

Technical Memorandum

Date: January 25, 2018

Project: Enatai Water Inlet Station Improvements W-110

To: Doug Lane, P.E., Senior Engineer
City of Bellevue

From: Nathan Rostad, P.E.
Marshall Meyer, P.E.
Murraysmith

Re: Enatai Inlet Station – Alternatives Evaluation



Introduction

This memorandum summarizes the evaluation performed by Murraysmith to determine the preferred alternative for improvement of the City of Bellevue’s (City’s) existing Enatai Inlet Station.

Background

The City of Bellevue (City) has identified deficiencies in the Enatai Inlet Station and has prioritized the station for rehabilitation or replacement, as documented in the City’s 2016 Water System Plan. The Enatai Inlet Station was installed in the 1960’s when it was owned by King County Water District #68. The deficiencies in the station include operations staff not being able to access the pressure reducing valve (PRV) due to lack of clearance, the meter vault not meeting current City access requirements, excessive flow velocity, and insufficient capacity to meet growth. The evaluation of alternatives to rehabilitate or replace the existing inlet and preparation of this preliminary engineering report has been included in CIP W-110 of the City’s Capital Investment Program.

Existing Inlet Station Description

The existing Enatai Inlet Station receives water from an 8-inch tap on Seattle Public Utility’s (SPU’s) Mercer Island Pipeline (MIPL), as shown in **Figure 1**. East of the existing 8-inch tap, the MIPL branches from a 30-inch concrete cylinder pipe to a 20-inch steel pipe that is located underwater and a 16-inch ductile iron pipe on the I-90 East Channel Bridge to Mercer Island. The existing 8-inch tap is located on the 20-inch steel portion of the MIPL. An un-used 12-inch tap on the 16-inch ductile iron portion of the MIPL is located in a planter area northeast of the existing inlet station.

The existing Enatai Inlet Station consists of a SPU meter vault, a City meter vault, a PRV vault, and an above-grade enclosure for the electrical and telemetry equipment.

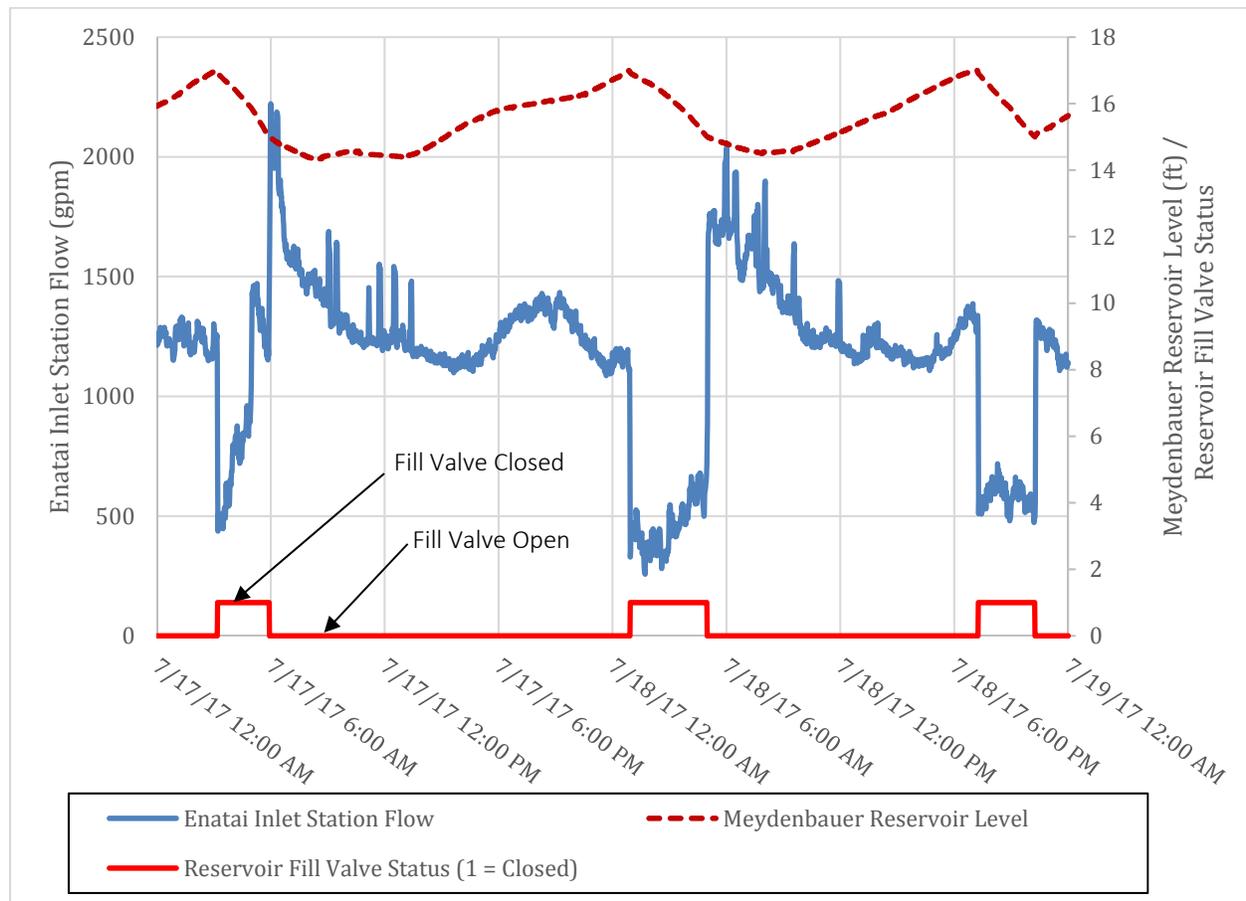
The PRV vault consists of an 8-inch Cla-Val PRV and a 3-inch Cla-Val PRV installed in parallel with each other. The existing Enatai Inlet Station has remote monitoring of flows and pressures, but does not have remote control capabilities. The PRV functions using hydraulic controls set to maintain a 300 Zone pressure. The Enatai Inlet Station is located in the parking lot of Enatai Beach Park.

