Appendix H: PSIC Memorandum

Kennedy Jenks
32001 32nd Avenue South, Suite 300
Federal Way, WA 98001
(253) 835-6400

Bremerton Puget Sound Industrial Center (PSIC) Feasibility Study

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Prepared for

City of Bremerton
345 6th Street
Bremerton, WA 98337

KJ Project No. 2397011*00

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Frequently Used Acronyms and Abbreviations

AWWA	American Water Works Association
AACE	Association for the Advancement of Cost Engineering
AAF	Average Annual Flow
AAL	Average Annual Loading
ADWF	Average Dry Weather Flow
AWWF	Average Wet Weather Flow
BOD	Biochemical Oxygen Demand
DOE	Department of Ecology
I/I	Inflow and Infiltration
MBR	Membrane Bioreactor
MGD	Million Gallons Per Day
MIC	Manufacturing Industrial Center
MM WWF	Maximum Month Wet Weather Flow
MML	Maximum Month Loading
O&M	Operations & Maintenance
OPCC	Opinion of Probably Construction Cost Estimate
PD WWF	Peak Daily Wet Weather Flow
PDL	Peak Daily Loading
PHF	Peak Hourly Flow
PPD	Pounds Per Day
PSIC	Puget Sound Industrial Center
ROW	Right-Of-Way
TSS	Total Suspended Solids
UV	Ultraviolet
WAC	Washington Administrative Code
WSDOT	Washington Department of Transportation

Section 1: Executive Summary

1.1 Executive Summary

The Puget Sound Industrial Center (PSIC) located in Bremerton, WA has long been identified as having potential for major commercial growth. Kitsap County Traffic Analysis Zone files have forecasted that the employment population in this area will increase from approximately 833 people in 2020 to more than 10,000 people in 2044. The City of Bremerton has retained Kennedy Jenks to develop conceptual alternatives for infrastructure that can feasibly accommodate the projected population growth over the planning horizon.

The Port of Bremerton (Port) currently owns and operates an existing large on-site septic system that currently serves the Olympic View Industrial Park and the Bremerton National Airport. The collection and treatment systems at the Port are currently managed by Port staff, however, the City has considered taking on service of flows generated by Port as it plans for servicing future expansion in the PSIC area.

Several options for increasing the PSIC collection system and treatment capacity were identified as part of this study. This included combinations of a new MBR treatment system and new pump stations. Benefits and drawbacks as well as risks and opportunities for these options were identified in this report. The alternatives that were developed are as follows:

- Alternative 1 – South PSIC flows are conveyed directed to Mason County via construction of a new pump station, and to a new MBR system via an additional pump station after threshold flows to Mason County are reached. North PSIC Flows will be directed to the MBR system as well. Treated effluent from the MBR system can be discharged as reclaimed water to Gold Mountain Golf Club or other receiving destination.

- Alternative 2 –South PSIC flows are conveyed via a new pump station to a new MBR system. The new MBR system sized for both North and South PSIC flows. Discharge as reclaimed water to Gold Mountain Golf Club or other receiving destination. There is No agreement with Mason County to send flows to their infrastructure.

- Alternative 3 – South PSIC flows are directed to Mason County via new pump station. An additional South PSIC pump station, or an expansion of the pump station conveying to Mason County, conveys flow to a new pump station serving North PSIC, located near the Port. The North PSIC pump station, sized for flows at full PSIC buildout, conveys to the City's existing Westside Wastewater Treatment Plant via connection to the Gorst basin. A phased approach can be considered to send flows to Mason County until flow limit is reached, with connection between South PSIC and North PSIC unnecessary until the agreement flow threshold is reached.

Several MBR effluent discharge considerations were also discussed in this report and included discharging to Gold Mountain Golf Club as reclaimed water and utilizing the existing drain fields, provided there is capacity to do so.

Evaluations were conducted for each alternative relative to several criteria, developed and weighted in collaboration with City engineering and operations staff. The criteria included cost, operation & maintenance (O&M), beneficial reuse, agency coordination, and permitting. The results of the evaluation scoring are presented in Table 1-1.

Table 1-1 Alternatives Scoring Matrix

	Alternative 1		Alternative 2		Alternative 3	
	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted
Cost (30%)	1	0.3	1	0.3	2	0.6
O&M (25%)	1	0.25	1	0.25	3	0.75
Beneficial Reuse (20%)	2	0.4	2	0.4	0	0
Agency Coordination (10%)	1	0.1	1	0.1	2	0.2
Permitting (15%)	2	0.3	1	0.15	2	0.3
Totals (100%)	**8**	**1.35**	**6**	**1.2**	**9**	**1.85**

The projected costs for each alternative are presented below in Table 1-2:

Table 1-2 Alternative Project Construction Costs

Estimated Total Project Capital Cost & Range		
Alternative 1	**Alternative 2**	**Alternative 3**
$78M	$85M	$62M
$55M to $118M	$59M to $127M	$43M to $93M

The results of the alternatives evaluation have shown that Alternative 3 scored the highest. A feasible phasing implementation plan is summarized below:

Phase 1

- City enters interagency agreement with Mason County to send up to 160,000 gpd of flow from South PSIC to their infrastructure.
- City begins design for constructing a new pump station in South PSIC that is capable of processing interagency agreement flows at a minimum. Applicable pump station

infrastructure would be sized for future capacity upgrades to accommodate more flow at full buildout of South PSIC per Phase 3.

Phase 2

- City begins design for constructing a new pump station in North PSIC that is capable of processing full buildout flows. The North PSIC pump station conveys to the City's existing collection system via connection to the Gorst basin.

Phase 3

- City begins developing plans for connecting the newly constructed North and South PSIC pump stations once a specific flow capacity threshold is reached.

Table 1-3 below shows a complete breakdown of project construction costs of the recommended phased approach for Alternative 3 as described within this report.

Table 1-3 Alternative 3 Phased Project Construction Costs

Estimated Project Construction Cost & Range		
Phase 1	**Phase 2**	**Phase 3**
$11M	$28M	$23M
$8M to $17M	$19M to $41M	$16M to $35M

Several risks and unknowns are associated with the implementation of Alternative 3, including sewage age concerns at the early onset of development, and the increased nutrient loading at the City's Westside Wastewater Treatment Plant. Ultimately, the phased approach gives the City a feasible framework for actionable development of the PSIC area.

Section 2: Project Background

2.1 Project Purpose and Understanding

The Puget Sound Industrial Center (PSIC) located in Bremerton, WA contains approximately 3,700 acres of property planned for future industrial development and usage. The City of Bremerton (City) recognizes this area as a major hub for future employment. The City has allocated the proposed increase in PSIC employment in the 2024 City Services Comprehensive Plan. The Port of Bremerton (Port) currently owns and operates an existing large on-site septic system (LOSS) that currently serves the Olympic View Industrial Park and the Bremerton National Airport. The LOSS utilizes lagoons for treatment and discharges to a large drain field. The collection and treatment systems at the Port are currently managed by Port staff, however, the City has considered taking on service of wastewater generated by the Port as it plans for servicing the expansion of the PSIC area. The City maintains an interest to treat the new effluent to Class A reclaimed water standards, and investigate the potential for beneficially reusing the Class A reclaimed water.

A previous evaluation was conducted by Richwine Environmental in December 2023 that recommended implementing a two-phase approach to increase the treatment capacity serving the Port. The first phase included increasing the hydraulic loading rate on the existing drain field soils and the second phase included constructing a new treatment facility featuring a MBR as the primary treatment component.

The purpose of this study is to build off previous evaluations and provide several options and alternatives for establishing treatment capacity to service the projected industrial development in the PSIC area with respect to the goals of the City. This feasibility study includes the following major components:

- Development of flows and loads for the 20-year planning period.
- Development of preliminary site plans for the evaluated options, including conveyance to deliver reclaimed water to the Gold Mountain Golf Club.
- Development of an Association for the Advancement of Cost Engineering (AACE) Class 5 Opinion of Probable Construction Cost (OPCC) for all evaluated alternatives discussed within this report.
- Alternatives analysis, including criteria development, weighting, and alternative evaluation.
- Preliminary phasing and implementation plan for the recommended alternative.

2.2 Project Location

The PSIC area is defined as the area in purple in Figure 2-1. This area was identified by the Puget Sound Regional Council (PSRC) as a Manufacturing and Industrial Center (MIC) and is

deemed an important area for future employment and economic growth. The unincorporated community of Gorst is located to the northeast of the PSIC area while Mason County borders the PSIC area to the southwest of the boundary. State Route 3 (Highway 3) runs through this area and there is a railway bordering the west side of PSIC. Figure 2-1 below shows the PSIC area in relation to surrounding City sewer basins in Southwest Bremerton to the Northeast, and Mason County to the Southwest of the PSIC area.

