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8.1 Objective

This technical memorandum (TM) summarizes alternatives considered for the sanitary conveyance system capital improvement program including methodology for comparing alternative costs and methodology for non-cost scoring used to select preferred sanitary conveyance system improvements.

8.2 Summary

The sanitary conveyance system was evaluated for capacity deficiencies for existing and future conditions. Available condition data in the system was reviewed to define opportunities to align capacity improvements with required system rehabilitation for the Fanno Creek Interceptor. Improvement alternatives were identified specifically for the Fanno Creek Interceptor and Metzger Trunk which have experience surcharging and overflows during winter storm events in the past 5 years. Recent surcharging was observed in the Fanno Creek Interceptor and overflows were observed adjacent to the Metzger Trunk in January 2021 for a storm event approximating the 5-year design storm.

The alternatives analysis considered life cycle cost and feasibility of gravity pipeline improvements, wet weather storage improvements, wet weather pumping improvements, and several hybrid alternative scenarios. All the alternatives considered a range of rainfall derived infiltration and inflow reduction (RDI/I). A wet weather pump station was selected as the preferred alternative for the Fanno Creek Interceptor and pipeline capacity upgrades were selected as the preferred alternative for the Metzger Trunk.

Additional analysis was performed to confirm improvements to accommodate growth in the Cities of Beaverton, Tigard, King City, Sherwood, and Tualatin. These growth-related improvements were originally identified in the city master planning documents as well as during the Upper Tualatin Interceptor Project 6493 (Clean Water Services, March 2017).

8.3 References

This TM references the following:

- TM 3 – Climate Sensitivity.
- TM 5 – Flow Development.
- TM 7 – Infiltration and Inflow Evaluation.
- TM 9 – Conveyance Implementation Plan.
- Condition Assessment Project (Brown and Caldwell (B&C), 2008).
- Fanno Creek Trunkline Study (Dean, Wyatt, 2016).
- Upper Tualatin Interceptor Project #6493 (Clean Water Services, CH2M, March 2017).
8.4 System Deficiencies Review

Prior to completion of the improvement alternatives analysis, the system was evaluated for deficiencies during existing and future conditions. In addition to system deficiency mapping presented in this TM for 2020 (Figure 8.1), 2040 (Figure 8.2), and buildout (Figure 8.5), the system deficiencies mapping for incremental time periods [2025 (Figure 7B.1), 2030 (Figure 7.6), and 2035 (Figure 7B.2)] can be found in TM 7, Infiltration, and Inflow Evaluation. The system deficiencies as well as the criteria are summarized below.

8.4.1 System Deficiency and Improvement Criteria

The District criteria for establishing sanitary conveyance system deficiencies are presented in Tables 8.1 and 8.2. For sanitary sewer pipelines, the criteria focus on allowable surcharging above the pipe crown during a wet weather 5-year design storm event. For pump stations, the criteria focus on pumping peak wet weather flows with the largest pump out of service (firm capacity) and maximum force main velocity. Maximum velocity and minimum scouring velocity for gravity pipelines are considered secondary criteria and are indicative of undersized or oversized piping, respectively.

The capacity deficiency criteria for this plan assume a high risk to property and health when the surcharged pipeline hydraulic grade line (HGL) is within 3 feet of the ground surface and a moderate to low risk when the surcharged HGL is within 10 feet of the ground surface during the 5-year design storm. The District HGL criteria are summarized in Table 8.2 based on allowable freeboard during the 5-year design storm event and District HGL deficiency codes. The code includes a two-letter designation where:

- **First letter:**
  - L = HGL daylights (zero freeboard).
  - H = HGL high (zero to 3 feet of freeboard).
  - I = HGL intermediate (3 to 10 feet of freeboard).
  - D = HGL deep (greater than 10 feet of freeboard).

- **Second letter:**
  - S = HGL slope is at least 5-percent greater than the pipe slope indicating that the pipeline is undersized and may cause a backwater impact.
  - H = HGL slope is less than 5-percent greater than the pipe slope indicating that the pipe has adequate capacity and does not create a significant backwater impact.

- **Other:**
  - OK = HGL is within the pipe crown.

- City of Tigard, Engage Tigard website, Fanno Creek Alignment Study (Tigard, 2020).
- Metro, Southwest Corridor website, Southwest Corridor Plan (Metro, 2020):
Table 8.1  District Sanitary Conveyance System Design Criteria for Establishing System Deficiencies and Improvements

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Category</th>
<th>Criteria</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum water depth to diameter ratio during dry weather conditions</td>
<td>0.8</td>
<td>When the depth to diameter ratio exceeds 0.9, the pipe begins to lose gravity capacity due to greater frictional loss</td>
<td></td>
</tr>
<tr>
<td>Minimum freeboard during 5-year design storm, (clearance from water surface to manhole rim)</td>
<td>3 feet minimum, HGL categories determine risk (Table 8.2)</td>
<td>The District standard considers risk of overflow when prioritizing improvements</td>
<td></td>
</tr>
<tr>
<td>Pump station firm capacity</td>
<td>Pump stations have capacity to pump at flows greater than or equal to peak hour flows with largest pump out of service</td>
<td>The firm capacity criteria protect against loss of service during equipment failure and allows for pump cycling for longer equipment life</td>
<td></td>
</tr>
<tr>
<td>Maximum force main velocity</td>
<td>8.0 fps</td>
<td>The velocity criteria protect against excessive head loss and allows pumps to operate efficiently</td>
<td></td>
</tr>
<tr>
<td>Maximum gravity pipeline velocity</td>
<td>Less than 15.0 fps or energy dissipation structure</td>
<td>The maximum velocity criteria protect pipelines from turbulent flow conditions and excessive air entrainment</td>
<td></td>
</tr>
<tr>
<td>Minimum cleansing/scouring velocity, gravity pipeline</td>
<td>2.0 fps</td>
<td>Pipe diameters and minimum slopes should be selected to prevent solids deposition, with a minimum pipe diameter of 8-inches</td>
<td></td>
</tr>
<tr>
<td>Minimum cleansing/scouring velocity of force mains</td>
<td>3.5 fps</td>
<td>Pipe diameters should be selected to prevent solids deposition, with a minimum pipe diameter of 4 inches</td>
<td></td>
</tr>
</tbody>
</table>

Note: Abbreviation: fps – feet per second.
Table 8.2  District Freeboard Criteria and HGL Codes for Wet Weather Deficiencies

<table>
<thead>
<tr>
<th>HGL Status</th>
<th>System Response</th>
<th>Risk Level</th>
<th>Action</th>
<th>Color Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>LS(1)</td>
<td>Overflow or pressure with significant HGL increase</td>
<td>High</td>
<td>Improve</td>
<td>Red</td>
</tr>
<tr>
<td>LH</td>
<td>Overflow or pressure</td>
<td>High</td>
<td>Improve</td>
<td>Yellow</td>
</tr>
<tr>
<td>HS(1)</td>
<td>Less than 3 feet freeboard with significant HGL increase(1)</td>
<td>High</td>
<td>Improve</td>
<td>Orange</td>
</tr>
<tr>
<td>HH</td>
<td>Less than 3 feet freeboard</td>
<td>High</td>
<td>Improve</td>
<td>Brown</td>
</tr>
<tr>
<td>IS(1)</td>
<td>3 to 10 feet freeboard with significant HGL increase</td>
<td>Low</td>
<td>Improve(2)</td>
<td>Purple</td>
</tr>
<tr>
<td>IH</td>
<td>3 to 10 feet freeboard</td>
<td>Low</td>
<td>None</td>
<td>Pink</td>
</tr>
<tr>
<td>DS(1)</td>
<td>Greater than 10 feet freeboard with significant HGL increase</td>
<td>Negligible</td>
<td>None</td>
<td>Light Blue</td>
</tr>
<tr>
<td>DH</td>
<td>Surcharged MH with greater than 10 feet freeboard</td>
<td>Negligible</td>
<td>None</td>
<td>Dark Green</td>
</tr>
<tr>
<td>OK</td>
<td>HGL below pipe crown</td>
<td>Negligible</td>
<td>None</td>
<td>Light Green</td>
</tr>
</tbody>
</table>

Notes:
(1) A significant increase in HGL indicates that the peak flow rate exceeds the full flow capacity of the pipeline. This “S” designation in the HGL Status is given to pipelines where the HGL slope exceeds the pipeline slope by greater than 5 percent, causing a backwater impact in the upstream system.
(2) Improve in some cases. Improvement decision based on review of localized risks.

