.G	Operations and Maintenance Manual Update	As necessary	
S6.E	Industrial User Survey	1/permit cycle	December 31, 2022
S8.A	Effluent Mixing Report	1/permit cycle	December 31, 2021
S9	Outfall Evaluation	1/permit cycle	December 31, 2022
S10.A	Acute Toxicity Effluent Test Results	2/permit cycle	April 15, 2022 October 15, 2022
S11.A	Chronic Toxicity Effluent Test Results	2/permit cycle	April 15, 2022 October 15, 2022
S12	Engineering Report	1/permit cycle	December 31, 2019
S12	Plans and Specifications	1/permit cycle	December 31, 2020
S12	Declaration of Construction of Water Pollution Control Facilities	1/permit cycle	December 31, 2022
S13	Application for Permit Renewal	1/permit cycle	December 31, 2022
G1	Notice of Change in Authorization	As necessary	
G4	Reporting Planned Changes	As necessary	
G5	Engineering Report for Construction or Modification Activities	As necessary	
G7	Notice of Permit Transfer	As necessary	
G10	Duty to Provide Information	As necessary	
G20	Compliance Schedules	As necessary	
G21	Contract Submittal	As necessary	

Special Conditions

S1. Discharge limits

S1.A. Effluent limits

All discharges and activities authorized by this permit must comply with the terms and conditions of this permit. The discharge of any of the following pollutants more frequently than, or at a level in excess of, that identified and authorized by this permit violates the terms and conditions of this permit.

Beginning on the effective date of this permit, the Permittee may discharge treated domestic wastewater to the Skykomish River at the permitted location subject to compliance with the following limits:

Effluent Limits: Outfall 001 Latitude: 47.844501, Longitude: -121.974614		
Parameter	**Average Monthly** [a]	**Average Weekly** [b]
Biochemical Oxygen Demand (5-day) (BOD_5)	30 milligrams/liter (mg/L) 711 pounds/day (lbs/day) 85% removal of influent BOD5	45 mg/L 1066 lbs/day
Total Suspended Solids (TSS)	30 mg/L 711 lbs/day 85% removal of influent TSS	45 mg/L 1066 lbs/day
Parameter	**Minimum**	**Maximum**
pH – INTERIM LIMIT [c]	6.0 standard units	9.0 standard units
pH – FINAL LIMIT [d]	6.7 standard units	9.0 standard units
Parameter	**Monthly Geometric Mean**	**Weekly Geometric Mean**
Fecal Coliform Bacteria [e]	100/100 milliliter (mL)	200/100 mL

a	Average monthly effluent limit means the highest allowable average of daily discharges over a calendar month. To calculate the discharge value to compare to the limit, you add the value of each daily discharge measured during a calendar month and divide this sum by the total number of daily discharges measured. See footnote c for fecal coliform calculations.
b	Average weekly discharge limit means the highest allowable average of daily discharges over a calendar week, calculated as the sum of all daily discharges measured during a calendar week divided by the number of daily discharges measured during that week. See footnote c for fecal coliform calculations.
c	Interim limits for pH will apply from the effective date of the permit through December 31, 2022.
d	Final limits for pH will be effective as of January 1, 2023.
e	Ecology provides directions to calculate the monthly and the weekly geometric mean in publication No. 04-10-020, Information Manual for Treatment Plant Operators available at: https://fortress.wa.gov/ecy/publications/SummaryPages/0410020.html

S1.B. Mixing zone authorization

Mixing zone for Outfall 001

The following paragraphs define the maximum boundaries of the mixing zones:

Chronic mixing zone

The width of the chronic mixing zone is limited to a distance of 81 feet. The length of the chronic mixing zone extends 100 feet upstream and 301feet downstream of the outfall. The mixing zone extends from the bottom to the top of the water column. The concentration of pollutants at the edge of the chronic zone must meet chronic aquatic life criteria and human health criteria.

Acute mixing zone

The width of the acute mixing zone is limited to the most restrictive of the following: 10 feet upstream and 30.1 feet downstream of the outfall, or 2.5% of the river flow. The mixing zone extends from the bottom to the top of the water column. The concentration of pollutants at the edge of the acute zone must meet acute aquatic life criteria.

Available Dilution (dilution factor)	
Acute Aquatic Life Criteria	8.0
Chronic Aquatic Life Criteria	16.8
Human Health Criteria - Carcinogen	16.8
Human Health Criteria - Non-carcinogen	16.8

S2. Monitoring requirements

S2.A. Monitoring schedule

The Permittee must monitor in accordance with the following schedule and the requirements specified in Appendix A.

Parameter	Units & Speciation	Minimum Sampling Frequency	Sample Type
(1) Wastewater influent			
Wastewater Influent means the raw sewage flow from the collection system into the treatment facility. Sample the wastewater entering the headworks of the treatment plant excluding any side-stream returns from inside the plant.			
Biochemical Oxygen Demand (BOD_5)	mg/L	3/week	24-hour composite [1]
Biochemical Oxygen Demand (BOD_5)	lbs/day	3/week	Calculated [2]
Total Suspended Solids (TSS)	mg/L	3/week	24-hour composite
Total Suspended Solids (TSS)	lbs/day	3/week	Calculated
(2) Final wastewater effluent			
Final Wastewater Effluent means wastewater exiting the last treatment process or operation. Typically, this is after or at the exit from the chlorine contact chamber or other disinfection process.			
Flow	MGD	Continuous [3]	Metered/recorded
BOD_5	mg/L	3/week	24-hour composite
BOD_5	lbs/day	3/week	Calculated
BOD_5	% removal [4]	1/month	Calculated
TSS	mg/L	3/week	24-hour composite
TSS	lbs/day	3/week	Calculated
TSS	% removal	1/month	Calculated
Fecal Coliform [5]	# /100 ml	3/week	Grab [6]
pH [7]	Standard Units	Daily	Grab

Parameter	Units & Speciation	Minimum Sampling Frequency	Sample Type
Temperature [8]	Degrees centigrade (°C)	Continuous	Measurement
7-DAD Max Temperature [9]	°C	Daily	Calculated
(3) Whole effluent toxicity testing – final wastewater effluent			
Acute Toxicity Testing	See Section S10	2/permit cycle	24-hour composite
Chronic Toxicity Testing	See Section S11	2/permit cycle	24-hour composite
(5) Effluent characterization – final wastewater effluent			
Total Phosphorus	mg/L as P	Quarterly [10]	24-hour composite
Soluble Reactive Phosphorus	mg/L as P	Quarterly	24-hour composite
Total Ammonia	mg/L as N	Quarterly	24-hour composite
Nitrate plus Nitrite Nitrogen	mg/L as N	Quarterly	24-hour composite
Total Kjeldahl Nitrogen (TKN)	mg/L as N	Quarterly	24-hour composite
(6) Permit renewal application requirements – final wastewater effluent			
The Permittee must record and report the wastewater treatment plant flow discharged on the day it collects the sample for priority pollutant testing with the discharge monitoring report.			
Dissolved Oxygen	mg/L	Once per year	Grab
Oil and Grease	mg/L	Once per year	Grab
Total Dissolved Solids	mg/L	Once per year	24-hour composite
Total Hardness	mg/L	Once per year	24-hour composite
Cyanide	micrograms/liter (µg/L)		Grab
Total Phenolic Compounds	µg/L		Grab
Priority Pollutants (PP) – Total Metals	µg/L; nanograms (ng/L) for mercury	Once per year	24-hour composite Grab for mercury
PP – Volatile Organic Compounds	µg/L	Once per year	Grab
PP – Acid-extractable Compounds	µg/L	Once per year	24-hour composite
PP – Base-neutral Compounds	µg/L	Once per year	24-hour composite

1	24-hour composite means a series of individual samples collected over a 24-hour period into a single container, and analyzed as one sample.
2	Calculated means figured concurrently with the respective sample, using the following formula: Concentration (in mg/L) X Flow (in MGD) X Conversion Factor (8.34) = lbs/day
3	Continuous means uninterrupted except for brief lengths of time for calibration, power failure, or unanticipated equipment repair or maintenance. The time interval for the associated data logger must be no greater than 30 minutes.
4	% removal = $\frac{\text{Influent concentration (mg/L)} - \text{Effluent concentration (mg/L)}}{\text{Influent concentration (mg/L)}} \times 100$ Calculate the percent (%) removal of BOD_5 and TSS using the above equation.
5	Report a numerical value for fecal coliforms following the procedures in Ecology's *Information Manual for Wastewater Treatment Plant Operators*, Publication Number 04-10-020 available at: http://www.ecy.wa.gov/programs/wq/permits/guidance.html . Do not report a result as too numerous to count (TNTC).
6	Grab means an individual sample collected over a fifteen (15)-minute, or less, period.
7	Report the daily pH and the minimum and maximum for the monitoring period.
8	The Permittee must determine and report a daily maximum from half-hour measurements in a 24-hour period. Continuous monitoring instruments must achieve an accuracy of 0.2°C and the Permittee must verify accuracy annually.
9	Calculate a 7-DAD Max for each day by averaging each days maximum temperature value with the daily maximum temperatures of the three (3) days prior and the three (3) days after that specific date.
10	Quarterly sampling periods are January through March, April through June, July through September, and October through December. The Permittee must begin quarterly monitoring for the quarter beginning on January 1, 2019, and submit results by April 15, 2019.

S2.B. Sampling and analytical procedures

Samples and measurements taken to meet the requirements of this permit must represent the volume and nature of the monitored parameters. The Permittee must conduct representative sampling of any unusual discharge or discharge condition, including bypasses, upsets, and maintenance-related conditions that may affect effluent quality.

Sampling and analytical methods used to meet the monitoring requirements specified in this permit must conform to the latest revision of the *Guidelines Establishing Test Procedures for the Analysis of Pollutants* contained in 40 CFR Part 136 (or as applicable in 40 CFR subchapters N [Parts 400–471] or O [Parts 501-503]) unless otherwise specified in this permit . Ecology may only specify alternative methods for parameters without permit limits and for those parameters without an EPA approved test method in 40 CFR Part 136.

S2.C. Flow measurement and continuous monitoring devices

The Permittee must:

1. Select and use appropriate flow measurement and continuous monitoring devices and methods consistent with accepted scientific practices.
2. Install, calibrate, and maintain these devices to ensure the accuracy of the measurements is consistent with the accepted industry standard, the manufacturer's recommendation, and approved O&M manual procedures for the device and the wastestream.
3. Calibrate continuous monitoring instruments weekly unless it can demonstrate a longer period is sufficient based on monitoring records. The Permittee:
    a. May calibrate apparatus for continuous monitoring of dissolved oxygen by air calibration.
    b. Must calibrate continuous pH measurement instruments using a grab sample analyzed in the lab with a pH meter calibrated with standard buffers and analyzed within 15 minutes of sampling.
    c. Must calibrate continuous chlorine measurement instruments using a grab sample analyzed in the laboratory within 15 minutes of sampling.
4. Calibrate flow-monitoring devices at a minimum frequency of at least one calibration per year.
5. Maintain calibration records for at least three years.

S2.D. Laboratory accreditation

The Permittee must ensure that all monitoring data required by Ecology for permit specified parameters is prepared by a laboratory registered or accredited under the provisions of chapter 173-50 WAC, *Accreditation of Environmental Laboratories*. Flow, temperature, settleable solids, conductivity, pH, and internal process control parameters are exempt from this requirement. The Permittee must obtain accreditation for conductivity and pH if it must receive accreditation or registration for other parameters.

S3. Reporting and recording requirements

The Permittee must monitor and report in accordance with the following conditions. Falsification of information submitted to Ecology is a violation of the terms and conditions of this permit.

S3.A. Discharge monitoring reports

The first monitoring period begins on the effective date of the permit (unless otherwise specified). The Permittee must:

1. Summarize, report, and submit monitoring data obtained during each monitoring period on the electronic discharge monitoring report (DMR) form provided by Ecology within the Water Quality Permitting Portal. Include data for each of the parameters tabulated in Special Condition S2 and as required by the form. Report a value for each day sampling occurred (unless specifically exempted in the permit) and for the summary values (when applicable) included on the electronic form.
2. Ensure that DMRs are electronically submitted no later than the dates specified below, unless otherwise specified in this permit.
3. The Permittee must also submit an electronic copy of the laboratory report as an attachment using WQWebDMR. The contract laboratory reports must also include information on the chain of custody, QA/QC results, and documentation of accreditation for the parameter.
4. Submit DMRs for parameters with the monitoring frequencies specified in S2 (monthly, quarterly, annual, etc.) at the reporting schedule identified below. The Permittee must:
    a. Submit **monthly** DMRs by the 15th day of the following month.
    b. Submit **quarterly DMRs**, unless otherwise specified in the permit, by the 15th day of the month following the monitoring period. Quarterly sampling periods are January through March, April through June, July through September, and October through December. The Permittee must submit the first quarterly DMR on April 15, 2019 for the quarter beginning on January 1, 2019.
    c. Submit **annual DMRs**, unless otherwise specified in the permit, by January 15 for the previous calendar year. The annual sampling period is the calendar year.
5. Enter the “No Discharge” reporting code for an entire DMR, for a specific monitoring point, or for a specific parameter as appropriate, if the Permittee did not discharge wastewater or a specific pollutant during a given monitoring period.

6. Report single analytical values below detection as "less than the detection level (DL)" by entering < followed by the numeric value of the detection level (e.g. < 2.0) on the DMR. If the method used did not meet the minimum DL and quantitation level (QL) identified in the permit, report the actual QL and DL in the comments or in the location provided.
7. Report single analytical values between the detection level (DL) and the quantitation level (QL) by entering the estimated value, the code for estimated value/below quantitation limit (j) and any additional information in the comments. Submit a copy of the laboratory report as an attachment using WQWebDMR.
8. Not report zero for bacteria monitoring. Report as required by the laboratory method.
9. Calculate and report an arithmetic average value for each day for bacteria if multiple samples were taken in one day.
10. Calculate the geometric mean values for bacteria (unless otherwise specified in the permit) using:
    a. The reported numeric value for all bacteria samples measured above the detection value except when it took multiple samples in one day. If the Permittee takes multiple samples in one day it must use the arithmetic average for the day in the geometric mean calculation.
    b. The detection value for those samples measured below detection.
11. Report the test method used for analysis in the comments if the laboratory used an alternative method not specified in the permit and as allowed in Appendix A OR S2.
12. Calculate average values and calculated total values (unless otherwise specified in the permit) using:
    a. The reported numeric value for all parameters measured between the detection value and the quantitation value for the sample analysis.
    b. One-half the detection value (for values reported below detection) if the lab detected the parameter in another sample from the same monitoring point for the reporting period.
    c. Zero (for values reported below detection) if the lab did not detect the parameter in another sample for the reporting period.
13. Report single-sample grouped parameters (for example: priority pollutants, PAHs, pulp and paper chlorophenolics, TTOs) on the WQWebDMR form and include: sample date, concentration detected, detection limit (DL) (as necessary), and laboratory quantitation level (QL) (as necessary).

S3.B. Permit submittals and schedules

The Permittee must use the Water Quality Permitting Portal – Permit Submittals application (unless otherwise specified in the permit) to submit all other written permit-required reports by the date specified in the permit.

When another permit condition requires submittal of a paper (hard-copy) report, the Permittee must ensure that it is postmarked or received by Ecology no later than the dates specified by this permit. Send these paper reports to Ecology at:

Water Quality Permit Coordinator
Washington State Department of Ecology
Northwest Regional Office
3190 160th Avenue SE
Bellevue, WA 98008-5452

S3.C. Records retention

The Permittee must retain records of all monitoring information for a minimum of three (3) years. Such information must include all calibration and maintenance records and all original recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for this permit. The Permittee must extend this period of retention during the course of any unresolved litigation regarding the discharge of pollutants by the Permittee or when requested by Ecology.

S3.D. Recording of results

For each measurement or sample taken, the Permittee must record the following information:

1. The date, exact place, method, and time of sampling or measurement.
2. The individual who performed the sampling or measurement.
3. The dates the analyses were performed.
4. The individual who performed the analyses.
5. The analytical techniques or methods used.
6. The results of all analyses.

S3.E. Additional monitoring by the Permittee

If the Permittee monitors any pollutant more frequently than required by Special Condition S2 of this permit, then the Permittee must include the results of such monitoring in the calculation and reporting of the data submitted in the Permittee's DMR unless otherwise specified by Special Condition S2.

S3.F. Reporting permit violations

The Permittee must take the following actions when it violates or is unable to comply with any permit condition:

1. Immediately take action to stop, contain, and cleanup unauthorized discharges or otherwise stop the noncompliance and correct the problem.

2. If applicable, immediately repeat sampling and analysis. Submit the results of any repeat sampling to Ecology within thirty (30) days of sampling.

a. Immediate reporting

The Permittee must **immediately** report to Ecology and the Local Health Jurisdiction (at the numbers listed below), all:

- Failures of the disinfection system.
- Collection system overflows.
- Plant bypasses resulting in a discharge.
- Any other failures of the sewage system (pipe breaks, etc).

Northwest Regional Office	425-649-7000
Snohomish Health District	425-339-5252
Snohomish Health District	425-339-5295 (after hours)

Additionally, for any sanitary sewer overflow (SSO) that discharges to a municipal separate storm sewer system (MS4), the Permittee must notify the appropriate MS4 owner or operator.

b. Twenty-four-hour reporting

The Permittee must report the following occurrences of noncompliance by telephone, to Ecology at the telephone numbers listed above, within 24 hours from the time the Permittee becomes aware of any of the following circumstances:

1. Any noncompliance that may endanger health or the environment, unless previously reported under immediate reporting requirements.
2. Any unanticipated bypass that causes an exceedance of an effluent limit in the permit (See Part S5.F, “Bypass Procedures”).
3. Any upset that causes an exceedance of an effluent limit in the permit (See G.15, “Upset”).
4. Any violation of a maximum daily or instantaneous maximum discharge limit for any of the pollutants in Section S1.A of this permit.
5. Any overflow prior to the treatment works, whether or not such overflow endangers health or the environment or exceeds any effluent limit in the permit.

c. Report within five days

The Permittee must also submit a written report within five days of the time that the Permittee becomes aware of any reportable event under subparts a or b, above. The report must contain:

1. A description of the noncompliance and its cause.
2. The period of noncompliance, including exact dates and times.

3. The estimated time the Permittee expects the noncompliance to continue if not yet corrected.
4. Steps taken or planned to reduce, eliminate, and prevent recurrence of the noncompliance.
5. If the noncompliance involves an overflow prior to the treatment works, an estimate of the quantity (in gallons) of untreated overflow.

d. Waiver of written reports

Ecology may waive the written report required in subpart c, above, on a case-by-case basis upon request if the Permittee has submitted a timely oral report.

e. All other permit violation reporting

The Permittee must report all permit violations, which do not require immediate or within 24 hours reporting, when it submits monitoring reports for S3.A ("Reporting"). The reports must contain the information listed in subpart c, above. Compliance with these requirements does not relieve the Permittee from responsibility to maintain continuous compliance with the terms and conditions of this permit or the resulting liability for failure to comply.

S3.G. Other reporting

a. Spills of oil or hazardous materials

The Permittee must report a spill of oil or hazardous materials in accordance with the requirements of RCW 90.56.280 and chapter 173-303-145. You can obtain further instructions at the following website: http://www.ecy.wa.gov/programs/spills/other/reportaspill.htm .

b. Failure to submit relevant or correct facts

Where the Permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application, or in any report to Ecology, it must submit such facts or information promptly.

S3.H. Maintaining a copy of this permit

The Permittee must keep a copy of this permit at the facility and make it available upon request to Ecology inspectors.

S4. Facility loading

S4.A. Design criteria

The flows or waste loads for the permitted facility must not exceed the following design criteria:

Maximum Month Design Flow (MMDF)	2.84 MGD
BOD_5 Influent Loading for Maximum Month	6,090 lbs/day
TSS Influent Loading for Maximum Month	5,940 lbs/day

S4.B. Plans for maintaining adequate capacity

a. Conditions triggering plan submittal

The Permittee must submit a plan and a schedule for continuing to maintain capacity to Ecology when:

1. The actual flow or waste load reaches 85 percent of any one of the design criteria in S4.A for three consecutive months.
2. The projected plant flow or loading would reach design capacity within five years.

b. Plan and schedule content

The plan and schedule must identify the actions necessary to maintain adequate capacity for the expected population growth and to meet the limits and requirements of the permit. The Permittee must consider the following topics and actions in its plan.

1. Analysis of the present design and proposed process modifications
2. Reduction or elimination of excessive infiltration and inflow of uncontaminated ground and surface water into the sewer system
3. Limits on future sewer extensions or connections or additional waste loads
4. Modification or expansion of facilities
5. Reduction of industrial or commercial flows or waste loads

Engineering documents associated with the plan must meet the requirements of WAC 173-240-060, "Engineering Report," and be approved by Ecology prior to any construction.

S4.C. Duty to mitigate

The Permittee must take all reasonable steps to minimize or prevent any discharge or sludge use or disposal in violation of this permit that has a reasonable likelihood of adversely affecting human health or the environment.

S4.D. Notification of new or altered sources

1. The Permittee must submit written notice to Ecology whenever any new discharge or a substantial change in volume or character of an existing discharge into the wastewater treatment plant is proposed which:
   a. Would interfere with the operation of, or exceed the design capacity of, any portion of the wastewater treatment plant.
   b. Is not part of an approved general sewer plan or approved plans and specifications.
   c. Is subject to pretreatment standards under 40 CFR Part 403 and Section 307(b) of the Clean Water Act.

2. This notice must include an evaluation of the wastewater treatment plant's ability to adequately transport and treat the added flow and/or waste load, the quality and volume of effluent to be discharged to the treatment plant, and the anticipated impact on the Permittee's effluent [40 CFR 122.42(b)].

S5. Operation and maintenance

The Permittee must at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances), which are installed to achieve compliance with the terms and conditions of this permit. Proper operation and maintenance also includes keeping a daily operation logbook (paper or electronic), adequate laboratory controls, and appropriate quality assurance procedures. This provision of the permit requires the Permittee to operate backup or auxiliary facilities or similar systems only when the operation is necessary to achieve compliance with the conditions of this permit.

S5.A. Certified operator

This permitted facility must be operated by an operator certified by the state of Washington for at least a Class III plant. This operator must be in responsible charge of the day-to-day operation of the wastewater treatment plant. An operator certified for at least a Class II plant must be in charge during all regularly scheduled shifts.

S5.B. Operation and maintenance program

The Permittee must:

1. Institute an adequate operation and maintenance program for the entire sewage system.
2. Keep maintenance records on all major electrical and mechanical components of the treatment plant, as well as the sewage system and pumping stations. Such records must clearly specify the frequency and type of maintenance recommended by the manufacturer and must show the frequency and type of maintenance performed.
3. Make maintenance records available for inspection at all times.

S5.C. Short-term reduction

The Permittee must schedule any facility maintenance, which might require interruption of wastewater treatment and degrade effluent quality, during non-critical water quality periods and carry this maintenance out according to the approved O&M manual or as otherwise approved by Ecology.

If a Permittee contemplates a reduction in the level of treatment that would cause a violation of permit discharge limits on a short-term basis for any reason, and such reduction cannot be avoided, the Permittee must:

1. Give written notification to Ecology, if possible, thirty (30) days prior to such activities.

2. Detail the reasons for, length of time of, and the potential effects of the reduced level of treatment.

This notification does not relieve the Permittee of its obligations under this permit.

S5.D. Electrical power failure

The Permittee must ensure that adequate safeguards prevent the discharge of untreated wastes or wastes not treated in accordance with the requirements of this permit during electrical power failure at the treatment plant and/or sewage lift stations. Adequate safeguards include, but are not limited to, alternate power sources, standby generator(s), or retention of inadequately treated wastes.

The Permittee must maintain Reliability Class II (EPA 430-99-74-001) at the wastewater treatment plant. Reliability Class II requires a backup power source sufficient to operate all vital components and critical lighting and ventilation during peak wastewater flow conditions. Vital components used to support the secondary processes (i.e., mechanical aerators or aeration basin air compressors) need not be operable to full levels of treatment, but must be sufficient to maintain the biota.

S5.E. Prevent connection of inflow

The Permittee must strictly enforce its sewer ordinances and not allow the connection of inflow (roof drains, foundation drains, etc.) to the sanitary sewer system.

S5.F. Bypass procedures

A bypass is the intentional diversion of waste streams from any portion of a treatment facility. This permit prohibits all bypasses except when the bypass is for essential maintenance, as authorized in special condition S5.F.1, or is approved by Ecology as an anticipated bypass following the procedures in S5.F.2.

1. Bypass for essential maintenance without the potential to cause violation of permit limits or conditions.

   This permit allows bypasses for essential maintenance of the treatment system when necessary to ensure efficient operation of the system. The Permittee may bypass the treatment system for essential maintenance only if doing so does not cause violations of effluent limits. The Permittee is not required to notify Ecology when bypassing for essential maintenance. However the Permittee must comply with the monitoring requirements specified in special condition S2.B.