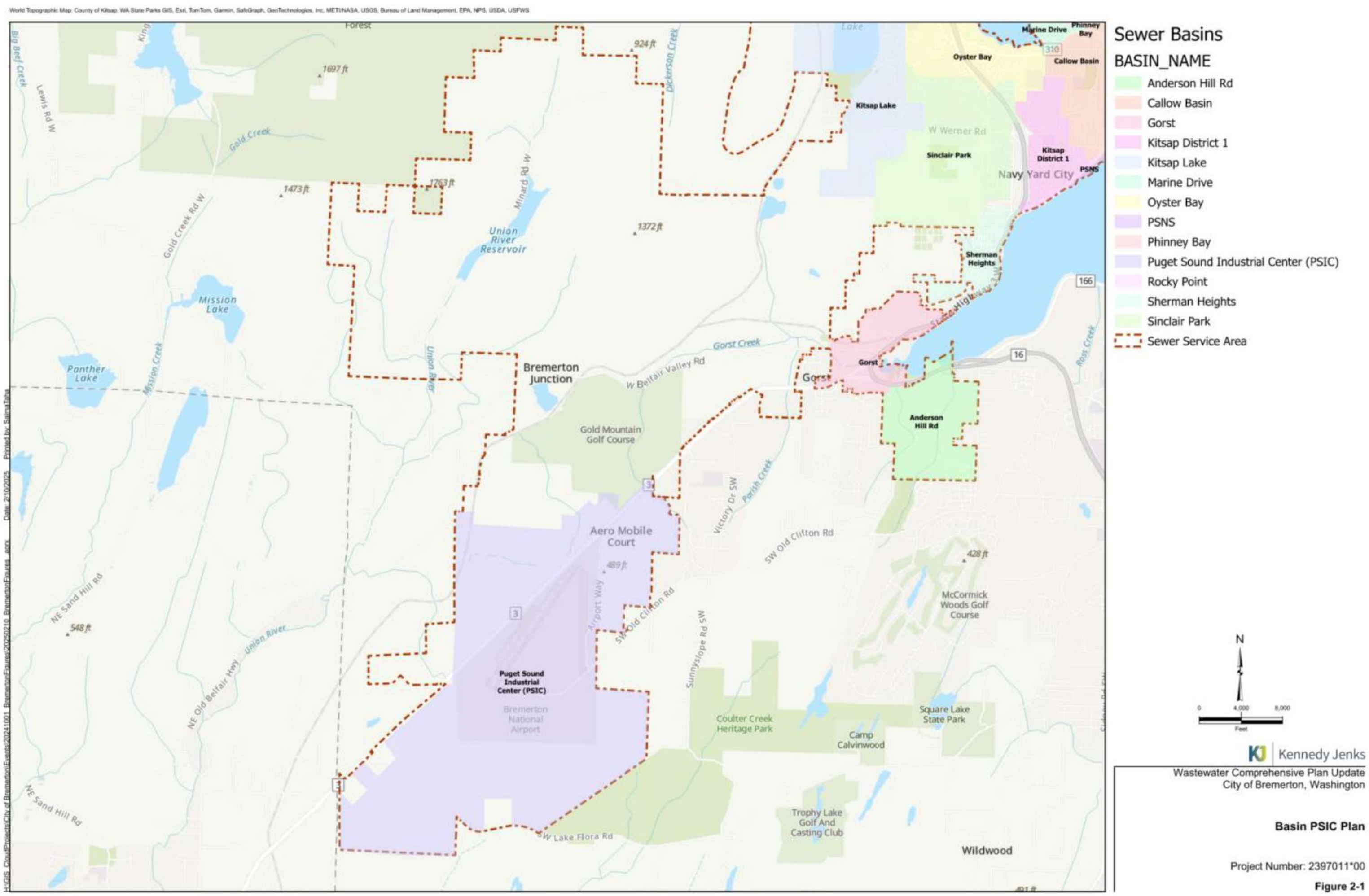

Figure 2-1 City of Bremerton Basin Map

2.3 Existing Information Review

The existing LOSS treatment system is comprised of aeration ponds and polishing ponds, and discharges to two existing drain fields. This system was originally installed as two systems that could be operated either in parallel or in series. The first system, installed in 1973, consists of an aeration pond, an influent pump station, polishing pond, dosing station, and a drain field. The second system was installed in 1987 and is composed of an aeration pond, polishing pond, effluent pump station, and a drain field.

Projected influent flows and loads were calculated based on current and future population projections for the PSIC area per county-provided Traffic Analysis Zone (TAZ) data. The population growth estimates as well as assumed water and sewer consumption for this area were provided by the City of Bremerton and summarized in the 2014 Wastewater Comprehensive Plan Update Report (HDR, 2014). The PSIC area is currently zoned as a MIC, and corresponding projected population increases in this area are all categorized as employment only. The annual population growth rate was calculated based on existing sewer flows for PSIC taken from the 2014 report to determine existing population, and from County-provided growth estimates (2044 TAZ data for Bremerton). For the purposes of estimation, the growth was considered linear across the planning horizon. Once the projected population values for the PSIC area were calculated, the projected flows and loads were then estimated by multiplying the future PSIC population by a standard sewer generation rate per Department of Ecology (DOE) Orange Book guidelines and design criteria. A summary of these inputs for calculating the projected flows and loads is below in Table 2-1.

Table 2-1 Inputs for Flow and Load Projections

Parameter	Units	Value
PSIC Population (Employment, 2020)	people	833
PSIC Population (Employment, 2044)	people	10,476
Annual Population Growth Rate for PSIC	%	11.1
Annual Population (Employment) Growth for PSIC	people/ year	402
Sewer Generation (Employment, per 8-hour shift)	gpdc	35
Sewer Generation (Employment) (TSS+BOD)	ppdc	0.04
Sewer Generation Growth for PSIC	gpd/y	14,063

Applying the Orange Book sewer generation flow rate to the 2044 PSIC population yielded the design average dry weather flow (ADWF) criterion. A peaking factor based on 2018-2023 Westside Wastewater Treatment Plant influent data was applied to yield average annual flow (AAF). For newly constructed sewer infrastructure, the Orange Book recommends implementing an empirical data-based ratio of peak hourly flow (PHF) to design average annual flow to determine peak hourly flow. For the projected PSIC population served in 2044, a peaking factor of 3.0 was applied to the average annual flow to obtain the peak hourly flow. According to the

Orange Book, this peaking factor does account for infiltration and inflow (I/I) associated with the new sewer infrastructure. To obtain other design criteria necessary for the analyses herein, peaking factors based on 2018-2023 Westside Wastewater Treatment Plant data were applied to the average annual flow. A summary of the peaking factors and flow and loads design criteria are presented in Tables 2-2 and 2-3, respectively.

Table 2-2 Peaking Factors

ADWF/AAF	MM WWF/AAF	PHF/AAF
0.77	2.1	3.0

Table 2-3 Design Criteria

ADWF (MGD)	AAF (MGD)	MM WWF (MGD)	PHF (MGD)
0.4	0.5	1.0	1.4

BOD (ppd)			TSS (ppd)	
AAL	MML	PDL	AAL	MML
442	600	915	443	600

2.4 Regulatory Requirements

The existing LOSS treatment system currently treats to Treatment Level C as prescribed by the discharge permit issued by the Washington Department of Health. These requirements are defined in Washington Administrative Code (WAC) 246-272B-06250 and summarized in Table 2-4 below.

Table 2-4 WAC 246-272B-06250 - Treatment Level C

	Effluent Parameters					
Treatment Level	CBOD5	TSS	O&G	FC	TN	P
C	25 mg/L	30 mg/L	-	-	-	-

Treating to Class A reclaimed water standards was considered in this study where possible for the purpose of providing a source of beneficial reuse for the City. Performance standards for Class A reclaimed water are defined in WAC 173-219-330 and are summarized in Table 2-5.