Oregon Department of Environmental Quality (DEQ) guidelines (Oregon Administrative Rule 340-041-0009) indicate that sanitary sewer overflows are prohibited except during a winter storm event exceeding the one in five-year frequency and a summer storm event exceeding the one in ten-year frequency. As described in TM 5, Flow Development, the District developed a 5-year design storm specifically for the East Basin to address the DEQ requirement. The design storm is a 3.6-inch, 72-hour event. The maximum hourly precipitation during the design storm is 0.28 inches per hour.

As described in TM 3, Climate Sensitivity, climate sensitivity storms are used to test the sensitivity of the system to potential changes in storm frequency and storm intensity with time. The climate storms were not used to specifically identify system deficiencies by 2040 but were used to consider oversizing infrastructure improvements to accommodate future conditions with increased climate risk. The climate sensitivity storms are described below:

- 5-year sensitivity storm, frequency (design storm+) – The frequency sensitivity storm utilizes the design storm distribution with an increased depth to account for 10-percent frequency change by 2050 (3.7-inch storm depth in 72-hours, 0.29 inches per hour maximum intensity)
- 5-year sensitivity storm, intensity (design storm + intensity) – The intensity sensitivity storm increases the maximum hour intensity of the design storm by 19-percent (3.7-inch storm depth in 72-hours, 0.34 inches per hour maximum intensity)
8.4.2 Existing System Deficiencies

The major system deficiencies related to existing wet weather system response during the 5-year design storm event are shown in Figure 8.1 and described below:

- **Fanno Creek Interceptor** – The interceptor has experienced historical surcharging and pressurized conditions (where manhole lids are sealed) during storm events approximating the 5-year design storm frequency or greater.
- **Metzger Trunk** – The sewer trunk has experienced historical surcharging and overflows at a linear storage facility adjacent to the trunk near SW 89th Avenue during storm events approximating the 5-year design storm frequency or greater. The overflow risk is increased when the Fanno Creek Interceptor produces a backwater effect into the tributary Metzger Trunk line. Recent surcharging was observed in the Fanno Creek Interceptor and overflows were observed adjacent to the Metzger Trunk in January 2021 for a storm event approximating the 5-year design storm.
- **Summer Creek/Scholls Trunk** – The sewer trunk has experienced historical surcharging during storm events approximating the 5-year design storm frequency or greater. To alleviate surcharging in the trunk during winter storms, a second River Terrace North Pump Station Force Main was constructed (2018-2019) which diverts flow away from the Summer Creek/Scholls Trunk to the River Terrace South Pump Station. Surcharging has been eliminated since this project was complete.
- **West (W) Tektronix Interceptor and other tributary sewers to the Tektronix Pump Station** (Beaverton) – The interceptors experience surcharging including risk of overflows during the 5-year design storm event. Current RDI/I reduction projects are being designed and constructed in the residential neighborhood upstream of the Tektronix Interceptor.

Additional existing system deficiencies where infrastructure experience low risk surcharging during the design storm event include:

- **Leron/Tigard Trunk Southwest and Northeast of the Fanno Creek Interceptor** (Tigard).
- **Triburary sewer to the Fanno Pump Station** (Washington County, Beaverton, Portland).
- **Hiteon Trunk** (Beaverton).
- **Cipole/Bluff Trunk** (Tualatin).
- **Sherwood Trunk** (Sherwood).
- **Rock Creek Trunk** (Sherwood).
Figure 8.1  East Basin, 2020 Sanitary Conveyance System Capacity Needs (Deficiencies), 5-year Design Storm
Clean Water Services, East Basin Master Plan

Pump Station Capacity
- Exceeds Firm Capacity
- Near Firm Capacity (monitor station)
- Adequate Firm Capacity
- Planned Decommissioning

Force main or Siphon Capacity
- Velocity > 10 fps
- Velocity > 7 fps
- Velocity <= 7 fps

Gravity Pipeline Capacity
- LS, surcharged, overflow risk
- LH, backwater, overflow risk
- HS, surcharged, < 3 ft freeboard
- HH, backwater, < 3 ft freeboard
- IS, surcharged, <= 10 ft freeboard
- IH, backwater, <= 10 ft freeboard
- DS, surcharged, > 10 ft freeboard
- DH, backwater, > 10 ft freeboard
- OK, not surcharged

Growth Area
- RDII Rate Assumed 2,500 gpnad
- RDII Rate (gpnad)
  - <= 2,500 gpnad
  - <= 4,000 gpnad
  - <= 5,000 gpnad
  - <= 6,000 gpnad
  - <= 7,500 gpnad
  - <= 10,000 gpnad
  - <= 12,500 gpnad
  - <= 15,000 gpnad
  - > 15,000 gpnad

gpnad = gallons per net acre per day
ft = feet, fps = feet per second
8.4.3 Future System Deficiencies

The system deficiencies related to wet weather system response for future conditions (2040) are located in similar interceptors and trunks as the existing analysis, however, the hydraulic deficiencies increase over time as a result of system in-fill or green-field development. The critical deficiencies for future conditions associated with growth and wet weather response during the 5-year design storm event are described below. Improvement alternatives to address major system improvements including the Fanno Creek Interceptor and Metzger Trunk are documented in this TM. Projects are defined to address all system capacity deficiencies as documented in the Capital Improvement Program (TM 9, Conveyance System Implementation Plan):

- **Fanno Creek Interceptor** – Existing surcharge deficiencies (IS to HS) and projected overflows by 2030.
- **Metzger Trunk** – Existing overflows and increasing overflows projected by 2025 (LS).
- **Summer Creek/Scholls Trunk** – Existing surcharge deficiencies and projected overflows eliminated for future conditions by diverting flows south with the River Terrace North Pump Station. Currently the River Terrace North Pump Station has the option to discharge either to the Summer Creek Trunk or to discharges to the Roy Rogers Road Trunk which then discharges to the River Terrace South Pump Station. For all wet weather analysis, the south diversion was assumed active to minimize impact to both the Summer Creek Trunk and the Fanno Creek Interceptor. Both the River Terrace North and River Terrace South Pump Stations are identified as deficient by 2025 due to projected growth in the Cities of Beaverton, Tigard, and King City.
- **Tributary sewer to the Fanno Pump Station** (Washington County, Beaverton, Portland) – Existing surcharge deficiencies (IS) remain similar through 2040.
- **W Tektronix Interceptor and other tributary sewers to the Tektronix Pump Station** (Beaverton) – Existing surcharge deficiencies and overflows remain similar through 2040 (IS to LS). Current RDII reduction projects are being designed and constructed in the vicinity of the W Tektronix Interceptor.
- **Cedar Hill Interceptor** (Beaverton) – Surcharge deficiencies (IS) projected by 2025 and more severe deficiencies (HS) projected by 2030. Local flow monitoring recommended to confirm system deficiencies.
- **Hiteon Trunk** (Beaverton) – Existing surcharge deficiencies (IS) increasing slightly by 2040 (HS). Local flow monitoring recommended to confirm system deficiencies.
- **Leron/Tigard Trunk Southwest of the Fanno Creek Interceptor** (Tigard) – Existing surcharge deficiencies remain similar through 2040 (IS to HS). Local flow monitoring recommended to confirm system deficiencies.
- **Leron/Tigard Trunk Northeast of the Fanno Creek Interceptor** (Tigard) – Surcharge deficiencies projected in 2025 with overflow risks projected by 2030 (IS to LS). Local flow monitoring recommended to confirm system deficiencies.
- **Sherwood Trunk** (Sherwood) – Existing surcharge deficiencies (IS) expanding to more severe surcharge deficiencies and extents in each 5-year increment to 2040 (IS to HS). Deficiencies due to in-fill growth, Brookman Area growth, and West Urban Reserve growth in the City of Sherwood.
• **Rock Creek Trunk** (Sherwood) – Existing surcharge deficiencies (IS/DS) expanding to more severe deficiencies (IS/HS) by 2040. Deficiencies due to in-fill growth and Tonquin Employment Area growth in the City of Sherwood.

• **SW Katherine Lateral** (Tigard) – Surcharge deficiencies (IS) projected by 2040. Local flow monitoring recommended to confirm system deficiencies.

• **128th Ave Lateral** (Tigard) – Limited pipeline segments experience existing surcharge deficiency (HS). Additional surcharge deficiencies (IS) projected by 2030. Local flow monitoring recommended to confirm system deficiencies.