Existing Inlet Station Supply Rates

The Enatai Inlet Station serves the City's EN300 Zone directly, serves the MB252 Zone indirectly via the Meydenbauer Reservoir, and can be used to supply the BV400 Zone via the Meydenbauer Pump Station. Historical hourly Enatai Inlet flow data was reviewed for the years between 2000 and 2016 and for a recent high demand period in July 2017. The average daily flow for this period was approximately 370 gpm. Flows through the inlet station vary seasonally, and have generally been increasing since 2000. The flow rate through the Enatai Inlet during highest demand month each year averaged approximately 625 gpm, with elevated flows associated with Meydenbauer Reservoir filling during all times of the year and associated with both Meydenbauer Reservoir filling and irrigation use in the summer months.

In July 2017, the overall average flow was 875 gpm, with an average flow of 478 gpm when the Meydenbauer Reservoir was not filling, and an average flow of 1,271 gpm when the Meydenbauer Reservoir was filling. Between 5:00 AM and 7:00 AM, the average flow through the Enatai Inlet in July 2017 was 1,045 gpm when the Meydenbauer Reservoir was not filling and 1,648 gpm when the Meydenbauer Reservoir was filling. Typically, residential irrigation occurs between 5:00 AM and 7:00 AM, which implies that irrigation use contributes to the peak flow through the Enatai Inlet. **Figure 2** shows the one-minute Enatai Inlet flow, Meydenbauer Reservoir level, and Meydenbauer Reservoir fill valve status over a two-day period in July 2017, which shows the highest Enatai Inlet flow each day occurring between 5:00 AM and 7:00 AM, and the lowest flow each day occurring in the evening or overnight hours when the Meydenbauer Reservoir is not filling.