2. Anticipated bypasses for non-essential maintenance

   Ecology may approve an anticipated bypass under the conditions listed below. This permit prohibits any anticipated bypass that is not approved through the following process.

a. If a bypass is for non-essential maintenance, the Permittee must notify Ecology, if possible, at least ten (10) days before the planned date of bypass. The notice must contain:

- A description of the bypass and the reason the bypass is necessary.
- An analysis of all known alternatives which would eliminate, reduce, or mitigate the potential impacts from the proposed bypass.
- A cost-effectiveness analysis of alternatives.
- The minimum and maximum duration of bypass under each alternative.
- A recommendation as to the preferred alternative for conducting the bypass.
- The projected date of bypass initiation.
- A statement of compliance with SEPA.
- A request for modification of water quality standards as provided for in WAC 173-201A-410, if an exceedance of any water quality standard is anticipated.
- Details of the steps taken or planned to reduce, eliminate, and prevent recurrence of the bypass.

b. For probable construction bypasses, the Permittee must notify Ecology of the need to bypass as early in the planning process as possible. The Permittee must consider the analysis required above during the project planning and design process. The project-specific engineering report as well as the plans and specifications must include details of probable construction bypasses to the extent practical. In cases where the Permittee determines the probable need to bypass early, the Permittee must continue to analyze conditions up to and including the construction period in an effort to minimize or eliminate the bypass.

c. Ecology will determine if the Permittee has met the conditions of special condition S5.F.2 a and b and consider the following prior to issuing a determination letter, an administrative order, or a permit modification as appropriate for an anticipated bypass:

- If the Permittee planned and scheduled the bypass to minimize adverse effects on the public and the environment.
- If the bypass is unavoidable to prevent loss of life, personal injury, or severe property damage. “Severe property damage” means substantial physical damage to property, damage to the treatment facilities which would cause them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass.
- If feasible alternatives to the bypass exist, such as:
  - The use of auxiliary treatment facilities.

- Retention of untreated wastes.
- Stopping production.
- Maintenance during normal periods of equipment downtime, but not if the Permittee should have installed adequate backup equipment in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventative maintenance.
- Transport of untreated wastes to another treatment facility.

S5.G. Operations and maintenance (O&M) manual

a. O&M manual submittal and requirements

The Permittee must:

1. Review the O&M Manual at least annually.
2. Submit to Ecology for review substantial changes or updates to the O&M Manual whenever it incorporates them into the manual.
3. Keep the approved O&M Manual at the permitted facility.
4. Follow the instructions and procedures of this manual.

b. O&M manual components

In addition to the requirements of WAC 173-240-080(1) through (5), the O&M Manual must be consistent with the guidance in Table G1-3 in the *Criteria for Sewage Works Design* (Orange Book), 2008. The O&M Manual must include:

1. Emergency procedures for cleanup in the event of wastewater system upset or failure.
2. A review of system components which if failed could pollute surface water or could impact human health. Provide a procedure for a routine schedule of checking the function of these components.
3. Wastewater system maintenance procedures that contribute to the generation of process wastewater.
4. Reporting protocols for submitting reports to Ecology to comply with the reporting requirements in the discharge permit.
5. Any directions to maintenance staff when cleaning or maintaining other equipment or performing other tasks which are necessary to protect the operation of the wastewater system (for example, defining maximum allowable discharge rate for draining a tank, blocking all floor drains before beginning the overhaul of a stationary engine).
6. The treatment plant process control monitoring schedule.
7. Minimum staffing adequate to operate and maintain the treatment processes and carry out compliance monitoring required by the permit.

S6. Pretreatment

S6.A. General requirements

The Permittee must work with Ecology to ensure that all commercial and industrial users of the publicly owned treatment works (POTW) comply with the pretreatment regulations in 40 CFR Part 403 and any additional regulations that the Environmental Protection Agency (U.S. EPA) may promulgate under Section 307(b) (pretreatment) and 308 (reporting) of the Federal Clean Water Act.

S6.B. Duty to enforce discharge prohibitions

1. Under federal regulations (40 CFR 403.5(a) and (b)), the Permittee must not authorize or knowingly allow the discharge of any pollutants into its POTW which may be reasonably expected to cause pass through or interference, or which otherwise violate general or specific discharge prohibitions contained in 40 CFR Part 403.5 or WAC 173-216-060.
2. The Permittee must not authorize or knowingly allow the introduction of any of the following into their treatment works:
   a. Pollutants which create a fire or explosion hazard in the POTW (including, but not limited to waste streams with a closed cup flashpoint of less than 140 degrees Fahrenheit or 60 degrees Centigrade using the test methods specified in 40 CFR 261.21).
   b. Pollutants which will cause corrosive structural damage to the POTW, but in no case discharges with pH lower than 5.0, or greater than 11.0 standard units, unless the works are specifically designed to accommodate such discharges.
   c. Solid or viscous pollutants in amounts that could cause obstruction to the flow in sewers or otherwise interfere with the operation of the POTW.
   d. Any pollutant, including oxygen-demanding pollutants, (BOD_5, etc.) released in a discharge at a flow rate and/or pollutant concentration which will cause interference with the POTW.
   e. Petroleum oil, non-biodegradable cutting oil, or products of mineral origin in amounts that will cause interference or pass through.
   f. Pollutants which result in the presence of toxic gases, vapors, or fumes within the POTW in a quantity which may cause acute worker health and safety problems.
   g. Heat in amounts that will inhibit biological activity in the POTW resulting in interference but in no case heat in such quantities such that the temperature at the POTW headworks exceeds 40 degrees Centigrade (104 degrees Fahrenheit) unless Ecology, upon request of the Permittee, approves, in writing, alternate temperature limits.
   h. Any trucked or hauled pollutants, except at discharge points designated by the Permittee.

i. Wastewaters prohibited to be discharged to the POTW by the Dangerous Waste Regulations (chapter 173-303 WAC), unless authorized under the Domestic Sewage Exclusion (WAC 173-303-071).

3. The Permittee must also not allow the following discharges to the POTW unless approved in writing by Ecology:
   a. Noncontact cooling water in significant volumes.
   b. Stormwater and other direct inflow sources.
   c. Wastewaters significantly affecting system hydraulic loading, which do not require treatment, or would not be afforded a significant degree of treatment by the system.
4. The Permittee must notify Ecology if any industrial user violates the prohibitions listed in this section (S6.B), and initiate enforcement action to promptly curtail any such discharge.

S6.C. Wastewater discharge permit required

The Permittee must:

1. Establish a process for authorizing non-domestic wastewater discharges that ensures all SIUs in all tributary areas meet the applicable state waste discharge permit (SWDP) requirements in accordance with chapter 90.48 RCW and chapter 173-216 WAC.
2. Immediately notify Ecology of any proposed discharge of wastewater from a source, which may be a significant industrial user (SIU) [see fact sheet definitions or refer to 40 CFR 403.3(v)(i)(ii)].
3. Require all SIUs to obtain a SWDP from Ecology prior to accepting their non-domestic wastewater, or require proof that Ecology has determined they do not require a permit.
4. Require the documentation as described in S6.C.3 at the earliest practicable date as a condition of continuing to accept non-domestic wastewater discharges from a previously undiscovered, currently discharging and unpermitted SIU.
5. Require sources of non-domestic wastewater, which do not qualify as SIUs but merit a degree of oversight, to apply for a SWDP and provide it a copy of the application and any Ecology responses.
6. Keep all records documenting that its users have met the requirements of S6.C.

S6.D. Identification and reporting of existing, new, and proposed industrial users

1. The Permittee must take continuous, routine measures to identify all existing, new, and proposed SIUs and potential significant industrial users (PSIUs) discharging or proposing to discharge to the Permittee's sewer system (see **Appendix C** of the fact sheet for definitions).

2. Within 30 days of becoming aware of an unpermitted existing, new, or proposed industrial user who may be a significant industrial user (SIU), the Permittee must notify such user by registered mail that, if classified as an SIU, they must apply to Ecology and obtain a State Waste Discharge Permit. The Permittee must send a copy of this notification letter to Ecology within this same 30-day period.

3. The Permittee must also notify all Potential SIUs (PSIUs), as they are identified, that if their classification should change to an SIU, they must apply to Ecology for a State Waste Discharge Permit within 30 days of such change.

S6.E. Industrial user survey

The Permittee must complete an industrial user survey listing all SIUs and potential significant industrial users (PSIUs) discharging to the POTW. The Permittee must submit the survey to Ecology by December 31, 2022. At a minimum, the Permittee must develop the list of SIUs and PSIUs by means of a telephone book search, a water utility billing records search, and a physical reconnaissance of the service area. Information on PSIUs must include, at a minimum, the business name, telephone number, address, description of the industrial process(s), and the known wastewater volumes and characteristics.

For industrial users for which there are potentially significant non-domestic discharges, the Permittee must obtain and include in the report the minimum information described in the paragraph above for PSIUs.

S7. Solid wastes

S7.A. Solid waste handling

The Permittee must handle and dispose of all solid waste material in such a manner as to prevent its entry into state ground or surface water.

S7.B. Leachate

The Permittee must not allow leachate from its solid waste material to enter state waters without providing all known, available, and reasonable methods of treatment, nor allow such leachate to cause violations of the State Surface Water Quality Standards, Chapter 173-201A WAC, or the State Ground Water Quality Standards, Chapter 173-200 WAC.

S8. Mixing study

S8.A. General requirements

The Permittee must

1. Update the Effluent Mixing Zone Study (Cosmopolitan, 2009). Submit a Plan of Study to Ecology for review by December 31, 2020, prior to initiation of the effluent mixing study.

2. Use the Guidance for Conducting Mixing Zone Analyses (Appendix C of Ecology's *Permit Writer's Manual*, 2015) and the protocols identified in S8.C.

3. Include the results of the effluent mixing study in the Effluent Mixing Report and submit it to Ecology for approval by December 31, 2021.
4. If the results of the mixing study, toxicity tests, and chemical analysis indicate that the concentration of any pollutant(s) exceeds or has a reasonable potential to exceed the state water quality standards, chapter 173-201A WAC, Ecology may modify this permit to impose effluent limits to meet the water quality standards.

S8.B. Reporting requirements

The mixing zone study must include:

1. A statement confirming that AKART has been applied to the discharge.
2. A description of the size of the mixing zone allowed under WAC 173-201A.
3. An analysis showing how mixing zones have been minimized based on using the lowest dilution from hydraulic limitation, width limitations, distance limitation and that predicted by the model.
4. A clear description of the critical conditions used for dilution factors:
    a. For ambient freshwater (unidirectional flow) use 7Q10 flows for acute, chronic and non-carcinogen pollutants, and harmonic flow for carcinogens.
    b. Generally, use depth of outfall at 7Q10 flows for rivers. For assessing human health in freshwater, depths of outfall should be established at the applicable flow (e.g. harmonic mean flow or 30Q5 flows).
    c. For unidirectional flow use centerline dilution factor for acute and chronic conditions, and flux average for human health dilution factors.
5. Diffuser information:
    a. Location, orientation, description and dimension of diffusers and ports.
    b. Port elevation above bottom and the depth of the diffuser/port below water surface based on 7Q10 flow for rivers.
    c. Plan view maps showing the mixing zone size and dimensions in relation to the diffuser.
    d. Schematic of waterbody cross-section, showing channel width, depth, and diffuser location in relation to shoreline and bottom.
    e. Report on the integrity of the diffuser and the ports being modeled.
6. Discharge characteristics:
    a. Existing and projected maximum daily, maximum monthly average, and annual average flows.
    b. Discharge density (temperature and salinity).
7. Ambient water characteristics:
    a. Critical stream flow statistics (7Q10, 30Q5, harmonic flow).
    b. Velocity profile in the vicinity of the diffuser.

c. Manning's roughness coefficient, if used.

d. Available information regarding background concentrations of chemical substances in the receiving water for which there are criteria in chapter 173-201A WAC.

8. Model selection and results:

a. Model selection and application discussion. Consider model applicability to single or multiport diffuser, opposing port configuration, submerged, surface or above-surface discharge, buoyant or non-buoyant discharge, and potential plume attachment to boundaries.

b. Description of mixing and plume dynamics (nearfield, farfield, tidal buildup/reflux).

c. Sensitivity analysis.

d. Calibration to empirical data (tracer studies), if applicable.

e. Provide model output and summary table of results.

S8.C. Protocols

The Permittee must determine the dilution ratio using protocols outlined in the following references, approved modifications thereof, or by another method approved by Ecology:

1. Doneker, R.L. and G.H. Jirka, *CORMIX User Manual: A Hydrodynamic Mixing Zone Model and Decision Support System for Pollutant Discharges into Surface Waters*, EPA-823-K-07-001, Dec. 2007. http://www.mixzon.com/downloads/.

   A complete list of general reference for CORMIX is at: http://www.cormix.info/references.php

2. Frick, W.E., Roberts, P.J.W., Davis, L.R., Keyes, D.J., Baumgartner, George, K.P. 2003. *Dilution Models for Effluent Discharges, 4th Edition (Visual Plumes)*. Ecosystems Research Div., USEPA, Athens, GA, USA.

3. Ecology, Water Quality Program, *Permit Writer's Manual*. 2015. Washington State Department of Ecology. Publication No. 92-109, Revised January 2015. https://fortress.wa.gov/ecy/publications/summarypages/92109.html.

4. Ecology, Guidance for conducting mixing zone analysis (Appendix C, Water Quality Program *Permit Writer's Manual*. 2015). https://fortress.wa.gov/ecy/publications/summarypages/92109.html.

5. Kilpatrick, F.A., and E.D. Cobb, *Measurement of Discharge Using Tracers, Chapter A16, Techniques of Water-Resources Investigations of the USGS*, Book 3, Application of Hydraulics, USGS, U.S. Department of the Interior, Reston, VA, 1985.

6. Wilson, J.F., E.D. Cobb, and F.A. Kilpatrick, *Fluorometric Procedures for Dye Tracing, Chapter A12. Techniques of Water-Resources Investigations of the USGS*, Book 3, Application of Hydraulics, USGS, U.S. Department of the Interior, Reston, VA, 1986.

S9. Outfall evaluation

The Permittee must inspect the submerged portion of the outfall line and diffuser to document its integrity and continued function. If conditions allow for a photographic verification, the Permittee must include such verification in the report. By December 31, 2022, the Permittee must submit the inspection report to Ecology through the Water Quality Permitting Portal – Permit Submittals application.

The inspector must at a minimum:

- Assess the physical condition of the outfall pipe, diffuser, and associated couplings.
- Determine the extent of sediment accumulation in the vicinity of the diffuser.
- Ensure diffuser ports are free of obstructions and are allowing uniform flow.
- Confirm physical location (latitude/longitude) of the diffuser section of the outfall.
- Assess physical condition of anchors used to secure the outfall pipe and diffuser sections.

S10. Acute toxicity

S10.A. Testing when there is no permit limit for acute toxicity

The Permittee must:

1. Conduct acute toxicity testing on final effluent two times, during the following quarters:
   a. January - March 2022.
   b. July - September 2022.
2. Conduct acute toxicity testing on a series of at least five concentrations of effluent, including 100% effluent and a control.
3. Use each of the following species and protocols for each acute toxicity test:

Acute Toxicity Tests	Species	Method
Fathead minnow 96-hour static-renewal test	*Pimephales promelas*	EPA-821-R-02-012
Daphnid 48-hour static test	*Ceriodaphnia dubia, Daphnia pulex,* or *Daphnia magna*	EPA-821-R-02-012

4. Submit the results electronically to Ecology using the Water Quality Permitting Portal – Permit Submittals application by April 15, 2022, and October 15, 2022.

S10.B. Sampling and reporting requirements

1. The Permittee must submit all reports for toxicity testing in accordance with the most recent version of Ecology Publication No. WQ-R-95-80, *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria*. Reports must contain toxicity data, bench sheets, and reference toxicant results for test methods. In addition, the Permittee must submit toxicity test data in electronic format (CETIS export file preferred) for entry into Ecology's database.

2. The Permittee must collect 24-hour composite effluent samples for toxicity testing. The Permittee must cool the samples to 0 - 6 degrees Celsius during collection and send them to the lab immediately upon completion. The lab must begin the toxicity testing as soon as possible but no later than 36 hours after sampling was completed.
3. The laboratory must conduct water quality measurements on all samples and test solutions for toxicity testing, as specified in the most recent version of Ecology Publication No. WQ-R-95-80, *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria*.
4. All toxicity tests must meet quality assurance criteria and test conditions specified in the most recent versions of the EPA methods listed in Subsection C and the Ecology Publication No. WQ-R-95-80, *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria*. If Ecology determines any test results to be invalid or anomalous, the Permittee must repeat the testing with freshly collected effluent.
5. The laboratory must use control water and dilution water meeting the requirements of the EPA methods listed in Section A or pristine natural water of sufficient quality for good control performance.
6. The Permittee must conduct whole effluent toxicity tests on an unmodified sample of final effluent.
7. The Permittee may choose to conduct a full dilution series test during compliance testing in order to determine dose response. In this case, the series must have a minimum of five effluent concentrations and a control. The series of concentrations must include the acute critical effluent concentration (ACEC). The ACEC equals 12.5% effluent.
8. All whole effluent toxicity tests, effluent screening tests, and rapid screening tests that involve hypothesis testing must comply with the acute statistical power standard of 29% as defined in WAC 173-205-020. If the test does not meet the power standard, the Permittee must repeat the test on a fresh sample with an increased number of replicates to increase the power.

S11. Chronic toxicity

S11.A. Testing when there is no permit limit for chronic toxicity

The Permittee must:

1. Conduct chronic toxicity testing on final effluent during the following two quarters:
   a. January - March 2022.
   b. July - September 2022.

2. Conduct chronic toxicity testing on a series of at least five concentrations of effluent and a control. This series of dilutions must include the acute critical effluent concentration (ACEC). The ACEC equals 12.5% effluent. The series of dilutions should also contain the CCEC of 6.0% effluent.
3. Compare the ACEC to the control using hypothesis testing at the 0.05 level of significance as described in Appendix H, EPA/600/4-89/001.
4. Submit the results electronically to Ecology using the Water Quality Permitting Portal – Permit Submittals application by April 15, 2022, and October 15, 2022.
5. Perform chronic toxicity tests with all of the following species and the most recent version of the following protocols:

Freshwater Chronic Test	Species	Method
Fathead minnow survival and growth	*Pimephales promelas*	EPA-821-R-02-013
Water flea survival and reproduction	*Ceriodaphnia dubia*	EPA-821-R-02-013

S11.B. Sampling and reporting requirements

1. The Permittee must submit all reports for toxicity testing in accordance with the most recent version of Ecology Publication No. WQ-R-95-80, *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria*. Reports must contain toxicity data, bench sheets, and reference toxicant results for test methods. In addition, the Permittee must submit toxicity test data in electronic format (CETIS export file preferred) for entry into Ecology's database.
2. The Permittee must collect 24-hour composite effluent samples for toxicity testing. The Permittee must cool the samples to 0 - 6 degrees Celsius during collection and send them to the lab immediately upon completion. The lab must begin the toxicity testing as soon as possible but no later than 36 hours after sampling was completed.
3. The laboratory must conduct water quality measurements on all samples and test solutions for toxicity testing, as specified in the most recent version of Ecology Publication No. WQ-R-95-80, *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria*.
4. All toxicity tests must meet quality assurance criteria and test conditions specified in the most recent versions of the EPA methods listed in Section C and the Ecology Publication no. WQ-R-95-80, *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria*. If Ecology determines any test results to be invalid or anomalous, the Permittee must repeat the testing with freshly collected effluent.
5. The laboratory must use control water and dilution water meeting the requirements of the EPA methods listed in Subsection C or pristine natural water of sufficient quality for good control performance.
6. The Permittee must conduct whole effluent toxicity tests on an unmodified sample of final effluent.

7. The Permittee may choose to conduct a full dilution series test during compliance testing in order to determine dose response. In this case, the series must have a minimum of five effluent concentrations and a control. The series of concentrations must include the CCEC and the ACEC. The CCEC and the ACEC may either substitute for the effluent concentrations that are closest to them in the dilution series or be extra effluent concentrations. The CCEC equals 6.0% effluent. The ACEC equals 12.5% effluent.
8. All whole effluent toxicity tests that involve hypothesis testing must comply with the chronic statistical power standard of 39% as defined in WAC 173-205-020. If the test does not meet the power standard, the Permittee must repeat the test on a fresh sample with an increased number of replicates to increase the power.

S12. Compliance schedule

By the dates tabulated below, the Permittee must complete the following tasks:

	Tasks	Date Due
1	Submit an Engineering Report according to the requirements of WAC 173-240-060 for facility improvements, including those necessary to meet the final effluent limits for pH.	**December 31, 2019**
2	Submit Plans and Specifications according to the requirements of WAC 173-240-070 for any facility improvements needed to meet final effluent limits for pH.	**December 31, 2020**
3	Complete construction and installation of facilities and equipment necessary to maintain compliance with final effluent limits for pH. Submit a Declaration of Construction of Water Pollution Control Facilities (WAC 173-240-090).	**December 31, 2022**

For engineering documents, the Permittee must submit an electronic copy and one half-size paper copy to Ecology at the address listed in Special Condition S3.B.

S13. Application for permit renewal or modification for facility changes

The Permittee must submit an application for renewal of this permit by **December 31, 2022.**

The Permittee must also submit a new application or addendum at least one hundred eighty (180) days prior to commencement of discharges, resulting from the activities listed below, which may result in permit violations. These activities include any facility expansions, production increases, or other planned changes, such as process modifications, in the permitted facility.

General Conditions

G1. Signatory requirements

1. All applications submitted to Ecology must be signed and certified.
   a. In the case of corporations, by a responsible corporate officer. For the purpose of this section, a responsible corporate officer means:
      - A president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision making functions for the corporation, or
      - The manager of one or more manufacturing, production, or operating facilities, provided, the manager is authorized to make management decisions which govern the operation of the regulated facility including having the explicit or implicit duty of making major capital investment recommendations, and initiating and directing other comprehensive measures to assure long-term environmental compliance with environmental laws and regulations; the manager can ensure that the necessary systems are established or actions taken to gather complete and accurate information for permit application requirements; and where authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures.

   b. In the case of a partnership, by a general partner.
   c. In the case of sole proprietorship, by the proprietor.
   d. In the case of a municipal, state, or other public facility, by either a principal executive officer or ranking elected official.

   Applications for permits for domestic wastewater facilities that are either owned or operated by, or under contract to, a public entity shall be submitted by the public entity.

2. All reports required by this permit and other information requested by Ecology must be signed by a person described above or by a duly authorized representative of that person. A person is a duly authorized representative only if:
   a. The authorization is made in writing by a person described above and submitted to Ecology.
   b. The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility, such as the position of plant manager, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters. (A duly authorized representative may thus be either a named individual or any individual occupying a named position.)

3. Changes to authorization. If an authorization under paragraph G1.2, above, is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of paragraph G1.2, above, must be submitted to Ecology prior to or together with any reports, information, or applications to be signed by an authorized representative.
4. Certification. Any person signing a document under this section must make the following certification:

   "I certify under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

G2. Right of inspection and entry

The Permittee must allow an authorized representative of Ecology, upon the presentation of credentials and such other documents as may be required by law:

1. To enter upon the premises where a discharge is located or where any records must be kept under the terms and conditions of this permit.
2. To have access to and copy, at reasonable times and at reasonable cost, any records required to be kept under the terms and conditions of this permit.
3. To inspect, at reasonable times, any facilities, equipment (including monitoring and control equipment), practices, methods, or operations regulated or required under this permit.
4. To sample or monitor, at reasonable times, any substances or parameters at any location for purposes of assuring permit compliance or as otherwise authorized by the Clean Water Act.

G3. Permit actions

This permit may be modified, revoked and reissued, or terminated either at the request of any interested person (including the Permittee) or upon Ecology's initiative. However, the permit may only be modified, revoked and reissued, or terminated for the reasons specified in 40 CFR 122.62, 40 CFR 122.64 or WAC 173-220-150 according to the procedures of 40 CFR 124.5.

1. The following are causes for terminating this permit during its term, or for denying a permit renewal application:
   a. Violation of any permit term or condition.
   b. Obtaining a permit by misrepresentation or failure to disclose all relevant facts.
   c. A material change in quantity or type of waste disposal.

   d. A determination that the permitted activity endangers human health or the environment, or contributes to water quality standards violations and can only be regulated to acceptable levels by permit modification or termination.
   e. A change in any condition that requires either a temporary or permanent reduction, or elimination of any discharge or sludge use or disposal practice controlled by the permit.
   f. Nonpayment of fees assessed pursuant to RCW 90.48.465.
   g. Failure or refusal of the Permittee to allow entry as required in RCW 90.48.090.

2. The following are causes for modification but not revocation and reissuance except when the Permittee requests or agrees:
   a. A material change in the condition of the waters of the state.
   b. New information not available at the time of permit issuance that would have justified the application of different permit conditions.
   c. Material and substantial alterations or additions to the permitted facility or activities which occurred after this permit issuance.
   d. Promulgation of new or amended standards or regulations having a direct bearing upon permit conditions, or requiring permit revision.
   e. The Permittee has requested a modification based on other rationale meeting the criteria of 40 CFR Part 122.62.
   f. Ecology has determined that good cause exists for modification of a compliance schedule, and the modification will not violate statutory deadlines.
   g. Incorporation of an approved local pretreatment program into a municipality's permit.
3. The following are causes for modification or alternatively revocation and reissuance:
   a. When cause exists for termination for reasons listed in 1.a through 1.g of this section, and Ecology determines that modification or revocation and reissuance is appropriate.
   b. When Ecology has received notification of a proposed transfer of the permit. A permit may also be modified to reflect a transfer after the effective date of an automatic transfer (General Condition G7) but will not be revoked and reissued after the effective date of the transfer except upon the request of the new Permittee.

G4. Reporting planned changes

The Permittee must, as soon as possible, but no later than one hundred eighty (180) days prior to the proposed changes, give notice to Ecology of planned physical alterations or additions to the permitted facility, production increases, or process modification which will result in:

1. The permitted facility being determined to be a new source pursuant to 40 CFR 122.29(b).
2. A significant change in the nature or an increase in quantity of pollutants discharged.
3. A significant change in the Permittee's sludge use or disposal practices. Following such notice, and the submittal of a new application or supplement to the existing application, along with required engineering plans and reports, this permit may be modified, or revoked and reissued pursuant to 40 CFR 122.62(a) to specify and limit any pollutants not previously limited. Until such modification is effective, any new or increased discharge in excess of permit limits or not specifically authorized by this permit constitutes a violation.