Table 2-5 Class A Reclaimed Water Performance Standards

Parameter	Class A Reclaimed Water	
Coagulation/Filtration		
Turbidity	Monthly Average	Sample Maximum
	2 NTU	5 NTU
Membrane Filtration		
Turbidity	Monthly Average	Sample Maximum
	0.2 NTU	0.5 NTU
Disinfection		
Total Coliform	7-day Median	Sample Maximum
	2.2 MPN/100 mL or CFU/100 mL	23 MPN/mL or CFU/mL
Virus Removal	Refer to WAC 173-219-340 requirements	
Denitrification		
Total Nitrogen	Monthly Average	Weekly Average
	10 mg/L	15 mg/L

Section 3: Alternatives Analysis

3.1 Introduction

This section focuses on presenting two primary options and the three alternatives that leveraged combinations of the building block options to meet the City's goals in providing wastewater service to the PSIC area, as well as providing a comprehensive comparison between these options. Three alternatives of the options were developed with two alternatives including a new MBR treatment system and one alternative including a new pump station/conveyance option. The MBR treatment system intends to provide for increased flows from the North PSIC and South PSIC areas and treat to Class A reclaimed water for beneficial reuse, while the new pump station option intends to focus the increased flows to existing or new conveyance away from the site. Several configurations of these alternatives are discussed in Section 3.4. Preliminary layouts are presented, and a high-level cost comparison will also be discussed. The calculated influent flows and loads generated for this evaluation per Table 2-3 Design CriteriaTable 2-3 were leveraged for preliminary sizing of the alternatives.

3.2 Membrane Bioreactor (MBR) Treatment System

The MBR treatment system option is leveraged in two of the three alternatives and is anticipated to be installed within the boundary of the secondary drain field for the existing LOSS treatment system at the Port. This system is expected to include fine screening, primary treatment, and effluent disinfection, as well as all required appurtenances, as part of the package. The MBR supplier will be responsible for providing this service and to ensure that the new system will meet the effluent requirements dictated by the discharge permit. The MBR supplier will also provide support for biological verification for treatment down to the specified effluent requirements. The MBR system will be capable of meeting Class A reclaimed water standards for beneficial reuse purposes.

3.2.1 Description, Sizing, and Location

A membrane bioreactor is a component of a treatment process that combines a conventional activated sludge process, which separates sludge between solids and liquids through clarification, with a microfiltration process using microporous membranes. MBR systems allow for a high biomass concentration to be maintained, therefore operating at a higher volumetric loading rate compared to a more conventional process. This allows for lower hydraulic retention times and smaller bioreactors and less overall space requirements. The effluent from MBR systems typically contains low concentrations of bacteria, TSS, BOD, and phosphorus, which facilitates high-level disinfection. MBR systems do, however, require a constant, minimum water level for normal operation which is generally achieved by constructing equalization basins. A typical MBR process includes the use of screening for influent flow, equalization basins, anoxic basins, pre-aeration and aerobic basins, membrane basins, and then discharging out of the system. Effluent disinfection in the form of ultraviolet (UV) type is common depending on desired effluent concentrations. The need for solids handling is another component of a typical MBR treatment process to further refine process solids for final disposal. This could be in the

form of a dewatering and aerobic digestion system that can dispense solids as Class B biosolids for land application purposes.

The MBR system will be sized according to the flows and loads described in Table 2-3 as well as from the effluent quality objectives for beneficial reuse. This information was submitted to a selected MBR manufacturer to determine preliminary sizing, treatment system components, and cost. Once the project progresses through to design and a manufacturer is selected for further assistance, the overall MBR system design can be refined for more precise layout configurations and actual treatment system performance. For this study, only preliminary design information from an MBR manufacturer was considered.

The MBR system is anticipated to be installed where the existing lagoon treatment system is located. Figure 3-2 depicts the approximate location of this system on Port property. The MBR system will need process buildings to house mechanical and electrical equipment necessary for routine operation. These buildings can be built with the expansion into the PSIC area in mind. The existing drain fields are also anticipated to be reused, provided the MBR system treats the incoming wastewater to the necessary permitted levels. Reclaimed water can also be discharged to the nearby Gold Mountain Golf Club, as discussed in Section 3.4.3.

3.2.2 Operations and Maintenance

The O&M requirements for a typical MBR system configuration includes several activities in the form of routine inspections of all active equipment, taking samples to ensure adequate treatment activity, annual cleaning, and replacement of parts when needed. Consistent sampling and monitoring of the biological process basins are especially important due to providing confirmation that the treatment is working as intended. The membranes themselves will also need to be replaced on an infrequent basis and is highly dependent on the type of membrane selected and the overall quality of the incoming water that is treated. O&M activities for MBR systems will require one or two onsite personnel several days a week to ensure proper function and operation. Depending on the solids handling performance and needs of the system, the solids holding tanks will need to be emptied on an infrequent basis.

3.2.3 Benefits and Drawbacks

A list of benefits and drawbacks were developed for this option.

Table 3-1 Benefits and Drawbacks – MBR Treatment System

Package MBR System	
Benefits	Drawbacks
• High treatment capabilities to provide reclaimed water for beneficial reuse opportunities and for future contaminants of emerging concern. • Remote monitoring capabilities. • Reduces cost for disposal compared to sending to separate or offsite treatment system. • Does not require additional force main to existing collection system. • Reduced overall footprint.	• Moderate complexity of operation; requires dedicated operators on a regular basis. • Requires higher level of operator certification for normal operation. • High capital and operating energy costs. • Minimum flows required for initial startup. • Sewage age could impede initial performance of treatment system.

3.3 New Pump Station

Pump stations are leveraged as part of all three proposed alternatives to varying degrees. These pumps will be sized according to employment projections in the PSIC industrial area and will convey influent sewage to new or existing infrastructure depending on the defined alternative. Additional pump stations may be required in the future to accommodate more sewage connections as the PSIC area develops.

3.3.1 Description, Sizing, and Location

A pump station is an engineered pumping system that is designed to collect and transport wastewater from a low to high elevation. The collection system of a pumping station generally receives incoming wastewater by gravity from nearby wastewater sources and collects the influent water in a large underground pit or wet well. The pump station will be outfitted with submersible or dry-pit pumps, various electrical and mechanical equipment, and instrumentation that can monitor and control the pump station.

The pumps are generally sized for flow anticipated for a predetermined area. In this study, the flow is represented by the peak flow anticipated for the PSIC industrial area in 20 years. The assumed design peak flow is 1.4 MGD. It should be noted that early phase design flows will be a fraction of this peak flow value, but the full buildout system will be forward compatible for this peak flow rate. During normal operation, only one pump will operate at a time until a specified flow rate is reached. Then, additional pumps may be required to operate increased flow. For this study, it is assumed that two pumps will be installed per pump station for redundancy. The

number of pump stations will be determined by the implementation approach and is assumed to be a total of two pump stations; one installed in South PSIC and one installed in North PSIC.

Several pump stations are anticipated to be installed along the specified route depending on the elevation differentials. As mentioned, pump stations are designed to transport the flow of wastewater from a low point to a high point where it then transitions to gravity before discharging into the next flow structure. The elevation profiles along the predetermined route will determine the number of pump stations required as well as how deep the conveyance lines will need to be.

3.3.2 Operations and Maintenance

Operation and maintenance (O&M) requirements for pump stations typically include routine visual and performative inspections and general maintenance. The City currently owns and operates dozens of pump stations of varying capacities so the O&M requirements will be very similar to what is currently being done. Visual inspections should be done on a regular basis to ensure there are no physical deficiencies, periodic maintenance is addressed, and that the pumping systems are functioning properly.

3.3.3 Benefits and Drawbacks

A list of benefits and drawbacks were developed for this option.

Table 3-2 Benefits and Drawbacks – Pump Stations

Pump Station	
Benefits	Drawbacks
• Routine O&M does not require additional training or certifications. • Minimal staffing increase. • Can provide for present and future capacity considerations. • Low energy consumption. • Remote monitoring capabilities.	• Requires extensive excavation and construction dewatering requirements. • No treatment capabilities to provide reclaimed water. • Odors and sewage age a concern early in PSIC development. • Requires additional O&M for current operators for each pump station added.

3.4 Alternative Scenarios

3.4.1 Alternative 1 – Centralized MBR with Mason County Agreement

Alternative 1 involves the installation of two new pump stations in the South PSIC area. One will convey flows directly to a predetermined tie-in point with Mason County infrastructure on the county line and the other will convey flows to a new MBR treatment system near the Port to the North. The new MBR treatment system would be installed in the North PSIC area, where the existing lagoon treatment system is currently located, to process and treat future flows accumulated in the North and South PSIC areas. This alternative is contingent upon an

agreement with Mason County being able to accept the future flows produced by the South PSIC developments, for which negotiations are currently underway. The South PSIC pump station routed to Mason County would be funded by others. Should Mason County accept a portion of the future flows, a phased approach for this alternative can be considered. It should be noted that this alternative is infeasible should Mason County not enter into an agreement.