Figure 2
Meydenbauer Reservoir Level and Enatai Inlet Flow



Recent flows during high demand months have resulted in high velocities through the existing 8-inch tap and inlet station. The Washington Department of Health Water System Design Manual Section 8.1.6 recommends velocities remain below 8 feet per second (fps) during peak hour demand conditions, which corresponds to a flow rate of 1,253 gpm in an 8-inch pipe. City standards indicate that velocities shall remain below 10 feet per second (1,566 gpm in 8-inch pipe) during the highest demand including fire flow. Review of one-minute flow data from June 1, 2017 through July 20, 2017 revealed that the flow was above 1,253 gpm (8 fps) approximately 22 percent of the time and above 1,566 gpm (10 fps) approximately 3 percent of the time during that period. The peak flow recorded during that time was 2,221 gpm, which results in velocities greater than 14 fps in the 8-inch pipe. In a 12-inch pipe, velocities would not reach 10 fps until the flow rate was greater than 3,570 gpm.

Although inlet flow is higher when Meydenbauer Reservoir is being filled, a change in control strategy would not be sufficient to reduce velocities below recommended standards, because during high-demand days the reservoir fill valve is already open for the majority of the day. For

example, on July 17, 2017 the reservoir fill valve was open for 21.5 hours, and on average for July 2017 the reservoir fill valve was open for 18.4 hours per day.

Proposed Inlet Station Supply Capacity

The City provided the maximum required supply rate for the proposed Enatai Inlet Station during this project. Since the EN300 Zone does not have direct access to storage, the City indicated that the Enatai Inlet Station should have a capacity to supply at a rate to meet the peak hour demands of the EN300 Zone. The City also indicated that the Enatai Inlet Station should be sized to supply the maximum day demand of the MB252 Zone. Based upon year 2034 demand projections for the EN300 and MB252 zones, the City calculated a maximum required capacity of 2,925 gpm for the proposed Enatai Inlet Station.

Proposed Inlet Station Design Requirements

Based upon City standards and discussions with City staff, the proposed inlet station should be designed to meet the City’s requirements presented in **Table 1**.

Table 1
Design Requirements

Item	Requirement
Flow meter, control valves, and water main sizing	<ul style="list-style-type: none"> Inlet station capacity at least 2,925 gpm Water mains sized based on maximum velocity of 10 feet per second at peak flow rate
Vault Access	<ul style="list-style-type: none"> Vault access in accordance with City and Washington Industrial Safety and Health Act (WISHA) standards Adequate room for operations and maintenance activities
Access hatch location	<ul style="list-style-type: none"> Outside of bike lanes Only SPU vault cover within sidewalks
Control valve operation	<ul style="list-style-type: none"> Remote monitoring and control capability
Park impacts	<ul style="list-style-type: none"> No reduction to usable area within Enatai Beach Park, including the number of parking spaces
EN300 Zone fire flow impacts	<ul style="list-style-type: none"> Minimize amount of time that EN300 Zone must rely on a secondary supply facility.

Existing Inlet Station Improvement Options

After review of the existing conditions, several types of improvement options were identified and examined for fatal flaws, as follows:

Option A – Do Nothing

This option allows the City to continue using the existing inlet station without making any improvements. Although this option would have the lowest capital cost, it will not correct any of the deficiencies in the existing station. The existing PRV and meter vault access do not meet City standards, the existing PRV would remain difficult to access or maintain, and hydraulic capacity would remain limited. The existing inlet station is approximately 50 years old. If left in service without any improvements, the PRV and associated equipment will eventually fail. Therefore, doing nothing is not an acceptable option and was not considered in the alternatives evaluation that follows.

Option B – Rehabilitate Existing Station

A second option is to rehabilitate the existing inlet station. A rehabilitation option would improve operational deficiencies without replacing the majority of the existing infrastructure. Rehabilitation would include improving vault access by replacing the meter vault and PRV vault tops and installing new access hatches and ladders. Replacing the existing locally controlled valves with valves that allow remote control would be another component of the rehabilitation option.

Although this option would improve some of the operational deficiencies, it would not increase the inlet capacity to alleviate the high velocities currently encountered or allow for future growth. Additionally, although replacing the vault tops may improve access, the rehabilitated vaults would not fully meet access standards due to the existing piping depths and vault dimensions. Rehabilitation of the inlet station would also involve taking the existing inlet station out of service for an extended period of time, negatively impacting the available fire flows in the EN300 Zone. Since the existing peak velocities exceed City standards, the rehabilitated vaults would not fully meet access standards, and an extended inlet shutdown causing reduced fire flow would be needed, this option was not considered in the alternatives evaluation that follows.