• **Bonita Trunk** (Beaverton) – Existing surcharge deficiencies (IS) expanding to more severe deficiencies (HS/LS) by 2030. Local flow monitoring recommended to confirm system deficiencies.

• **Cipole/Bluff Trunk** (Tualatin) – Existing surcharge deficiencies (IS) expanding to more severe deficiencies (IS/HS) by 2030. Local flow monitoring recommended to confirm system deficiencies. Increase in system risk due to growth in southwest Tualatin.

• **Tualatin Reservoir Trunk** (Tualatin) – Surcharge deficiencies (IS/DS) projected by 2025 with more severe deficiencies (IS/HS) by 2035 and (LS) 2040. Deficiencies due to in-fill growth and Basalt Creek Area growth in the City of Tualatin.

• **103rd Ave Trunk** (Tualatin) – Existing surcharge deficiencies (IS/DS) expanding to more severe deficiencies (IS/HS) by 2035. Deficiencies due to in-fill growth and Basalt Creek Area growth in the City of Tualatin.

• **Sherwood Trunk** (Tualatin) – Surcharge deficiencies (IS) projected by 2025 with more severe deficiencies (HS) by 2030. Deficiencies due to in-fill growth and Basalt Creek Area growth in the City of Tualatin.

• **Martinazzi Trunk** (Tualatin) – Existing surcharge deficiencies (IS) expanding to more severe deficiencies (HS/LS) by 2035. Deficiencies due to in-fill growth and Basalt Creek Area growth in the City of Tualatin.

• **Fuller Drive Sewer** (Tualatin) – Surcharge deficiencies (IS/DS) projected by 2030. Deficiencies due to Basalt Creek Area growth in the City of Tualatin.
Figure 8.2  East Basin, 2040 Sanitary Conveyance System Capacity Needs (Deficiencies), 5-year Design Storm
Clean Water Services, East Basin Master Plan

Pump Station Capacity
- Exceeds Firm Capacity
- Near Firm Capacity (monitor station)
- Adequate Firm Capacity
- Planned Decommissioning

Force main or Siphon Capacity
- Velocity > 10 fps
- Velocity > 7 fps
- Velocity <= 7 fps

Gravity Pipeline Capacity
- LS, surcharged, overflow risk
- LH, backwater, overflow risk
- HS, surcharged, < 3 ft freeboard
- HH, backwater, < 3 ft freeboard
- IS, surcharged, < 10 ft freeboard
- IH, backwater, < 10 ft freeboard
- DS, surcharged, > 10 ft freeboard
- DH, backwater, > 10 ft freeboard
- OK, not surcharged

Growth Area
- RDII Rate Assumed 2,500 gpnad
- RDII Rate (gpnad)
  - <= 2,500 gpnad
  - <= 4,000 gpnad
  - <= 5,000 gpnad
  - <= 6,000 gpnad
  - <= 7,500 gpnad
  - <= 10,000 gpnad
  - <= 12,500 gpnad
  - <= 15,000 gpnad
  - > 15,000 gpnad

gpnad = gallons per net acre per day
ft = feet, fps = feet per second

09/2021
8.4.4 System Condition for the Fanno Creek Interceptor

The condition of the Fanno Creek Interceptor was specifically reviewed during the improvement alternatives analysis to identify potential rehabilitation costs for alternatives where the interceptor was not upsized.

In 2015, 5.5 miles of the Fanno Creek Interceptor was inspected using closed circuit television (CCTV) and documented using the Pipeline Assessment and Certification Program (PACP) rating system from the National Association of Sewer Service Companies (NASSCO). The interceptor was also inspected in 2008 and condition was documented by Brown and Caldwell (B&C, 2008) using the same rating system. For the East Basin Master Plan, a compilation of the 2015 and 2008 work was provided in a document entitled “Fanno Creek Trunkline Study” (Dean, 2016). The summary information from the document was used to estimate cost of repair of the Fanno Creek Interceptor for use in the improvement alternatives analysis.

The summary document identified 4.6 miles of pipeline and manhole condition deficiencies with minor to major structural issues, H2S issues, and leaks causing susceptibility to groundwater and RDI/I influence. The condition assessment work also identified a 24-inch stubout that creates a hydraulic bottleneck near manhole 10906. A map summarizing the Fanno Creek Interceptor condition deficiencies is provided in Figure 8.3. Photographs of example system deficiencies are presented in Figures 8.4a and 8.4b. Specific types and quantities of deficiencies are shown in Tables 8.3a, 8.3b, and 8.3c.

Table 8.3a  Fanno Creek Interceptor Condition Summary (Manholes)

<table>
<thead>
<tr>
<th>Manhole Condition</th>
<th>Manhole Count</th>
<th>Priority for Repair</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obstruction</td>
<td>1</td>
<td>High</td>
</tr>
<tr>
<td>Leaking/H2S/Spalling</td>
<td>1</td>
<td>High</td>
</tr>
<tr>
<td>Leaking/H2S</td>
<td>17</td>
<td>High</td>
</tr>
<tr>
<td>Leaking</td>
<td>5</td>
<td>Medium</td>
</tr>
<tr>
<td>H2S</td>
<td>12</td>
<td>Medium</td>
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</tbody>
</table>

Table 8.3b  Fanno Creek Interceptor Condition Summary (Pipeline Leaking)

<table>
<thead>
<tr>
<th>Pipeline Condition (leaking and infiltration)</th>
<th>Priority for Rehabilitation</th>
<th>Length (feet)</th>
<th>Diameter (inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weeper/Dripper/Runner/Gusher/Jump</td>
<td>High</td>
<td>600</td>
<td>60</td>
</tr>
<tr>
<td>Weeper/Runner/Gusher</td>
<td>High</td>
<td>600</td>
<td>60</td>
</tr>
<tr>
<td>Dripper/Runner/Jump/High Water Level</td>
<td>Medium</td>
<td>500</td>
<td>60</td>
</tr>
<tr>
<td>High Water Level</td>
<td>Medium</td>
<td>100</td>
<td>60</td>
</tr>
<tr>
<td>Runner</td>
<td>Medium</td>
<td>2,600</td>
<td>54-60</td>
</tr>
<tr>
<td>Runner/High Water Level</td>
<td>Medium</td>
<td>500</td>
<td>54</td>
</tr>
<tr>
<td>Stain/Runner</td>
<td>Medium</td>
<td>500</td>
<td>60</td>
</tr>
<tr>
<td>Stain/Weeper/Runner</td>
<td>Medium</td>
<td>1,000</td>
<td>60</td>
</tr>
<tr>
<td>Weeper</td>
<td>Medium</td>
<td>700</td>
<td>60</td>
</tr>
<tr>
<td>Weeper/Dripper</td>
<td>Medium</td>
<td>1,600</td>
<td>48-60</td>
</tr>
<tr>
<td>Pipeline Condition (leaking and infiltration)</td>
<td>Priority for Rehabilitation</td>
<td>Length (feet)</td>
<td>Diameter (inch)</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>----------------------------</td>
<td>---------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Weeper/Dripper/Runner/Jump</td>
<td>Medium</td>
<td>1,300</td>
<td>60</td>
</tr>
<tr>
<td>Weeper/Dripper/Runner/Stain</td>
<td>Medium</td>
<td>800</td>
<td>54</td>
</tr>
<tr>
<td>Weeper/Jump</td>
<td>Medium</td>
<td>2,500</td>
<td>60</td>
</tr>
<tr>
<td>Weeper/Runner</td>
<td>Medium</td>
<td>400</td>
<td>60</td>
</tr>
<tr>
<td>Weeper/Runner/Jump</td>
<td>Medium</td>
<td>500</td>
<td>60</td>
</tr>
<tr>
<td>Dripper</td>
<td>Low</td>
<td>800</td>
<td>30-60</td>
</tr>
<tr>
<td>Dripper/Jump</td>
<td>Low</td>
<td>300</td>
<td>60</td>
</tr>
<tr>
<td>Dripper/Stain</td>
<td>Low</td>
<td>400</td>
<td>54</td>
</tr>
<tr>
<td>Stain</td>
<td>Low</td>
<td>2,300</td>
<td>54-60</td>
</tr>
<tr>
<td>Stain/Jump</td>
<td>Low</td>
<td>1,500</td>
<td>60</td>
</tr>
</tbody>
</table>

Table 8.3c  Fanno Creek Interceptor Condition Summary (Pipeline Structural)