G5. Plan review required

Prior to constructing or modifying any wastewater control facilities, an engineering report and detailed plans and specifications must be submitted to Ecology for approval in accordance with chapter 173-240 WAC. Engineering reports, plans, and specifications must be submitted at least one hundred eighty (180) days prior to the planned start of construction unless a shorter time is approved by Ecology. Facilities must be constructed and operated in accordance with the approved plans.

G6. Compliance with other laws and statutes

Nothing in this permit excuses the Permittee from compliance with any applicable federal, state, or local statutes, ordinances, or regulations.

G7. Transfer of this permit

In the event of any change in control or ownership of facilities from which the authorized discharge emanate, the Permittee must notify the succeeding owner or controller of the existence of this permit by letter, a copy of which must be forwarded to Ecology.

1. Transfers by Modification

   Except as provided in paragraph (2) below, this permit may be transferred by the Permittee to a new owner or operator only if this permit has been modified or revoked and reissued under 40 CFR 122.62(b)(2), or a minor modification made under 40 CFR 122.63(d), to identify the new Permittee and incorporate such other requirements as may be necessary under the Clean Water Act.

2. Automatic Transfers

   This permit may be automatically transferred to a new Permittee if:

   a. The Permittee notifies Ecology at least thirty (30) days in advance of the proposed transfer date.
   b. The notice includes a written agreement between the existing and new Permittees containing a specific date transfer of permit responsibility, coverage, and liability between them.

c. Ecology does not notify the existing Permittee and the proposed new Permittee of its intent to modify or revoke and reissue this permit. A modification under this subparagraph may also be minor modification under 40 CFR 122.63. If this notice is not received, the transfer is effective on the date specified in the written agreement.

G8. Reduced production for compliance

The Permittee, in order to maintain compliance with its permit, must control production and/or all discharges upon reduction, loss, failure, or bypass of the treatment facility until the facility is restored or an alternative method of treatment is provided. This requirement applies in the situation where, among other things, the primary source of power of the treatment facility is reduced, lost, or fails.

G9. Removed substances

Collected screenings, grit, solids, sludges, filter backwash, or other pollutants removed in the course of treatment or control of wastewaters must not be resuspended or reintroduced to the final effluent stream for discharge to state waters.

G10. Duty to provide information

The Permittee must submit to Ecology, within a reasonable time, all information which Ecology may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit or to determine compliance with this permit. The Permittee must also submit to Ecology upon request, copies of records required to be kept by this permit.

G11. Other requirements of 40 CFR

All other requirements of 40 CFR 122.41 and 122.42 are incorporated in this permit by reference.

G12. Additional monitoring

Ecology may establish specific monitoring requirements in addition to those contained in this permit by administrative order or permit modification.

G13. Payment of fees

The Permittee must submit payment of fees associated with this permit as assessed by Ecology.

G14. Penalties for violating permit conditions

Any person who is found guilty of willfully violating the terms and conditions of this permit is deemed guilty of a crime, and upon conviction thereof shall be punished by a fine of up to ten thousand dollars ($10,000) and costs of prosecution, or by imprisonment in the discretion of the court. Each day upon which a willful violation occurs may be deemed a separate and additional violation.

Any person who violates the terms and conditions of a waste discharge permit may incur, in addition to any other penalty as provided by law, a civil penalty in the amount of up to ten thousand dollars ($10,000) for every such violation. Each and every such violation is a separate and distinct offense, and in case of a continuing violation, every day's continuance is deemed to be a separate and distinct violation.

G15. Upset

Definition – "Upset" means an exceptional incident in which there is unintentional and temporary noncompliance with technology-based permit effluent limits because of factors beyond the reasonable control of the Permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

An upset constitutes an affirmative defense to an action brought for noncompliance with such technology-based permit effluent limits if the requirements of the following paragraph are met.

A Permittee who wishes to establish the affirmative defense of upset must demonstrate, through properly signed, contemporaneous operating logs, or other relevant evidence that:

1. An upset occurred and that the Permittee can identify the cause(s) of the upset.
2. The permitted facility was being properly operated at the time of the upset.
3. The Permittee submitted notice of the upset as required in Special Condition S3.F.
4. The Permittee complied with any remedial measures required under S3.F of this permit.

In any enforcement action the Permittee seeking to establish the occurrence of an upset has the burden of proof.

G16. Property rights

This permit does not convey any property rights of any sort, or any exclusive privilege.

G17. Duty to comply

The Permittee must comply with all conditions of this permit. Any permit noncompliance constitutes a violation of the Clean Water Act and is grounds for enforcement action; for permit termination, revocation and reissuance, or modification; or denial of a permit renewal application.

G18. Toxic pollutants

The Permittee must comply with effluent standards or prohibitions established under Section 307(a) of the Clean Water Act for toxic pollutants within the time provided in the regulations that establish those standards or prohibitions, even if this permit has not yet been modified to incorporate the requirement.

G19. Penalties for tampering

The Clean Water Act provides that any person who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required to be maintained under this permit shall, upon conviction, be punished by a fine of not more than $10,000 per violation, or by imprisonment for not more than two (2) years per violation, or by both. If a conviction of a person is for a violation committed after a first conviction of such person under this condition, punishment shall be a fine of not more than $20,000 per day of violation, or by imprisonment of not more than four (4) years, or by both.

G20. Compliance schedules

Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule of this permit must be submitted no later than fourteen (14) days following each schedule date.

G21. Service agreement review

The Permittee must submit to Ecology any proposed service agreements and proposed revisions or updates to existing agreements for the operation of any wastewater treatment facility covered by this permit. The review is to ensure consistency with chapters 90.46 and 90.48 RCW as required by RCW 70.150.040(9). In the event that Ecology does not comment within a thirty-day (30) period, the Permittee may assume consistency and proceed with the service agreement or the revised/updated service agreement.

Appendix A

LIST OF POLLUTANTS WITH ANALYTICAL METHODS, DETECTION LIMITS AND QUANTITATION LEVELS

The Permittee must use the specified analytical methods, detection limits (DLs) and quantitation levels (QLs) in the following table for permit and application required monitoring unless:

- Another permit condition specifies other methods, detection levels, or quantitation levels.
- The method used produces measurable results in the sample and EPA has listed it as an EPA-approved method in 40 CFR Part 136.

If the Permittee uses an alternative method, not specified in the permit and as allowed above, it must report the test method, DL, and QL on the discharge monitoring report or in the required report.

If the Permittee is unable to obtain the required DL and QL in its effluent due to matrix effects, the Permittee must submit a matrix-specific detection limit (MDL) and a quantitation limit (QL) to Ecology with appropriate laboratory documentation.

When the permit requires the Permittee to measure the base neutral compounds in the list of priority pollutants, it must measure all of the base neutral pollutants listed in the table below. The list includes EPA required base neutral priority pollutants and several additional polynuclear aromatic hydrocarbons (PAHs). The Water Quality Program added several PAHs to the list of base neutrals below from Ecology's Persistent Bioaccumulative Toxics (PBT) List. It only added those PBT parameters of interest to Appendix A that did not increase the overall cost of analysis unreasonably.

Ecology added this appendix to the permit in order to reduce the number of analytical "non-detects" in permit-required monitoring and to measure effluent concentrations near or below criteria values where possible at a reasonable cost.

The lists below include conventional pollutants (as defined in CWA section 502(6) and 40 CFR Part 122.), toxic or priority pollutants as defined in CWA section 307(a)(1) and listed in 40 CFR Part 122 Appendix D, 40 CFR Part 401.15 and 40 CFR Part 423 Appendix A), and nonconventionals. 40 CFR Part 122 Appendix D (Table V) also identifies toxic pollutants and hazardous substances which are required to be reported by dischargers if expected to be present. This permit Appendix A list does not include those parameters.

CONVENTIONAL POLLUTANTS

Pollutant	CAS Number (if available)	Recommended Analytical Protocol	Detection (DL)[1] *µg/L unless specified*	Quantitation Level (QL)[2] *µg/L unless specified*
Biochemical Oxygen Demand		SM5210-B		2 mg/L
Biochemical Oxygen Demand, Soluble		SM5210-B [3]		2 mg/L
Fecal Coliform		SM 9221E,9222	N/A	Specified in method - sample aliquot dependent
Oil and Grease (HEM) (Hexane Extractable Material)		1664 A or B	1,400	5,000
pH		SM4500-H^+ B	N/A	N/A
Total Suspended Solids		SM2540-D		5 mg/L

NONCONVENTIONAL POLLUTANTS

Pollutant & CAS No. (if available)	CAS Number (if available)	Recommended Analytical Protocol	Detection (DL)[1] µg/L unless specified	Quantitation Level (QL)[2] µg/L unless specified
Alkalinity, Total		SM2320-B		5 mg/L as CaCO3
Aluminum, Total	7429-90-5	200.8	2.0	10
Ammonia, Total (as N)		SM4500-NH3-B and C/D/E/G/H		20
Barium Total	7440-39-3	200.8	0.5	2.0
BTEX (benzene +toluene + ethylbenzene + m,o,p xylenes)		EPA SW 846 8021/8260	1	2
Boron, Total	7440-42-8	200.8	2.0	10.0
Chemical Oxygen Demand		SM5220-D		10 mg/L
Chloride		SM4500-Cl B/C/D/E and SM4110 B		Sample and limit dependent
Chlorine, Total Residual		SM4500 Cl G		50.0

NONCONVENTIONAL POLLUTANTS

Pollutant & CAS No. (if available)	CAS Number (if available)	Recommended Analytical Protocol	Detection (DL)[1] µg/L unless specified	Quantitation Level (QL)[2] µg/L unless specified
Cobalt, Total	7440-48-4	200.8	0.05	0.25
Color		SM2120 B/C/E		10 color units
Dissolved oxygen		SM4500-OC/OG		0.2 mg/L
Flow		Calibrated device		
Fluoride	16984-48-8	SM4500-F E	25	100
Hardness, Total		SM2340B		200 as CaCO3
Iron, Total	7439-89-6	200.7	12.5	50
Magnesium, Total	7439-95-4	200.7	10	50
Manganese, Total	7439-96-5	200.8	0.1	0.5
Molybdenum, Total	7439-98-7	200.8	0.1	0.5
Nitrate + Nitrite Nitrogen (as N)		SM4500-NO3- E/F/H		100
Nitrogen, Total Kjeldahl (as N)		SM4500-N_{org}B/C and SM4500NH_3-B/C/D/EF/G/H		300
NWTPH Dx [4]		Ecology NWTPH Dx	250	250
NWTPH Gx [5]		Ecology NWTPH Gx	250	250
Phosphorus, Total (as P)		SM 4500 PB followed by SM4500-PE/PF	3	10
Salinity		SM2520-B		3 practical salinity units or scale (PSU or PSS)
Settleable Solids		SM2540 -F		Sample and limit dependent
Soluble Reactive Phosphorus (as P)		SM4500-P E/F/G	3	10
Sulfate (as mg/L SO_4)		SM4110-B		0.2 mg/L
Sulfide (as mg/L S)		SM4500-S^2F/D/E/G		0.2 mg/L

NONCONVENTIONAL POLLUTANTS

Pollutant & CAS No. (if available)	CAS Number (if available)	Recommended Analytical Protocol	Detection (DL)[1] µg/L unless specified	Quantitation Level (QL)[2] µg/L unless specified
Sulfite (as mg/L SO_3)		SM4500-SO3B		2 mg/L
Temperature (max. 7-day avg.)		Analog recorder or use micro-recording devices known as thermistors		0.2º C
Tin, Total	7440-31-5	200.8	0.3	1.5
Titanium, Total	7440-32-6	200.8	0.5	2.5
Total Coliform		SM 9221B, 9222B, 9223B	N/A	Specified in method - sample aliquot dependent
Total Organic Carbon		SM5310-B/C/D		1 mg/L
Total dissolved solids		SM2540 C		20 mg/L

PRIORITY POLLUTANTS	PP #	CAS Number (if available)	Recommended Analytical Protocol	Detection (DL)[1] *µg/L unless specified*	Quantitation Level (QL)[2] *µg/L unless specified*
METALS, CYANIDE & TOTAL PHENOLS					
Antimony, Total	114	7440-36-0	200.8	0.3	1.0
Arsenic, Total	115	7440-38-2	200.8	0.1	0.5
Beryllium, Total	117	7440-41-7	200.8	0.1	0.5
Cadmium, Total	118	7440-43-9	200.8	0.05	0.25
Chromium (hex) dissolved	119	18540-29-9	SM3500-Cr C	0.3	1.2
Chromium, Total	119	7440-47-3	200.8	0.2	1.0
Copper, Total	120	7440-50-8	200.8	0.4	2.0
Lead, Total	122	7439-92-1	200.8	0.1	0.5
Mercury, Total	123	7439-97-6	1631E	0.0002	0.0005
Nickel, Total	124	7440-02-0	200.8	0.1	0.5

PRIORITY POLLUTANTS	**PP #**	**CAS Number (if available)**	**Recommended Analytical Protocol**	**Detection (DL)[1] *µg/L unless specified***	**Quantitation Level (QL)[2] *µg/L unless specified***
METALS, CYANIDE & TOTAL PHENOLS					
Selenium, Total	125	7782-49-2	200.8	1.0	1.0
Silver, Total	126	7440-22-4	200.8	0.04	0.2
Thallium, Total	127	7440-28-0	200.8	0.09	0.36
Zinc, Total	128	7440-66-6	200.8	0.5	2.5
Cyanide, Total	121	57-12-5	335.4	5	10
Cyanide, Weak Acid Dissociable	121		SM4500-CN I	5	10
Cyanide, Free Amenable to Chlorination (Available Cyanide)	121		SM4500-CN G	5	10
Phenols, Total	65		EPA 420.1		50

PRIORITY POLLUTANTS	**PP #**	**CAS Number (if available)**	**Recommended Analytical Protocol**	**Detection (DL)[1] *µg/L unless specified***	**Quantitation Level (QL)[2] *µg/L unless specified***
ACID COMPOUNDS					
2-Chlorophenol	24	95-57-8	625.1	3.3	9.9
2,4-Dichlorophenol	31	120-83-2	625.1	2.7	8.1
2,4-Dimethylphenol	34	105-67-9	625.1	2.7	8.1
4,6-dinitro-o-cresol (2-methyl-4,6,-dinitrophenol)	60	534-52-1	625.1/1625B	24	72
2,4 dinitrophenol	59	51-28-5	625.1	42	126
2-Nitrophenol	57	88-75-5	625.1	3.6	10.8
4-Nitrophenol	58	100-02-7	625.1	2.4	7.2
Parachlorometa cresol (4-chloro-3-methylphenol)	22	59-50-7	625.1	3.0	9.0
Pentachlorophenol	64	87-86-5	625.1	3.6	10.8
Phenol	65	108-95-2	625.1	1.5	4.5
2,4,6-Trichlorophenol	21	88-06-2	625.1	2.7	8.1

PRIORITY POLLUTANTS	**PP #**	**CAS Number (if available)**	**Recommended Analytical Protocol**	**Detection (DL)[1] *µg/L unless specified***	**Quantitation Level (QL)[2] *µg/L unless specified***
VOLATILE COMPOUNDS					
Acrolein	2	107-02-8	624	5	10
Acrylonitrile	3	107-13-1	624	1.0	2.0
Benzene	4	71-43-2	624.1	4.4	13.2
Bromoform	47	75-25-2	624.1	4.7	14.1
Carbon tetrachloride	6	56-23-5	624.1/601 or SM6230B	2.8	8.4
Chlorobenzene	7	108-90-7	624.1	6.0	18.0
Chloroethane	16	75-00-3	624/601	1.0	2.0
2-Chloroethylvinyl Ether	19	110-75-8	624	1.0	2.0
Chloroform	23	67-66-3	624.1 or SM6210B	1.6	4.8
Dibromochloromethane (chlordibromomethane)	51	124-48-1	624.1	3.1	9.3
1,2-Dichlorobenzene	25	95-50-1	624	1.9	7.6
1,3-Dichlorobenzene	26	541-73-1	624	1.9	7.6
1,4-Dichlorobenzene	27	106-46-7	624	4.4	17.6
Dichlorobromomethane	48	75-27-4	624.1	2.2	6.6
1,1-Dichloroethane	13	75-34-3	624.1	4.7	14.1
1,2-Dichloroethane	10	107-06-2	624.1	2.8	8.4
1,1-Dichloroethylene	29	75-35-4	624.1	2.8	8.4
1,2-Dichloropropane	32	78-87-5	624.1	6.0	18.0
1,3-dichloropropene (mixed isomers) (1,2-dichloropropylene)[6]	33	542-75-6	624.1	5.0	15.0
Ethylbenzene	38	100-41-4	624.1	7.2	21.6
Methyl bromide (Bromomethane)	46	74-83-9	624/601	5.0	10.0

PRIORITY POLLUTANTS	**PP #**	**CAS Number (if available)**	**Recommended Analytical Protocol**	**Detection (DL)[1] *µg/L unless specified***	**Quantitation Level (QL)[2] *µg/L unless specified***
VOLATILE COMPOUNDS					
Methyl chloride (Chloromethane)	45	74-87-3	624	1.0	2.0
Methylene chloride	44	75-09-2	624.1	2.8	8.4
1,1,2,2-Tetrachloroethane	15	79-34-5	624.1	6.9	20.7
Tetrachloroethylene	85	127-18-4	624.1	4.1	12.3
Toluene	86	108-88-3	624.1	6.0	18.0
1,2-Trans-Dichloroethylene (Ethylene dichloride)	30	156-60-5	624.1	1.6	4.8
1,1,1-Trichloroethane	11	71-55-6	624.1	3.8	11.4
1,1,2-Trichloroethane	14	79-00-5	624.1	5.0	15.0
Trichloroethylene	87	79-01-6	624.1	1.9	5.7
Vinyl chloride	88	75-01-4	624/SM6200B	1.0	2.0

PRIORITY POLLUTANTS	**PP #**	**CAS Number (if available)**	**Recommended Analytical Protocol**	**Detection (DL)[1] *µg/L unless specified***	**Quantitation Level (QL)[2] *µg/L unless specified***
BASE/NEUTRAL COMPOUNDS (compounds in bold are Ecology PBTs)					
Acenaphthene	1	83-32-9	625.1	1.9	5.7
Acenaphthylene	77	208-96-8	625.1	3.5	10.5
Anthracene	78	120-12-7	625.1	1.9	5.7
Benzidine	5	92-87-5	625.1	44	132
Benzyl butyl phthalate	67	85-68-7	625.1	2.5	7.5
Benzo(*a*)anthracene	72	56-55-3	625.1	7.8	23.4
Benzo(b)fluoranthene (3,4-benzofluoranthene) [7]	74	205-99-2	610/625.1	4.8	14.4
Benzo(j)fluoranthene [7]		**205-82-3**	625	0.5	1.0

PRIORITY POLLUTANTS	PP #	CAS Number (if available)	Recommended Analytical Protocol	Detection (DL)[1] *µg/L unless specified*	Quantitation Level (QL)[2] *µg/L unless specified*
BASE/NEUTRAL COMPOUNDS (compounds in bold are Ecology PBTs)					
Benzo(k)fluoranthene (11,12-benzofluoranthene)[7]	75	207-08-9	610/625.1	2.5	7.5
Benzo(r,s,t)pentaphene		**189-55-9**	625	1.3	5.0
Benzo(*a*)pyrene	73	50-32-8	610/625.1	2.5	7.5
Benzo(*ghi*)Perylene	79	191-24-2	610/625.1	4.1	12.3
Bis(*2-chloroethoxy)*methane	43	111-91-1	625.1	5.3	15.9
Bis(*2-chloroethyl*)ether	18	111-44-4	611/625.1	5.7	17.1
Bis(*2-chloroisopropyl*)ether	42	39638-32-9	625	0.5	1.0
Bis(*2-ethylhexyl*)phthalate	66	117-81-7	625.1	2.5	7.5
4-Bromophenyl phenyl ether	41	101-55-3	625.1	1.9	5.7
2-Chloronaphthalene	20	91-58-7	625.1	1.9	5.7
4-Chlorophenyl phenyl ether	40	7005-72-3	625.1	4.2	12.6
Chrysene	76	218-01-9	610/625.1	2.5	7.5
Dibenzo (a,h)acridine		**226-36-8**	610M/625M	2.5	10.0
Dibenzo (a,j)acridine		**224-42-0**	610M/625M	2.5	10.0
Dibenzo(a-*h*)anthracene (1,2,5,6-dibenzanthracene)	82	53-70-3	625.1	2.5	7.5
Dibenzo(a,e)pyrene		192-65-4	610M/625M	2.5	10.0
Dibenzo(a,h)pyrene		189-64-0	625M	2.5	10.0
3,3-Dichlorobenzidine	28	91-94-1	605/625.1	16.5	49.5
Diethyl phthalate	70	84-66-2	625.1	1.9	5.7
Dimethyl phthalate	71	131-11-3	625.1	1.6	4.8
Di-n-butyl phthalate	68	84-74-2	625.1	2.5	7.5
2,4-dinitrotoluene	35	121-14-2	609/625.1	5.7	17.1

PRIORITY POLLUTANTS	**PP #**	**CAS Number (if available)**	**Recommended Analytical Protocol**	**Detection (DL)[1] *µg/L unless specified***	**Quantitation Level (QL)[2] *µg/L unless specified***
BASE/NEUTRAL COMPOUNDS (compounds in bold are Ecology PBTs)					
2,6-dinitrotoluene	36	606-20-2	609/625.1	1.9	5.7
Di-n-octyl phthalate	69	117-84-0	625.1	2.5	7.5
1,2-Diphenylhydrazine (*as Azobenzene*)	37	122-66-7	1625B	5.0	20
Fluoranthene	39	206-44-0	625.1	2.2	6.6
Fluorene	80	86-73-7	625.1	1.9	5.7
Hexachlorobenzene	9	118-74-1	612/625.1	1.9	5.7
Hexachlorobutadiene	52	87-68-3	625.1	0.9	2.7
Hexachlorocyclopentadiene	53	77-47-4	1625B/625	2.0	4.0
Hexachloroethane	12	67-72-1	625.1	1.6	4.8
Indeno(*1,2,3-cd*)Pyrene	83	193-39-5	610/625.1	3.7	11.1
Isophorone	54	78-59-1	625.1	2.2	6.6
3-Methyl cholanthrene		**56-49-5**	625	2.0	8.0
Naphthalene	55	91-20-3	625.1	1.6	4.8
Nitrobenzene	56	98-95-3	625.1	1.9	5.7
N-Nitrosodimethylamine	61	62-75-9	607/625	2.0	4.0
N-Nitrosodi-n-propylamine	63	621-64-7	607/625	0.5	1.0
N-Nitrosodiphenylamine	62	86-30-6	625	1.0	2.0
Perylene		**198-55-0**	625	1.9	7.6
Phenanthrene	81	85-01-8	625.1	5.4	16.2
Pyrene	84	129-00-0	625.1	1.9	5.7
1,2,4-Trichlorobenzene	8	120-82-1	625.1	1.9	5.7

PRIORITY POLLUTANT	**PP #**	**CAS Number (if available)**	**Recommended Analytical Protocol**	**Detection (DL)[1] *µg/L unless specified***	**Quantitation Level (QL)[2] *µg/L unless specified***
DIOXIN					
2,3,7,8-Tetra-Chlorodibenzo-P-Dioxin (2,3,7,8 TCDD)	129	1746-01-6	1613B	1.3 pg/L	5 pg/L

PRIORITY POLLUTANTS	**PP #**	**CAS Number (if available)**	**Recommended Analytical Protocol**	**Detection (DL)[1] *µg/L unless specified***	**Quantitation Level (QL)[2] *µg/L unless specified***
PESTICIDES/PCBs					
Aldrin	89	309-00-2	608.3	4.0 ng/L	12 ng/L
alpha-BHC	102	319-84-6	608.3	3.0 ng/L	9.0 ng/L
beta-BHC	103	319-85-7	608.3	6.0 ng/L	18 ng/L
gamma-BHC (Lindane)	104	58-89-9	608.3	4.0 ng/L	12 ng/L
delta-BHC	105	319-86-8	608.3	9.0 ng/L	27 ng/L
Chlordane [8]	91	57-74-9	608.3	14 ng/L	42 ng/L
4,4'-DDT	92	50-29-3	608.3	12 ng/L	36 ng/L
4,4'-DDE	93	72-55-9	608.3	4.0 ng/L	12 ng/L
4,4' DDD	94	72-54-8	608.3	11ng/L	33 ng/L
Dieldrin	90	60-57-1	608.3	2.0 ng/L	6.0 ng/L
alpha-Endosulfan	95	959-98-8	608.3	14 ng/L	42 ng/L
beta-Endosulfan	96	33213-65-9	608.3	4.0 ng/L	12 ng/L
Endosulfan Sulfate	97	1031-07-8	608.3	66 ng/L	198 ng/L
Endrin	98	72-20-8	608.3	6.0 ng/L	18 ng/L
Endrin Aldehyde	99	7421-93-4	608.3	23 ng/L	70 ng/L
Heptachlor	100	76-44-8	608.3	3.0 ng/L	9.0 ng/L
Heptachlor Epoxide	101	1024-57-3	608.3	83 ng/L	249 ng/L
PCB-1242 [9]	106	53469-21-9	608.3	0.065	0.195

PRIORITY POLLUTANTS	**PP #**	**CAS Number (if available)**	**Recommended Analytical Protocol**	**Detection (DL)[1] *µg/L unless specified***	**Quantitation Level (QL)[2] *µg/L unless specified***
PESTICIDES/PCBs					
PCB-1254	107	11097-69-1	608.3	0.065	0.195
PCB-1221	108	11104-28-2	608.3	0.065	0.195
PCB-1232	109	11141-16-5	608.3	0.065	0.195
PCB-1248	110	12672-29-6	608.3	0.065	0.195
PCB-1260	111	11096-82-5	608.3	0.065	0.195
PCB-1016 [9]	112	12674-11-2	608.3	0.065	0.195
Toxaphene	113	8001-35-2	608.3	240 ng/L	720 ng/L

1. Detection level (DL) or detection limit means the minimum concentration of an analyte (substance) that can be measured and reported with a 99% confidence that the analyte concentration is greater than zero as determined by the procedure given in 40 CFR part 136, Appendix B.
2. Quantitation Level (QL) also known as Minimum Level of Quantitation (ML) – The lowest level at which the entire analytical system must give a recognizable signal and acceptable calibration point for the analyte. It is equivalent to the concentration of the lowest calibration standard, assuming that the lab has used all method-specified sample weights, volumes, and cleanup procedures. The QL is calculated by multiplying the MDL by 3.18 and rounding the result to the number nearest to (1, 2, or 5) x 10^n, where n is an integer (64 FR 30417).
ALSO GIVEN AS:
The smallest detectable concentration of analyte greater than the Detection Limit (DL) where the accuracy (precision & bias) achieves the objectives of the intended purpose. (Report of the Federal Advisory Committee on Detection and Quantitation Approaches and Uses in Clean Water Act Programs Submitted to the US Environmental Protection Agency, December 2007).
3. Soluble Biochemical Oxygen Demand method note: First, filter the sample through a Millipore Nylon filter (or equivalent) - pore size of 0.45-0.50 um (prep all filters by filtering 250 ml of laboratory grade deionized water through the filter and discard). Then, analyze sample as per method 5210-B.
4. NWTPH Dx - Northwest Total Petroleum Hydrocarbons Diesel Extended Range – see https://fortress.wa.gov/ecy/publications/documents/97602.pdf
5. NWTPH Gx - Northwest Total Petroleum Hydrocarbons Gasoline Extended Range – see https://fortress.wa.gov/ecy/publications/documents/97602.pdf
6. 1, 3-dichloroproylene (mixed isomers) You may report this parameter as two separate parameters: cis-1, 3-dichlorpropropene (10061-01-5) and trans-1, 3-dichloropropene (10061-02-6).
7. Total Benzofluoranthenes - Because Benzo(b)fluoranthene, Benzo(j)fluoranthene and Benzo(k)fluoranthene co-elute you may report these three isomers as total benzofluoranthenes.
8. Chlordane – You may report alpha-chlordane (5103-71-9) and gamma-chlordane (5103-74-2) in place of chlordane (57-74-9). If you report alpha and gamma-chlordane, the DL/PQLs that apply are 14/42 ng/L.
9. PCB 1016 & PCB 1242 – You may report these two PCB compounds as one parameter called PCB 1016/1242.