Option C – Replace Existing Station with a New Station Using the Existing 8-Inch SPU Tap

A third option is to replace the existing inlet station with a new water inlet station that utilizes the same 8-inch SPU tap as the existing inlet station. This option may allow re-use of the SPU meter vault, while replacing the City meter vault and PRV vault. Although this option would provide updated equipment and vaults meeting city access requirements, it would continue to rely on a 1960's era SPU connection and would not increase the inlet capacity to alleviate the high velocities currently encountered or allow for future growth. Therefore, this option was not considered further in the alternatives evaluation.

Option D – Replace Existing Station with a New Station Using the Existing Un-Used 12-Inch SPU Tap

A fourth option is to replace the existing inlet station with a new water inlet station that utilizes the unused 12-inch SPU tap that was installed in 1984 when a second SPU crossing was installed with the I-90 bridge. This option would involve the installation of a new SPU meter vault, a new City vault containing a flow meter and PRV, and a new connection to the City's 12-inch water main.

This option would provide both updated equipment and vaults meeting City access requirements. It would also increase the inlet capacity to alleviate the high velocities currently encountered and allow for future growth. Since this is the only option that will fully meet City standards regarding access and pipeline velocities, three alternative locations for a replacement inlet station that connects to the un-used 12-inch SPU tap were evaluated further, as described below.

Siting Alternatives for Proposed Inlet Station

The area near the existing Enatai Inlet Station and un-used 12-inch SPU tap contains numerous site constraints that were considered when identifying alternative locations for the proposed inlet station. The area around Enatai Beach Park contains numerous underground utilities, including wastewater, storm drains, buried telecommunications lines, underground electric, gas, City water mains, and SPU water mains. Enatai Beach Park is a popular public park with limited parking, and use of park lands for the inlet station is limited due to grant funding considerations.

Another site constraint is the I-90 limited access right-of-way (ROW) immediately adjacent to the Park. Work within the limited access ROW requires approval from both the Washington State Department of Transportation (WSDOT) and the Federal Highway Administration (FHWA). This area may potentially be used for the inlet station through a limited access encroachment variance request, but WSDOT staff indicated that there would need to be a compelling reason to install the inlet station within the Limited Access ROW. Due to numerous permitting risks, the City prefers to avoid the limited access ROW area if feasible.

One location within the Limited Access ROW was considered (southwest corner of Enatai Beach Park's north parking lot), to eliminate the existing parking impact in the south lot. However, discussion with the local canoe rental vendor and Parks Department staff revealed that the area considered is used frequently for parking a canoe/kayak transport trailer. Relocating the inlet to the north lot may therefore actually increase parking impacts.

Beyond the limited access ROW, WSDOT has additional general ROW area as shown on **Figure 1**. Construction within this general ROW will require a WSDOT franchise / permit, but not approval from FHWA.

Considering these site constraints, three siting alternatives for a new water inlet station to replace the existing Enatai Inlet Station were developed and evaluated. **Figure 1** shows the three alternative sites included in the evaluation, which are 1) within the Enatai Beach Park parking lot (Alternative 1), 2) in the planter area near the SE Lake Road cul-de-sac (Alternative 2), and 3) within

the SE Lake Road Travel lane (Alternative 3). All three siting alternatives would be capable of providing 2,925 gpm capacity. A description of each siting alternative follows.

Site Alternative 1 – Within Enatai Beach Park Parking Lot

There is potential space for a replacement inlet station within the Enatai Beach Park south parking lot, north of the existing inlet station. Locating the inlet station within the parking lot would either involve relocating the Americans with Disabilities Act (ADA) accessible parking spaces, or relocating a portion of the storm drainage system within the parking lot. The location shown on **Figure 1** would involve storm drainage relocation, the cost of which is accounted for in the site improvements portion of the planning level cost estimate presented later. Approximately 75 feet of 12-inch water main would be required to connect the proposed vaults to the 12-inch SPU tap and the 12-inch City of Bellevue water main.