Highway 3 is considered a limited access right-of-way (ROW) and Washington State Department of Transportation (WSDOT) does not allow utilities to be installed unless all other options are expended. Further conversations with WSDOT should be had if conveyance along Highway 3 is considered. Figure 3-1 below depicts a preliminary plan view of this alternative. If the Port does not allow the installation of a new MBR system on Port property, alternative locations on City property may be considered. Figure 3-1 below shows an approximate footprint of a new MBR treatment plant sized for the projected flows and loads. The new MBR plant is assumed to include anoxic, pre-aeration, and membrane basins, pumps, blowers, and instrumentation necessary for complete operation. Headworks, in the form of fine screens, equalization tanks, sludge holding tanks, and effluent holding tanks also need to be considered for normal operation and proper effluent disposal. Ancillary needs such as a process and operations building to house the system should also be considered with respect to system layout.

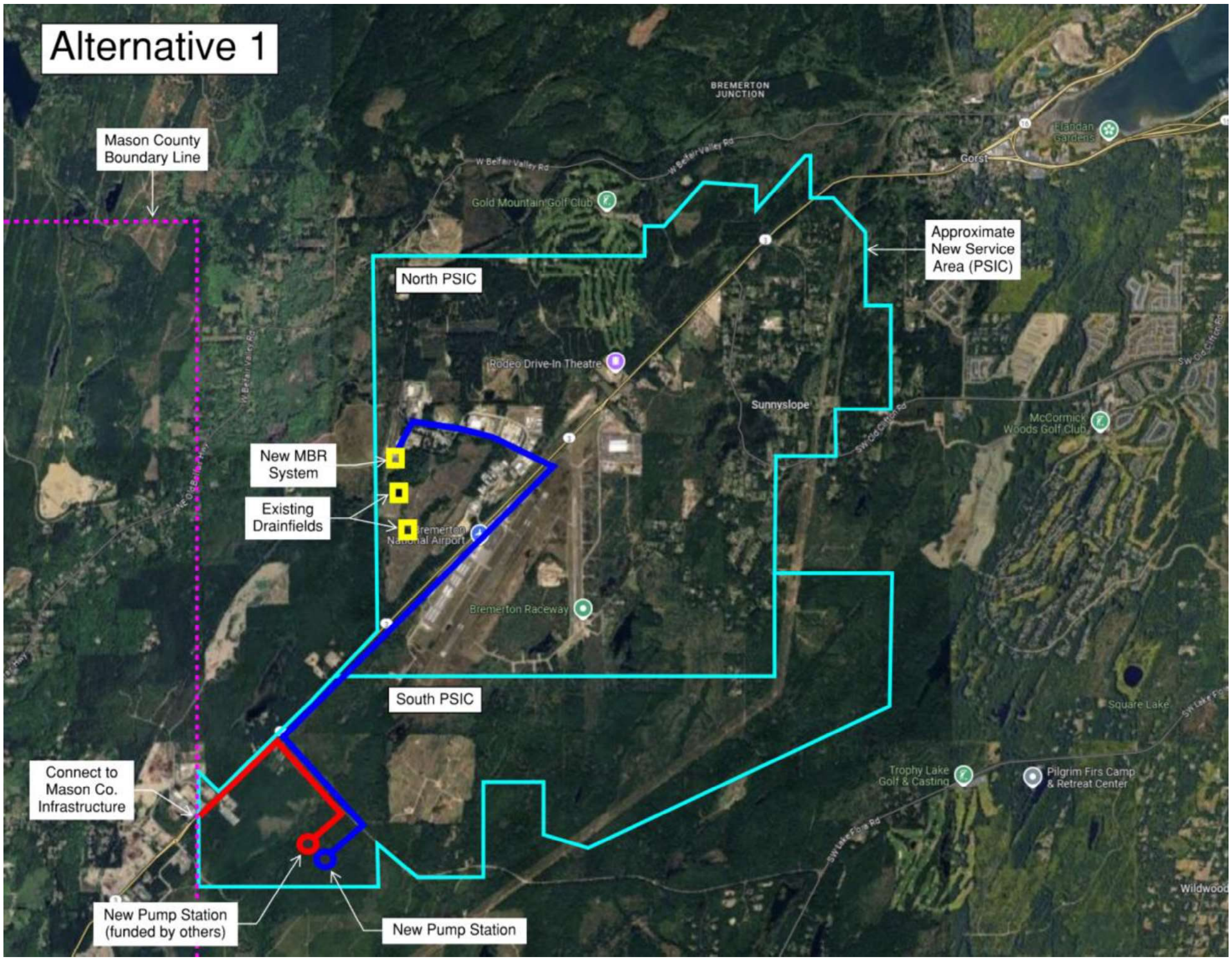

Figure 3-1 Alternative 1 Conceptual Plan

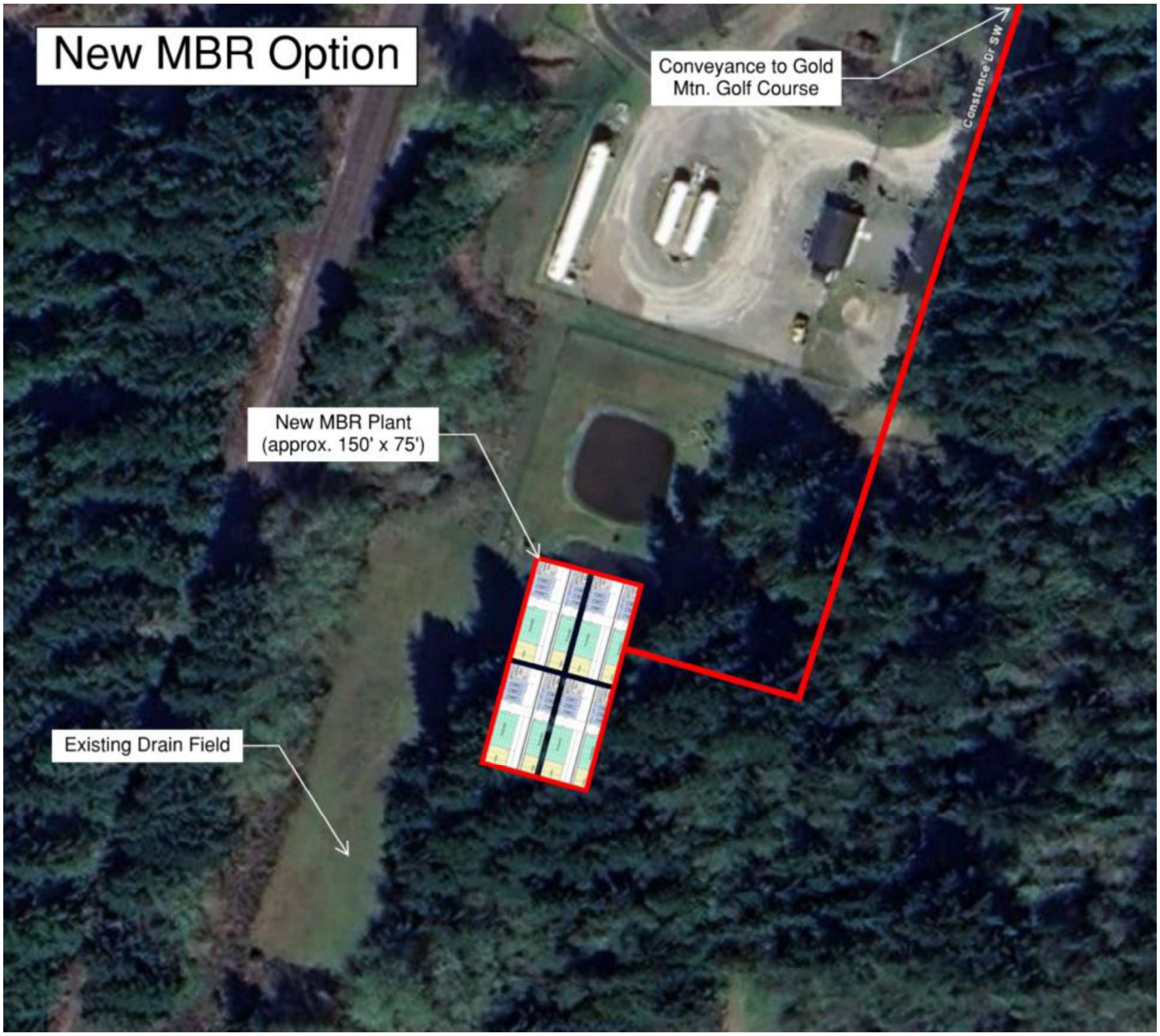

Figure 3-2 MBR Treatment System Conceptual Layout

3.4.2 Alternative 2 – Centralized MBR without Mason County Agreement

Alternative 2 is similar to alternative 1, except that it considers the proposed agreement with Mason County not coming to fruition. The installation of a new pump station in the South PSIC area which will convey future flows in this area to a newly installed MBR treatment system in the North PSIC area, similar to Alternative 1. This MBR system will be sized to accommodate all future flows in the entire PSIC basin and will convey discharge flows to either the Gold Mountain Golf Club for beneficial reuse or another location as discussed in Section 3.4.3. The beneficial reuse capability of MBR effluent is contingent upon the MBR system treating flows to reclaimed water standards and the golf course being able to accommodate these flows for storage. Figure

3-2 depicts the approximate footprint for a new MBR system on the existing lagoon treatment system site. Figure 3-3 below depicts a preliminary plan view of this alternative. Highway 3 is considered a limited access ROW and WSDOT does not allow utilities to be installed unless all other options are expended. Further conversations with WSDOT should be had if conveyance along Highway 3 is considered. And since there is a possibility that the Port may not allow the installation of a new MBR system on their property, alternative locations on City property should be considered.