Appendix B

Draft SEPA Checklist

SEPA ENVIRONMENTAL CHECKLIST

Purpose of checklist:

Governmental agencies use this checklist to help determine whether the environmental impacts of your proposal are significant. This information is also helpful to determine if available avoidance, minimization or compensatory mitigation measures will address the probable significant impacts or if an environmental impact statement will be prepared to further analyze the proposal.

Instructions for applicants:

This environmental checklist asks you to describe some basic information about your proposal. Please answer each question accurately and carefully, to the best of your knowledge. You may need to consult with an agency specialist or private consultant for some questions. You may use "not applicable" or "does not apply" only when you can explain why it does not apply and not when the answer is unknown. You may also attach or incorporate by reference additional studies reports. Complete and accurate answers to these questions often avoid delays with the SEPA process as well as later in the decision-making process.

The checklist questions apply to all parts of your proposal, even if you plan to do them over a period of time or on different parcels of land. Attach any additional information that will help describe your proposal or its environmental effects. The agency to which you submit this checklist may ask you to explain your answers or provide additional information reasonably related to determining if there may be significant adverse impact.

Instructions for Lead Agencies:

Please adjust the format of this template as needed. Additional information may be necessary to evaluate the existing environment, all interrelated aspects of the proposal and an analysis of adverse impacts. The checklist is considered the first but not necessarily the only source of information needed to make an adequate threshold determination. Once a threshold determination is made, the lead agency is responsible for the completeness and accuracy of the checklist and other supporting documents.

Use of checklist for nonproject proposals:

For nonproject proposals (such as ordinances, regulations, plans and programs), complete the applicable parts of sections A and B plus the SUPPLEMENTAL SHEET FOR NONPROJECT ACTIONS (part D). Please completely answer all questions that apply and note that the words "project," "applicant," and "property or site" should be read as "proposal," "proponent," and "affected geographic area," respectively. The lead agency may exclude (for non-projects) questions in Part B - Environmental Elements –that do not contribute meaningfully to the analysis of the proposal.

A. Background [HELP]

1. Name of proposed project, if applicable:
   City of Monroe – 2022 Engineering Report
2. Name of applicant:
   City of Monroe Public Works Department

3. Address and phone number of applicant and contact person:

John Lande

City of Monroe

Public Works Department

806 West Main Street

Monroe, WA 98272

360-863-4502

4. Date checklist prepared:
March 2022

5. Agency requesting checklist:
City of Monroe

6. Proposed timing or schedule (including phasing, if applicable):
Proposed WWTP improvements are scheduled to occur as follows:
- **CIP 1: pH and Filament Control – In Construction, Completion in 2022**
- **CIP 5: Solids Treatment and Handling Upgrades – Plan for Construction Starting 2023**
- **CIP 3: Secondary Treatment Upgrades – Plan for Construction Starting as Early as 2027 (Dependent on Nutrient General Permit requirements)**
- **CIP 6: Plantwide Pump and UV Disinfection Upgrades – Plan for Construction Starting 2029**

7. Do you have any plans for future additions, expansion, or further activity related to or connected with this proposal? If yes, explain.
Currently no other additions, upgrades, or expansions of the WWTP are planned.

8. List any environmental information you know about that has been prepared, or will be prepared, directly related to this proposal.

City of Monroe 2022 Wastewater Treatment Plant (WWTP) Engineering Report

City of Monroe Final Wastewater Treatment Plant (WWTP) Engineering Report – pH and Filament Control (dated March 2020)

City of Monroe 2015 Utility Plan

City of Monroe Comprehensive Plan

9. Do you know whether applications are pending for governmental approvals of other proposals directly affecting the property covered by your proposal? If yes, explain.
No other governmental approvals or proposals that may affect the property covered within this proposal are known.

10. List any government approvals or permits that will be needed for your proposal, if known.
The Engineering Report and subsequent design documents must be approved by the Washington State Department of Ecology. A building permit and fire department review will be required from the City of Monroe. An electrical permit will be required from the Washington State Department of Labor and Industries. A

permit will be required from the Puget Sound Clean Air Agency for exhaust from the proposed dryer (CIP 5) and the accompanying odor control system. It is expected that the proposed increase in the effluent discharge related to CIP 3 will require a biological assessment under the Endangered Species Act and Sustainable Fisheries Act.

11. Give brief, complete description of your proposal, including the proposed uses and the size of the project and site. There are several questions later in this checklist that ask you to describe certain aspects of your proposal. You do not need to repeat those answers on this page. (Lead agencies may modify this form to include additional specific information on project description.)

The capital improvement plan (CIP) included in the 2022 WWTP Engineering Report includes the projects listed below. The 6-year CIP will include CIP 1 and CIP 5. The remaining projects will occur beyond the 6-year CIP.

- **CIP 1: CIP 1 was already evaluated and approved as part of the March 2020 "City of Monroe Final Wastewater Treatment Plant (WWTP) Engineering Report – pH and Filament Control" and is currently in construction. This project adds a permanent system for dosing sodium hypochlorite into the return activated sludge (RAS) to kill filamentous organisms that can cause poor settling, upgrades the existing magnesium hydroxide system to improve system reliability and provide controls for automated dosing based on flow and pH, utilizes existing metering pumps and sodium hydroxide storage to provide backup effluent pH control if under certain conditions magnesium hydroxide alone cannot maintain pH within the required range, installs baffles in Aeration Basins No. 1 and 2 to allow the two diffuser zones to operate at different dissolved oxygen concentrations, and makes improvements to mixed liquor recycle pumping to allow automated control of pumping rate based on nitrate levels and flow rates.**
- **CIP 3: As an alternate to CIP 2A and 2B, convert the existing SBC tanks into membrane bioreactors (MBRs) and convert Aeration Basin 3 to pre-anoxic and aerobic zones for treatment prior to the MBRs. The MBRs will operate as a sidestream process in parallel with the existing conventional activated sludge (CAS) process utilizing Aeration Basins 1 and 2 and the existing clarifiers to provide increased capacity for projected flows and load through the planning horizon (2020-2040). The sidestream MBR will also require construction of a support building to house aeration, pumping and chemical equipment and fine screening for protection of the membranes. This project may also include construction of a surface wasting system to collect and waste foam and scum from the mixed liquor channel.**
- **CIP 5: As an alternate to CIP 4, modify the existing dewatering building to a 2-story structure with a new screw press on the second story (replacing the existing belt filter press) and a new biosolids dryer on the ground floor. Also, replace the existing primary sludge flow meter and install a new primary sludge solids meter.**
- **CIP 6: Upsize two influent pumps and their discharge piping to increase their capacity from 1 million gallons per day (MGD) to 2 MGD for increased firm pumping capacity, replace the UV reactors and upsize connecting piping to increase firm capacity of the disinfection process, upgrade the existing effluent pumps by adding a bowl and upsizing the motor and VFD to increase firm pumping capacity, and replace the plant water pumps with newer pumps more appropriately sized for the demands.**

12. Location of the proposal. Give sufficient information for a person to understand the precise location of your proposed project, including a street address, if any, and section, township, and range, if known. If a proposal would occur over a range of area, provide the range or boundaries of the site(s). Provide a legal description, site plan, vicinity map, and topographic map, if reasonably available. While you should submit any plans required by the agency, you are not required to duplicate maps or detailed plans submitted with any permit applications related to this checklist.

The proposed improvements to the Monroe Wastewater Treatment Plant are located on tax parcel #27060100408700 (Monroe WWTP). This parcel is located at 522 South Sams Street in Monroe, Washington. The project is located in the southwest quarter of Section 1 and the northeast quarter of Section 12, in Township 27 North, Range 6 East, Willamette Meridian.

B. Environmental Elements [HELP]

1. *Earth* [help]

a. General description of the site:

(circle one): **Flat**, rolling, hilly, steep slopes, mountainous, other _____________

b. What is the steepest slope on the site (approximate percent slope)?

The project vicinity is relatively flat with a 10 to 15 foot retaining wall on the southeast corner of the WWTP site. No steep slopes are present.

c. What general types of soils are found on the site (for example, clay, sand, gravel, peat, muck)? If you know the classification of agricultural soils, specify them and note any agricultural land of long-term commercial significance and whether the proposal results in removing any of these soils.

Based on the Snohomish Soil Survey, the site soils are Sultan silt loam. According to Shannon & Wilson's 2000 Geotechnical Report for the WWTP expansion, the WWTP site soils consist of medium dense to dense, silty, gravelly fine to medium sand and soft to very stiff, clayey silt (fill material), underlain by dense to very dense, slightly silty, sandy gravel to gravelly sand. An extensive discussion of the soils and their properties can be found in the *USDA Soil Survey of Snohomish County*.

d. Are there surface indications or history of unstable soils in the immediate vicinity? If so, describe.

There are no surface indications or history of unstable soil known in the immediate vicinity of the project site.

e. Describe the purpose, type, total area, and approximate quantities and total affected area of any filling, excavation, and grading proposed. Indicate source of fill.

CIP 3 would require excavation of about 300 cubic yards for the new support building foundation. The total disturbed area is expected to be less than 1 acre.

f. Could erosion occur as a result of clearing, construction, or use? If so, generally describe.

No erosion is expected to occur as a result of any of the proposed CIP projects, as the disturbed area is limited and mitigation measures will be in place to ensure

stockpiled material is limited and protected from erosion and graded areas are protected from erosion using best management practices prior to surfacing.

g. About what percent of the site will be covered with impervious surfaces after project construction (for example, asphalt or buildings)?

Within the existing site boundaries, no significant change to the amount of impervious surfaces is expected to occur. All projects will take place within existing buildings or be built at locations that already have an impervious surface (e.g., adding tank or building where asphalt currently exists).

h. Proposed measures to reduce or control erosion, or other impacts to the earth, if any:

All drainage and stormwater is discharged to the existing system of catch basins discharging to the Skykomish River. Best management practices will be followed to avoid sediment transport to the river (e.g., catch basin filters, covered stockpiles, silt fencing, etc.).

2. Air [help]

a. What types of emissions to the air would result from the proposal during construction, operation, and maintenance when the project is completed? If any, generally describe and give approximate quantities if known.

Emissions resulting from this proposal include diesel engine exhaust from heavy equipment during construction. Diesel engine exhaust includes particulate matter, carbon dioxide, and other gas pollutants. Heavy equipment will be provided by the contractor and will be required to meet State and Federal emissions standards. It is unknown what quantity of exhaust fumes will be associated with this proposal. CIP 5 will require odor control for exhaust from the dryer. The exhaust emissions and odor control provided will need to comply with air quality requirements per the Puget Sound Clean Air Agency.

b. Are there any off-site sources of emissions or odor that may affect your proposal? If so, generally describe.

Currently, odor is produced and treated on site. This will continue to be the case for all proposed improvements. There are no off-site sources of emissions or odors associated with the proposed improvements.

c. Proposed measures to reduce or control emissions or other impacts to air, if any:

For CIP 5, a new odor control system would be installed to treat exhaust from the new biosolids dryer. Other proposed improvements should not significantly alter current emissions.

3. Water [help]

a. Surface Water: [help]

1) Is there any surface water body on or in the immediate vicinity of the site (including year-round and seasonal streams, saltwater, lakes, ponds, wetlands)? If yes, describe type and provide names. If appropriate, state what stream or river it flows into.
The Skykomish River lies approximately 1,200 feet to the southeast of the WWTP and is the waterbody to which the WWTP discharges.

2) Will the project require any work over, in, or adjacent to (within 200 feet) the described waters? If yes, please describe and attach available plans.
While the outfall is located in the Skykomish River, all work at the WWTP will take place more than 200 feet away from the river and outside the shoreline management area.

3) Estimate the amount of fill and dredge material that would be placed in or removed from surface water or wetlands and indicate the area of the site that would be affected. Indicate the source of fill material.
No fill or dredge material will be placed in or removed from surface water or wetlands.

4) Will the proposal require surface water withdrawals or diversions? Give general description, purpose, and approximate quantities if known.
No surface water withdrawals or diversions will be necessary.

5) Does the proposal lie within a 100-year floodplain? If so, note location on the site plan.
The WWTP site is elevated such that it does not lie within the 100-year floodplain.

6) Does the proposal involve any discharges of waste materials to surface waters? If so, describe the type of waste and anticipated volume of discharge.
The WWTP currently discharges treated wastewater to the Skykomish River. Wastewater is treated for biochemical oxygen demand, total suspended solids, fecal coliform, and pH. CIP 1 and CIP 5 do not propose increasing the current capacity of the WWTP. However, CIP 3 and CIP 6, which fall outside of the 6-year CIP, will increase capacity and add treatment for total inorganic nitrogen (i.e., ammonia, nitrite, and nitrate). As such, an updated mixing zone analysis has been completed. It is expected that a biological assessment will need to be performed when CIP 3 is in design and more detailed information on anticipated effluent quality impacts are known.

b. Ground Water: [help]

1) Will groundwater be withdrawn from a well for drinking water or other purposes? If so, give a general description of the well, proposed uses and approximate quantities withdrawn from the well. Will water be discharged to groundwater? Give general description, purpose, and approximate quantities if known.
The proposed CIP projects will not require any groundwater withdrawal or discharge to groundwater.

2) Describe waste material that will be discharged into the ground from septic tanks or other sources, if any (for example: Domestic sewage; industrial, containing the following chemicals…; agricultural; etc.). Describe the general size of the system, the number of such systems, the number of houses to be served (if applicable), or the number of animals or humans the system(s) are expected to serve.
The projects included in the CIP will not require any waste material discharge into the ground.

c. Water runoff (including stormwater):

1) Describe the source of runoff (including storm water) and method of collection and disposal, if any (include quantities, if known). Where will this water flow? Will this water flow into other waters? If so, describe.
Runoff as a result of construction related to this project will be controlled following stormwater best management practices and enter the existing City stormwater collection system.

2) Could waste materials enter ground or surface waters? If so, generally describe.
The proposed CIP projects are not expected to impact ground or surface waters.

3) Does the proposal alter or otherwise affect drainage patterns in the vicinity of the site? If so, describe.
The proposed CIP projects are not expected to have an effect on drainage patterns.

d. Proposed measures to reduce or control surface, ground, and runoff water, and drainage pattern impacts, if any:
The proposed CIP projects are not expected to have an effect on surface, ground, or runoff waters.

4. Plants [help]

a. Check the types of vegetation found on the site:

_x__ deciduous tree: **alder**, **maple**, aspen, other
_x__ evergreen tree: fir, cedar, **pine**, other
_x__ **shrubs**
_x__ **grass**
____ pasture
____ crop or grain
____ Orchards, vineyards or other permanent crops.
____ wet soil plants: cattail, buttercup, bullrush, skunk cabbage, other
____water plants: water lily, eelgrass, milfoil, other
____other types of vegetation

b. What kind and amount of vegetation will be removed or altered?
The proposed CIP projects would not remove or alter vegetation.

c. List threatened and endangered species known to be on or near the site.
There are no known threatened or endangered species on or near the site.

d. Proposed landscaping, use of native plants, or other measures to preserve or enhance vegetation on the site, if any:
The proposed CIP projects would not involve additional landscaping or plantings.

e. List all noxious weeds and invasive species known to be on or near the site.
There are no noxious weeds or invasive spaces known to be on or near the site.

5. Animals [help]

a. List any birds and other animals which have been observed on or near the site or are known to be on or near the site.

Examples include:

birds: **hawk**, **heron**, eagle, **songbirds**, other:
mammals: deer, bear, elk, beaver, other:
fish: bass, **salmon**, **trout**, herring, shellfish, other ________

b. List any threatened and endangered species known to be on or near the site.

The Skykomish River is known to support fall Chinook and winter Steelhead spawning habitat, bull trout rearing habitat, and is known to support summer Chinook and summer Steelhead species. No known threatened or endangered terrestrial or avian species are known to occur in the project vicinity.

c. Is the site part of a migration route? If so, explain.

The WWTP site is not part of a migration corridor; however, the Skykomish River is located in the vicinity of the WWTP site, which is a migration corridor for several anadromous fish species.

d. Proposed measures to preserve or enhance wildlife, if any:

There are no proposed measures for wildlife preservation or enhancement as the project is not expected to displace or impact wildlife species.

e. List any invasive animal species known to be on or near the site.

There are no known invasive animal species on or near the site.

6. Energy and Natural Resources [help]

a. What kinds of energy (electric, natural gas, oil, wood stove, solar) will be used to meet the completed project's energy needs? Describe whether it will be used for heating, manufacturing, etc.

Energy needs for the WWTP will be primarily met through electricity for the general operational needs of the facility (lighting, pumps, blowers, and other equipment); however, the proposed dryer (CIP 5) will be powered primarily by natural gas. A standby diesel generator will be maintained for use as an emergency source of power should utility power fail.

b. Would your project affect the potential use of solar energy by adjacent properties? If so, generally describe.

The projects included in the CIP will not have an impact on potential solar energy use by adjacent properties.

c. What kinds of energy conservation features are included in the plans of this proposal? List other proposed measures to reduce or control energy impacts, if any:

The proposed improvements would include variable frequency drives on pumps and blowers so that turndown can match demand to reduce energy use. New flow meters and water quality monitoring instruments will help to optimize recycle pumping and aeration. Improvements for denitrification in the aeration basins will reduce oxygen demand and therefore air demand from the blowers. High efficiency

equipment with premium efficiency motors will be utilized. The dryer will likely utilize waste heat to improve efficiency and reduce natural gas consumption.

7. Environmental Health [help]

a. Are there any environmental health hazards, including exposure to toxic chemicals, risk of fire and explosion, spill, or hazardous waste, that could occur as a result of this proposal? If so, describe.

The type and quantities of chemicals required and the ways in which they are utilized would not change significantly such that there would not be a significant change in health hazards or exposure to toxic chemicals. The proposed improvements would not generate any hazardous waste nor increase the potential for any spills. With the implementation of CIP 5, there would be some increased risk due to potential for combustion of dust from the dried biosolids. This will be mitigated by inclusion of dust control and fire suppression devices.

1) Describe any known or possible contamination at the site from present or past uses.

   There is no known contamination at the site.

2) Describe existing hazardous chemicals/conditions that might affect project development and design. This includes underground hazardous liquid and gas transmission pipelines located within the project area and in the vicinity.
   No existing hazardous conditions are known which could affect project development or design.

3) Describe any toxic or hazardous chemicals that might be stored, used, or produced during the project's development or construction, or at any time during the operating life of the project.
   Sodium hydroxide and sodium hypochlorite, both hazardous chemicals, are currently stored for use with the chemical odor scrubber at the WWTP and for periodic chlorination of the RAS. With the completion of CIP 1 (under construction), the containment and handling of the chemical will be further improved. Magnesium hydroxide will continue to be stored and utilized as the primary means of pH control in similar quantities. Magnesium hydroxide is considered slightly hazardous. In addition to bulk storage for odor control, sodium hypochlorite will continue to be utilized from totes occasionally for chlorination of the RAS. In the future, should strict limits for total inorganic nitrogen be enforced under the NPDES permit, the City may utilize a supplemental carbon source, such as Micro-C, which is non-hazardous. With implementation of CIP 3, small quantities (totes) of citric acid and sodium hypochlorite would be utilized a few times a year for chemically cleaning the membranes. Citric acid is slightly hazardous.

4) Describe special emergency services that might be required.
   Emergency services that might be required include emergency care necessary as a result of an accident. Emergency care includes hospitalization at Valley General Hospital or other appropriate medical facility.

5) Proposed measures to reduce or control environmental health hazards, if any:
   The contractor and City staff are responsible for implementing all appropriate safety measures and providing all personal protective equipment (PPE).

b. Noise

1) What types of noise exist in the area which may affect your project (for example: traffic, equipment, operation, other)?
Noise generated from the project construction will be temporary and will occur on City property and within the hours allowed by City ordinance. Noise associated with the WWTP currently produces elevated background noise levels, but the proposed improvements are not expected to alter current noise levels.

2) What types and levels of noise would be created by or associated with the project on a short-term or a long-term basis (for example: traffic, construction, operation, other)? Indicate what hours noise would come from the site.
Noise generated as a result of the proposal includes periodic increased noise levels in the short-term due to construction activities. Noise from construction activities would occur during normal work and school hours. No additional long-term noise impacts due to operation of the improvements are, as normal operating noise levels are not expected to exceed current noise levels at the WWTP.

3) Proposed measures to reduce or control noise impacts, if any:
New blowers will include silencers, similar to existing blowers. New equipment that may produce significant noise will be housed in buildings, as is similar with existing equipment.

8. Land and Shoreline Use [help]

a. What is the current use of the site and adjacent properties? Will the proposal affect current land uses on nearby or adjacent properties? If so, describe.
The parcel where most of the work will occur is occupied by the Monroe WWTP. Adjacent properties include single-family housing, multi-family housing and a park. Current land uses will not be affected.

b. Has the project site been used as working farmlands or working forest lands? If so, describe. How much agricultural or forest land of long-term commercial significance will be converted to other uses as a result of the proposal, if any? If resource lands have not been designated, how many acres in farmland or forest land tax status will be converted to nonfarm or nonforest use?
The site has not been used for agriculture or as forest land in the recent past.

1) Will the proposal affect or be affected by surrounding working farm or forest land normal business operations, such as oversize equipment access, the application of pesticides, tilling, and harvesting? If so, how:
No, there are no surrounding farm or forest land business operations.

c. Describe any structures on the site.
Structures on site include buildings and other structures necessary to operate the WWTP. These include clarifiers, aeration basins, digester tanks, headworks building, pump stations, an operations building, and a dewatering building.

d. Will any structures be demolished? If so, what?
The existing aeration basins will be modified, but not demolished. Under CIP 3, the existing submerged biological contactor (SBC) tanks would be retrofitted as

membrane tanks. Under CIP 5, the existing dewatering building would be modified, but not completely demolished.

e. What is the current zoning classification of the site?

The WWTP property is zoned as multi-family residential (MR6000).

f. What is the current comprehensive plan designation of the site?

Under the current comprehensive plan, the WWTP is designated as Residential (R8- I 1 Dwellings per Acre).

g. If applicable, what is the current shoreline master program designation of the site?

The WWTP property does not have a shoreline designation.

h. Has any part of the site been classified as a critical area by the city or county? If so, specify.

No, but the Skykomish River to the south and wetlands at the south end of the adjacent park are critical areas.

i. Approximately how many people would reside or work in the completed project?

Projects under the 6-year CIP are not expected to increase the number of employees at the WWTP. However, CIP 3 may increase the number of workers at the WWTP by 1 or 2 full-time employees.

j. Approximately how many people would the completed project displace?

The proposed projects would not replace any workers or residents.

k. Proposed measures to avoid or reduce displacement impacts, if any:

No measures are proposed to avoid displacement impacts as displacement is not expected to occur with any of the proposed projects.

L. Proposed measures to ensure the proposal is compatible with existing and projected land uses and plans, if any:

No measures will be implemented to ensure the proposal is compatible with projected land uses and plans.

m. Proposed measures to reduce or control impacts to agricultural and forest lands of long-term commercial significance, if any:

There are no proposed measures to reduce impacts to agricultural or forest lands as they are not expected to be impacted by the proposed projects.