This alternative would also involve re-striping the parking lot. The re-striping would prevent parking over the proposed City of Bellevue vault and allow parking in the space above the existing vault where parking is currently not allowed. The proposed SPU vault is shown within park's sidewalk, similar to the SPU vault for the existing inlet station. Access to the SPU meter vault for maintenance would require partial closure of the sidewalk to ensure pedestrian safety. It is anticipated that SPU will infrequently access the vault for monitoring and maintenance a minimum of one time per year.

Site Alternative 2 – In Planter Area Near SE Lake Road Cul-De-Sac

The replacement inlet station could be located within a planter area along SE Lake Road. The SPU and City of Bellevue vaults would not be in the path of vehicular traffic and would not occupy the Park's existing parking space. This alternative relies on the parking space adjacent to the planter area for City maintenance vehicles. Installation of the vaults would require the removal of trees located within the planter area and the relocation of a light pole. The removal and relocation of these items is accounted for in the site improvements line item of this alternative's cost estimate.

Approximately 460 feet of 12-inch ductile iron water main would be required to connect the SPU vault to the 12-inch SPU tap. An additional 520 feet of 12-inch main is needed to connect the City of Bellevue vault to the City of Bellevue's 12-inch water main. As this water main will be installed within the SE Lake Road travel lane, this alternative will require additional traffic control to guide homeowners and park visitors in the area during construction of the proposed improvements.

This alternative location is in close proximity to the Limited Access ROW, which may increase costs of this alternative in two ways. This alternative would require temporary construction impacts within the Limited Access ROW that would increase permitting and landscaping restoration costs. It is also possible that engineered shoring would need to be designed in advance and reviewed by WSDOT and FHWA to avoid any excavation in the Limited Access ROW. An allowance for these costs is included in the "Bellevue Vault" and "Site Improvements" portion of the cost estimate presented below.

Alternative 3 – Within SE Lake Road Travel Lane

The third alternative is to locate the replacement inlet station within SE Lake Road. **Figure 1** shows the location of the proposed vaults within the west-bound travel lane of SE Lake Road as the east-bound travel lane is occupied by an existing gas line and the north shoulder contains a drainage swale. With this alternative, regular maintenance access to the vault by the City's maintenance crew would require substantial additional labor (second crew to perform traffic control), would impact traffic for local residents, and is not a desirable location for safety reasons. This alternative would require approximately 240 feet of 12-inch ductile iron main upstream of the SPU vault and approximately 290 feet of 12-inch pipe downstream of the PRV vault.

Planning Level Cost Estimates

Planning level project cost estimates were developed for each of the site alternatives, as shown in **Tables 2, 3, and 4**. The cost of the vault for the inlet station and the SPU meter vault comprise all mechanical and electrical components inside the vault as well as installation. The opinion of project costs are planning-level preliminary estimates of project costs prepared on the basis of limited available project information. The project costs are expected to change in the future as new and more detailed information is collected as the project evolves from planning through design and to construction. Project costs should be revised as the design is further refined.

The total project cost for Alternative 2 is the largest of the alternatives. This is primarily due to the additional length of water main installation required. Water main installation for Alternative 2 exceeds that of Alternatives 3 by \$160,000 and that of Alternative 1 by \$320,000. The cost for the Bellevue vault for Alternative 1 exceeds the vault costs for the other alternatives due to its proximity to Lake Washington and anticipated need for additional dewatering and shoring. Alternative 1 has the lowest overall project cost, primarily due to the proposed vaults close proximity to the existing 12-inch SPU tap and City of Bellevue 12-inch water main, resulting in less water main improvements and associated costs.

Table 2
Alternative 1 (In Parking Lot) Project Cost Estimate

Item No.	Description	Estimated Cost
1	Bellevue Vault	\$590,000
2	SPU Vault	\$110,000
3	Site Improvements	\$80,000
4	12-inch Water Main (70 LF)	\$50,000
Construction Cost Estimate Subtotal		\$830,000
Sales Tax (10.0%)		\$83,000
Construction Cost Estimate Total Without Contingency		\$913,000
Soft Costs (Consultant Design & Construction Support, City Staff Labor, Permits / Other) (55%)		\$502,000
Construction & Soft Costs Total		\$1,415,000
Project Contingency (30%)		\$425,000
Total Project Cost with Contingency		\$1,840,000