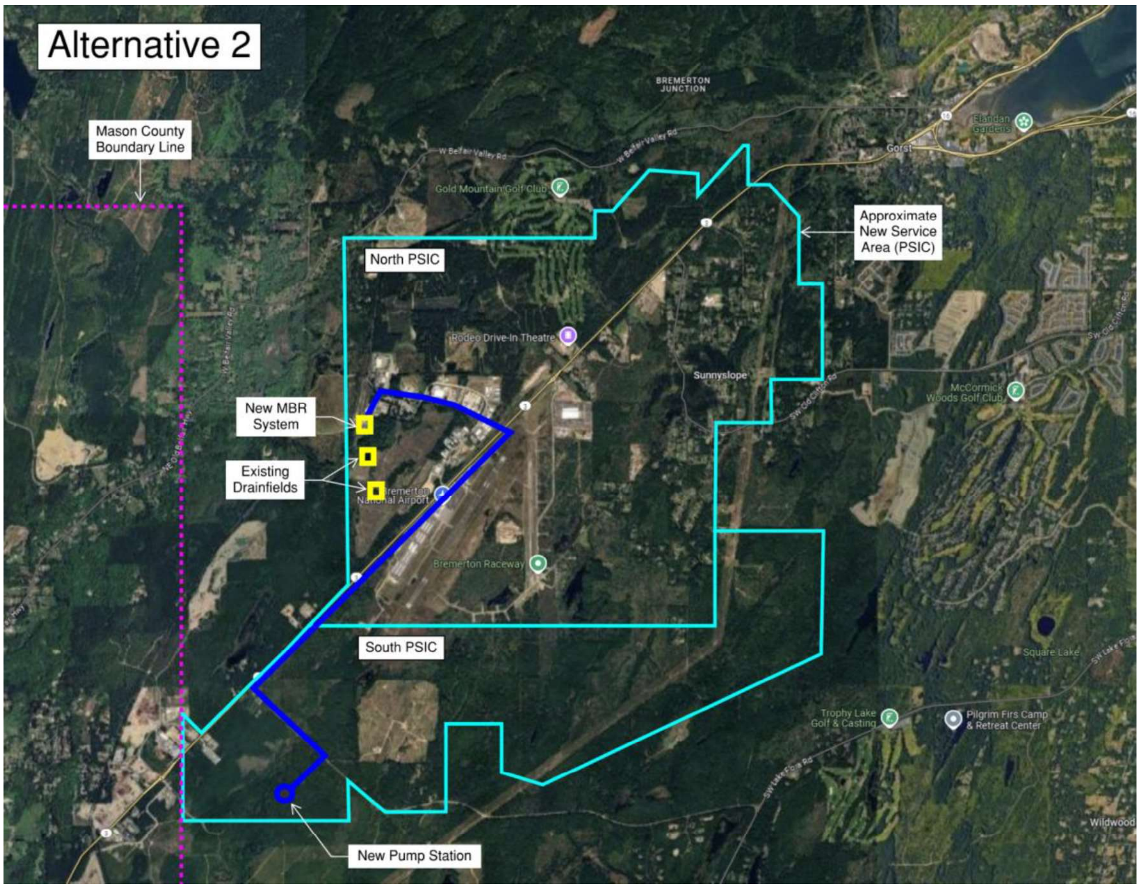

Figure 3-3 Alternative 2 Conceptual Plan

3.4.3 MBR Effluent Discharge Options

Beneficial reuse of the effluent from a possible new MBR treatment system as reclaimed water was explored for this study. Several discharge points were considered for each alternative and are as follows:

- Discharge as reclaimed water to Gold Mountain Golf Club irrigation system for beneficial reuse.
- Discharge to the rock quarry area southwest of East Fork Union River.
- Discharge to the existing drain fields.

Discharging to the nearby Gold Mountain Golf Club is a viable option for beneficial reuse but will require extensive conveyance from the treatment facility location to the golf course's onsite storage for irrigation water. This option for discharge also requires treatment to Class A reclaimed water standards as shown in Table 2-5. Thus, the alternatives that cannot meet this parameter should not be considered for this discharge option. The golf course is currently on City property so conversations with other entities will be minimal regarding the potential usage of reclaimed water. A preliminary site plan depicting two potential conveyance alignment options from the treatment plant to the golf course are shown in Figure 3-4. Option 1 will likely require less restoration efforts due to the alignment's location along a tree-cleared route while Option 2 is aligned along existing roadways and will require coordination with WSDOT as well as extensive restoration efforts. Depending on the elevation profiles in this area, one or more pump stations may be needed to convey the effluent water to the designated discharge point.

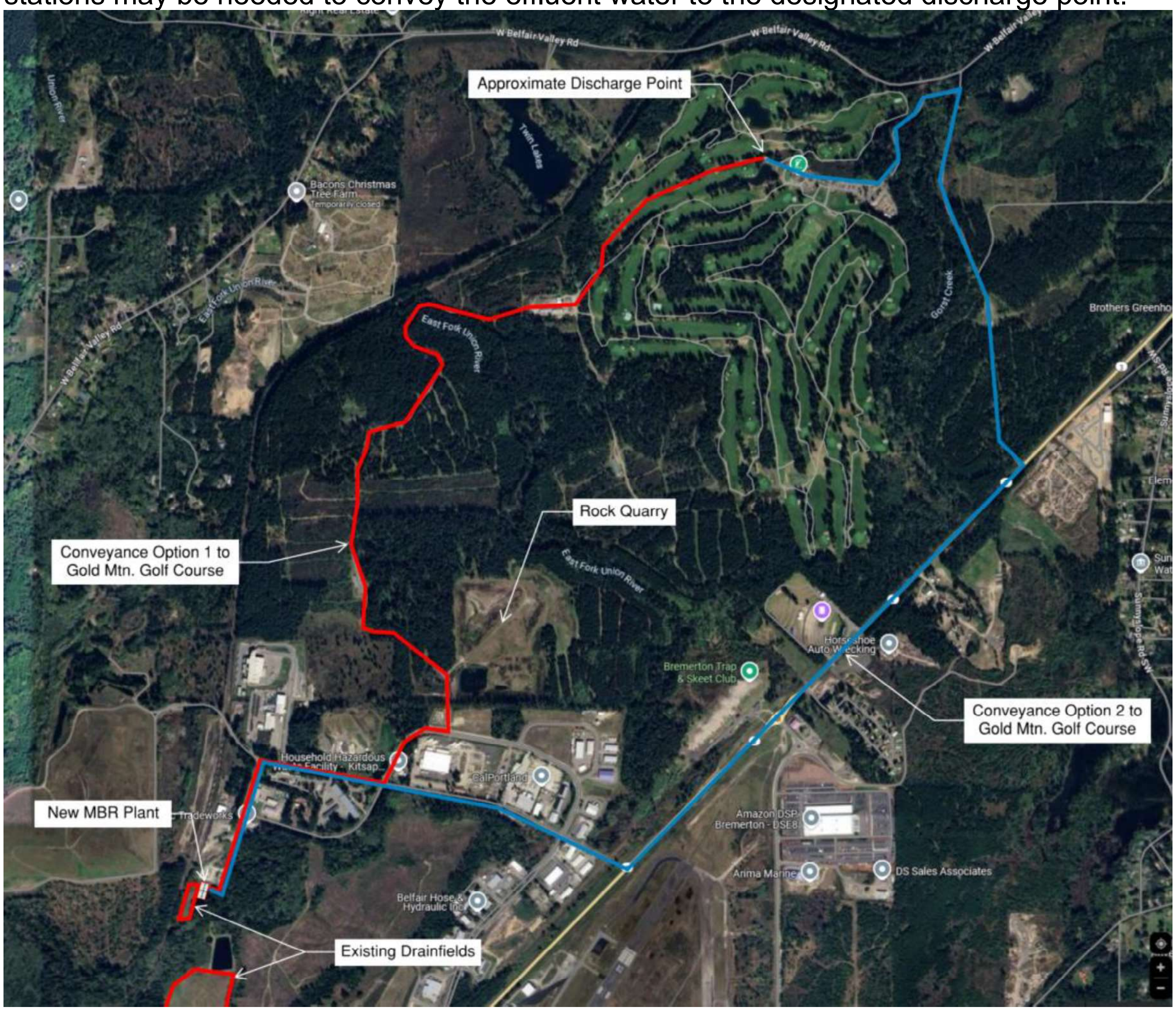

Figure 3-4 MBR Effluent Discharge Options

Discharging to the nearby rock quarry southwest of East Fork Union River is an option to consider if the Gold Mountain Golf Club and the existing drain fields do not have sufficient capacity. This location is available for consideration and is on City property. The City would

need to conduct an independent study to confirm this area is suitable for discharge from the treatment system and modify the discharge area accordingly.