9. Housing [help]

a. Approximately how many units would be provided, if any? Indicate whether high, middle, or low-income housing.

Not applicable.

b. Approximately how many units, if any, would be eliminated? Indicate whether high, middle, or low-income housing.

None.

c. Proposed measures to reduce or control housing impacts, if any:

No impacts to housing.

10. Aesthetics [help]

a. What is the tallest height of any proposed structure(s), not including antennas; what is the principal exterior building material(s) proposed?

All improvements will be within the envelope of existing structures.

b. What views in the immediate vicinity would be altered or obstructed?

None.

c. Proposed measures to reduce or control aesthetic impacts, if any:

Not applicable.

11. Light and Glare [help]

a. What type of light or glare will the proposal produce? What time of day would it mainly occur?

The overall light or glare from the WWTP facility is not anticipated to be substantially different from existing levels. Some additional lighting will be provided in areas with new equipment, but the level of lighting will be similar to other areas of the WWTP.

b. Could light or glare from the finished project be a safety hazard or interfere with views?

Any additional lighting would be contained within areas that already have some existing lighting, such that there should not be any interference.

c. What existing off-site sources of light or glare may affect your proposal?

None.

d. Proposed measures to reduce or control light and glare impacts, if any:

Additional lighting will be at the same level of lighting elsewhere at the facility and will be directed at the facilities, so as to minimize glare for adjacent properties.

12. Recreation [help]

a. What designated and informal recreational opportunities are in the immediate vicinity?

The Skykomish River Centennial Park is located due south of the WWP. It includes four ball fields and a manicured lawn.

b. Would the proposed project displace any existing recreational uses? If so, describe.

No.

c. Proposed measures to reduce or control impacts on recreation, including recreation opportunities to be provided by the project or applicant, if any:

Not applicable.

13. Historic and cultural preservation [help]

a. Are there any buildings, structures, or sites, located on or near the site that are over 45 years old listed in or eligible for listing in national, state, or local preservation registers ? If so, specifically describe.

Based on the Washington State Department of Archeology and Historic Preservation (DAHP) Washington Information System for Architectural and

Archaeological Records Data (WISAARD) mapping website, there are no registered historic places or objects in the vicinity of the proposed project.

b. Are there any landmarks, features, or other evidence of Indian or historic use or occupation? This may include human burials or old cemeteries. Are there any material evidence, artifacts, or areas of cultural importance on or near the site? Please list any professional studies conducted at the site to identify such resources.

There are no known landmarks, features, or other evidence of Indian or historic use on site.

c. Describe the methods used to assess the potential impacts to cultural and historic resources on or near the project site. Examples include consultation with tribes and the department of archeology and historic preservation, archaeological surveys, historic maps, GIS data, etc.

The WISSARD mapping website from DAHP was used to determine any potential conflicts with the site location and none were identified.

d. Proposed measures to avoid, minimize, or compensate for loss, changes to, and disturbance to resources. Please include plans for the above and any permits that may be required.

Not applicable.

14. Transportation [help]

a. Identify public streets and highways serving the site or affected geographic area and describe proposed access to the existing street system. Show on site plans, if any.

Public streets and highways serving the site include State Route 2, State Route 522, West Main Street, and Sams Street.

b. Is the site or affected geographic area currently served by public transit? If so, generally describe. If not, what is the approximate distance to the nearest transit stop?

The Snohomish Community Transit Bus Route #271 is the closet public transit to the site. This route stops at the intersection of Village Way and Sky River Parkway. The Duvall-Monroe Shuttle stops at the intersection of Sumac Drive and South Lewis Street.

c. How many additional parking spaces would the completed project or non-project proposal have? How many would the project or proposal eliminate?

The proposed projects are not expected to eliminate nor add parking spots. The current parking spots are expected to remain.

d. Will the proposal require any new or improvements to existing roads, streets, pedestrian, bicycle or state transportation facilities, not including driveways? If so, generally describe (indicate whether public or private).

No.

e. Will the project or proposal use (or occur in the immediate vicinity of) water, rail, or air transportation? If so, generally describe.

The proposed projects will not occur in the immediate vicinity of water, rail, or air transportation.

f. How many vehicular trips per day would be generated by the completed project or proposal? If known, indicate when peak volumes would occur and what percentage of the volume would be trucks (such as commercial and nonpassenger vehicles). What data or transportation models were used to make these estimates?

The proposed projects are not expected to have a significant effect on number of vehicular trips per day. It is possible that vehicular trips to the WWTP site could be increased by a few additional trips per day due to addition of employees after completion of CIP 3 and/or addition of vendor trips for deliveries/maintenance associated with the proposed improvements.

g. Will the proposal interfere with, affect or be affected by the movement of agricultural and forest products on roads or streets in the area? If so, generally describe.

The proposed projects will not interfere with the movement of agricultural or forest product on roads or streets.

h. Proposed measures to reduce or control transportation impacts, if any:

No measures are proposed to reduce or control transportation impacts, as impacts will be minimal.

15. Public Services [help]

a. Would the project result in an increased need for public services (for example: fire protection, police protection, public transit, health care, schools, other)? If so, generally describe.

The proposed projects will not change the need for public services.

b. Proposed measures to reduce or control direct impacts on public services, if any.

No proposed measures necessary.

16. Utilities [help]

a. Circle utilities currently available at the site:
electricity, natural gas, water, refuse service, telephone, sanitary sewer, septic system, other ___________

d. Describe the utilities that are proposed for the project, the utility providing the service, and the general construction activities on the site or in the immediate vicinity which might be needed.

The proposed projects include upgrades to the wastewater utilities at the Monroe WWTP. For CIP 3, a new larger electrical service may be required for the WWTP site. For CIP 5, a larger natural gas service may be required to fuel the biosolids dryer.

C. Signature [HELP]

The above answers are true and complete to the best of my knowledge. I understand that the lead agency is relying on them to make its decision.

Signature: ____

Name of signee ____

Position and Agency/Organization __________________________________

Date Submitted: ____________

D. Supplemental sheet for nonproject actions [HELP]

(**IT IS NOT NECESSARY** to use this sheet for project actions)

Because these questions are very general, it may be helpful to read them in conjunction with the list of the elements of the environment.

When answering these questions, be aware of the extent the proposal, or the types of activities likely to result from the proposal, would affect the item at a greater intensity or at a faster rate than if the proposal were not implemented. Respond briefly and in general terms.

1. How would the proposal be likely to increase discharge to water; emissions to air; production, storage, or release of toxic or hazardous substances; or production of noise?

   Proposed measures to avoid or reduce such increases are:

2. How would the proposal be likely to affect plants, animals, fish, or marine life?

   Proposed measures to protect or conserve plants, animals, fish, or marine life are:

3. How would the proposal be likely to deplete energy or natural resources?

   Proposed measures to protect or conserve energy and natural resources are:

4. How would the proposal be likely to use or affect environmentally sensitive areas or areas designated (or eligible or under study) for governmental protection; such as parks, wilderness, wild and scenic rivers, threatened or endangered species habitat, historic or cultural sites, wetlands, floodplains, or prime farmlands?

Proposed measures to protect such resources or to avoid or reduce impacts are:

5. How would the proposal be likely to affect land and shoreline use, including whether it would allow or encourage land or shoreline uses incompatible with existing plans?

Proposed measures to avoid or reduce shoreline and land use impacts are:

6. How would the proposal be likely to increase demands on transportation or public services and utilities?

Proposed measures to reduce or respond to such demand(s) are:

7. Identify, if possible, whether the proposal may conflict with local, state, or federal laws or requirements for the protection of the environment.

Appendix C

Monroe Infiltration and Inflow Evaluation (2016)

MONROE
WASHINGTON

September 5, 2016

Ms. Laura Fricke
Department of Ecology
Northwest Regional Office
3190 160th Ave Se
Bellevue, WA 98008-5452

Re: 2015 Infiltration and Inflow (I/I) Evaluation, City of Monroe WWTP

Dear Ms. Fricke:

Based on EPA publication #97-03 Infiltration/Inflow:

1. Daily Wet Weather Peak Flow (December 2015): 3.700 MG
   Population Served: 18,090
   Gallons Per Capita Per Day (gpcd): 204

The EPA guideline states that if the wet weather flow is ≤ 275 gpcd, then a determination of non-excessive inflow has been made. As the 2015 wet weather peak flow was 204 gpcd, the City of Monroe had non-excessive inflow during wet weather.

2. Daily Dry Weather Flow (September 2015): 0.944 MG
   Population Served: 18,090
   Gallons Per Capita Per Day (gpcd): 52

The EPA guideline state that if the dry weather flow is ≤ 120 gpcd, then a determination of non-excessive infiltration has been made. As the 2015 dry weather flow was 52 gpcd, the City of Monroe had non-excessive infiltration during dry weather.

Sincerely,

John Lande
WWTP Manager

806 West Main Street, Monroe, WA 98272
Phone (360) 794-7400 Fax (360) 794-4007
www.monroeadventure.org

Appendix D

Monroe Industrial User Survey (2016)

MONROE
WASHINGTON

October 27, 2016

Ms. Laura Fricke
Washington State Department of Ecology
Northwest Regional Office
3190 160th Ave Se
Bellevue, WA 98008-5452

Re: City of Monroe WWTP Industrial User Survey

Dear Ms. Fricke,

The City of Monroe WWTP Staff performed the Industrial User Survey (IUS) during the summer and fall of 2016. All establishments that have business licenses within the City of Monroe were surveyed. The initial list of 989 businesses was reduced to 146 businesses that would get further review. Water billing records, internet searches, telephone interviews, and site visits were conducted on the remaining businesses to further survey their potential as a Significant Industrial User (SIU) or Potential Significant Industrial User (PSIU). In all, five (5) establishments were identified meeting the criteria, as determined by staff, which classified them as a SIU or PSIU.

The following list includes:

(1) Valley General Hospital (VGH)
14701 179th Ave Se
Monroe WA 98272

VGH is subject to categorical pretreatment standards 40 CFR part 460. The WWTP does not identify any problems associated with this SIU.

(2) Ocean Beauty Seafoods (OBS)
14651 172nd
Monroe WA 98272

OBS currently operates under Washington Permit #ST-7377. OBS is a fish processing facility which includes smoking and brining fish and seafoods. OBS is subject to categorical pretreatment standards 40 CFR part 408.180 and/or 408.190.

806 West Main Street, Monroe, WA 98272
Phone (360) 794-7400 Fax (360) 794-4007
www.monroeadventure.org

Based on consumption, OBS daily use exceeds 25,000 gpd on some months. The WWTP does not identify any problems associated with this SIU.

(3) Thermo Tech

17197 Tye St SE
Monroe WA 98272

Thermo Tech is subject to categorical pretreatment standard 40 CFR part 433. Thermo Tech is a powder coating facility. The WWTP does not identify any problems associated with this SIU.

(4) Metal Tech

14792 172nd Dr SE
Monroe WA 98272

Metal Tech is an electroplating and powder coating company. They are supposed to be zero discharge. They are subject to categorical pretreatment standard 40 CFR parts 423 and 433. The WWTP does not identify any problems associated with this SIU.

(5) Washington State Dept of Corrections (DOC)

PO Box 777
Monroe WA 98272

The DOC is a state prison that operates an aerated pretreatment lagoon for their wastewater. The DOC effluent flow from the lagoon is approximately 27% of the total flow of the WWTP. There is great potential for pass through and interference of suspended algae that populates the lagoon seasonally. Additionally, any other pollutant has the same potential based on volume of flow of 0.420 MGD. Currently, the WWTP does not identify any problems associated with this SIU.

The WWTP staff is notified of any new business or business alteration during the business application process. This ensures that any new or altered sources is brought to the attention of staff allowing for continual survey for any PSIU or SIU.

If you have any further questions regarding any of these sources or any other business information including our field notes or site visits, please let me know.

Respectfully,

John Lande
WWTP Manager
Public Works Division

Appendix E

Flood Insurance Rate Map No. 53061C1376F

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevation** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevation (BFEs) shown on this map apply only landward of 0.0' National Geodetic Vertical Datum (NGVD). Users of this FIRM should be aware that coastal flood elevations may also be provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this community. Elevations shown in the Summary of Stillwater Elevations table should be used for construction, and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures.** Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures in this jurisdiction.

The **projection** used in the preparation of this map is Universal Tranverse Mercator (UTM) zone 10. The **horizontal datum** is NAD27, CLARKE1866 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

Flood elevations on this map are referenced to the National Geodetic Vertical Datum of 1929. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum.** For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

Spatial Reference System Division
National Geodetic Survey, NOAA
Silver Spring Metro Center
1315 East-West Highway
Silver Spring, Maryland 20910
(301) 713-3191

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242,** or visit their website at www.ngs.noaa.gov.

Base map information shown on this FIRM was provided in digital format by the Snohomish County Geographic Information Systems Department and from the City of Everett.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

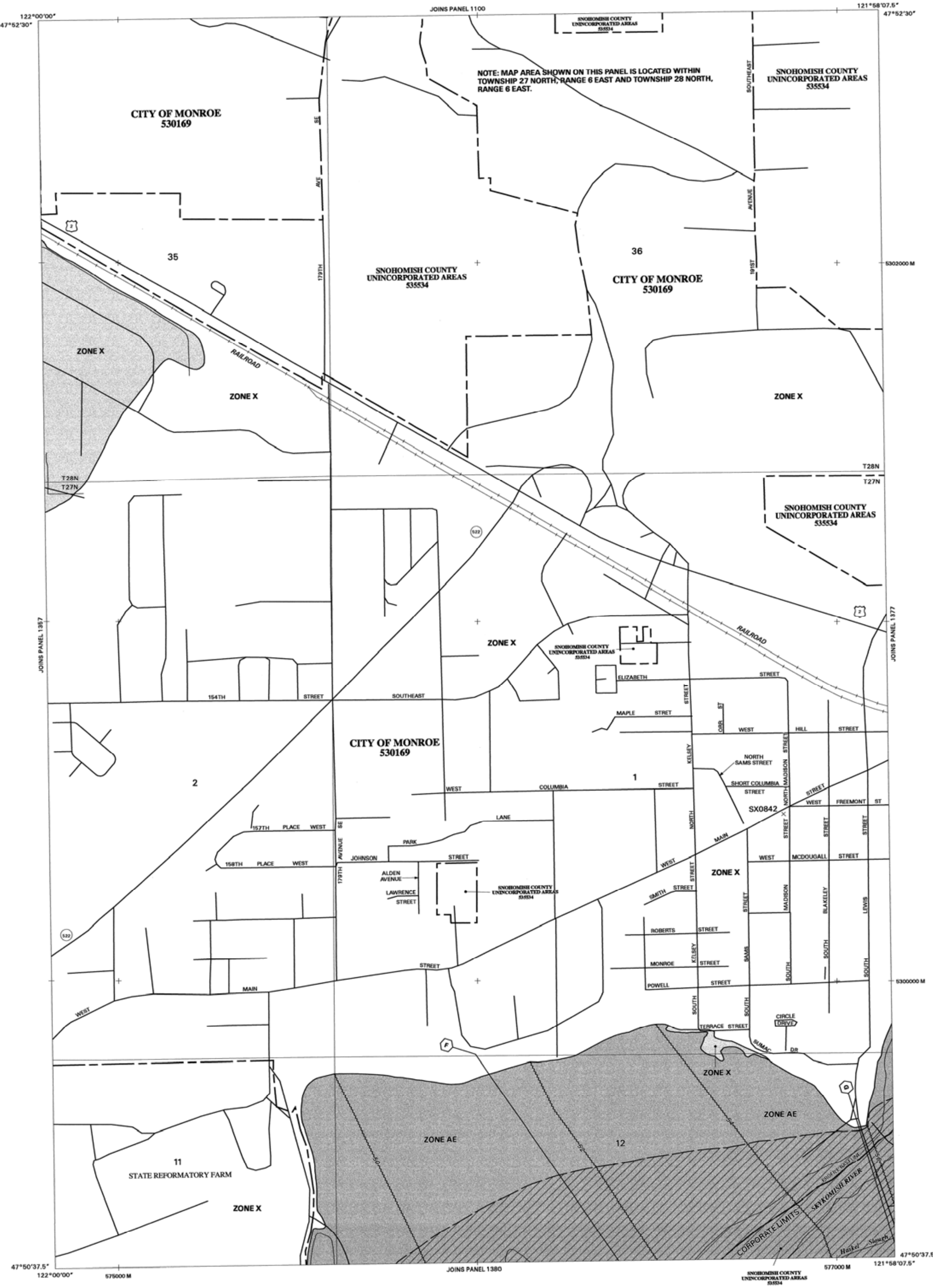
An accompanying Flood Insurance Study report, Letters of Map Revision or Letters of Map Amendment revising portions of this panel, and digital versions of this PANEL may be available. Contact the **FEMA Map Service Center** at the following phone numbers and Internet address for infomation on all related products available from FEMA;

Phone: 800-358-9616
FAX: 800-358-9620
www.fema.gov/msc

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA-MAP** (1-877-336-2627) or visit the FEMA website at www.fema.gov.

This map reflects more detailed and up-to-date stream channel configurations than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study report may reflect stream channel distances that differ from what is shown on this map.

Appendix D_Flood Insurance Rate Map No. 53061C1376F



LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD EVENT

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water surface elevation of the 1% annual chance flood.

ZONE A	No base flood elevations determined.
ZONE AE	Base flood elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); base flood elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Area of special flood hazard formerly protected from the 1% annual chance flood event by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood event.
ZONE A99	Area to be protected from 1% annual chance flood event by a Federal flood protection system under construction; no base flood elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no base flood elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); base flood elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

	Floodplain boundary
	Floodway boundary
	Zone D boundary
	CBRS and OPA boundary
	Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or velocities.
513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the National Geodetic Vertical Datum of 1929

(A)———(A)	Cross Section Line
(23)- - - - -(23)	Transect Line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1927 (NAD 27)
4276000M	1000-meter Universal Transverse Mercator grid values, zone 10
600000 FT	5000-foot grid ticks
DX5510×	Bench mark (see explanation in Notes to Users section of this FIRM panel).
• M1.5	River Mile

MAP REPOSITORY
Refer to Repository Listing on Index Map

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
NOVEMBER 8, 1999

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

September 16, 2005: to increase base flood elevations, to add special flood hazard areas, to change special flood hazard areas, to add roads and road names, and to reflect updated topographic information.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at (800) 638-6620.

MAP SCALE 1" = 500'

250 0 500 1000 FEET

150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 1376F

FIRM
FLOOD INSURANCE RATE MAP
SNOHOMISH COUNTY,
WASHINGTON
AND INCORPORATED AREAS

PANEL 1376 OF 1575

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
SNOHOMISH COUNTY, UNINCORPORATED AREAS	535534	1376	F
MONROE, CITY OF	530169	1376	F

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
53061C1376F

MAP REVISED:
SEPTEMBER 16, 2005

Federal Emergency Management Agency

Appendix F

Biosolids Evaluation

City of Monroe Biosolids Scoring Methodology and Criteria

PROCESS ALTERNATIVES	Phasing Potential	Technology Maturity and Performance	Footprint	Odor Potential	Capital Costs	O&M Costs	Operational Complexity	Regulatory Certainty	Long-term Reliability of Beneficial Use	WEIGHTED AVERAGE	PURPOSE OF PROCESS ALTERNATIVE
WEIGHT OF EACH CRITERION	5.0%	6.0%	8.0%	7.0%	22.0%	22.0%	8.0%	10.0%	12.0%	100%	
Stabilization											**Purpose:** Stabilize solids to produce Class B or Class A biosolids for beneficial use.
Aerobic (Class B) - Conventional (existing process)	4	5	5	4	5	3	5	5	3	**4.2**	
Aerobic (Class A) - ATAD	2	2	2	1	1	2	1	2	3	**1.8**	
Anaerobic (Class B) - Conventional	2	4	3	3	1	4	3	5	3	**3.0**	
Anaerobic (Class A) - Thermophillic	2	2	3	2	1	4	3	4	2	**2.6**	
Anaerobic (Class A) - Acid Phase	1	1	1	2	1	2	1	2	2	**1.5**	
Dewatering											**Purpose:** Removes additional water from stabilized solids (i.e., biosolids) to reduce amount of solids storage, handling, hauling, and beneficial use or disposal.
Rehabilitate Belt Filter Press (existing process)	4	5	4	3	5	3	5	3	3	**3.9**	
New Belt Filter Press	3	5	4	3	4	4	5	3	3	**3.8**	
Centrifuge	3	4	5	3	2	2	2	3	3	**2.7**	
Fan Press	3	2	4	3	3	4	3	3	3	**3.2**	
Screw Press	3	5	4	3	4	4	5	3	3	**3.8**	

City of Monroe Biosolids Scoring Methodology and Criteria

PROCESS ALTERNATIVES	Phasing Potential	Technology Maturity and Performance	Footprint	Odor Potential	Capital Costs	O&M Costs	Operational Complexity	Regulatory Certainty	Long-term Reliability of Beneficial Use	WEIGHTED AVERAGE	PURPOSE OF PROCESS ALTERNATIVE
Additional Treatment (Class A)											**Purpose:** Provide treatment for the purposes of generating a
Invessel Composting (onsite side stream)	4	5	2	2	3	2	5	5	4	**3.3**	biosolids product for sale/distribution to the public with very
Indirect Belt Drying	4	3	4	3	3	3	4	5	5	**3.7**	little regulatory restrictions.
Direct Drying	1	3	4	2	2	1	2	3	3	**2.2**	**Notes:** Potential to combine with Class B land application
Lime/Heat Pasteurization (add on to dewatering unit)	3	2	3	1	2	1	2	2	2	**1.8**	
Storage											**Purpose:** Provide temporary storage of Class A and/or B
Class B dewatered biosolids storage - onsite	1	3	1	2	2	3	4	2	2	**2.3**	biosolids prior to sale/distribution or land application.
Class B dewatered biosolids storage - offsite	2	2	2	2	1	2	3	3	2	**2.0**	**Notes:** Storage time needed may range from days to months.
Class A biosolids storage - onsite	2	4	2	3	2	3	4	3	3	**2.8**	
Class A biosolids storage - offsite	3	3	3	3	1	2	3	4	3	**2.4**	
Beneficial Use / Disposal											**Purpose:** Method of ultimate disposition for the biosolids.
Landfill Disposal	5	3	5	5	4	1	5	1	1	**2.9**	**Notes:** May include blending of options. Land application site(s)
Local Class B land application	1	4	3	2	2	2	2	1	1	**1.9**	may be City and/or farmer owned.
Distant Class B land application	4	4	3	3	4	2	3	3	2	**3.0**	
Class A give away / sale	4	4	4	4	3	3	4	4	4	**3.6**	

Alternatives Discluded From Analysis	**Comments:**
Lagoon Storage	Not adequate space at treatment plant, high odor potential, regressive biosolids management approach
Solar Drying	Not adequate space at treatment plant, high odor potential, not suitable for Western Washington location
Thermal Hydrolosis	Expensive for design and construction, not applicable for size plant, few applications in North America, ~46 globally
Deep Well Injection	Extensive environmental assessment required, likely not permittable, complex public acceptance and outreach process, 1 known in North America
Thermal Conversion - Incineration	Public acceptance complexities, Ecology and air authority permitting challenges, trend in Washington (less of these in operation)
Thermal Conversion - Pyrolysis/Gasification	1 sludge (only) operating facility in North America, inadequate data regarding viability of technology for sludge or biosolids
Offsite Hauling and Treatment	Eliminated due to lack of control over the process and uncertainty in terms of its long term viability.
Covered Aerated Static Pile Composting (off-site)	Space intensive and no room at the Plant. Not a desired process given past experience.

KEY:

Scoring - Alternatives received a 1, 2, 3, 4, or 5 for each selection critieria with each being weighted. The higher the number the better the score.

Scoring - Relative to other alternatives within each Process Alternative category.

Criteria

1. **Phasing Potential.** Ability to expand facilities (e.g., capacity, or increasing solids classification from Class B to Class A) in the future without a high degree of design, modification, or construction. Considers flexibility in sizing expansion modules
2. **Technology Maturity and Performance .** Use of proven technologies with a track record. Number, size and longevity of similar facilities operating under similar circumstances. Ability to consistently meet treatment objectives while handling both flow and load variability.
3. **Footprint.** Ability to maintain the alternative onsite at the treatment plant.
4. **Odor Potential.** Potential for presence of nuisance odors and ease with which potential odor sources can be mitigated.
5. **Capital Costs.** Relative capital costs of alternatives.
6. **Operation and Maintenance Costs (O&M).** Relative annual operations and maintenance costs of alternatives this includes staffing.
7. **Operational Complexity.** Degree of complexity required to operate and maintain the treatment units. Includes both number of systems and mechanical complexity.
8. **Regulatory Certainty.** The ability for the alternative to have relatively greater regulatory acceptance and reduced risk from uncertainty.
9. **Long-term Reliability of Beneficial Use**. The ability of the alternative to be resilient / low risk to the City.