Table 3
Alternative 2 (Planter Area Near SE Lake Rd. Cul-de-sac) Project Cost Estimate

Item No.	Description	Estimated Cost
1	Bellevue Vault	\$580,000
2	SPU Vault	\$110,000
3	Site Improvements	\$75,000
4	12-inch Water Main (980 LF)	\$370,000
Construction Cost Estimate Subtotal		\$1,135,000
Sales Tax (10.0%)		\$113,500
Construction Cost Estimate Total Without Contingency		\$1,248,500
Soft Costs (Consultant Design & Construction Support, City Staff Labor, Permits / Other) (55%)		\$687,000
Construction & Soft Costs Total		\$1,935,500
Project Contingency (30%)		\$581,000
Total Project Cost with Contingency		\$2,520,000

Table 4
Alternative 3 (SE Lake Road Travel Lane) Project Cost Estimate

Item No.	Description	Estimated Cost
1	Bellevue Vault	\$545,000
2	SPU Vault	\$110,000
3	Site Improvements	\$65,000
4	12-inch Water Main (530 LF)	\$210,000
Construction Cost Estimate Subtotal		\$930,000
Sales Tax (10.0%)		\$93,000
Construction Cost Estimate Total Without Contingency		\$1,023,000
Soft Costs (Consultant Design & Construction Support, City Staff Labor, Permits / Other) (55%)		\$563,000
Construction & Soft Costs Total		\$1,586,000
Project Contingency (30%)		\$476,000
Total Project Cost with Contingency		\$2,060,000

Evaluation of Siting Alternatives

The criteria used to evaluate the site alternatives were discussed and determined at a workshop with City staff on November 7, 2017. The criteria include the overall cost of the alternatives, the risk associated with the proximity to I-90 and limited access right-of-way, and maintenance access risk.

Project Costs

Alternative 1 has the lowest overall cost due to its proximity to the SPU tap and City of Bellevue water mains. This alternative has a total project cost with contingency of approximately \$220,000 lower than Alternative 3, and \$680,000 lower than Alternative 2.

During the workshop, several potential ways to reduce the cost of Alternative 2 were discussed. One potential cost saving alternative would be to provide a new tap to the SPU Mercer Island Pipeline near the proposed vault location. This would reduce the amount of water main required by approximately 50 percent. A new Mercer Island pipeline tap would add risk to the project, and could be rejected by SPU. The potential for this alternative to include replacement of the existing asbestos cement (AC) water main in SE Lake Road and share a portion of the cost for this alternative with the City's AC water main replacement program was also discussed. If both of these potential cost savings are incorporated, the total estimated project cost for Alternative 2 would be reduced to approximately \$2,106,000, which is still \$266,000 higher than Alternative 1.

WSDOT / FHWA Approval Requirements

All alternatives are located in the general WSDOT ROW, and will require approval from WSDOT. Under most recent franchise agreements with WSDOT, the City is required to relocate improvements at the City's cost if required by a WSDOT project. Relocating the new inlet station would add cost and water supply interruption if required in the future. Although WSDOT has no current plans to expand I-90 or impact the portion of the right-of-way near the inlet station, this potential represents a risk in the future.

In the workshop, the City expressed the view that placing the new facility as close as possible to the existing inlet station will increase the likelihood that the inlet station project could be considered a maintenance project during WSDOT permitting or franchise negotiations. Additionally, it was generally agreed that the risk for WSDOT requiring the inlet station to be relocated in the future increases by being closer to I-90.

The location of Alternative 1 improvements is closest to the existing inlet station and furthest from the Limited Access Right-of-Way. This location provides the lowest uncertainty and risk of complications from WSDOT.

Alternative 2 is the closest to I-90 and the furthest from the existing inlet station. This location increases both the risk of WSDOT approval being denied, and the long-term risk of needing to relocate the facility if I-90 right-of-way is improved in the future. Additionally, Alternative 2 would require temporary disturbance within the Limited Access Right-of-Way, necessitating FHWA review and approval.