<table>
<thead>
<tr>
<th>Pipeline Condition (leaking and infiltration)</th>
<th>Priority for Rehabilitation</th>
<th>Length (feet)</th>
<th>Diameter (inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H2S (corrosion)/Exposed Aggregate</td>
<td>High</td>
<td>300</td>
<td>60</td>
</tr>
<tr>
<td>Exposed Rebar/Exposed Aggregate</td>
<td>High</td>
<td>1,200</td>
<td>60</td>
</tr>
<tr>
<td>Exposed Rebar</td>
<td>Medium</td>
<td>1,400</td>
<td>48-60</td>
</tr>
<tr>
<td>Exposed Aggregate</td>
<td>Medium</td>
<td>8,300</td>
<td>48-60</td>
</tr>
<tr>
<td>Tap-in (42-inch)</td>
<td>Medium</td>
<td>200</td>
<td>60</td>
</tr>
<tr>
<td>Cracks/Exposed Aggregate (minor)</td>
<td>Low</td>
<td>500</td>
<td>24</td>
</tr>
<tr>
<td>Exposed Aggregate (minor)</td>
<td>Low</td>
<td>8,200</td>
<td>54-60</td>
</tr>
</tbody>
</table>
Figure 8.3  Fanno Creek Interceptor Pipeline and Manhole Condition

Clean Water Services, East Basin Master Plan

Manhole (condition)
- H2S
- Leaking
- H2S and Leaking
- Obstruction

Pipeline (infiltration, leaking)
- High Priority
- Medium Priority
- Lower Priority

Pipeline (structural)
- Cracks, Rebar or Aggregate Exposed

Existing Gravity Mains
- Existing Gravity Main >= 12-inch
- Existing Gravity Main < 12-inch

Environmental
- Vegetated Area
- Wetlands

High priority pipelines to reduce infiltration and leaking also have the greatest capacity constraints.
Figure 8.4a  Fanno Creek Interceptor Pipeline and Manhole Condition (Cracks, Infiltration, Leaking)

Cracks
(infiltration leaks)
8.4.5 Pump Station Capacity Assessment

Pump Stations were evaluated for projected peak hour wet weather flows during the 5-year design storm compared to the stations existing firm capacity (largest pump out of service). The pump station capacity assessment is presented in Table 8.4. Pump station deficiencies include the following:

- Sherwood Pump Station deficient by 2025 due to growth in the City of Sherwood including the Brookman and the West Urban Reserve. The Chicken Creek Pump Station and Force Main were considered as improvements to divert flow away from the Sherwood Pump Station and alleviate capacity deficiencies (see Section 8.10).
- River Terrace North Pump Station deficient by 2025 due to growth in the City of Beaverton including Cooper Mountain. Additional pumping capacity is required for planned growth. The River Terrace North Force Main Extension and the King City Trunk improvement alternatives were considered to alleviate capacity constraints in both the River Terrace North and River Terrace South Pump Stations (see Section 8.9).
- River Terrace South Pump Station deficient by 2025 due to flow contribution from the River Terrace North Pump Station and growth in the City of King City. The River Terrace North Force Main Extension and the King City Trunk improvement alternatives were considered to alleviate capacity constraints in both the River Terrace North and River Terrace South Pump Stations (see Section 8.9).
• 2025 flow projections to the Cipole Pump Station approximates the firm capacity of the pump station. Monitoring of this station is recommended to confirm influent flows.
• Other pump stations influent flows are not anticipated to reach their firm capacity until after 2040.
<table>
<thead>
<tr>
<th>Pump Station Name</th>
<th>Firm Capacity (mgd)</th>
<th>Peak Hour Flow Estimate (mgd)</th>
<th>Timing of Deficiency</th>
<th>Note(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2020</td>
<td>2025</td>
<td>2030</td>
<td>2035</td>
</tr>
<tr>
<td>Sherwood</td>
<td>5.8</td>
<td>4.9</td>
<td>6.5</td>
<td>9.0</td>
</tr>
<tr>
<td>River Terrace South</td>
<td>3.7</td>
<td>1.0</td>
<td>4.4</td>
<td>6.0</td>
</tr>
<tr>
<td>River Terrace North</td>
<td>1.9</td>
<td>1.0</td>
<td>3.6</td>
<td>4.3</td>
</tr>
<tr>
<td>Pleasant View</td>
<td>0.6</td>
<td>0.5</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>Lower Tualatin</td>
<td>22.0</td>
<td>12.9</td>
<td>14.4</td>
<td>15.1</td>
</tr>
<tr>
<td>Saum Creek</td>
<td>0.5</td>
<td>0.3</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Cipole</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>Borland</td>
<td>0.4</td>
<td>0.1</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>Beaverton</td>
<td>1.2</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
</tr>
<tr>
<td>Tektronix</td>
<td>5.2</td>
<td>4.0</td>
<td>4.1</td>
<td>4.1</td>
</tr>
<tr>
<td>Fanno</td>
<td>25.0</td>
<td>24.5</td>
<td>24.7</td>
<td>24.7</td>
</tr>
<tr>
<td>Nyberg</td>
<td>0.6</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Fox Hill</td>
<td>0.3</td>
<td>0.04</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>South Bull Mn</td>
<td>2.6</td>
<td>1.1</td>
<td>1.5</td>
<td>1.6</td>
</tr>
<tr>
<td>Orchard Hill</td>
<td>0.6</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Victoria Woods</td>
<td>0.3</td>
<td>0.1</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Meyers Farm</td>
<td>0.8</td>
<td>0.2</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>Scholls Country Estates</td>
<td>0.2</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Note: Abbreviation: mgd = million gallons per day.
(1) Project number references associated with Capital Improvement Program numbering documented in TM9, Conveyance Implementation Plan.
8.4.6 Long-term System Deficiencies

Multiple urban reserves were assumed to have limited growth during the 20-year planning horizon. The longer-term impact of these urban reserves beyond 2040 is described below. Buildout system deficiencies are presented in Figure 8.5:

- **Sherwood South Urban Reserve** – The urban reserve contributes to severity of deficiencies in the downstream Sherwood Trunk which is deficient prior to 2040 (LS). The urban reserve also triggers deficiencies in the most upstream segments of the trunk sewer between 2040 and buildout (LS).

- **Tonquin Urban Reserve** – The urban reserve contributes to severity of deficiencies in the Sherwood Rock Creek Trunk which is deficient prior to 2040 (HS/LS).

- **Urban Reserves in Southeast Tualatin** – Portions of the Elligsen Road Urban Reserve, 1-5 East Washington County Urban Reserve, Norwood Urban Reserve, and Borland Urban Reserve are adjacent to the City of Tualatin. These urban reserves are primarily south of I-205. If these areas were to be served through the City of Tualatin, several concepts may be considered including: (1) a pipe crossing under I-205 to the west which contributes to severity and extent of deficiencies in the Martinazzi Trunk (HS/LS) and/or (2) a pipe crossing under I-205 to the north contributing to deficiencies in the Saum Creek Pump Station, Orchard Hill Pump Station, Borland Pump Station, gravity piping downstream of the pump stations (LS), and the Nyberg Trunk (LS) to the Lower Tualatin Pump Station.
Figure 8.5  East Basin, Buildout Sanitary Conveyance System Capacity Needs (Deficiencies), 5-year Design Storm
Clean Water Services, East Basin Master Plan

<table>
<thead>
<tr>
<th>Pump Station Capacity</th>
<th>Gravity Pipeline Capacity</th>
<th>Growth Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exceeds Firm Capacity</td>
<td>LS, surcharged, overflow risk</td>
<td>&lt;= 6,000 gpnad</td>
</tr>
<tr>
<td>Near Firm Capacity (monitor station)</td>
<td>LH, backwater, overflow risk</td>
<td>&lt;= 5,000 gpnad</td>
</tr>
<tr>
<td>Adequate Firm Capacity</td>
<td>HS, surcharged, &lt;= 3 ft freeboard</td>
<td>&lt;= 10,000 gpnad</td>
</tr>
<tr>
<td>Planned Decommissioning</td>
<td>HH, backwater, &lt;= 3 ft freeboard</td>
<td>&lt;= 12,500 gpnad</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Force main or Siphon Capacity</th>
<th>RDII Rate (gpnad)</th>
<th>RDII Rate Assumed 2,500 gpnad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Velocity &gt; 10 fps</td>
<td>&lt;= 2,500 gpnad</td>
<td></td>
</tr>
<tr>
<td>Velocity &gt; 7 fps</td>
<td>&lt;= 4,000 gpnad</td>
<td></td>
</tr>
<tr>
<td>Velocity &lt;= 7 fps</td>
<td>&lt;= 5,000 gpnad</td>
<td></td>
</tr>
<tr>
<td>gpnad = gallons per net acre per day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ft = feet, fps = feet per second</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

09/2021
8.5 Improvement Alternatives Approach

The major system infrastructure including the Fanno Creek Interceptor and Metzger Trunk were evaluated for multiple improvement alternatives to alleviate both capacity and condition deficiencies. The improvement alternatives selection process included review of capital costs, life cycle costs, and non-cost factors. The process was focused on integrating multiple perspectives in scoring and selecting system improvements including District staff representing conveyance, pumping and treatment, natural resources, and operations and maintenance (O&M).