BIOSOLIDS ALTERNATIVES	Treatment Process Ranking				Benefical Use Ranking	WEIGHTED AVERAGE	PURPOSE OF PROCESS ALTERNATIVE
WEIGHT OF EACH CRITERION	50.0%				50.0%	100%	
Stabilization -> Dewatering -> Additional Treatment (optional) -> Solids End Use							
Aerobic Digestion, Belt Filter Press, Onsite Storage, Class B Land Application (Distant)	4.2	3.8	2.3		3.0	**3.2**	Represents current treatment system, status quc
Aerobic Digestion, Screw Press, Onsite Storage, Class B Land Application (Distant)	4.2	3.8	2.3		3.0	**3.2**	
Aerobic Digestion, Belt Filter Press, Dryer, Onsite Storage, Class A giveaway	4.2	3.8	2.8	3.7	3.6	**3.6**	
Aerobic Digestion, Screw Press, Dryer, Onsite Storage, Class A giveaway	4.2	3.8	2.8	3.7	3.6	**3.6**	Greatest change to the existing process
Aerobic Digestion, Belt Filter Press, Dryer, Onsite Storage, Class A giveaway/Class B Land Application	4.2	3.8	2.6	3.7	3.3	**3.4**	
Aerobic Digestion, Screw Press, Dryer, Onsite Storage, Class A giveaway/Class B Land Application	4.2	3.8	2.6	3.7	3.3	**3.4**	

**Thickening was removed from the alternative analysis as all options would utilize the City's existing Disc Thickener

***Assumes that additional aerobic digestion is added to existing system to meet VAR

City of Monroe — **City of Monroe Biosolids Program Evaluation**

			Sensitivity Adjustments (%)			Results		
Agency:	City of Monroe	Risk Premium	Benefits	Capital Costs	Other Costs	Capital Costs	20-year NPV	Difference
Project/Problem:	BiosolidsTreatment Alternatives Analysis							
Alternative 1	Status Quo: Existing Aerobic Digestion with Rehabilitated BFP Class B Land Application					$1,510,000	($23,630,992)	($3,236,238)
Alternative 2	Expanded Aerobic Digestion with Screw Press and Class B Land App					$9,360,000	($22,050,771)	($1,656,017)
Alternative 3	Existing Aerobic Digestion with Screw Press, Full Dryer, Onsite Storage, Class A Giveaway					$14,900,000	($20,394,754)	
Alternative 4								
Alternative 5								
Alternative 6								
Alternative 7								

Year of analysis:	2019
Escalation rate:	4.00%
Discount rate:	6.00%

Select one
- (●) All entries in dollars
- ( ) All entries in thousands of dollars

Note: "Status quo" refers to Alternative 1

Make entries in yellow cells only

Annual Operation and Maintenance Costs

Conversions

160.18	mg/L to 1 lb/ccf
1.341	BHP to kw
3412	kWhr to BTU
525949	min per year
8765.8	hr per year
748	gal per ccf
99976	BTU in a therm
2000	lb to ton

Assumptions Common to All Alternatives	Value	Notes	
Escalation Rate	4		
Discount Rate	6		
All Alternatives			
Electrical Costs ($/kWh)	0.0635	Avg Industrial Electricity Rate Monroe WA	
Natural Gas Use ($/therm)	0.661	Avg Industrial NG Rate Monroe WA	
Annual Employee Labor Rate ($/yr)	65,000	Assumption	
Dewatering Polymer ($/lb)	2.50	Assumption	
Foul Air Scrubber Chemical ($/gal)	2.00	Assumption	
Diesel Fuel Cost ($/gal)	3.28	Triple AAA Avg WA gas price, 2019	
Diesel Truck Fuel Efficiency (mpg)	5.00	Assumption	
Odor Control Media ($/Lb)	6.00	From Enviro Supply Service	
Motor Efficiency of Electrical Equipment	80%	Assumption	
Class B Land App Haul to Douglas Co (miles/load roundtrip)	420	Google Maps	
Class B Biosolids to Land Application ($/WT)	$71.77	Quote from Monroe, Current contract is June 2016 contract $62/WT @ approximately 16% TS; Escalataed to 2019 at 5%	
Annual Long Haul Biosolids Cost Increase	5%	Assumption	
Roosevelt Landfill Round Trip Haul Distance (miles/load roundtrip	462	Google Maps	
Roosevelt Landfill Tipping Fee ($/WT)	100.00	Requested Quote from Roosevelt Landfill, 08/15/2019 & 8/20/2019	
Roosevelt Landfill Entrance Fee ($/Truck)	20.00	Requested Quote from Roosevelt Landfill, 08/15/2019	
Biosolid Haul Truck Capacity - Dewatered Cake (DT/load)	8	Calculated	
Biosolid Haul Truck Capacity - Dry Product (DT/load)	15	Calculated	
Driver Hourly Rate ($/hr)	25	Assumption	
Driver Haul Rate to Roosevelt ($/round trip)	250	10 hours round trip	
Driver Haul Rate to Class B Land App ($/round trip)	250	10 hours round trip	
Alt 1. Status Quo: Aerobic (current capacity), Dewater (Rehab BFP), Class B Land App			
Aerobic Average Future WAS in 2040 (lb/day)	2638	Calculated in Monroe Dig Capacity Calcs. xls	
Biosolids in 2040 (DT/yr)	481	Calculated	
Dewatered Cake TS (%)	0.16	Monroe Biosolids Annual Report - BFP	
Labor	1	FTE Assumption	
Power -BFP + Conveyors (kwhr/yr)	7,800	See Calculations Right, Assumes BFP width matches existing @ 1M; used BDP as basis of design https://www.bdpindustries.com/wp-content/uploads/:	
Power- Blowers (kwhr/yr)	1,601,438	See Calculations	
Chemicals - Polymer (lb/yr)	5,144	See Calculations	
Polymer Usage Rate (lb/DT)	15	BDP Brochure Info	
Fuel - Front End Loader (gal/yr)	719	Calculated	
Annual Maintenance - Aerobic Digesters	28,118	0.5% of aerobic equipment	
Annual Maintenance - Dewatering Equipment	22,708	0.5% of dewatering equipment	
Risk			
Emergency Landfill ($/wk event)	$6,432	Calculated	Can't go over the pass for 1 week
Chance of occurrence (%/yr)	1.0	Assumption	
Loss of Storage at DOC ($/event)	$323,943	Calculated	Higher frequency of hauling, add 50%
Chance of occurrence (%/yr)	0.25	Assumption	
Ecology Regulation Change ($/event)	$5,805,384	Calculated	Emergency aerobic digester project and haul to landfill
Chance of Occurrence (%/yr)	0.10	Assumption	
Reliance on Third Party Hauler ($/event)	$19,295	Calculated	**Emergency landfill for 3 weeks, Pierce county paid $43K for 2 weeks emergency landfill so ours may be a**
Chance of Occurrence (%/yr)	0.50	Assumption	
Alt 2. Aerobic (Expanded Capacity), Dewatering (SP), Class B			
Aerobic Average Future WAS in 2040 (lb/day)	2,638	Calculated in Monroe Dig Capacity Calcs. xls	
Biosolids in 2040 (DT/yr)	481	Calculated	
Dewatered Cake TS (%)	0.16	Assumption	
Labor ($/yr)	1	FTE Assumption	
Power - SP + Conveyors (kwhr/yr)	7,800	Calculated	
Power - Blowers with extended capacity (kwhr/yr)	2,217,375	Calculated	
Power - Sludge Pump for extended capacity (kwhr/yr)	27,375	Calculated	
Fuel - Front End Loader (gal)	719	Calculated	
Chemicals - Polymer (lb/yr)	5,144	Calculated	
Polymer Usage Rate (lb/DT)	15	Assumption	
Annual Maintenance - Aerobic Equipment ($/yr)	28,118	0.5% of aerobic equipment	
Annual Maintenance - Dewater Equipment ($/yr)	22,708	0.5% of aerobic equipment	
Risk			
Emergency Landfill ($/wk event)	$6,432	Calculated	Can't go over the pass for 1 week
Chance of occurrence (%/yr)	1.0	Assumption	
Loss of Storage at DOC ($/event)	$323,943	Calculated	Higher frequency of hauling, add 50%
Chance of occurrence (%/yr)	0.25	Assumption	
Reliance on Third Party Hauler ($/event)	19,295		
Chance of Occurrence (%/yr)	0.50		
Alt 3: Aerobic, Dewater (SP), Full Size Dryer, Class A Only			
Aerobic Average Future WAS in 2040 (lb/day)	2,638	Calculated in Monroe Dig Capacity Calcs. xls	
Biosolids in 2040 (DT/yr)	481	Calculated	
Thermal Dried Product (%)	90%	Assumption	
Labor	1.0	Assumption	
Power - Screw Press + Conveyors (kwhr/yr)	7,800	Calculated	
Power- Dryer (kwhr/yr)	522,080	Calculated	
Power - Blowers with existing capacity (kwhr/yr)	1,601,438	Calculated	
Power - FA Fan (kwhr/yr)	58,661	Calculated	
Odor Control Scrubber Chemicals (gal/yr)	15,000	Assumption	
Fuel - Klein Dryer (therm/yr)	5,631	Calculated	
Fuel - Front End Loader (gal/yr)	575	Calculated	
Odor Control Media Replacement (Lbs/yr)	864	Calculated	
Chemicals - Polymer (lb/yr)	5,144	Calculated	
Polymer Usage Rate (lb/DT)	15	Assumption	
Class A Biosolids Community Giveaway ($/DT)	0	Assumption - no profit at the moment	
Annual Maintenance - Aerobic Digesters	28,118	0.5% of aerobic equipment	
Annual Maintenance - Dewatering Equipment	20,370	0.5% of dewatering equipment	
Annual Maintenance - Drying & Odor Control Equipment ($/yr)	16,299	0.5% of drying & OC equipment	

NO RISK

Cost Summary by Alternative

Initial System Capital Costs	Alt 1. Status Quo	Alt 2. Aerobic Expansion / SP (CIP 4)	Alt 3. SP + Dryer (CIP 5)	Alt 2. Aerobic Expansion / SP (CIP 4)	Alt 3. SP + Dryer (CIP 5)
Capital Costs (with Mark-ups + Contingencies)	$1,510,000	$9,360,000	$14,900,000	$9,360,000	14900000
Operation Costs					
Annual Power Costs (Electrical and Nat Gas)	$102,187	$143,037	$139,061		
Annual Labor Costs	$65,000	$65,000	$65,000		
Annual Material Costs (Polymer, Chemical, Carbon, Fuel Use)	$15,216	$15,216	$45,615		
Annual Biosolid Haul and Disposal Costs	$215,962	$215,962	$0		
Maintenance Costs					
Annual Maintenance Digesters (Parts and Labor)	$28,118	$28,118	$28,118		
Annual Maintenance Dewatering Equipment (Parts and Labor)	$22,708	$22,708	$20,370		
Annual Maintenance Dryer & Odor Control (Parts and Labor)	$0	$0	$16,299		
Risk Costs					
Biosolids to Landfill	$6,432	$6,432	$0		
Loss of Storage at DOC	$80,986	$80,986	$0		
Violation of Ecology Regulations	$580,538	$0	$0		
Reliance on Third Party Hauler	$9,647	$9,647			
Descriptions of each alternative	Existing aerobic system, new BFP, Class B land app	Updated aerobic system, new BFP, Class B land app	Existing aerobic system, new screw press, new dryer, Class A giveaway		

City of Monroe
BiosolidsTreatment Alternatives Analysis
Life Cycle Alternative Cost Analysis
Alternative 1 - Status Quo: Existing Aerobic Digestion with Rehabilitated BFP Class B Land Application

From Summary Sheet:

Year of analysis	2019	**Benefits**	0%		
Escalation rate	4.00%	**Capital costs**	0%	Annual Biosolids Hauling Cost Increase	
Discount rate	6.00%	**Running costs**	0%		5%

Risk adjustments (+/- percent):

		Year																				
		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Expressed in 2019 dollars, unescalated -- dollars																						
Capital Outlays & Replacement Costs																						
Capital Costs	0	1,510,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Replacement Parts		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total capital outlays		**1,510,000**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Benefits:																						
Total benefits		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Annual Running Costs:																						
Annual Power Costs (Electrical and Nat Gas)		102,187	102,187	102,187	102,187	102,187	102,187	102,187	102,187	102,187	102,187	102,187	102,187	102,187	102,187	102,187	102,187	102,187	102,187	102,187	102,187	102,187
Annual Labor Costs		65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000
Annual Material Costs (Polymer, Chemical, Carbon, Fuel Use)		15,216	15,216	15,216	15,216	15,216	15,216	15,216	15,216	15,216	15,216	15,216	15,216	15,216	15,216	15,216	15,216	15,216	15,216	15,216	15,216	15,216
Annual Biosolid Haul and Disposal Costs		215,962	226,760	238,098	250,003	262,503	275,628	289,410	303,880	319,074	335,028	351,779	369,368	387,837	407,228	427,590	448,969	471,418	494,989	519,738	545,725	573,011
Annual Maintenance Digesters (Parts and Labor)		28,118	28,118	28,118	28,118	28,118	28,118	28,118	28,118	28,118	28,118	28,118	28,118	28,118	28,118	28,118	28,118	28,118	28,118	28,118	28,118	28,118
Annual Maintenance Dewatering Equipment (Parts and Labor)		22,708	22,708	22,708	22,708	22,708	22,708	22,708	22,708	22,708	22,708	22,708	22,708	22,708	22,708	22,708	22,708	22,708	22,708	22,708	22,708	22,708
Risk Adjustments		677,603	677,603	677,603	677,603	677,603	677,603	677,603	677,603	677,603	677,603	677,603	677,603	677,603	677,603	677,603	677,603	677,603	677,603	677,603	677,603	677,603
Total running costs		**1,126,793**	**1,137,591**	**1,148,929**	**1,160,834**	**1,173,334**	**1,186,460**	**1,200,241**	**1,214,711**	**1,229,905**	**1,245,859**	**1,262,611**	**1,280,199**	**1,298,668**	**1,318,060**	**1,338,421**	**1,359,801**	**1,382,249**	**1,405,820**	**1,430,569**	**1,456,556**	**1,483,843**
Net Benefit/(cost)		**(2,636,793)**	**(1,137,591)**	**(1,148,929)**	**(1,160,834)**	**(1,173,334)**	**(1,186,460)**	**(1,200,241)**	**(1,214,711)**	**(1,229,905)**	**(1,245,859)**	**(1,262,611)**	**(1,280,199)**	**(1,298,668)**	**(1,318,060)**	**(1,338,421)**	**(1,359,801)**	**(1,382,249)**	**(1,405,820)**	**(1,430,569)**	**(1,456,556)**	**(1,483,843)**
Expressed in escalated dollars with sensitivity adjustments																						
Capital Outlays & Replacement Costs																						
Capital Costs		1,510,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Replacement Parts		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total capital outlays		**1,510,000**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Benefits:																						
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total benefits		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Annual Running Costs:																						
Annual Power Costs (Electrical and Nat Gas)		102,187	106,274	110,525	114,946	119,544	124,326	129,299	134,471	139,849	145,443	151,261	157,312	163,604	170,148	176,954	184,032	191,394	199,049	207,011	215,292	223,903
Annual Labor Costs		65,000	67,600	70,304	73,116	76,041	79,082	82,246	85,536	88,957	92,515	96,216	100,065	104,067	108,230	112,559	117,061	121,744	126,614	131,678	136,945	142,423
Annual Material Costs (Polymer, Chemical, Carbon, Fuel Use)		15,216	15,825	16,458	17,116	17,801	18,513	19,253	20,023	20,824	21,657	22,524	23,425	24,362	25,336	26,349	27,403	28,500	29,640	30,825	32,058	33,340
Annual Biosolid Haul and Disposal Costs		215,962	235,830	257,527	281,219	307,092	335,344	366,196	399,886	436,675	476,849	520,719	568,625	620,939	678,065	740,447	808,569	882,957	964,189	1,052,894	1,149,761	1,255,538
Annual Maintenance Digesters (Parts and Labor)		28,118	29,243	30,412	31,629	32,894	34,210	35,578	37,001	38,481	40,021	41,621	43,286	45,018	46,818	48,691	50,639	52,664	54,771	56,962	59,240	61,610
Annual Maintenance Dewatering Equipment (Parts and Labor)		22,708	23,616	24,560	25,543	26,565	27,627	28,732	29,882	31,077	32,320	33,613	34,957	36,355	37,810	39,322	40,895	42,531	44,232	46,001	47,841	49,755
Risk Adjustments		677,603	704,707	732,896	762,211	792,700	824,408	857,384	891,679	927,347	964,441	1,003,018	1,043,139	1,084,864	1,128,259	1,173,389	1,220,325	1,269,138	1,319,903	1,372,700	1,427,608	1,484,712
Total running costs		**1,126,793**	**1,183,095**	**1,242,682**	**1,305,781**	**1,372,635**	**1,443,509**	**1,518,688**	**1,598,477**	**1,683,211**	**1,773,246**	**1,868,972**	**1,970,808**	**2,079,209**	**2,194,666**	**2,317,712**	**2,448,924**	**2,588,927**	**2,738,398**	**2,898,071**	**3,068,745**	**3,251,282**
#																						
Net escalated benefit/(cost)		**(2,636,793)**	**(1,183,095)**	**(1,242,682)**	**(1,305,781)**	**(1,372,635)**	**(1,443,509)**	**(1,518,688)**	**(1,598,477)**	**(1,683,211)**	**(1,773,246)**	**(1,868,972)**	**(1,970,808)**	**(2,079,209)**	**(2,194,666)**	**(2,317,712)**	**(2,448,924)**	**(2,588,927)**	**(2,738,398)**	**(2,898,071)**	**(3,068,745)**	**(3,251,282)**
Life cycle cost analysis																						
PVs in 2019		(2,636,793)	(1,116,127)	(1,105,983)	(1,096,359)	(1,087,256)	(1,078,674)	(1,070,615)	(1,063,079)	(1,056,067)	(1,049,582)	(1,043,624)	(1,038,197)	(1,033,303)	(1,028,945)	(1,025,126)	(1,021,850)	(1,019,121)	(1,016,943)	(1,015,321)	(1,014,260)	(1,013,765)
Cumulative		(2,636,793)	(3,752,921)	(4,858,903)	(5,955,262)	(7,042,517)	(8,121,192)	(9,191,806)	(10,254,885)	(11,310,952)	(12,360,534)	(13,404,158)	(14,442,355)	(15,475,659)	(16,504,604)	(17,529,730)	(18,551,581)	(19,570,702)	(20,587,646)	(21,602,967)	(22,617,227)	(23,630,992)
NPV as of 2019		**(23,630,992)**																				
PV of O&M		1,126,793	1,116,127	1,105,983	1,096,359	1,087,256	1,078,674	1,070,615	1,063,079	1,056,067	1,049,582	1,043,624	1,038,197	1,033,303	1,028,945	1,025,126	1,021,850	1,019,121	1,016,943	1,015,321	1,014,260	1,013,765
NPV of O&M		**27,202,642**																				

From Summary Sheet:

Year of analysis	2019
Escalation rate	4.00%
Discount rate	6.00%

Risk adjustments (+/- percent):

Benefits	
Capital costs	
Running costs	

Annual Biosolid Hauling Cost Increase: 5%

City of Monroe
BiosolidsTreatment Alternatives Analysis
Life Cycle Alternative Cost Analysis
Alternative 2 - Expanded Aerobic Digestion with Screw Press and Class B Land App

	Year										
	2019	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**
Expressed in 2019 dollars, unescalated -- dollars											
Capital Outlays & Replacement Costs											
Capital Costs	9,360,000										
Replacement Parts											
Total capital outlays	**9,360,000**										
Benefits:											
Total benefits											
Annual Running Costs:											
Annual Power Costs (Electrical and Nat Gas)	143,037	143,037	143,037	143,037	143,037	143,037	143,037	143,037	143,037	143,037	143,037
Annual Labor Costs	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000
Annual Material Costs (Polymer, Chemical, Carbon, Fuel Use)	15,216	15,216	15,216	15,216	15,216	15,216	15,216	15,216	15,216	15,216	15,216
Annual Biosolid Haul and Disposal Costs	215,962	226,760	238,098	250,003	262,503	275,628	289,410	303,880	319,074	335,028	351,779
Annual Maintenance Digesters (Parts and Labor)	$28,118	$28,118	$28,118	$28,118	$28,118	$28,118	$28,118	$28,118	$28,118	$28,118	$28,118
Annual Maintenance Dewatering Equipment (Parts and Labor)	22,708	22,708	22,708	22,708	22,708	22,708	22,708	22,708	22,708	22,708	22,708
Risk Adjustments	97,065	97,065	97,065	97,065	97,065	97,065	97,065	97,065	97,065	97,065	97,065
Total running costs	**587,105**	**597,903**	**609,241**	**621,146**	**633,646**	**646,771**	**660,553**	**675,023**	**690,217**	**706,171**	**722,922**
Net Benefit/(cost)	**(9,947,105)**	**(597,903)**	**(609,241)**	**(621,146)**	**(633,646)**	**(646,771)**	**(660,553)**	**(675,023)**	**(690,217)**	**(706,171)**	**(722,922)**
Expressed in escalated dollars with sensitivity adjustments											
Capital Outlays & Replacement Costs											
Capital Costs	9,360,000										
Replacement Parts											
Total capital outlays	**9,360,000**										
Benefits:											
Total benefits											
Annual Running Costs:											
Annual Power Costs (Electrical and Nat Gas)	143,037	148,758	154,709	160,897	167,333	174,026	180,987	188,227	195,756	203,586	211,730
Annual Labor Costs	65,000	67,600	70,304	73,116	76,041	79,082	82,246	85,536	88,957	92,515	96,216
Annual Material Costs (Polymer, Chemical, Carbon, Fuel Use)	15,216	15,825	16,458	17,116	17,801	18,513	19,253	20,023	20,824	21,657	22,524
Annual Biosolid Haul and Disposal Costs	215,962	235,830	257,527	281,219	307,092	335,344	366,196	399,886	436,675	476,849	520,719
Annual Maintenance Digesters (Parts and Labor)	28,118	29,243	30,412	31,629	32,894	34,210	35,578	37,001	38,481	40,021	41,621
Annual Maintenance Dewatering Equipment (Parts and Labor)	22,708	23,616	24,560	25,543	26,565	27,627	28,732	29,882	31,077	32,320	33,613
Risk Adjustments	97,065	100,947	104,985	109,185	113,552	118,094	122,818	127,731	132,840	138,153	143,680
Total running costs	**587,105**	**621,819**	**658,955**	**698,705**	**741,277**	**786,896**	**835,810**	**888,285**	**944,610**	**1,005,102**	**1,070,102**
Net escalated benefit/(cost)	**(9,947,105)**	**(621,819)**	**(658,955)**	**(698,705)**	**(741,277)**	**(786,896)**	**(835,810)**	**(888,285)**	**(944,610)**	**(1,005,102)**	**(1,070,102)**
Cumulative escalated (benefit)/cost	**(9,947,105)**	**(10,568,925)**	**(11,227,880)**	**(11,926,585)**	**(12,667,861)**	**(13,454,758)**	**(14,290,568)**	**(15,178,853)**	**(16,123,463)**	**(17,128,565)**	**(18,198,666)**
Life cycle cost analysis											
PVs in 2019	(9,947,105)	(586,622)	(586,468)	(586,646)	(587,160)	(588,015)	(589,213)	(590,760)	(592,660)	(594,918)	(597,539)
Cumulative PV	(9,947,105)	(10,533,727)	(11,120,195)	(11,706,841)	(12,294,002)	(12,882,017)	(13,471,230)	(14,061,990)	(14,654,650)	(15,249,568)	(15,847,107)
NPV as of 2019	**(22,050,771)**										
PV of O&M	587,105	586,622	586,468	586,646	587,160	588,015	589,213	590,760	592,660	594,918	597,539
NPV of O&M	**16,030,605**										

	Year									
	2030	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**
Expressed in 2019 dollars, unescalated -- dollars										
Capital Outlays & Replacement Costs										
Capital Costs										
Replacement Parts										
Total capital outlays										
Benefits:										
Total benefits										
Annual Running Costs:										
Annual Power Costs (Electrical and Nat Gas)	143,037	143,037	143,037	143,037	143,037	143,037	143,037	143,037	143,037	143,037
Annual Labor Costs	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000
Annual Material Costs (Polymer, Chemical, Carbon, Fuel Use)	15,216	15,216	15,216	15,216	15,216	15,216	15,216	15,216	15,216	15,216
Annual Biosolid Haul and Disposal Costs	369,368	387,837	407,228	427,590	448,969	471,418	494,989	519,738	545,725	573,011
Annual Maintenance Digesters (Parts and Labor)	$28,118	$28,118	$28,118	$28,118	$28,118	$28,118	$28,118	$28,118	$28,118	$28,118
Annual Maintenance Dewatering Equipment (Parts and Labor)	22,708	22,708	22,708	22,708	22,708	22,708	22,708	22,708	22,708	22,708
Risk Adjustments	97,065	97,065	97,065	97,065	97,065	97,065	97,065	97,065	97,065	97,065
Total running costs	**740,511**	**758,980**	**778,372**	**798,733**	**820,113**	**842,561**	**866,132**	**890,881**	**916,868**	**944,155**
Net Benefit/(cost)	**(740,511)**	**(758,980)**	**(778,372)**	**(798,733)**	**(820,113)**	**(842,561)**	**(866,132)**	**(890,881)**	**(916,868)**	**(944,155)**
Expressed in escalated dollars with sensitivity adjustments										
Capital Outlays & Replacement Costs										
Capital Costs										
Replacement Parts										
Total capital outlays										
Benefits:										
Total benefits										
Annual Running Costs:										
Annual Power Costs (Electrical and Nat Gas)	220,199	229,007	238,167	247,694	257,601	267,905	278,622	289,767	301,357	313,412
Annual Labor Costs	100,065	104,067	108,230	112,559	117,061	121,744	126,614	131,678	136,945	142,423
Annual Material Costs (Polymer, Chemical, Carbon, Fuel Use)	23,425	24,362	25,336	26,349	27,403	28,500	29,640	30,825	32,058	33,340
Annual Biosolid Haul and Disposal Costs	568,625	620,939	678,065	740,447	808,569	882,957	964,189	1,052,894	1,149,761	1,255,538
Annual Maintenance Digesters (Parts and Labor)	43,286	45,018	46,818	48,691	50,639	52,664	54,771	56,962	59,240	61,610
Annual Maintenance Dewatering Equipment (Parts and Labor)	34,957	36,355	37,810	39,322	40,895	42,531	44,232	46,001	47,841	49,755
Risk Adjustments	149,427	155,404	161,620	168,085	174,808	181,800	189,072	196,635	204,501	212,681
Total running costs	**1,139,983**	**1,215,151**	**1,296,046**	**1,383,147**	**1,476,976**	**1,578,101**	**1,687,139**	**1,804,762**	**1,931,703**	**2,068,759**
Net escalated benefit/(cost)	**(1,139,983)**	**(1,215,151)**	**(1,296,046)**	**(1,383,147)**	**(1,476,976)**	**(1,578,101)**	**(1,687,139)**	**(1,804,762)**	**(1,931,703)**	**(2,068,759)**
Cumulative escalated (benefit)/cost	**(19,338,650)**	**(20,553,801)**	**(21,849,847)**	**(23,232,994)**	**(24,709,971)**	**(26,288,072)**	**(27,975,211)**	**(29,779,973)**	**(31,711,677)**	**(33,780,436)**
Life cycle cost analysis										
PVs in 2019	(600,529)	(603,893)	(607,637)	(611,767)	(616,291)	(621,214)	(626,543)	(632,287)	(638,453)	(645,049)
Cumulative PV	(16,447,636)	(17,051,529)	(17,659,166)	(18,270,934)	(18,887,224)	(19,508,438)	(20,134,981)	(20,767,269)	(21,405,722)	(22,050,771)
NPV as of 2019										
PV of O&M	600,529	603,893	607,637	611,767	616,291	621,214	626,543	632,287	638,453	645,049
NPV of O&M										