Alternative 3 provides a location that is further from I-90 and the Limited Access Right-of-Way than alternative 2, but closer than Alternative 1.

Maintenance Access Risk

The proposed inlet station must be located to enable safe access by City staff for regular operations and maintenance activities.

Alternative 1 would provide a striped pavement area to prevent parking over the vault hatches. This is similar to the existing inlet station. Unlike the existing inlet station, Alternative 1 would provide an improved vault with better internal layout for maintenance and hatch locations to facilitate control valve maintenance and removal. City operations staff expressed that the existing location within the parking lot is less than ideal for maintenance purposes when the parking lot is full.

Alternative 2 provides the best location of all three alternatives for maintenance access. Its location within the planter area avoids the need for traffic control or striping a parking space. Additionally, the adjacent parking lot provides a nearby area for staff to park during maintenance activities. The distance of this location from Enatai Beach Park reduces park impacts, and allows City crews to perform work without interruption from park activities.

Alternative 3 would require traffic control any time maintenance is performed, which increases the long-term cost of the alternative. Additionally, the location in the travel lane increases the risk to staff safety during maintenance activities.

Construction Scheduling

The selected alternative will need to be constructed outside of the park's busy season, which extends from early June through early September, to minimize impacts to Enatai Beach Park users. Alternative 1 is expected to require the shortest on-site construction period due to the least amount of water main improvements. Alternatives 2 and 3 are estimated to require approximately four weeks longer than Alternative 1 for on-site construction.

Alternative 1 has a total estimated on-site construction time of approximately three months. Prior to the on-site construction, additional time will be required for pre-construction activities such as submittal reviews and material procurement. It is recommended that a pre-construction window of approximately four months for material procurement be allowed in the construction contract due to specialty valves and instrumentation that may have long lead times. This estimated schedule is a planning-level preliminary estimate prepared on the basis of limited available project information. Additionally, many factors such as material availability and weather may impact the required construction time.

Consideration of other projects planned in the Enatai Beach Park area should also be made when scheduling construction of the selected alternative. The Sound Transit East Link project will be using a portion of the park from staging from 2017 to 2019. Additionally, the King County Enatai interceptor project is planned to pass through the park and is scheduled for construction from 2021 to 2023. Ideally, the Enatai inlet station improvement project would be constructed without impacts from these two other projects, which could be accomplished by scheduling the project after Sound Transit leaves the area in 2019 and prior to the King County project in 2021.

The WSDOT approval process should also be accounted for in overall project scheduling. WSDOT staff estimates the franchise / permit approval process to take approximately four to six months.