A previous study from Richwine Environmental in 2023 evaluated the use of discharging to the existing drain fields. The study concluded the existing treatment system, as well as a newly constructed MBR treatment facility, should discharge into the existing drain field points. Since the flow currently received by the plant are well within the permitted limits, the drain fields could be reused up to the design capacity. This option would likely require an evaluation of the drain field's capacity to verify the increased flows from the treatment system are able to be met.

Another discharge option to consider is to install a new watermain from the Gold Mountain Golf Club to the nearby BS10 reservoirs as well as repurposing the existing watermain piping for non-potable reuse. A new sprayfield could also be installed adjacent to the golf course provided effluent reclaimed water standards are met.

3.4.4 Alternative 3 –Mason County Agreement Conveyance to Existing Service Area

Alternative 3 involves the installation of a new pump station in the South PSIC area which is intended to convey flows to a Mason County similar to as described for alternative 1. An additional new pump station would be installed in the North PSIC area that would convey the flows north to the City's existing lift station SB-3 in Gorst. This alternative is contingent upon an agreement with Mason County being able to accept the future flows anticipated to be produced by the South PSIC developments, which is currently underway. The South PSIC pump station routed to Mason County would be funded by others. Should Mason County accept a portion of the future flows, a phased approach for this alternative can be considered. Alternative phasing details are discussed in Section 4.3.4. Highway 3 is considered a limited access ROW and WSDOT does not allow utilities to be installed unless all other options are expended. Further conversations with WSDOT should be had if conveyance along Highway 3 is considered. Figure 3-5 below depicts a preliminary plan view of this alternative.

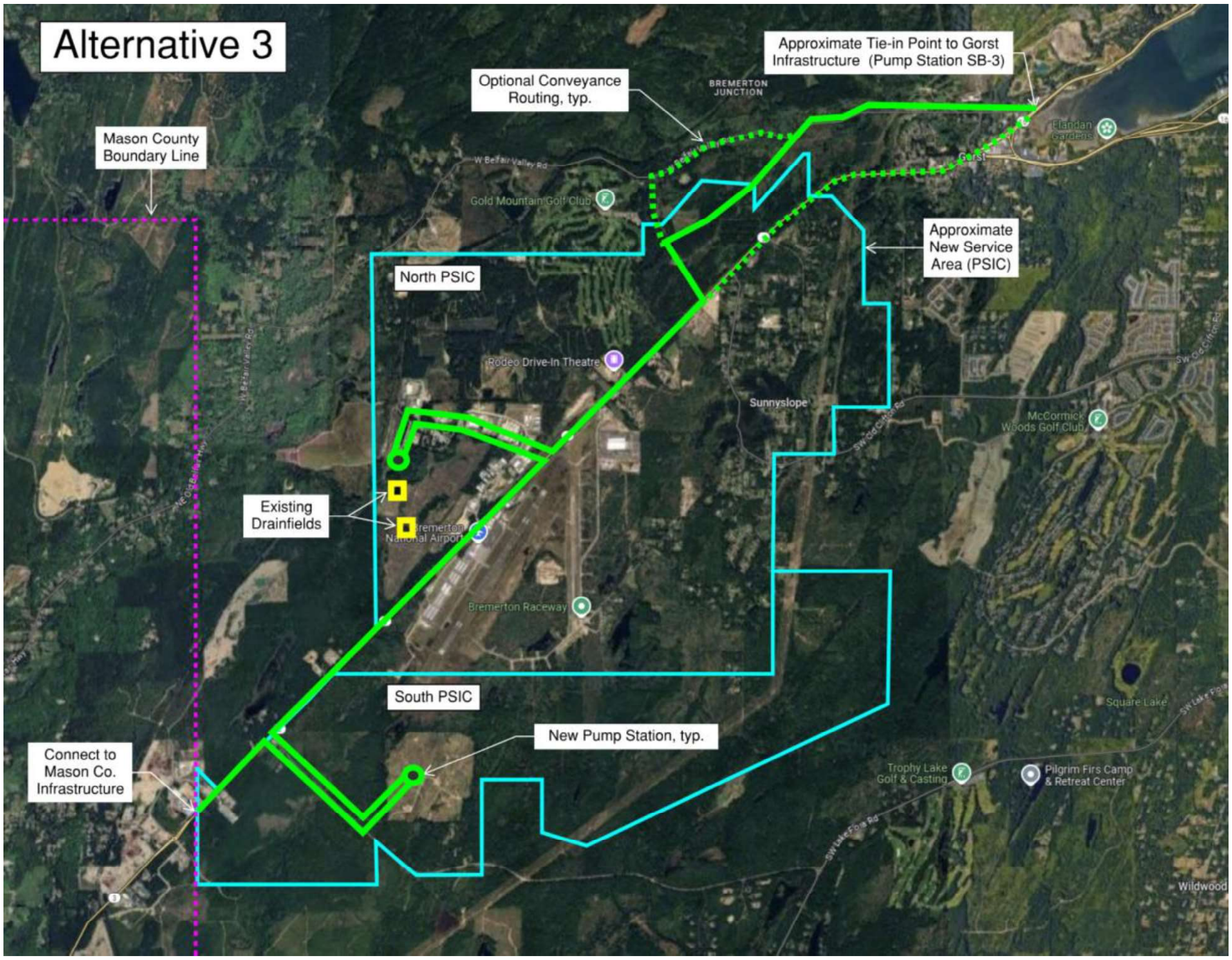

Figure 3-5 Alternative 3 Conceptual Plan

3.4.4.1 Alternative 3 Flow Analysis

Kennedy Jenks performed a brief hydraulic analysis to determine the existing City infrastructure's capability to accept flows from PSIC across the planning horizon. Because the existing Pump Station SB-3 is only rated for 500 gpm, and projections for this service area are to exceed this flow rate, additional improvements at pump station SB-3 will be needed to accommodate the additional flow. SB-3 also receives flows from existing pump stations SB-1 and SB-4. From SB-3, one 10-inch and two 8-inch force mains convey flow approximately two miles downstream to Bremerton's Westside Wastewater Treatment Plant; these force mains are known collectively as the South Bremerton Force Main (SBFM). A summary of the peak flows from the existing pump stations as well as projected PSIC flows are presented below.

Table 3-3 SBFM Peak Flows

Peak Flow Rates	
SB-1	900 gpm
SB-3	500 gpm
SB-4	580 gpm
PSIC	972 gpm
Total	**2,952 gpm**

Notes:
Pump Stations SB-1, SB-3, and SB-4 peak flow rates per City of Bremerton 2014 Wastewater Comprehensive Plan Update.

Because pump station SB-3 contains three parallel effluent force mains, the total flow can be assumed to be flowing through all three pipelines during peak flow conditions. The head losses through each pipe would be the same since the starting location and destination are the same, however the diameters differ and therefore the velocities and volumetric flow rates will differ slightly. The calculated pipe velocity through the 10-inch and two 8-inch force mains would vary between 5 and 6 feet per second. Given the total flow rate calculated for the build-out flow, the velocity ranges observed would be within typical design standards. Additionally, velocities through the force mains would increase should one of the force mains require maintenance during periods after full buildout. Based on this preliminary analysis, there appears to be sufficient capacity in the existing SBFM to accommodate future PSIC flows.

The City should conduct an independent study on this matter to confirm existing flows and conditions of the existing infrastructure. This assessment was performed solely based on existing pump station's rated capacities and not historical flows for this area. Additionally, no analysis was performed for effects on treatment plant performance, capacity, or nutrient loading.