8.5.1 Equivalent Uniform Annual Cost Approach (Life Cycle Cost Analysis)

The economic evaluation of conveyance alternatives utilizes the Equivalent Uniform Annual Cost (EUAC) methodology. The EUAC methodology calculates the annualized present value of constructing, operating, and maintaining each component of the system. The EUAC factors the initial and replacement cost of capital, annual O&M costs, and annual energy costs. EUACs may be discounted based on timing of improvement implementation. The approach considers a varied design life for infrastructure component replacement as follows:

- Gravity Pipelines – 80 years.
- Access Structures or Manholes – 80-years.
- Diversion Structures – 50-years.
- Force Mains – 50-years.
- Pump Station Wet Wells – 50-years.
- Storage Facility Structural Components – 50-years.
- Pump Station or Storage Mechanical and Electrical Components – 20-years.

For the methodology, an EUAC is calculated for each component of an improvement alternative. The component parts are then summed to provide an EUAC for the improvement alternative. The EUACs of multiple alternatives are compared factoring in timing of implementation, varied design life, O&M requirements, and energy requirements of the component parts.

The EUAC methodology and the unit capital costs and cost markup details for conveyance infrastructure are documented in Appendix 8A in more detail. Unit capital cost rates used for the evaluation are consistent with Class 5 budget estimates, as established by the American Association of Cost Engineers (AACE). This preliminary estimate class is used for conceptual screening and assumes project definition maturity level below two percent. The expected accuracy range is -20 to -50 percent on the low end, and +30 to +100 percent on the high end. Cost estimates are intended to be used as guidance in establishing funding requirements at the project planning level based on information available at the time of the estimate. The unit costs were developed in 2020 dollars.

8.5.2 Non-Cost Scoring Approach

Through workshop discussions, District staff identified non-cost factors to evaluate and score improvement alternatives. The non-cost scoring factors and the scoring criteria are described below and presented in Table 8.5. Factors selected for non-cost scoring include:

*Operations and Maintenance* - Alternatives consider ease of access for maintenance, frequency of operation, odor control, corrosion, and design life. High performing alternatives promote reliable infrastructure and safety guidelines while minimizing resources for day-to-day operations.
Environmental Impact and Permitting - Alternatives consider permitting and mitigation for environmentally sensitive areas including vulnerable habitats and endangered species. Preferred alternatives minimize requirements for environmental permitting associated with regulated lands, wetlands, and water bodies. Benefits are considered where a conveyance project may align with an opportunity to enhance the environment or improve a wetland area.

Public Impacts – Alternatives consider construction challenges and impacts to commercial, residential, and public areas including parks and trailways. Preferred alternatives minimize requirements for land use permitting outside of the Urban Growth Boundary. Benefits are considered where a conveyance project may be used to enhance public access to parks or trails.

Risk - Alternatives consider feasibility and risk of construction including ground and soils conditions (erosion and landslide potential) and challenges associated with construction access (proximity to creeks, wetlands, utilities, etc.). Preferred alternatives limit risk to construction schedule, minimize change orders, and maximize infrastructure design life based on site conditions or construction techniques. Opportunities are considered to improve infrastructure for seismic resiliency.

Easements and Property Acquisition - Alternatives consider land ownership, number of parties, and existing assets or easements owned by the District. Preferred alternatives minimize complexity of negotiating and purchasing additional property or easements.

Flexibility and Balance - Alternatives consider phasing of infrastructure to accommodate timing of development without excessive over-building of capacity. Preferred alternatives favor flexibility in system operations and timing of capital projects to maximize use of the existing system while meeting future regulation. Additional consideration is given to a balance of improvement types (such as capacity upgrades and wet weather flow reduction) to provide both flexibility and redundancy.
<table>
<thead>
<tr>
<th>Criteria</th>
<th>Description</th>
<th>Group Weighting Value</th>
<th>Score of 1 (worst)</th>
<th>Score of 3</th>
<th>Score of 5 (best)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operations and Maintenance</td>
<td>Ease of use and cleaning, routine and emergency access, design life and frequency of operations. Opportunity for flexible operation at the treatment plant.</td>
<td>20.0%</td>
<td>Frequent actions required, difficult access, complex operation.</td>
<td>Typical sanitary conveyance system and pump station operations.</td>
<td>Limited or consolidated pump station use, gravity system, easy to access.</td>
</tr>
<tr>
<td>Environmental Impact and Permitting</td>
<td>Challenging mitigation for endangered species, vulnerable habitat, regulated lands. Environmental permitting and mitigation requirements. Environmental enhancement opportunities.</td>
<td>17.5%</td>
<td>Project disturbances necessarily impact significant resources with mitigation. Project cannot receive a permit or requires large mitigation effort.</td>
<td>Typical types of localized challenges requiring additional time and attention to receive permit compliance. Potential to collaborate on environmental enhancement activities.</td>
<td>Project disturbances are limited to areas with no known or field identified resources. Permitting is confined to standard documentation. High potential to collaborate on environmental enhancement activities.</td>
</tr>
<tr>
<td>Public Impacts</td>
<td>Construction challenges to commercial or residential areas. Land use permitting (outside vs inside Urban Growth Boundary). Public engagement opportunities. Increased public access to improved areas (parks).</td>
<td>15.9%</td>
<td>Project disturbances necessarily impact significant resources. Project cannot receive a permit or requires large mitigation effort.</td>
<td>Typical types of localized challenges requiring additional time and attention to receive public support and permit compliance. Potential to improve public access.</td>
<td>Project disturbances are limited to areas with no known or field identified resources. Permitting is confined to standard documentation. High potential to increase public access.</td>
</tr>
<tr>
<td>Risk</td>
<td>Constructability, creek construction, erosion, landslides. Opportunity to improve seismic resiliency.</td>
<td>15.6%</td>
<td>Ground conditions change frequently or erratically to create large cost impacts to construction or operations.</td>
<td>Typical change order rate, schedule slippage, and operations for major infrastructure. Potential to improve seismic resiliency.</td>
<td>Project constructed on schedule and budget; no emergency repairs expected during design life. High potential to improve seismic resiliency.</td>
</tr>
<tr>
<td>Easements and Property Acquisition</td>
<td>Land ownership, number of parties, existing assets</td>
<td>12.4%</td>
<td>Numerous owners, contentious negotiation, prohibitive time and expense.</td>
<td>Typical easement and acquisition process with few challenging or prohibitive negotiations.</td>
<td>Streamlined process with limited land owners, strategic placement of facilities on friendly or District properties.</td>
</tr>
<tr>
<td>Flexibility &amp; Balance</td>
<td>Providing needed service at the time of development pressure, not over building capacity, considers timing of wet weather reduction, balance of improvement types</td>
<td>18.6%</td>
<td>Large capacity system with fixed cost and limited phasing ability.</td>
<td>Typical mix of incremental improvements and fixed elements that allows for some timing of delivery to development.</td>
<td>Phasing strategy minimizes stranded assets by &quot;just in time&quot; incremental capacity improvements.</td>
</tr>
</tbody>
</table>
The non-cost scoring includes a weighting of the above criteria and a 1 to 5 score for each alternative and each criterion as listed below:

- Score 1 = Considerably Below Average.
- Score 2 = Moderately Below Average.
- Score 3 = Average Performance.
- Score 4 = Moderately Above Average.
- Score 5 = Considerably Above Average.

Where: Alternative Composite Score = \( \sum_i (\text{Criterion Weight}_i \times \text{Criterion Score}_i) \); \( i = \text{Criterion} \)

District staff provided individualized opinions on the weighting of the non-cost scoring criteria as demonstrated in Figure 8.6. The greatest divergence in opinion on weighting occurred for the "Flexibility and Balance" criterion which demonstrates the varied perspectives from engineering, O&M, and natural resources staff. The average of the individualized weighting for the criterion were established as the group weighting. The group weighting for the criterion were then applied to individualized scoring of alternatives. Individualized and group average alternative scores were calculated and discussed as input into the preferred alternative selection.