Summary and Conclusion

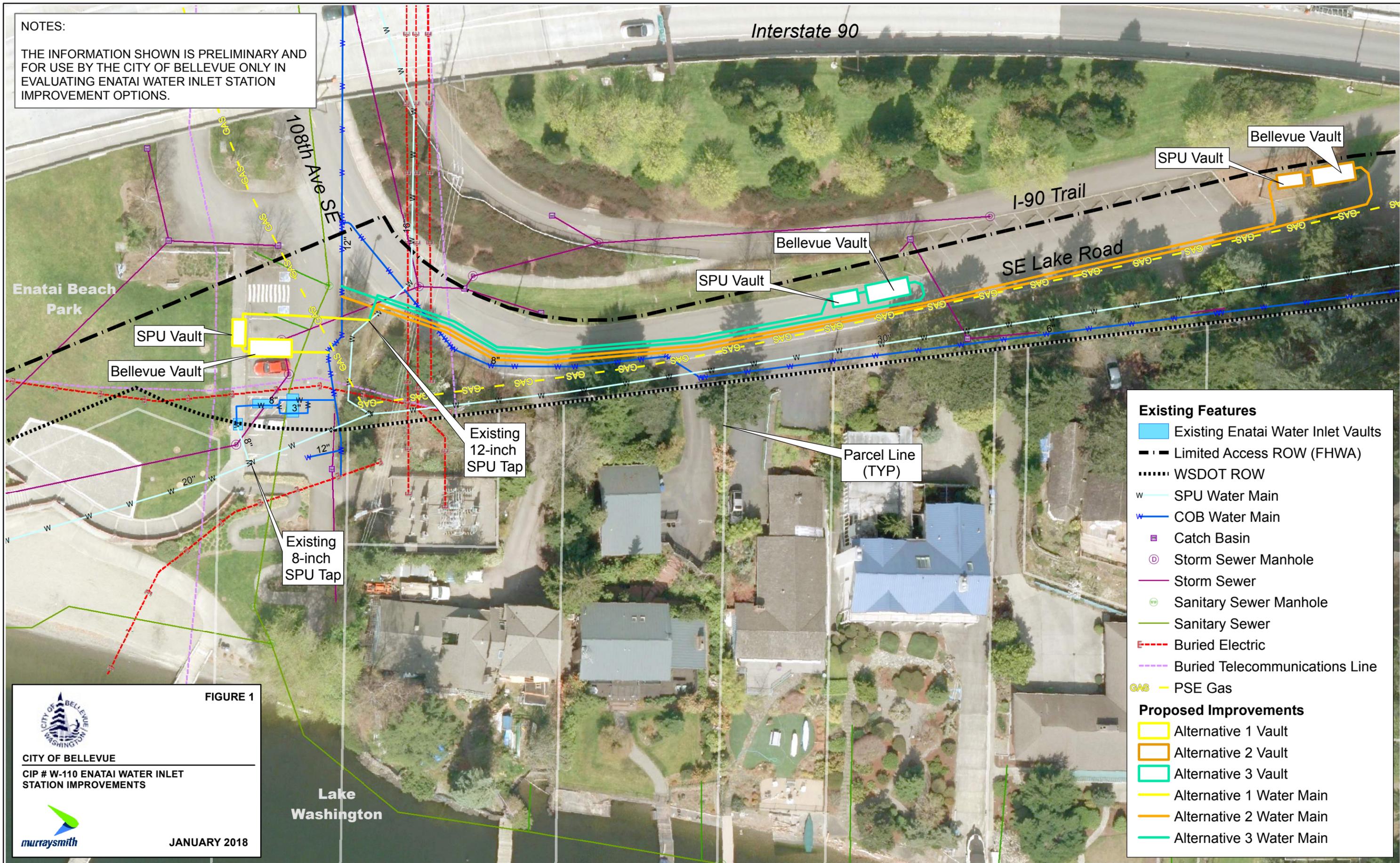
Table 5 presents a summary of the key criteria used in the alternatives evaluation. Alternatives 2 and 3 have higher project costs and higher levels of risk related to WSDOT franchise approval. Alternative 3 also has poor characteristics related to its location for maintenance access. Based upon the scoring of these criteria, Alternative 1 is the preferred location for the proposed inlet station.

Table 5
Alternative Comparison Summary

Alternative	Project Costs	WSDOT Risk	Maintenance Access Risk	Total Score
1	Low (1)	Low (1)	Med (2)	4
2	High (3)	High (3)	Low (1)	7
3	Med (2)	Med (2)	High (3)	7

Scoring: Low = 1, Med = 2, High = 3. The lowest score has the lowest cost / risk.

NOTES:
 THE INFORMATION SHOWN IS PRELIMINARY AND FOR USE BY THE CITY OF BELLEVUE ONLY IN EVALUATING ENATAI WATER INLET STATION IMPROVEMENT OPTIONS.



- Existing Features**
- Existing Enatai Water Inlet Vaults
 - Limited Access ROW (FHWA)
 - WSDOT ROW
 - SPU Water Main
 - COB Water Main
 - Catch Basin
 - Storm Sewer Manhole
 - Storm Sewer
 - Sanitary Sewer Manhole
 - Sanitary Sewer
 - Buried Electric
 - Buried Telecommunications Line
 - PSE Gas
- Proposed Improvements**
- Alternative 1 Vault
 - Alternative 2 Vault
 - Alternative 3 Vault
 - Alternative 1 Water Main
 - Alternative 2 Water Main
 - Alternative 3 Water Main

FIGURE 1



CITY OF BELLEVUE
 CIP # W-110 ENATAI WATER INLET STATION IMPROVEMENTS



JANUARY 2018

Scale: 1" = 40'