3.5 Alternative Project Costs

Class 5 OPCC estimates were developed for each alternative following AACE guidelines. The expected accuracy range for a Class 5 estimate ranges from -30% to +50%. These estimates serve as a high-level cost comparison between each alternative and should be considered in further evaluations.

3.5.1 Cost Comparison

Project costs were developed for each alternative. Several markups and contingencies were also applied to these estimates to provide a preliminary cost for ancillary project needs such as electrical and instrumentation and controls, as well as soft costs such as construction administration and permitting. A summary of the project costs are presented in Table 3-4 below, while the full detailed estimates are available in Appendix A.

Table 3-4 Alternative Project Construction Costs

Estimated Project Construction Cost & Range		
Alternative 1	**Alternative 2**	**Alternative 3**
$78M	$85M	$62M
$55M to $118M	$59M to $127M	$43M to $93M

Alternative 2 has the highest projected cost, followed by Alternative 1 and then Alternative 3. Alternatives 1 and 2 contain a new MBR treatment system sized for North PSIC and South PSIC flows and two new pump stations for conveyance to Mason County and to the new MBR system. The bulk of the costs in these options come from the MBR system and its necessary components. Alternative 3 contains no MBR treatment system but a series of pump stations that convey flows northeast to existing Pump Station SB-3. The bulk of these costs mainly come from the installation of several pump stations and lengthy conveyance from the PSIC area to Gorst. Upgrade efforts will likely be extensive for this alternative due to a portion of the conveyance installed along a major highway. Pump Station SB-3 will need minor upgrades for the expected increase in flows coming from PSIC.

Section 4: Alternatives Evaluation

4.1 Criteria Descriptions

A set of criteria were developed to evaluate the alternatives based on factors relevant to the City and the overall study.

4.1.1 Costs

Capital project costs for each alternative vary depending on the goals and components of the alternative. For each alternative, there are costs associated with influent and effluent conveyance as well as the major components for flow. The costs for pump stations were developed by assuming a cost per unit of flow, developed based on similar projects completed in the past in Kennedy Jenks project completion portfolio. The new MBR system costs for the alternatives that included this represents a major cost component due to the primary equipment, installation, and ancillary items for construction. Several standard markups were also applied to each alternative cost estimate. Alternatives with a higher estimated project capital cost score lower than alternatives with a lower cost.

4.1.2 Operations & Maintenance

O&M of the alternatives is a major factor to consider. Adding a new MBR treatment system introduces new operational demands the City may not have much experience implementing. An MBR system requires consistent onsite maintenance, such as onsite sampling, to ensure it is operating properly and the biological treatment is working as intended. This would likely involve utilizing current staff or hiring a third-party contractor to perform onsite maintenance daily or as required by the manufacturer. Additional pump stations will require the City to maintain infrastructure that is similar to what the City currently operates and maintains. Alternatives with similar or minimal operations and maintenance will score higher than alternatives with newer operational challenges or more frequent maintenance activities.

4.1.3 Beneficial Reuse

Considerations for beneficial reuse of effluent water is another factor to consider for this study. A pump station on its own will not be able to produce Class A reclaimed water so options that contain a new MBR treatment system will score higher due to being able to produce this quality of water. Not being able to produce Class A reclaimed water will limit the alternative’s ability to discharge to the Gold Mountain Golf Club so other methods of discharge must be considered for those options. Alternatives that can produce Class A reclaimed water for beneficial reuse score higher than alternatives that cannot.

4.1.4 Agency Coordination & Permitting

Coordination with applicable agencies is an important factor to consider. Assumptions were made for alternatives that were contingent upon Mason County accepting a portion of flows from the South PSIC area. This will require communication on the intent as well as developing a plan

for routing the flows to the county boundary line. The new MBR treatment system is also anticipated to be installed on Port property so coordination with this entity is needed unless the City ultimately decides to consider alternative locations for the treatment system on City property. Alternatives with minimal or no interagency coordination will score higher than alternatives that will require several coordination efforts.

Permitting with applicable agencies is another important factor to consider before moving forward with any alternative. The alternatives that have been identified to contain installation of conveyance along Highway 3 will require coordination with WSDOT as Highway 3 is considered a limited access corridor in this area. All alternatives will require some level of installation along this highway so coordination with WSDOT is expected. Installation of a new MBR treatment system will require coordination with DOE as flows are anticipated to process above 100,000 gpd. Coordination with DOE will need to occur prior to and throughout detailed design. Discharging to the golf course as reclaimed water will also require a reclaimed water management plan and associated permit with DOE. Alternatives with minimal permitting efforts score higher than alternatives with several permitting efforts.

4.1.5 Implementation/Phasing

Implementation and phasing is a critical factor to consider when it comes to the development of the PSIC area, as several concepts to develop the area have failed to initiate in the past. An MBR system generally can be implemented with a phased approach where the overall facility can be built while the membranes themselves can be installed according to the flow rates anticipated to be received in the interim. Once a threshold is reached, the remaining membranes can be procured and installed accordingly in later years. Pump stations generally pose some phasing flexibility too, as wetwells, mechanical galleries, and electrical rooms can be sized for future flows. The important factor is the costs during each phase to achieve a reasonable implementation. Alternatives with high costs to initiate score lower in this category than those options with less expensive means to initiate.

4.2 Alternative Criteria Matrix

Each alternative was provided a score based on a criteria matrix developed for this project and are presented in Table 4-1**.** The justification for each score is detailed for each individual criterion. Weighting was also applied to each criterion and was determined according to the overall impact to the City's goals for this study. Criteria and weighting were developed collaboratively with City staff during workshops held before finalization of the memorandum.

Table 4-1 Scoring Criteria Matrix

	Evaluation Scoring			
Criteria (Weighting)	3	2	1	0
Cost (30%)	Total project capital cost <$50M	Total project capital cost between $50M and $75M	Total project capital cost between $75M and $100M	-
O&M (25%)	Alternative requires minimal onsite presence and minor impacts to City's current O&M operations	Alternative requires some level of onsite presence and requires some new operator responsibilities	Alternative requires frequent onsite presence and many new operator responsibilities at initial Alternative implementation	Alternative requires full time staff onsite daily and new operator certifications required for routine O&M
Beneficial Reuse of Reclaimed Water (20%)	-	Alternative can provide full discharge flow for beneficial reuse (reclaimed water) and/or requires minimal effluent conveyance challenges	-	Alternative can provide no level of RW for beneficial reuse and/or requires extensive effluent conveyance challenges
Local Agency Coordination & Permitting (10%)	Alternative requires no inter-agency coordination going into design and construction and no additional permitting beyond current operations	Alternative requires one inter-agency coordination exercise and some new permitting efforts prior to design and construction	Alternative requires two or more agency coordination efforts and several new permitting efforts prior to design and construction	Alternative is not viable due to extensive agency coordination that is known to be infeasible and requires known extensive permitting efforts that highly impact future construction efforts
Implementation/ Phasing (15%)	Alternative can initiate in a phased approach, greatly reducing costs and schedule to initiate before full implementation	Alternative can initiate in a phased approach, moderately reducing costs and schedule to initiate before full implementation	Alternative can initiate in a phased approach, somewhat reducing costs and schedule to initiate before full implementation	Alternative can provide no level of streamlined implementation with no reduction to overall project costs or schedule before full implementation

Scores for each alternative ranged from zero (0) to three (3) with 3 being the most favorable and 0 being the least favorable in the specified criteria.

4.3 Evaluation Criteria and Weighting

Based on the criteria matrix in Table 4-1, each alternative was assigned a score for each. The unweighted and weighted scores are presented in Table 4-2 below.

Table 4-2 Alternatives Scoring Matrix

	Alternative 1		Alternative 2		Alternative 3	
	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted
Cost	1	0.3	1	0.3	2	0.6
O&M	1	0.25	1	0.25	3	0.75
Beneficial Reuse	2	0.4	2	0.4	0	0
Agency Coordination & Permitting	1	0.1	1	0.1	2	0.2
Implementation/ Phasing	2	0.3	1	0.15	2	0.3
Totals	**8**	**1.35**	**6**	**1.20**	**9**	**1.85**

4.3.1 Alternatives Comparison

Each alternative was developed with a different purpose for serving the future developments in the PSIC industrial area. Alternatives 1 and 2 represent the alternatives with lower overall conveyance scope but higher complexity due to needing a new MBR treatment system for the North and South PSIC development. Alternative 1 was considered due to the City's ongoing conversations with Mason County for a potential agreement on sending a portion of flows from the South PSIC area to Mason County infrastructure. The conveyance agreement with Mason County could potentially allow for several years of buffer time before operations staff would need be trained to operate an MBR system, therefore Alternative 1 scored higher than Alternative 2 in the Implementation/Phasing category.