Figure 8.6  Diversity of Individualized Weighting of Non-cost Scoring Criterion
8.6 Improvement Alternatives Evaluation

The EUAC and non-cost scoring approaches were used to evaluate alternatives for the Fanno Creek Interceptor and Metzger Trunk as the major capacity limitations in the sanitary conveyance system. The scoring and cost approaches allowed the District staff to factor in the complexity of infrastructure condition, wet weather impacts from RDII, and other elements of the scoring criteria into a collaborative decision process to select preferred alternatives.

8.6.1 Alternatives Considerations

The alternatives considered gravity pipeline capacity upgrades, wet weather storage, wet weather bypass pumping, and multiple hybrid options as described below.

8.6.1.1 Gravity Pipeline Alternatives

Gravity system pipeline improvements (upsizing) were considered as the base alternative in considering capacity improvements. Existing pipeline alignments for the capacity limited sections of the Fanno Creek Interceptor and Metzger Trunk are located in vegetated corridors and creek corridors. The following describes some of the issues discussed for the gravity pipeline alternatives:

- Gravity pipeline upsizing costs including open trench construction in public right of way and trenchless construction for creek crossings, highway under crossings, and railway under crossings. Trenchless construction techniques include costs for micro-tunneling, auger boring, or pipe ramming.
- Construction risks associated with landslide potential and erosion of steep slopes including construction accessibility.
- Seismic risks including landslide susceptibility and liquefaction probability. Seismic risks are generally moderate for the critical capacity limiting sections of the Fanno Creek Interceptor and Metzger Trunks.
- Environmental risks including construction access through vegetated areas or recently restored vegetated areas adjacent to Fanno Creek. New restoration opportunities were also considered as a benefit.
- Risk of permit denial associated with environmental impact.
- Impact to public businesses or construction inconvenience associated with greenways and trails adjacent to Fanno Creek.
- Land acquisition or new easement requirements outside of public right of way or existing easements.
- Number of parties and potential cooperation of landowners for easement or property acquisition.
- Phasing of capacity improvements from downstream to upstream.
- Preferred maintenance cycle and frequency for large interceptors. To minimize linear asset maintenance requirements, upsizing of existing pipelines was prefer of parallel pipeline capacity.
- Condition of existing assets particularly for the condition deficient sections of the Fanno Creek Interceptor. Where capacity and condition improvements overlap, the capacity improvement was assumed to eliminate the need for existing pipeline rehabilitation.
8.6.1.2 Storage Alternatives

Both offline and linear wet weather storage were considered as alternatives to gravity system capacity improvements. The following describes some of the issues discussed for the storage alternatives.

Offline Storage

- Localized construction footprint for storage (avoids substantial right-of-way requirements and significant traffic, environmental, and public impacts).
- Large footprint requires large excavation area and longer construction duration in single location than linear assets.
- Up front cost for land, excavation, and construction does not present substantial opportunities for phasing.
- Flushing system are typically reliable when well designed. Flushing options include flushing gates (stored wastewater), tipping buckets (potable or re-use water), or pressure nozzles. Flushing systems do not require confined entry.
- O&M may require occasional entry into a confined space for cleaning when flushing systems are inadequate or to clean out debris that is not removed with the flushing system.
- A small pump back system may be required to fully empty storage facility.
- Facility is used infrequently but may require seasonal startup and maintenance. Infrequent use of pumping system presents some maintenance challenges.
- Because of infrequent use, odor is typically not an issue for an extended period of time. Fans and blowers may be used to dry out facility between uses.
- A screen or baffle is required at entry to prevent grit and floatable debris.
- Large area of land acquisition is required. Opportunity to partner with local parks to improve park above offline storage facility.
- Cost per gallon stored decreases with increased sizing which allows for economical oversizing associated with climate impacts or unknowns related to RDI/I reduction effectiveness.

Linear Storage

- Location of oversized storage pipeline driven by topography and sewer depth for both passive diversion and passive return flow. Functionality of linear storage may not always be possible as a passive gravity system without a deep sewer.
- Larger construction footprint than typical pipeline assets.
- O&M may require confined space entry for cleaning and manual flushing.
- Cost per gallon tends to increase with greater storage volume requirements.

Storage Impacts to Treatment

A number of high-level benefits were identified for conveyance storage alternatives for the Durham Advanced Wastewater Treatment Facility (AWWTF) which were considered as part of the “Flexibility and Balance” non-cost scoring criteria including:

- Reduction of peak hour flows to the Durham AWWTF which may delay or eliminate influent pump station and headworks improvement requirements. The influent pump station and headworks capacity are not identified for improvement within the 20-year planning horizon.
Opportunity to utilize storage to equalize summertime flows to the Durham AWWTF requiring frequent operation of the storage facility and odor control.

**Wet Weather Storage Frequency of Use**

The frequency of use for a wet weather storage facility was evaluated by modeling large rainfall events over a recent 5-year period (2015-2019) and applying the rainfall to existing and future system conditions. The frequency of use analysis was used to provide understanding on number of times per year a wet weather facility would require operation and associated post-use maintenance.

The number of annual rainfall events projected to exceed system capacity in the Fanno Creek Interceptor and Metzger Trunk ranged from two events in a dry year to seven events in a wet year. Similarly, the number of projected hours that a wet weather storage facility may be used to minimize system deficiencies ranges from less than 5-hours in a dry year to 110 hours in a wet year. The results of the storage frequency evaluation are presented in Figures 8.7a and 8.7b.

![Number of Events Annually with Historic Rainfall](image-url)
8.6.1.3  Wet Weather Pumping Alternatives

Wet weather pumping was also considered as a viable alternative to gravity system improvements. Wet weather pumping will have a similar frequency of use as described for the storage alternatives and presented in Figures 8.7a and 8.7b. The following describes some of the issues discussed for the wet weather pumping alternatives:

- Localized construction footprint for wet well and pumping facility.
- Force main linear assets require slightly smaller footprint than gravity pipeline improvements and are constructed at lesser depth.
- Force main may be constructed through public right of way for better access and to avoid impact to vegetated and creek corridors or greenway/trail systems.
- Up front cost for land, excavation, and pipeline assets does not present substantial opportunities for phasing.
- Facility is used infrequently and may require seasonal startup and maintenance. Infrequent use of pumping system presents some maintenance challenges.
- Because of infrequent use, odor is typically not an issue for an extended period of time.
- Opportunity to place wet weather pump station in public park and partner with local parks department for park improvements.
- Force mains may be constructed in common trench as re-use piping and present some opportunity for cost savings in expanding the District re-use program.
- Force mains may also be considered for dual use if sized appropriately for both wet weather capacity in the summer and re-use capacity in the winter. Dual use piping requires disinfection when operation is shifted from winter wet weather use to summer re-use operation.
- The wet weather pump station provides some redundancy to gravity system capacity if gravity pipeline service is interrupted by a seismic event or other catastrophic failure. The wet weather pump station may be used to bypass significant portions of the Fanno
Creek Interceptor up to 20 mgd while repairs are implemented for the emergency condition.

8.6.1.4 Hybrid Alternatives

Hybrid improvement alternatives were considered for both the Fanno Creek Interceptor and Metzger Trunk. Hybrid alternatives include combinations of wet weather storage or wet weather pumping with reduced length of gravity pipeline improvements typically located in the downstream segments of the project. The hybrids present opportunities to selectively implement gravity improvements where construction may be more feasible while reducing the size of a wet weather storage or pumping facilities. Typically, a hybrid alternative will have a higher cost due to the base cost of purchasing land and excavating an area for either a storage facility or a wet well. Additional O&M requirements and cost are also needed to accommodate hybrid solutions because of the varied type of assets constructed.

8.6.1.5 Pipeline Rehabilitation

For alternatives, where pipeline upsizing was not considered (wet weather storage, wet weather pumping, hybrids) pipeline rehabilitation costs were identified for the existing Fanno Creek Interceptor based on available condition data as described in Section 8.4.4. The Metzger Trunk was also assumed to require rehabilitation improvement if not upsized. All costs for rehabilitation assumed Cured in Place Pipe Lining (CIPP) for large diameter projects and spot repairs to manholes. Pipe bursting was not considered an option based on the size of infrastructure.