From Summary Sheet:

Year of analysis	2019	Benefits	
Escalation rate	4.00%	Capital costs	
Discount rate	6.00%	Running costs	

Risk adjustments (+/- percent):

Annual Biosolids Growth & Elelctrical Growth

City of Monroe
BiosolidsTreatment Alternatives Analysis
Life Cycle Alternative Cost Analysis
Alternative 3 - Existing Aerobic Digestion with Screw Press, Full Dryer, Onsite Storage, Class A Giveaway

	Year																				
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Expressed in 2019 dollars, unescalated -- dollars																					
Capital Outlays & Replacement Costs																					
Capital Costs	14,900,000																				
Replacement Parts																					
Total capital outlays	**14,900,000**																				
Benefits:																					
Total benefits																					
Annual Running Costs:																					
Annual Power Costs (Electrical and Nat Gas)	139,061	139,061	139,061	139,061	139,061	139,061	139,061	139,061	139,061	139,061	139,061	139,061	139,061	139,061	139,061	139,061	139,061	139,061	139,061	139,061	139,061
Annual Labor Costs	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000
Annual Material Costs (Polymer, Chemical, Carbon, Fuel Use)	45,615	45,615	45,615	45,615	45,615	45,615	45,615	45,615	45,615	45,615	45,615	45,615	45,615	45,615	45,615	45,615	45,615	45,615	45,615	45,615	45,615
Annual Biosolid Haul and Disposal Costs																					
Annual Maintenance Digesters (Parts and Labor)	$28,118	$28,118	$28,118	$28,118	$28,118	$28,118	$28,118	$28,118	$28,118	$28,118	$28,118	$28,118	$28,118	$28,118	$28,118	$28,118	$28,118	$28,118	$28,118	$28,118	$28,118
Annual Maintenance Dewatering Equipment (Parts and Labor)	20,370	20,370	20,370	20,370	20,370	20,370	20,370	20,370	20,370	20,370	20,370	20,370	20,370	20,370	20,370	20,370	20,370	20,370	20,370	20,370	20,370
Annual Maintenance Dryer & Odor Control (Parts and Labor)	16,299	16,299	16,299	16,299	16,299	16,299	16,299	16,299	16,299	16,299	16,299	16,299	16,299	16,299	16,299	16,299	16,299	16,299	16,299	16,299	16,299
Total running costs	**314,463**	**314,463**	**314,463**	**314,463**	**314,463**	**314,463**	**314,463**	**314,463**	**314,463**	**314,463**	**314,463**	**314,463**	**314,463**	**314,463**	**314,463**	**314,463**	**314,463**	**314,463**	**314,463**	**314,463**	**314,463**
Net Benefit/(cost)	**(15,214,463)**	**(314,463)**	**(314,463)**	**(314,463)**	**(314,463)**	**(314,463)**	**(314,463)**	**(314,463)**	**(314,463)**	**(314,463)**	**(314,463)**	**(314,463)**	**(314,463)**	**(314,463)**	**(314,463)**	**(314,463)**	**(314,463)**	**(314,463)**	**(314,463)**	**(314,463)**	**(314,463)**
Expressed in escalated dollars with sensitivity adjustments																					
Capital Outlays & Replacement Costs																					
Capital Costs	14,900,000																				
Replacement Parts																					
Total capital outlays	**14,900,000**																				
Benefits:																					
Total benefits																					
Annual Running Costs:																					
Annual Power Costs (Electrical and Nat Gas)	139,061	144,624	150,408	156,425	162,682	169,189	175,957	182,995	190,315	197,927	205,844	214,078	222,641	231,547	240,809	250,441	260,459	270,877	281,712	292,981	304,700
Annual Labor Costs	65,000	67,600	70,304	73,116	76,041	79,082	82,246	85,536	88,957	92,515	96,216	100,065	104,067	108,230	112,559	117,061	121,744	126,614	131,678	136,945	142,423
Annual Material Costs (Polymer, Chemical, Carbon, Fuel Use)	45,615	47,440	49,337	51,311	53,363	55,498	57,718	60,026	62,427	64,924	67,521	70,222	73,031	75,952	78,990	82,150	85,436	88,853	92,408	96,104	99,948
Annual Biosolid Haul and Disposal Costs																					
Annual Maintenance Digesters (Parts and Labor)	28,118	29,243	30,412	31,629	32,894	34,210	35,578	37,001	38,481	40,021	41,621	43,286	45,018	46,818	48,691	50,639	52,664	54,771	56,962	59,240	61,610
Annual Maintenance Dewatering Equipment (Parts and Labor)	20,370	21,185	22,032	22,913	23,830	24,783	25,775	26,806	27,878	28,993	30,153	31,359	32,613	33,918	35,274	36,685	38,153	39,679	41,266	42,917	44,633
Annual Maintenance Dryer & Odor Control (Parts and Labor)	16,299	16,951	17,629	18,334	19,067	19,830	20,623	21,448	22,306	23,198	24,126	25,091	26,095	27,139	28,224	29,353	30,527	31,748	33,018	34,339	35,713
Total running costs	**314,463**	**327,041**	**340,123**	**353,728**	**367,877**	**382,592**	**397,896**	**413,811**	**430,364**	**447,578**	**465,482**	**484,101**	**503,465**	**523,604**	**544,548**	**566,330**	**588,983**	**612,542**	**637,044**	**662,525**	**689,026**
#																					
Net escalated benefit/(cost)	**(15,214,463)**	**(327,041)**	**(340,123)**	**(353,728)**	**(367,877)**	**(382,592)**	**(397,896)**	**(413,811)**	**(430,364)**	**(447,578)**	**(465,482)**	**(484,101)**	**(503,465)**	**(523,604)**	**(544,548)**	**(566,330)**	**(588,983)**	**(612,542)**	**(637,044)**	**(662,525)**	**(689,026)**
Life cycle cost analysis																					
PVs in 2019	(15,214,463)	(308,529)	(302,708)	(296,997)	(291,393)	(285,895)	(280,501)	(275,208)	(270,016)	(264,921)	(259,922)	(255,018)	(250,207)	(245,486)	(240,854)	(236,310)	(231,851)	(227,476)	(223,184)	(218,973)	(214,842)
Cumultaive PV	(15,214,463)	(15,522,992)	(15,825,700)	(16,122,697)	(16,414,090)	(16,699,985)	(16,980,486)	(17,255,694)	(17,525,709)	(17,790,630)	(18,050,553)	(18,305,571)	(18,555,778)	(18,801,264)	(19,042,118)	(19,278,427)	(19,510,278)	(19,737,754)	(19,960,939)	(20,179,912)	(20,394,754)
NPV as of 2019	**(20,394,754)**																				
PV of O&M	314,463	308,529	302,708	296,997	291,393	285,895	280,501	275,208	270,016	264,921	259,922	255,018	250,207	245,486	240,854	236,310	231,851	227,476	223,184	218,973	214,842
NPV of O&M	**6,509,666**																				

Appendix G

Capital Improvement Plan Cost Analysis and
Opinion of Probable Construction Costs

BASIS OF ESTIMATE

KENNEDY/JENKS CONSULTANTS
OPINION OF PROBABLE CONSTRUCTION AND PROJECT COST

PROJECT INFORMATION:

Client:	City of Monroe
Project:	Monroe WWTP Engineering Report
KJ Job No.:	1997002*00
Estimate Date:	1/31/2020
Prepared By:	J. Hoffman, A. Storey, R. Wilmouth, R. Walz
Reviewed By:	J. Hoffman
Estimate Type:	Conceptual
AACE Class Level Estimate :	Class 4

PROJECT DESCRIPTION:

The City of Monroe (City) owns and operates a secondary wastewater treatment plant (WWTP) implementing a Modified Ludzack-Ettinger process with UV disinfection, aerobic digestion, belt press dewatering, and utilizing contract hauling and application of the City's biosolids to a Beneficial Use Facility. The WWTP has a design capacity of 2.84 MGD Maximum Month Design Flow (MMDF). The original primary treatment plant was built in the early 1950's with the modification to secondary treatment in 1976. Major facility upgrades occurred in 1996, 2002, and 2014 (Phase I-III). Additional facility improvements have been made over the years including, digester blower replacement, aeration basin blower replacement, aeration basin diffuser upgrades, odor control scrubber modifications, WAS thickening and secondary clarifier modifications under the Energy Conservation Projects through the Washington State Department of Enterprise Services program.

The City's current Sanitary Sewer System Plan was updated in 2015. Several necessary improvements were identified at the WWTP to meet process capacities, equipment obsolescence, and efficiency needs All of the plant modifications recommended in the plan have been accomplished or are currently being performed in the current Energy Conservation Project (ECP) Phase III. The 2015 to 2021 Capital Plan identified a need for a detailed WWTP Engineering Report, a WWTP Rerating Study (Capacity Analysis), a Mixing Zone Analysis, and a Biosolids Management Study. Furthermore, the City's Draft NPDES permit is currently out for public comment and is requiring engineering solutions for pending pH limits.

The City selected the CONSULTANT to provide assistance in preparation of the WWTP Engineering Report that must comply with the requirements of Washington State WAC 173-240-505, 173-240-060, RCW 35.70A (Growth Management Act), RCW 82.02, including the identification and analysis of funding sources for a list of recommended WWTP improvements. The Engineering Report will be submitted to the Washington State Department of Ecology (Ecology) for review, comment and approval.

ESTIMATE DOCUMENTS:

DRAWINGS: N/A
DOCUMENTS: N/A
COSTS PROVIDED BY OTHERS: N/A

SOURCE OF COST DATA:

RS Means Costworks 2018 data;

DESIGN CONTINGENCY:

A design contingency of 30% has been included.

Note: This allowance is intended to provide a Design Contingency allowance. It is not intended to provide for a Construction Contingency for change orders during construction or to cover unforeseen conditions.

ESCALATION:

An escalation factor has been included to account for a midpoint of construction, which varies per project (see tab "CIP Cost Summary").
The owner is cautioned that the project cost should be adjusted for any changes in the project schedule.

Annual Inflation Escalation Factor (%):	3.5%	
Time Until Project Midpoint (# of Months)	VARIABLE	varies per project (see tab "CIP Cost Summary")

ACCURACY:

The level of accuracy is commensurate with levels developed by the AACE, the Association for the Advancement of Cost Engineering International. At increasing levels of design completion, the narrower the range between upper and lower limits and the greater the accuracy of the estimate. This estimate is considered a Class 4 level estimate in accordance with AACE guidelines. Typically this level of estimate has an expected accuracy range of +20 to +50% on high side and -15% to -30% on low side. This estimate is based upon project with multiple bidders.
The enclosed Engineer's Estimate of Probable Construction Cost is only an opinion of possible items that may be considered for budgeting purposes. This Project Estimate is limited to the conditions existing at issuance and is not a guarantee of actual construction cost or schedule. Uncertain market conditions such as, but not limited to, local labor or contractor availability, wages, other work, material market fluctuations, price escalations, force majeure events and developing bidding conditions, etc. may affect the accuracy of this review. Kennedy/Jenks is not responsible for any variance from this Project Estimate or actual prices and conditions obtained.

OTHER COMMENTS:

None.

Date last updated: 31-Jan-20

CIP No.	Project Elements	CIP 1	CIP 2		CIP 3	CIP 4	CIP 5	CIP 6
			Secondary Treatment Alternatives			Solids Upgrades Alternatives		
		pH and Filament Control	Phase 1 Conventional Activated Sludge	Phase 2 Conventional Activated Sludge	Sidestream MBR	Class B Solids Handling Upgrades	Class A Solids Handling Upgrades	Plantwide Pumps and Ultraviolet Disinfection Upgrades
1	1. Permanent RAS Chlorination	$140,000						
	2. Upgraded Magnesium Hydroxide Feed System	$270,000						
	3. Secondary Effluent Sodium Hydroxide Feed System	$270,000						
	4. Baffling of Aeration Basins	$350,000						
	5. Surface Wasting System	$410,000						
	6. Mixed Liquor Return Optimization	$320,000						
	CIP 1 Total (2020 Dollars)	**$1,760,000**						
2 Phase 1	1. Add 3rd Secondary Clarifier		$4,240,000					
	2. Aeration Basin Upgrades		$3,780,000					
	3. Site Prep, Retaining Wall and Force Main Relocation		$1,010,000					
	CIP 2 Phase 1 Total (2020 Dollars)		**$9,030,000**					
2 Phase 2	1. Add 4th Secondary Clarifier			$4,140,000				
	CIP 2 Phase 2 Total (2020 Dollars)			**$4,140,000**				
3	1. Sidestream MBR				$20,030,000			
	CIP 3 Total (2020 Dollars)				**$20,030,000**			
4	1. Construct New Digester Next to Primary Clarifiers					$6,310,000		
	2. Install New Screw Press					$3,310,000		
	3. Install New Flow Meters and TSS Meters					$70,000		
	CIP 4 Total (2020 Dollars)					**$9,690,000**		
5	1. Class A Sludge Dryer						$12,040,000	
	2. Install New Screw Press						$3,310,000	
	3. Install New Flow Meters and TSS Meters						$70,000	
	CIP 5 Total (2020 Dollars)						**$15,420,000**	
6	1. Upgrade Effluent Pumps							$830,000
	2. 3W System Upgrades							$460,000
	3. Upgrade Influent Pumps							$640,000
	4. Upgrade UV System							$3,200,000
	CIP 6 Total (2020 Dollars)							**$5,130,000**
	Total Project Cost (2020 Dollars)	**$1,760,000**	**$9,030,000**	**$4,140,000**	**$20,030,000**	**$9,690,000**	**$15,420,000**	**$5,130,000**
	Total Lifecycle Costs[1] (2020 Dollars)	**$2,050,000**	**$9,950,000**	**$4,500,000**	**$25,270,000**	**$10,536,000**	**$12,630,000**	**$7,210,000**
	Lifecycle of Risk Costs (2020 Dollars)					**$1,941,294**	**$0**	
	Total Lifecycle Costs plus Lifecycle of Risk Costs (2020 Dollars)					**$12,477,294**	**$12,630,000**	
	Estimated Midpoint of Construction (Year)	**2021**	**2027**	**2040**	**2027**	**2023**	**2023**	**2029**
	Total Project Cost Escalated to Midpoint of Construction (Escalated $s)	**$1,830,000**	**$11,170,000**	**$6,940,000**	**$24,780,000**	**$10,670,000**	**$16,980,000**	**$6,700,000**

Escalation to Midpt of Construction[2] (Escalated $s)							
Year[3,4]	**CIP 1**	**CIP 2 Phase 1**	**CIP 2 Phase 2**	**CIP 3**	**CIP 4**	**CIP 5**	**CIP 6**
2020	**$200,000**						
2021	**$1,630,000**						
2022					**$750,000**	**$1,200,000**	
2023					**$6,000,000**	**$9,500,000**	
2024					**$3,920,000**	**$6,280,000**	
2025							
2026		**$750,000**		**$1,700,000**			
2027		**$6,500,000**		**$14,000,000**			
2028		**$3,920,000**		**$9,080,000**			**$450,000**
2029							**$6,250,000**
2030							
2031							

CIP No.	Project Elements	CIP 1 pH and Filament Control	Secondary Treatment Alternatives CIP 2 Phase 1 Conventional Activated Sludge	Phase 2 Conventional Activated Sludge	CIP 3 Sidestream MBR	Solids Upgrades Alternatives CIP 4 Class B Solids Handling Upgrades	CIP 5 Class A Solids Handling Upgrades	CIP 6 Plantwide Pumps and Ultraviolet Disinfection Upgrades
	2032							
	2033							
	2034							
	2035							
	2036							
	2037							
	2038							
	2039			$475,000				
	2040			$6,465,000				
	Escalation to Year Dollars Spent (Escalated $s)							
	Year[3,4]	CIP 1	CIP 2 Phase 1	CIP 2 Phase 2	CIP 3	CIP 4	CIP 5	CIP 6
	2020	$194,175						
	2021	$1,630,000						
	2022					$728,155	$1,165,049	
	2023					$6,000,000	$9,500,000	
	2024					$4,037,600	$6,468,400	
	2025							
	2026		$728,155		$1,650,485			
	2027		$6,500,000		$14,000,000			
	2028		$4,037,600		$9,352,400			$436,893
	2029							$6,250,000
	2030							
	2031							
	2032							
	2033							
	2034							
	2035							
	2036							
	2037							
	2038							
	2039			$461,165				
	2040			$6,465,000				

NOTES:

1. Total Lifecycle Cost includes costs that the City will incur over the lifetime of an improvement (typically 20 years). It includes the initial capital cost to build and/or install the improvement plus operations and maintenance cost over the expected lifetime of the improvement. The operations and maintenance costs are adjusted to represent its present value in order to determine the total lifecycle cost.
2. Distribution of project costs assumes 12 month design phase followed by: A) 12 month construction phase for project less than $10M, and B) 24 month construction phase for project exceeding $10M
3. The 6-year period (2020 through 2025) is emphasized for the City's capital planning.
4. The NPDES renewal is anticipated to occur in 2024 assuming no delays.

Years within the 20-year planning period but not within the 6-year planning period.

Useful for financial comparison of alternatives.

	Costs Across CIP Packages			
	1, 2, 4, 6	1,3,4,6	1,2,5,6	1,3,5,6
Total Project Cost (2020 Dollars)	$29,750,000	$36,610,000	$35,480,000	$42,340,000
Total Lifecycle Costs[1] (2020 Dollars)	$34,246,000	$45,066,000	$36,340,000	$47,160,000
[redacted]				
Total Lifecycle Costs plus Lifecycle of Risk Costs (2020 Dollars)	$36,187,294	$47,007,294	$36,340,000	$47,160,000

Escalation to Midpt of Construction[2]	Annual Total Project Costs (Escalated $s) Across CIP Packages			
Year[3,4]	1, 2, 4, 6	1,3,4,6	1,2,5,6	1,3,5,6
2020	$200,000	$200,000	$200,000	$200,000
2021	$1,630,000	$1,630,000	$1,630,000	$1,630,000
2022	$750,000	$750,000	$1,200,000	$1,200,000
2023	$6,000,000	$6,000,000	$9,500,000	$9,500,000
2024	$3,920,000	$3,920,000	$6,280,000	$6,280,000
2025	$0	$0	$0	$0
2026	$750,000	$1,700,000	$750,000	$1,700,000
2027	$6,500,000	$14,000,000	$6,500,000	$14,000,000
2028	$4,370,000	$9,530,000	$4,370,000	$9,530,000
2029	$6,250,000	$6,250,000	$6,250,000	$6,250,000
2030	$0	$0	$0	$0
2031	$0	$0	$0	$0
2032	$0	$0	$0	$0
2033	$0	$0	$0	$0
2034	$0	$0	$0	$0
2035	$0	$0	$0	$0
2036	$0	$0	$0	$0
2037	$0	$0	$0	$0
2038	$0	$0	$0	$0
2039	$475,000	$0	$475,000	$0
2040	$6,465,000	$0	$6,465,000	$0

Escalation to Year Dollars Spent (Escalated $s)	Annual Total Project Costs (Escalated $s) Across CIP Packages				Annual Add'l O&M Costs (Escalated $s) Across CIP Packages				
Year[3,4]	1, 2, 4, 6	1,3,4,6	1,2,5,6	1,3,5,6	1, 2, 4, 6	1,3,4,6	1,2,5,6	1,3,5,6	
2020	$194,175	$194,175	$194,175	$194,175	$0	$0	$0	$0	
2021	$1,630,000	$1,630,000	$1,630,000	$1,630,000	$0	$0	$0	$0	
2022	$728,155	$728,155	$1,165,049	$1,165,049	$15,372	$15,372	$15,372	$15,372	CIP 1 Online
2023	$6,000,000	$6,000,000	$9,500,000	$9,500,000	$15,834	$15,834	$15,834	$15,834	CIP 1 Online
2024	$4,037,600	$4,037,600	$6,468,400	$6,468,400	$16,309	$16,309	$16,309	$16,309	CIP 1 Online
2025	$0	$0	$0	$0	$65,835	$65,835	-$144,921	-$144,921	CIP 1 and CIP 4/5 Online
2026	$728,155	$1,650,485	$728,155	$1,650,485	$67,810	$67,810	-$149,268	-$149,268	CIP 1 and CIP 4/5 Online
2027	$6,500,000	$14,000,000	$6,500,000	$14,000,000	$69,845	$69,845	-$153,747	-$153,747	CIP 1 and CIP 4/5 Online
2028	$4,474,493	$9,789,293	$4,474,493	$9,789,293	$71,940	$71,940	-$158,359	-$158,359	CIP 1 and CIP 4/5 Online
2029	$6,250,000	$6,250,000	$6,250,000	$6,250,000	$134,118	$415,949	-$103,090	$178,741	CIP 1 and CIP 4/5 and CIP 2.1/3 Online
2030	$0	$0	$0	$0	$277,908	$568,194	$33,584	$323,870	CIP 1 and CIP 4/5 and CIP 2.1/3 and CIP6 Online
2031	$0	$0	$0	$0	$286,246	$585,240	$34,592	$333,587	CIP 1 and CIP 4/5 and CIP 2.1/3 and CIP6 Online
2032	$0	$0	$0	$0	$294,833	$602,797	$35,630	$343,594	CIP 1 and CIP 4/5 and CIP 2.1/3 and CIP6 Online
2033	$0	$0	$0	$0	$303,678	$620,881	$36,699	$353,902	CIP 1 and CIP 4/5 and CIP 2.1/3 and CIP6 Online
2034	$0	$0	$0	$0	$312,788	$639,508	$37,800	$364,519	CIP 1 and CIP 4/5 and CIP 2.1/3 and CIP6 Online
2035	$0	$0	$0	$0	$322,172	$658,693	$38,934	$375,455	CIP 1 and CIP 4/5 and CIP 2.1/3 and CIP6 Online
2036	$0	$0	$0	$0	$331,837	$678,454	$40,102	$386,718	CIP 1 and CIP 4/5 and CIP 2.1/3 and CIP6 Online
2037	$0	$0	$0	$0	$341,792	$698,807	$41,305	$398,320	CIP 1 and CIP 4/5 and CIP 2.1/3 and CIP6 Online
2038	$0	$0	$0	$0	$352,046	$719,772	$42,544	$410,269	CIP 1 and CIP 4/5 and CIP 2.1/3 and CIP6 Online
2039	$461,165	$0	$461,165	$0	$362,608	$741,365	$43,820	$422,577	CIP 1 and CIP 4/5 and CIP 2.1/3 and CIP6 Online
2040	$6,465,000	$0	$6,465,000	$0	$373,486	$763,606	$45,135	$435,255	CIP 1 and CIP 4/5 and CIP 2.1/3 and CIP6 Online

NOTES:

1. Total Lifecycle Cost includes costs that the City will incur over the lifetime of an improvement (typically 20 years). It includes the initial capital cost to build and/or install the improvement plus operations and maintenance cost over the expected lifetime of the improvement. The operations and
2. Distribution of project costs assumes 12 month design phase followed by: A) 12 month construction phase for project less than $10M, and B) 24 month construction phase for project exceeding $10M.
3. The 6-year period (2020 through 2025) is emphasized for the City's capital planning.
4. The NPDES renewal is anticipated to occur in 2024 assuming no delays.

(grey box) Years within the 20-year planning period but not within the 6-year planning period.

(green box) Engineer's recommendation in January 2020. Engineers recommend reassessment of WWTP performance after completion of CIP1 and re-review of regulatory requirements as of 2022.