Alternative 2 should be considered provided Mason County does not allow the City to send any flows to their jurisdiction and a high level of treatment is desired with a localized MBR system. This alternative scored the lowest in the Implementation/Phasing category due to the overall construction requirements of a full-scale MBR system and the minimum flows required to initially operate. In the case for Alternatives 1 and 2, a new MBR system is more costly and more complex than Alternative 3.

Alternative 3 represents the option that is the least complex due to not needing a new MBR treatment system but does require a higher number of pump stations along the specified routing. The absence of a new MBR system defaults this alternative to not being able to provide

any amount of effluent as reclaimed water. While a new MBR system does provide more value for beneficial reuse, pump stations provide more value to O&M as they are familiar to City operations staff and can easily be integrated into existing maintenance routines. Alternative 3 does include more pipeline and conveyance infrastructure than Alternatives 1 and 2, however the Alternative is estimated to be significantly less costly. Similar to Alternative 1, an agreement with Mason County could provide a substantial buffer between implementation phases. This alternative can be considered provided an agreement with Mason County is made and the City prefers to work with a system that is familiar.

4.3.2 Recommendation & Phasing Strategy

Based on the final results from the alternative evaluation scoring and the comparison between the alternatives, it is recommended that the City proceeds with developing plans for alternative 3. Although this alternative does require an initial agreement with Mason County to send a portion of flows to their infrastructure, this allows the City to concurrently begin making the necessary plans for future buildout.

In preparing for considerable capacity increases with no existing infrastructure, a phased approach would involve determining preliminary sizing for the South PSIC pump station up to the maximum amount of flow allowed by Mason County while concurrently developing a plan for another pump station sized for the remaining future flows in the South PSIC area or negotiating this expanded service with Mason County. This new pump station that would convey flows to Mason County would be influenced and funded by others and should not be considered in future plans for this study. Should funding allow, the South PSIC pump station may be sized for future buildout flows, effectively combining the two South PSIC pump stations. An additional new pump station would be designed and installed in the North PSIC area to process flows generated in this area following construction of the South PSIC pump station. The North PSIC pump station would process flows to Gorst where it would connect at the existing lift station SB-3. Once both pump stations are constructed and operational, the City would need to determine a specific threshold that needs to be reached in order to begin developing plans to connect the newly constructed North and South PSIC infrastructure. This final phase is intended to account for any potential future expansion that would require additional capacity. An example phased plan is summarized below:

Phase 1

- City enters interagency agreement with Mason County to send up to 160,000 gpd of flow from South PSIC to their infrastructure.
- City begins design for constructing a new pump station in South PSIC that is capable of processing interagency agreement flows at a minimum. Applicable pump station

infrastructure would be sized for future capacity upgrades to accommodate more flow at full buildout of South PSIC per Phase 3.

Phase 2

- City begins design for constructing a new pump station in North PSIC that is capable of processing full build out flows.

Phase 3

- City begins developing plans for connecting the newly constructed North and South PSIC pump stations once a specific flow capacity threshold is reached.

Table 4-3 below shows a breakdown of project construction costs of the recommended phased approach for alternative 3 as described within this section.

Table 4-3 Alternative 3 Phased Project Construction Costs

Estimated Project Construction Cost & Range		
Phase 1	**Phase 2**	**Phase 3**
$11M	$28M	$23M
$8M to $17M	$19M to $41M	$16M to $35M

4.3.3 Risks and Opportunities

Several risks and opportunities have been identified relevant to Alternative 3. The risks are as follows:

- The nutrient impact downstream to the Westside WWTP should be investigated further to confirm capacity at the design flows determined in this report. This is especially critical considering the City is aware of increased stringency upcoming in the plant's next NDPES permitting cycle.
- High sewage age within the conveyance system to the Gorst basin in the early stages of development could lead to unwanted odors and the possible need for odor control measures.
- Future sewer service increases in the Gorst basin could raise capacity concerns in the SBFM. The SBFM has been identified by City staff as a high criticality asset that is difficult to access for repairs or capacity improvements.
- Conveyance alignment will require coordination with WSDOT along Highway 3.

The opportunities are as follows:

- The relatively low cost compared to other Alternatives, and the phased implementation possibilities give the City a feasible financial grounding for actionable development of the PSIC area.
- Pump stations can provide for additional capacity for future development in the area.
- The O&M responsibilities may be easily integrated into the existing routines.

Appendix A: Opinion of Probable Construction Cost Estimates (Class 5)

t @ ____________ **% Complete**

Description	Qty	Units	Total Costs $/Unit	Total	Total		
station, manhole, odor control, piping, gency generator, site improvements	1	LS	1,914,250.00	1,914,250	1,914,250		Ref $/MGD as
accessories	3	EA	48,262.50	144,788	434,363		Ref quote fro
			Subtotal Pump Stations			**2,348,613**	
np Station to Mason County Line							
enching, restoration	6,900	LF	200.00	1,380,000	1,380,000		Assumes 6" D
), trenching, restoration, manholes	3,100	LF	280.00	868,000	868,000		Assumes 8" D
	1	LS	10,000.00	10,000	10,000		Allowance
for in roadway	7,000	LF	240.00	1,680,000	1,680,000		Trenching, pa
			Subtotal Pipelines			**3,938,000**	
bonds, permits		10%		628,661	628,661		
		15%		942,992	942,992		
			Subtotal Facility Total Cost		**1,571,653**	**1,571,653**	
TOTAL						**7,858,266**	
cy		30%		2,357,480	2,357,480	2,357,480	
		Project Construction Cost Total				**10,215,745**	
(Brementon)		9.2%				939,849	
		Project Construction Cost Total				**11,155,594**	
Project Soft Costs							
gn		5%			557,780		
ment		8%			892,448		
tting		1%			111,556		
		0.5%			55,778		
					1,617,561	**1,617,561**	
Total Project Cost (Construction + Soft Costs)						**$ 12,773,155**	

t @ ___________ % Complete

Description	Qty	Units	Total Costs $/Unit	Total	Total		
	1	LS	3,000,000.00	3,000,000	3,000,000		
t station, manhole, odor control, piping, gency generator, site improvements	1	LS	2,170,000.00	2,170,000	2,170,000		Ref $/MGD as
accessories	3	EA	48,262.50	144,788	434,363		Ref quote fror
			Subtotal Pump Stations			**5,604,363**	
np Station to Gorst							
enching, restoration	5,900	LF	200.00	1,180,000	1,180,000		Assumes 6" D
), trenching, restoration, manholes	22,100	LF	280.00	6,188,000	6,188,000		Assumes 8" D
	1	LS	10,000.00	10,000	10,000		Allowance
for in roadway	10,600	LF	240.00	2,544,000	2,544,000		Trenching, pa
			Subtotal Pipelines			**9,922,000**	
bonds, permits		10%		1,552,636	1,552,636		
		15%		2,328,954	2,328,954		
			Subtotal Facility Total Cost		**3,881,591**	**3,881,591**	
TOTAL						**19,407,953**	
cy		30%		5,822,386	5,822,386	5,822,386	
			Project Construction Cost Total			**25,230,339**	
k (Brementon)		9.2%				2,321,191	
			Project Construction Cost Total			**27,551,530**	
Project Soft Costs							
gn		5%			1,377,577		
ment		8%			2,204,122		
tting		1%			275,515		
		0.5%			137,758		
					3,994,972	**3,994,972**	
			Total Project Cost (Construction + Soft Costs)			**$ 31,546,502**	

_______ % Complete

Description	Qty	Units	Total Costs $/Unit	Total	Total		
Pump Station to North PSIC Pump Station							
hing, restoration	8,500	LF	200.00	1,700,000	1,700,000		Assumes 6" D
renching, restoration, manholes	19,300	LF	280.00	5,404,000	5,404,000		Assumes 8" D
	1	LS	10,000.00	10,000	10,000		Allowance
in roadway	24,800	LF	240.00	5,952,000	5,952,000		Trenching, pav
			Subtotal Pipelines			**13,066,000**	
nds, permits		10%		1,306,600	1,306,600		
		15%		1,959,900	1,959,900		
			Subtotal Facility Total Cost		**3,266,500**	**3,266,500**	
TOTAL						**16,332,500**	
		30%		4,899,750	4,899,750	4,899,750	
		Project Construction Cost Total				**21,232,250**	
rementon)		9.2%				1,953,367	
		Project Construction Cost Total				**23,185,617**	
Project Soft Costs							
		5%			1,159,281		
nt		8%			1,854,849		
g		1%			231,856		
		0.5%			115,928		
					3,361,914	**3,361,914**	
Total Project Cost (Construction + Soft Costs)						**$ 26,547,531**	