8.6.1.6 RDI/I Reduction Program

As described in TM 7, Infiltration and Inflow Evaluation, the RDI/I reduction cost effective analysis consistently showed that the least cost improvement solutions occurred when targeting RDI/I reduction in basins where the RDI/I rate exceeded 12,000 gallons per net acre per day (gpnad), (7,500 gallons per gross acre per day, [gpgad]) and building additional system conveyance capacity to eliminate any excess deficiencies. The cost effectiveness was slightly improved when the RDI/I rates exceeded 15,000 gpnad (10,000 gpgad) indicating the benefit of focusing on basins with the highest RDI/I rates when consider wet weather flow reduction.

The District staff preferred to maintain a balance of improvements that considered some RDI/I reduction and some capacity upgrades. Based on review of the cost-effectiveness evaluation and discussions with District staff, three target RDI/I reduction levels implemented were evaluated for all improvement alternatives for the Fanno Creek Interceptor and Metzger Trunk as described below:

- 8,000 gpnad (5,000 gpgad) – RDI/I reduction threshold was shown to not be cost effective but was considered for sensitivity analysis and to document the benefits of focusing on higher RDI/I reduction thresholds.
- 12,000 gpnad (7,500 gpgad) – RDI/I reduction threshold represents the lower end of optimal cost effectiveness when combined with capacity improvements.
- 15,000 gpnad (10,000 gpgad) – RDI/I reduction threshold represents the middle to higher end of optimal cost effectiveness when combined with capacity improvements.
8.6.2 Creek Corridor Enhancement Opportunities

Environmental and trail enhancement opportunities were considered for gravity pipeline improvement alternatives in stream corridors for both the Fanno Creek Interceptor and the Metzger Trunk. Issues and opportunities associated with creek corridor and environmental or trail enhancement are summarized below and presented in Figure 8.8:

- **2-mile section of Fanno Creek Interceptor between Tigard Street and Bonita Road has low to moderate potential for environmental enhancement and high potential for environmental impact:**
  - Trail and restoration work is already underway.
  - Small access footprint adjacent to creek is less conducive to pipeline work.
  - Public is typically opposed to interrupting creek access for construction activities.
  - Construction presents potential impact to mature trees and vegetation.
  - Location immediately north of Bonita Road may present an opportunity to coordinate with Metro environmental restoration activities. Moderate to high difficulty in coordinating conveyance easements with Metro historically.

- **1.5-mile section of Fanno Creek Interceptor south of Bonita Road has moderate to high potential for environmental enhancement and trail enhancement:**
  - Opportunity to coordinate with upcoming trail work by the City of Tigard (see Figure 8.9).
  - Low to moderate difficulty in coordinating conveyance projects with the City of Tigard historically.
  - Timing of trail work critical for coordination. As of mid-2020, the trail work did not have funding and was in the concept phase awaiting public feedback.

- **The Metzger Trunk immediately north of Highway 217 has high potential for environmental enhancement with challenges associated with private landownership in Black Bull Area:**
  - The privately owned Black Bull Area has been identified as a potential environmental enhancement project area.
  - Black Bull Area and Metzger Trunk existing easement located within or adjacent to large wetland area.
  - The District would consider potential environmental enhancements on the land adjacent to an upsized Metzger Trunk in the Black Bull Area. The environmental enhancements and associated land purchase would require exploration of partnering and non-District funding opportunities.
Figure 8.8 Environmental Enhancement and Public Access Opportunities

Fanno Creek Interceptor between Tigard Street & Bonita Road:
- On-going trail work
- Small footprint is less conducive to pipeline construction
- High impact to mature trees and vegetation

Fanno Creek Interceptor south of Bonita Road – Opportunity to coordinate with upcoming City of Tigard trail enhancement

Black Bull Area – Potential for future restoration

Metro-owned property – Longer-term restoration opportunity

OR 217 Undercrossing
8.6.3 Coordination with ODOT Transportation and TriMet Mass Transit Projects

The Metro Southwest Corridor mass transit project is located adjacent to the Fanno Creek Interceptor and existing transit lines are located adjacent to the Metzger Trunk and the confluence with the Fanno Creek Interceptor as shown in Figure 8.10. Pipeline improvement alternatives for the Fanno Creek Interceptor considered requirements to coordinate with Metro and the mass transit line, which is scheduled for design between 2020 and 2022, and construction between 2022 and 2027. Pipeline improvement alternatives for the Metzger Trunk considered a trenchless pipeline crossing under the existing transit line.

The Oregon Department of Transportation (ODOT) will be widening OR 217 between Beaverton-Hillsdale Highway and OR 99W scheduled between 2021 and 2025. The Metzger Trunk crosses under an OR 217 bridge.
8.7 Fanno Creek Interceptor Evaluation

The following improvement alternatives were evaluated for the Fanno Creek Interceptor:

- **Gravity Pipeline**: Up to 3.5 miles of pipeline upsizing from 60-inch to 72-inch diameter. The project may be implemented in three phases working downstream to upstream as shown in Figure 8.11:
  - **Phase 1 (1.5 miles, Bonita Road south)**:
    - Opportunity to partner with trail enhancement work or re-route onto 74th Avenue with a deep sewer (see profile in Figure 8.12).
  - **Phases 2 and 3 (1 mile each, Bonita Road north)**:
    - Narrow corridor with mature trees.
    - Challenging environmental permitting.
    - Some environmental restoration already complete.
  - Rehabilitation of the Fanno Creek Interceptor required for pipelines that are not being upsized.
- **Wet Weather Storage**: Up to 3 million gallons of wet weather storage (with diversion, screening, tipping bucket flushing system, and small pump back system):
  - Preferred storage location identified on Tigard Street in City of Tigard Park as shown in Figure 8.13. This preferred location is immediately upstream of the critical capacity limitations in the Fanno Creek Interceptor. Alternate location identified further north on Allen Road near SW 107th Avenue.
  - Rehabilitation of existing Fanno Creek Interceptor included in the alternative.
- Project presents an opportunity to partner with City of Tigard on park improvements.
- Storage avoids major pipeline projects and environmental impacts in Fanno Creek corridor.

Figure 8.13  Fanno Creek Interceptor Wet Weather Storage Alternative

- **Hybrid Gravity Pipeline and Wet Weather Storage**: 1.5 miles of pipeline upsizing (60-inch to 72-inch, downstream segment from Bonita Road south). 1 to 2 million gallons of storage. The project may be implemented in two phases as shown in Figure 8.14:
  - Phase 1 (1.5 miles, Bonita Road south):
    - Opportunity to partner with trail enhancement work or re-route onto 74th Avenue with a deep sewer (see profile in Figure 8.12).
  - Phases 2 (storage, 2+ million gallons with diversion, screening, tipping bucket flushing system, and small pump back system):
    - Preferred storage location identified on Tigard Street in City of Tigard Park.
    - Opportunity to partner with City of Tigard on park improvements.
  - Rehabilitation of existing Fanno Creek Interceptor included in the alternative for segments that are not upsized.
  - Storage avoids major pipeline projects and environmental impacts in Fanno Creek corridor where permitting will be most challenging.
**Wet Weather Pump Station**: 20+ mgd wet weather pump station and up to 3.5 miles of force main (single 36-inch or dual 24-inch diameter). Downstream section(s) may operate as gravity pipeline. Force main routing can be considered in public right of way as shown in Figure 8.15. This preliminary route is conceptual and will require additional routing analysis to determine utility conflicts:

- Alternate force main route(s) provide opportunity to collaborate with environmental or trail enhancement projects.
- Preferred pump station location identified on Tigard Street in City of Tigard Park. Opportunity to partner with City of Tigard on park improvements.
- Rehabilitation of existing Fanno Creek Interceptor included in the alternative.
- Discharge location of force main may be located at the Durham AWWTF bypassing the influent pump station.
- Opportunity to consider dual use pipeline (wet weather force main during the winter and re-use pipeline during the summer). If the sizing of the force main is too large for re-use, a dedicated re-use pipeline may be constructed in a common trench as the force main to reduce re-use project costs. See example profile for wet weather pumping and re-use in Figure 8.16.
- Wet weather pumping avoids major pipeline projects and environmental impacts in Fanno Creek corridor where permitting will be most challenging.
- Wet weather pump station provides moderate level of conveyance redundancy for gravity pipeline break during seismic event.