OPINION OF PROBABLE CONSTRUCTION COST

Client: City of Monroe

Project: Monroe WWTP Capital Improvement Plan — CIP 1 pH and Filament Control

Prepared By: AS
Reviewed By: JH
Date Prepared: 19-Sep-19
Project Number: 1997002*00

Estimate Type:

- ■ **Conceptual**
- ☐ **Preliminary (w/o plans)**
- ☐ **Design Development**
- ☐ **Construction**
- ☐ **Change Order**

Months to Midpoint of Construct 12

Project Element		**1**	**2**	**3**	**4**	**5**	**6**	**Total**
Description of Improvements		**RAS Chlorination Improvements**	**Upgrade Magnesium Hydroxide Feed**	**Install Backup Sodium Hydroxide Feed**	**Baffling of Aeration Basins**	**Surface Wasting System**	**Mixed Liquor Return Optimization**	
Base Cost		$52,563	$103,125	$104,594	$135,350	$157,863	$122,309	**$675,803**
Division 1 Costs @	10%	$5,256	$10,313	$10,459	$13,535	$15,786	$12,231	$67,580
Subtotals		$57,819	$113,438	$115,053	$148,885	$173,649	$134,540	$743,383
Bonds & Insurance @	2.25%	$1,301	$2,552	$2,589	$3,350	$3,907	$3,027	$16,726
Subtotals		$59,120	$115,990	$117,642	$152,235	$177,556	$137,567	$760,110
Contractor OH&P @	15%	$8,868	$17,398	$17,646	$22,835	$26,633	$20,635	$114,016
Subtotals		$67,988	$133,388	$135,288	$175,070	$204,189	$158,203	$874,126
Estimate Contingency @	30.0%	$20,396	$40,016	$40,586	$52,521	$61,257	$47,461	$262,238
Subtotal		$88,384	$173,405	$175,875	$227,591	$265,446	$205,663	$1,136,364
Escalate to Midpt. of Const. Per year @	3.5%	$3,093	$6,069	$6,156	$7,966	$9,291	$7,198	$39,773
Subtotal at Midpt. Of Const.		$91,477	$179,474	$182,030	$235,557	$274,737	$212,862	$1,176,137
Sales Tax	9.3%	$8,507	$16,691	$16,929	$21,907	$25,551	$19,796	$109,381
Estimated Bid Price (Rounded to 1K, 2019 Dollars)		$100,000	$196,000	$199,000	$257,000	$300,000	$233,000	**$1,285,000**
Eng Design + Bid Support + ESDC @	15.0%	$15,000	$29,400	$29,850	$38,550	$45,000	$34,950	$192,750
Construction Mgmt @	10.0%	$10,000	$19,600	$19,900	$25,700	$30,000	$23,300	$128,500
Legal/Admin Costs @	2.0%	$2,000	$3,920	$3,980	$5,140	$6,000	$4,660	$25,700
Owner's Contingency @	10.0%	$10,000	$19,600	$19,900	$25,700	$30,000	$23,300	$128,500
County Permits/Inspections/Agency Revie	1.0%	$1,000	$1,960	$1,990	$2,570	$3,000	$2,330	$12,850
Estimated Project Price (Rounded to 10K, 2020 Dollars)		$140,000	$270,000	$270,000	$350,000	$410,000	$320,000	**$1,760,000**

Escalate to Year: **2021**
Months to Midpoint of Construct **24**

Escalation Table		**1**	**2**	**3**	**4**	**5**	**6**	**Total**
Description of Improvements		**RAS Chlorination Improvements**	**Upgrade Magnesium Hydroxide Feed**	**Install Backup Sodium Hydroxide Feed**	**Aeration Basin Optimization**	**Surface Wasting System**	**Mixed Liquor Return Optimization**	
Subtotal (from table above)		$88,384	$173,405	$175,875	$227,591	$265,446	$205,663	$1,136,364
Escalate to Midpt. of Const. Per year @	3.5%	$6,187	$12,138	$12,311	$15,931	$18,581	$14,396	$79,545
Subtotal at Midpt. Of Const.		$94,571	$185,543	$188,186	$243,523	$284,027	$220,060	$1,215,909
Sales Tax	9.3%	$8,795	$17,256	$17,501	$22,648	$26,415	$20,466	$113,080
Estimated Bid Price (Rounded to 1K)		$103,000	$203,000	$206,000	$266,000	$310,000	$241,000	**$1,329,000**
Eng Design + Bid Support + ESDC @	15.0%	$15,450	$30,450	$30,900	$39,900	$46,500	$36,150	$199,350
Construction Mgmt @	10.0%	$10,300	$20,300	$20,600	$26,600	$31,000	$24,100	$132,900
Legal/Admin Costs @	2.0%	$2,060	$4,060	$4,120	$5,320	$6,200	$4,820	$26,580
Owner's Contingency @	10.0%	$10,300	$20,300	$20,600	$26,600	$31,000	$24,100	$132,900
County Permits/Inspections/Agency Revie	1.0%	$1,030	$2,030	$2,060	$2,660	$3,100	$2,410	$13,290
Estimated Project Price (Rounded to 10K)		$140,000	$280,000	$280,000	$370,000	$430,000	$330,000	**$1,830,000**

OPINION OF PROBABLE CONSTRUCTION COST

Client: City of Monroe

Project: Monroe WWTP Capital Improvement Plan CIP 2 (Phase 1) Conventional Activated Sludge

Prepared By: CB
Reviewed By: TG
Date Prepared: 2-Oct-19
Project Number: 1997002*00

Estimate Type:
- ■ **Conceptual**
- ☐ **Preliminary (w/o plans)**
- ☐ **Design Development**
- ☐ **Construction**
- ☐ **Change Order**

Months to Midpoint of Construct 12

Project Element		1	2	3	Total
Description of Improvements		**Add 3rd Secondary Clarifier**	**Aeration Basin Upgrades**	**Parking Lot Site Preparation, Retaining Wall and FM Relocation**	
Construction Cost		**$1,505,510**	**$1,341,012**	**$360,339**	**$3,206,861**
Division 1 Costs @	10%	$150,551	$134,101	$36,034	$320,686
Subtotal		$1,656,061	$1,475,113	$396,373	$3,527,547
Bonds & Insurance @	2.25%	$37,261	$33,190	$8,918	$79,370
Subtotal		$1,693,322	$1,508,303	$405,292	$3,606,916
Contractor OH&P @	15%	$253,998	$226,245	$60,794	$541,037
Subtotal		$1,947,320	$1,734,548	$466,085	$4,147,954
Estimate Contingency @	30.0%	$584,196	$520,364	$139,826	$1,244,386
Subtotal		$2,531,516	$2,254,913	$605,911	$5,392,340
Escalate to Midpt. of Const. Per Year @	3.5%	$88,603	$78,922	$21,207	$188,732
Subtotal at Midpt. Of Const.		$2,620,119	$2,333,835	$627,118	$5,581,072
Sales Tax @	9.3%	$243,671	$217,047	$58,322	$519,040
Estimated Bid Price (Rounded to 1K)		**$2,864,000**	**$2,551,000**	**$685,000**	**$6,100,000**
Design, Bid Support, ESDC @	15.0%	$429,600	$382,650	$102,750	$915,000
Construction Mgmt @	10.0%	$286,400	$255,100	$68,500	$610,000
Legal/Admin Costs @	2.0%	$57,280	$51,020	$13,700	$122,000
Owner's Contingency @	20.0%	$572,800	$510,200	$137,000	$1,220,000
Permits/Inspections/Review @	1.0%	$28,640	$25,510	$6,850	$61,000
Estimated Project Price (Rounded to 10K, 2019 Dollars)		**$4,240,000**	**$3,780,000**	**$1,010,000**	**$9,030,000**

Escalate to Year: **2027**
Months to Midpoint of Construct **96**

Escalation Table		1	2	3	Total
Description of Improvements		**Add a secondary clarifier**	**Aeration Basin Upgrade**	**Property Acquisition**	
Subtotal (from table above)		$2,531,516	$2,254,913	$605,911	$5,392,340
Escalate to Midpt. of Const. Per Year @	3.5%	$708,825	$631,376	$169,655	$1,509,855
Subtotal at Midpt. Of Const.		$3,240,341	$2,886,288	$775,566	$6,902,195
Sales Tax @	9.3%	$301,352	$268,425	$72,128	$641,904
Estimated Bid Price (Rounded to 1K)		**$3,542,000**	**$3,155,000**	**$848,000**	**$7,545,000**
Design, Bid Support, ESDC @	15.0%	$531,300	$473,250	$127,200	$1,131,750
Construction Mgmt @	10.0%	$354,200	$315,500	$84,800	$754,500
Legal/Admin Costs @	2.0%	$70,840	$63,100	$16,960	$150,900
Owner's Contingency @	20.0%	$708,400	$631,000	$169,600	$1,509,000
Permits/Inspections/Review @	1.0%	$35,420	$31,550	$8,480	$75,450
Estimated Project Price (Rounded to 10K)		**$5,240,000**	**$4,670,000**	**$1,260,000**	**$11,170,000**

OPINION OF PROBABLE CONSTRUCTION COST

Client: City of Monroe
Project: Monroe WWTP Capital Improvement Plan CIP 2 Phase 2 - Conventional Activated Sludge

Prepared By: CB
Reviewed By: TG
Date Prepared: 2-Oct-19
Project Number: 1997002*00

Estimate Type:
- ■ **Conceptual**
- ☐ **Preliminary (w/o plans)**
- ☐ **Design Development**
- ☐ **Construction**
- ☐ **Change Order**

Months to Midpoint of Construct 12

Project Element		1	Total
Description of Improvements		Add 4th Secondary Clarifier	
Construction Cost		$1,471,348	**$1,471,348**
Division 1 Costs @	10%	$147,135	$147,135
Subtotals		$1,618,483	$1,618,483
Bonds & Insurance @	2.25%	$36,416	$36,416
Subtotals		$1,654,899	$1,654,899
Contractor OH&P @	15%	$248,235	$248,235
Subtotals		$1,903,134	$1,903,134
Estimate Contingency @	30.0%	$570,940	$570,940
Subtotal		$2,474,074	$2,474,074
Escalate to Midpt. of Const. Per Year @	3.5%	$86,593	$86,593
Subtotal at Midpt. Of Const.		$2,560,666	$2,560,666
Sales Tax	9.3%	$238,142	$238,142
Estimated Bid Price (Rounded to 1K)		**$2,799,000**	**$2,799,000**
Design, Bid Support, ESDC @	15.0%	$419,850	$419,850
Construction Mgmt @	10.0%	$279,900	$279,900
Legal/Admin Costs @	2.0%	$55,980	$55,980
Owner's Contingency @	20.0%	$559,800	$559,800
Permits/Inspections/Review @	1.0%	$27,990	$27,990
Estimated Project Price (Rounded to 10K, 2019 Dollars)		**$4,140,000**	**$4,140,000**

Escalate to Year: **2040**
Months to Midpoint of Construct **252**

Escalation Table

Escalation Table		1	Total
Description of Improvements		Add 4th Secondary Clarifier	
Subtotal (from table above)		2,474,074	2,474,074
Escalate to Midpt. of Const. Per Year @	3.5%	$1,818,444	$1,818,444
Subtotal at Midpt. Of Const.		$4,292,518	$4,292,518
Sales Tax @	9.3%	$399,204	$399,204
Estimated Bid Price (Rounded to 1K)		**$4,692,000**	**$4,692,000**
Design, Bid Support, ESDC @	15.0%	$703,800	$703,800
Construction Mgmt @	10.0%	$469,200	$469,200
Legal/Admin Costs @	2.0%	$93,840	$93,840
Owner's Contingency @	20.0%	$938,400	$938,400
Permits/Inspections/Review @	1.0%	$46,920	$46,920
Estimated Project Price (Rounded to 10K)		**$6,940,000**	**$6,940,000**

OPINION OF PROBABLE CONSTRUCTION COST

Client: City of Monroe

Project: Monroe WWTP Capital Improvement Plan CIP 3 Sidestream MBR

Prepared By: CB
Reviewed By: TG
Date Prepared: 2-Oct-19
Project Number: 1997002*00

Estimate Type:

- ■ **Conceptual**
- ☐ **Preliminary (w/o plans)**
- ☐ **Design Development**
- ☐ **Construction**
- ☐ **Change Order**

Months to Midpoint of Construct 12

Project Element		1	Total
Description of Improvements		**Sidestream MBR**	
Construction Cost		**$7,116,117**	**$7,116,117**
Division 1 Costs @	10%	$711,612	$711,612
Subtotals		$7,827,728	$7,827,728
Bonds & Insurance @	2.25%	$176,124	$176,124
Subtotals		$8,003,852	$8,003,852
Contractor OH&P @	15%	$1,200,578	$1,200,578
Subtotals		$9,204,430	$9,204,430
Estimate Contingency @	30.0%	$2,761,329	$2,761,329
Subtotal		$11,965,759	$11,965,759
Escalate to Midpt. of Const. Per Year @	3.5%	$418,802	$418,802
Subtotal at Midpt. Of Const.		$12,384,561	$12,384,561
Sales Tax	9.3%	$1,151,764	$1,151,764
Estimated Bid Price (Rounded to 1K)		**$13,536,000**	**$13,536,000**
Design, Bid Support, ESDC @	15.0%	$2,030,400	$2,030,400
Construction Mgmt @	10.0%	$1,353,600	$1,353,600
Legal/Admin Costs @	2.0%	$270,720	$270,720
Owner's Contingency @	20.0%	$2,707,200	$2,707,200
Permits/Inspections/Review @	1.0%	$135,360	$135,360
Estimated Project Price (Rounded to 10K, 2019 Dollars)		**$20,030,000**	**$20,030,000**

Escalate to Year: **2027**
Months to Midpoint of Construct **96**

Escalation Table		1	Total
Description of Improvements		**Sidestream MBR**	
Subtotal from table above		$11,965,759	$11,965,759
Escalate to Midpt. of Const. Per Year @	3.5%	$3,350,413	$418,802
Subtotal at Midpt. Of Const.		$15,316,172	$15,316,172
Sales Tax	9.3%	$1,424,404	$1,424,404
Estimated Bid Price (Rounded to 1K)		**$16,741,000**	**$16,741,000**
Design, Bid Support, ESDC @	15.0%	$2,511,150	$2,511,150
Construction Mgmt @	10.0%	$1,674,100	$1,674,100
Legal/Admin Costs @	2.0%	$334,820	$334,820
Owner's Contingency @	20.0%	$3,348,200	$3,348,200
Permits/Inspections/Review @	1.0%	$167,410	$167,410
Estimated Project Price (Rounded to 10K)		**$24,780,000**	**$24,780,000**

OPINION OF PROBABLE CONSTRUCTION COST

Client: City of Monroe

Project: Monroe WWTP Capital Improvement Plan CIP 4 - Class B Solids Upgrades

Estimate Type:

- [x] **Conceptual**
- [ ] **Preliminary (w/o plans)**
- [ ] **Design Development**
- [ ] **Construction**
- [ ] **Change Order**

Prepared By: AS
Reviewed By: JH
Date Prepared: 1-Oct-19
Project Number: 1997002*00

Months to Midpoint of Construct 12

Project Element		1	2	3	Total
Description of Improvements		**Construct New Digester Next to Primary Clarifiers**	**Install New Screw Press**	**Install New Flow Meters and TSS Meters on PE Sludge Pipe**	
Base Cost		$2,241,346	$1,175,688	$23,438	**$3,440,471**
Division 1 Costs @	10%	$224,135	$117,569	$2,344	$344,047
Subtotals		$2,465,480	$1,293,256	$25,781	$3,784,518
Bonds & Insurance @	2.25%	$55,473	$29,098	$580	$85,152
Subtotals		$2,520,954	$1,322,355	$26,361	$3,869,669
Contractor OH&P @	15%	$378,143	$198,353	$3,954	$580,450
Subtotals		$2,899,097	$1,520,708	$30,316	$4,450,120
Estimate Contingency @	30.0%	$869,729	$456,212	$9,095	$1,335,036
Subtotal		$3,768,826	$1,976,920	$39,410	$5,785,156
Escalate to Midpt. of Const. Pe	3.5%	$131,909	$69,192	$1,379	$202,480
Subtotal at Midpt. Of Const.		$3,900,734	$2,046,112	$40,790	$5,987,636
Sales Tax	9.3%	$362,768	$190,288	$3,793	$556,850
Estimated Bid Price (Rounded to 1K)		$4,264,000	$2,236,000	$45,000	**$6,545,000**
Eng Design + Bid Support + ES	15.0%	$639,600	$335,400	$6,750	$981,750
Construction Mgmt @	10.0%	$426,400	$223,600	$4,500	$654,500
Legal/Admin Costs @	2.0%	$85,280	$44,720	$900	$130,900
Owner's Contingency @	20.0%	$852,800	$447,200	$9,000	$1,309,000
County Permits/Inspections/Ag	1.0%	$42,640	$22,360	$450	$65,450
Estimated Project Price (Rounded to 10K, 2019 Dollars)		$6,310,000	$3,310,000	$70,000	**$9,690,000**

Escalate to Year: **2023**

Months to Midpoint of Construct **48**

Escalation Table		1	2	3	Total
Description of Improvements		**Construct New Digester Next to Primary Clarifiers**	**Install New Screw Press**	**Install New Flow Meters and TSS Meters on PE Sludge Pipe**	
Subtotal from table above		$3,768,826	$1,976,920	$39,410	$5,785,156
Escalate to Midpt. of Const. Pe	3.5%	$527,636	$276,769	$5,517	$809,922
Subtotal at Midpt. Of Const.		$4,296,461	$2,253,689	$44,928	$6,595,078
Sales Tax	9.3%	$399,571	$209,593	$4,178	$613,342
Estimated Bid Price (Rounded to 1K)		**$4,696,000**	**$2,463,000**	**$49,000**	**$7,208,000**
Design, Bid Support, ESDC @	15.0%	$704,400	$369,450	$7,350	$1,081,200
Construction Mgmt @	10.0%	$469,600	$246,300	$4,900	$720,800
Legal/Admin Costs @	2.0%	$93,920	$49,260	$980	$144,160
Owner's Contingency @	20.0%	$939,200	$492,600	$9,800	$1,441,600
Permits/Inspections/Review @	1.0%	$46,960	$24,630	$490	$72,080
Estimated Project Price (Rounded to 10K)		**$6,950,000**	**$3,650,000**	**$70,000**	**$10,670,000**

OPINION OF PROBABLE CONSTRUCTION COST

Client:	City of Monroe	**Prepared By:**	AS
		Reviewed By:	JH
Project:	Monroe WWTP Capital Improvement Plan - CIP 5: Class A Solids Upgrades	**Date Prepared:**	1-Oct-19
		Project Number:	1997002*00

Estimate Type:

- [x] **Conceptual**
- [ ] **Preliminary (w/o plans)**
- [ ] **Design Development**
- [ ] **Construction**
- [ ] **Change Order**

Months to Midpoint of Construct 12

Project Element		**1**	**2**	**3**	**Total**
Description of Improvements		**Class A Sludge Dryer**	**Install New Screw Press**	**Install New Flow Meters and TSS Meters on PE Sludge Pipe**	
Construction Cost		**$4,277,558**	**$1,175,688**	**$23,438**	**$5,476,683**
Division 1 Costs @	10%	$427,756	$117,569	$2,344	$547,668
Subtotals		$4,705,314	$1,293,256	$25,781	$6,024,352
Bonds & Insurance @	2.25%	$105,870	$29,098	$580	$135,548
Subtotals		$4,811,184	$1,322,355	$26,361	$6,159,900
Contractor OH&P @	15%	$721,678	$198,353	$3,954	$923,985
Subtotals		$5,532,861	$1,520,708	$30,316	$7,083,885
Estimate Contingency @	30.0%	$1,659,858	$456,212	$9,095	$2,125,165
Subtotal		$7,192,720	$1,976,920	$39,410	$9,209,050
Escalate to Midpt. of Const. Per year @	3.5%	$251,745	$69,192	$1,379	$322,317
Subtotal at Midpt. Of Const.		$7,444,465	$2,046,112	$40,790	$9,531,367
Sales Tax	9.3%	$692,335	$190,288	$3,793	$886,417
Estimated Bid Price (Rounded to 1K)		**$8,137,000**	**$2,236,000**	**$45,000**	**$10,418,000**
Eng Design + Bid Support + ESDC @	15.0%	$1,220,550	$335,400	$6,750	$1,562,700
Construction Mgmt @	10.0%	$813,700	$223,600	$4,500	$1,041,800
Legal/Admin Costs @	2.0%	$162,740	$44,720	$900	$208,360
Owner's Contingency @	20.0%	$1,627,400	$447,200	$9,000	$2,083,600
County Permits/Inspections/Agency Review/O	1.0%	$81,370	$22,360	$450	$104,180
Estimated Project Price (Rounded to 10K, 2019 Dollars)		**$12,040,000**	**$3,310,000**	**$70,000**	**$15,420,000**

Escalate to Year: **2023**
Months to Midpoint of Construct **48**

Escalation Table		**1**	**2**	**3**	**Total**
Description of Improvements		**Class A Sludge Dryer**	**Install New Screw Press**	**Install New Flow Meters and TSS Meters on PE Sludge Pipe**	
Subtotal from table above		$7,192,720	$1,976,920	$39,410	$9,209,050
Escalate to Midpt. of Const. Per Year @	3.5%	$1,006,981	$276,769	$5,517	$1,289,267
Subtotal at Midpt. Of Const.		$8,199,700	$2,253,689	$44,928	$10,498,317
Sales Tax	9.3%	$762,572	$209,593	$4,178	$976,343
Estimated Bid Price (Rounded to 1K)		**$8,962,000**	**$2,463,000**	**$49,000**	**$11,475,000**
Design, Bid Support, ESDC @	15.0%	$1,344,300	$369,450	$7,350	$1,721,250
Construction Mgmt @	10.0%	$896,200	$246,300	$4,900	$1,147,500
Legal/Admin Costs @	2.0%	$179,240	$49,260	$980	$229,500
Owner's Contingency @	20.0%	$1,792,400	$492,600	$9,800	$2,295,000
Permits/Inspections/Review @	1.0%	$89,620	$24,630	$490	$114,750
Estimated Project Price (Rounded to 10K)		**$13,260,000**	**$3,650,000**	**$70,000**	**$16,980,000**

OPINION OF PROBABLE CONSTRUCTION COST

Client: City of Monroe

Project: Monroe WWTP Capital Improvement Plan CIP 6 - Plantwide Pump and UV System Upgrades

Prepared By: CB
Reviewed By: TG
Date Prepared: 2-Oct-19
Project Number: 1997002*00

Estimate Type:
- [x] Conceptual
- [ ] Preliminary (w/o plans)
- [ ] Design Development
- [ ] Construction
- [ ] Change Order

Months to Midpoint of Construct 12

Project Element		1	2	3	4	Total
Description of Improvements		**Upgrade Effluent Pumps**	**3W System Upgrades**	**Upgrade Influent Pumps**	**UV System Upgrade**	
Construction Cost		**$293,478**	**$165,272**	**$227,214**	**$1,138,066**	**$1,824,030**
Division 1 Costs @	10%	$29,348	$16,527	$22,721	$113,807	$1,824,030
Subtotals		$322,826	$181,799	$249,936	$1,251,873	$2,006,433
Bonds & Insurance @	2.25%	$7,264	$4,090	$5,624	$28,167	$45,145
Subtotals		$330,090	$185,889	$255,559	$1,280,040	$2,051,578
Contractor OH&P @	15%	$49,513.45	$27,883.37	$38,333.87	$192,006.01	$307,736.71
Subtotals		$379,603	$213,773	$293,893	$1,472,046	$2,359,315
Estimate Contingency @	30.0%	$113,881	$64,132	$88,168	$441,614	$707,794
Subtotal		$493,484	$277,904	$382,061	$1,913,660	$3,067,109
Escalate to Midpt. of Const. Per Year @	3.5%	$17,272	$9,727	$13,372	$66,978	$107,349
Subtotal at Midpt. Of Const.		$510,756	$287,631	$395,433	$1,980,638	$3,174,458
Sales Tax	9.3%	$47,500	$26,750	$36,775	$184,199	$295,225
Estimated Bid Price (Rounded to 1K)		**$558,000**	**$314,000**	**$432,000**	**$2,165,000**	**$3,469,000**
Design, Bid Support, ESDC @	15.0%	$83,700	$47,100	$64,800	$324,750	$520,350
Construction Mgmt @	10.0%	$55,800	$31,400	$43,200	$216,500	$346,900
Legal/Admin Costs @	2.0%	$11,160	$6,280	$8,640	$43,300	$69,380
Owner's Contingency @	20.0%	$111,600	$62,800	$86,400	$433,000	$693,800
Permits/Inspections/Review @	1.0%	$5,580	$3,140	$4,320	$21,650	$34,690
Estimated Project Price (Rounded to 10K, 2019 Dollars)		**$830,000**	**$460,000**	**$640,000**	**$3,200,000**	**$5,130,000**

Escalate to Year: **2029**
Months to Midpoint of Construct **120**

Escalation Table		1	2	3	4	Total
Description of Improvements		**Upgrade Effluent Pumps**	**3W System Upgrades**	**Upgrade Influent Pumps**	**UV System Upgrade**	
Subtotal from table above		$493,484	$277,904	$382,061	$1,913,660	$3,067,109
Escalate to Midpt. of Const. Per Year @	3.5%	$172,719	$97,267	$133,721	$669,781	$1,073,488
Subtotal at Midpt. Of Const.		$666,203	$375,171	$515,782	$2,583,441	$4,140,597
Sales Tax @	9.3%	$61,957	$34,891	$47,968	$240,260	$385,076
Estimated Bid Price (Rounded to 1K)		**$728,000**	**$410,000**	**$564,000**	**$2,824,000**	**$4,526,000**
Design, Bid Support, ESDC @	15.0%	$109,200	$61,500	$84,600	$423,600	$678,900
Construction Mgmt @	10.0%	$72,800	$41,000	$56,400	$282,400	$452,600
Legal/Admin Costs @	2.0%	$14,560	$8,200	$11,280	$56,480	$90,520
Owner's Contingency @	20.0%	$145,600	$82,000	$112,800	$564,800	$905,200
Permits/Inspections/Review @	1.0%	$7,280	$4,100	$5,640	$28,240	$45,260
Estimated Project Price (Rounded to 10K)		**$1,080,000**	**$610,000**	**$830,000**	**$4,180,000**	**$6,700,000**