![Wet Weather Pump Station Profile](image-url)

- **Wet Weather Pump Station Profile**
  - Fanno Creek Wet Weather Pump Station
  - Durham AWWTF
  - Dur 110 feet TDH (90 ft static) @ 20 mgd
  - Re-use 120 feet TDH (110 ft static) @ 5 mgd
  - Pump 8,000 feet through dual 24-inch 5 fps velocity
  - Pump 11,500 feet through single 24-inch 2.5 fps velocity

![Figure 8.15](image-url)

**Figure 8.15  Fanno Creek Interceptor Wet Weather Pump Station and Force Main(s) Alternative**

![Figure 8.16](image-url)

**Figure 8.16  Fanno Creek Interceptor Wet Weather Force Main and Re-Use Pipeline Profiles (Dual Use)**
- **Hybrid Gravity Pipeline and Wet Weather Pump Station**: 1.5 miles of pipeline upsizing (60-inch to 72-inch diameter, downstream segment from Bonita Rd south). Up to 20 mgd wet weather pump station and up to 2.5 miles of force main (single 36-inch or dual 24-inch diameter). Force main routing can be considered in public right of way as shown in Figure 8.17. The project is identified in two phases:
  - Phase 1 (1.5 miles, Bonita Road south):
    - Opportunity to partner with trail enhancement work or re-route onto 74th Avenue with a deep sewer (see profile in Figure 8.12).
  - Phase 2 (Pump Station and Force Main):
    - Force main may discharge into the Bonita Road Trunk which also requires improvement and may be oversized to accommodate the wet weather pump station peak flows. The Bonita Road Trunk discharges into the Fanno Creek Interceptor.
    - Alternate force main route(s) provide opportunity to collaborate with environmental or trail enhancement projects.
    - Preferred pump station location identified on Tigard Street in City of Tigard Park. Opportunity to partner with City of Tigard on park improvements.
  - Rehabilitation of existing Fanno Creek Interceptor included in the alternative for segments that are not upsized.
  - Wet weather pumping avoids major pipeline projects and environmental impacts in the Fanno Creek corridor where permitting will be most challenging.
Figure 8.17  Fanno Creek Interceptor Wet Weather Pump Station and Force Main(s) and Gravity Hybrid Alternative

8.7.1  Fanno Creek Interceptor Cost Analysis

Initial capital costs and life cycle costs (EUAC) were estimated for each of the Fanno Creek Interceptor alternatives. Initial capital costs are presented in Figure 8.18 and EUACs are presented in Figure 8.19. The least cost alternative for both initial capacity and life cycle was the wet weather pump station. Gravity pipeline improvements, including the hybrids with gravity piping mixed with storage or wet weather pumping, trended higher in cost because of the large diameter construction requirements through the creek corridor and the environmental restoration requirements. Storage costs were slightly greater than wet weather pumping costs because of the cost of excavation requirements associated with an offline storage volume of 2 to 3 million gallons and diversion piping requirements to and from the storage facility.
Figure 8.18  Fanno Creek Interceptor Initial Capital Cost Comparison of Alternatives

Figure 8.19  Fanno Creek Interceptor Lifecycle Annualized Cost (EUAC) Comparison of Alternatives at varied RDI/I Reduction Thresholds
8.7.2 Fanno Creek Interceptor Scoring and Preferred Alternative Selection

District staff scored each of the Fanno Creek Interceptor alternatives for the non-cost factors. A summary of each alternatives and the issues associated with each of the non-cost scoring criteria is presented in Table 8.6. The results of the group scoring are presented in Figure 8.20. Initial capital and life cycle costs vs scoring for each alternative are presented in Figures 8.210a and 8.21b respectively.

The highest scoring alternative and selected preferred alternative was the Fanno Creek Interceptor Wet Weather Pump Station and Force main(s) which is also the least cost alternative. The alternative scored high because it minimizes the environmental and public impact associated with construction through the Fanno Creek corridor and limits construction risk by routing the force main through public right of way. The alternative was also considered flexible because of the opportunity to coordinate the force main project with the District’s re-use initiatives including consideration for common pipe trenches or dual use piping.

The wet weather storage alternative was the second highest scored alternative because it also minimizes the environmental and public impact associated with construction through the Fanno Creek corridor. The O&M requirements for a storage facility were scored lower than the O&M requirements of the wet weather pump station alternative.

The gravity pipeline and hybrid alternatives were scored low primarily because of the construction requirements of a large diameter interceptor and associated environmental and public impacts through the Fanno Creek corridor.

![Figure 8.20 Fanno Creek Interceptor Non-Cost Scoring of Alternatives](image)
Figure 8.21a  Fanno Creek Interceptor Non-Cost Scoring of Alternatives vs Initial Capital Cost

Figure 8.21b  Fanno Creek Interceptor Non-Cost Scoring of Alternatives vs Lifecycle Annualized Cost (EUAC)
### Table 8.6  
**Fanno Creek Interceptor, Non-cost Alternatives**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Gravity Pipeline</th>
<th>Wet Weather Storage</th>
<th>Gravity/Storage Hybrid</th>
<th>Wet Weather Pump Station</th>
<th>Gravity Pipe/Wet Weather Pump Station Hybrid</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operations and Maintenance</strong></td>
<td>Projected use of storage is 2 to 8 times per year. Weekly maintenance check when storage facility is not in use. Tipping bucket flushing after each use. Screen cleaning as needed. Challenge of infrequent facility use.</td>
<td>Projected use of storage is 2 to 8 times per year. Weekly check of storage facility when not in use. Tipping bucket flushing after each use. Screen cleaning as needed. Standard large diameter O&amp;M (CCTV 7-year cycle) for pipeline. Challenging pipeline access near creek. Opportunity to improve access.</td>
<td>Projected use of pump station is 2 to 8 times per year. Seasonal shutdown activities. Challenge of reliability with infrequent use (need to run pumps periodically to keep functioning efficiently).</td>
<td>Projected use of pump station/storage is 2 to 8 times per year. Seasonal shutdown activities. Challenge of reliability with infrequent use (need to run pumps periodically to keep functioning efficiently).</td>
<td>Opportunity to minimize environmental impact and permitting to upstream pipe segments through use of wet weather pumping/storage in upstream segments (north of Bonita Rd). Opportunity to consider pipeline re-route and/or partnering with enhancement and trail projects for gravity pipeline improvement in downstream 1.5-mile section. Tigard Park has areas that are outside of sensitive wetland and vegetated areas. Force main route can consider minimizing impact to environment or collaboration with environmental and trail enhancement. Pipeline rehabilitation will impact environment in select locations during construction to implement open trench or trenchless repairs.</td>
</tr>
<tr>
<td><strong>Environmental Impact and Permitting</strong></td>
<td>Challenging permit requirements in vegetated and wetland areas adjacent to Fanno Creek including creek crossings. Opportunity to partner with environmental and trail enhancement activities. Upper 2-miles is challenging because of narrow corridor and impact on mature trees.</td>
<td>Less environmental impact area for storage. Tigard Park has areas that are outside of sensitive wetland and vegetated areas (~10 acres). Outside of creek corridor. Pipeline rehabilitation will impact environment in select locations during construction to implement open trench or trenchless repairs.</td>
<td>Opportunity to minimize environmental impact and permitting to upstream pipe segments through use of storage. Pipeline rehabilitation will impact environment in select locations during construction to implement open trench or trenchless repairs. Opportunity to consider pipeline re-route and/or partnering with enhancement and trail projects for gravity pipeline improvement in downstream 1.5-mile section.</td>
<td>Limited environmental impact for pump station. Tigard Park has areas that are outside of sensitive wetland and vegetated areas. Force main route can consider minimizing impact to environment or collaboration with environmental and trail enhancement. Pipeline rehabilitation will impact environment in select locations during construction to implement open trench or trenchless repairs.</td>
<td>Opportunity to minimize environmental impact and permitting to upstream pipe segments through use of wet weather pumping/storage in upstream segments (north of Bonita Rd). Opportunity to consider pipeline re-route and/or partnering with enhancement and trail projects for gravity pipeline improvement in downstream 1.5-mile section. Tigard Park has areas that are outside of sensitive wetland and vegetated areas for pump station facility. Force main route can consider minimizing impact to environment or collaboration with environmental and trail enhancement. Pipeline rehabilitation will impact environment in select locations during construction to implement open trench or trenchless repairs.</td>
</tr>
<tr>
<td><strong>Public Impacts</strong></td>
<td>Construction impact to existing trail system along Fanno Creek (public trail). Opportunity to partner with new trails in downstream segments (1.5 miles).</td>
<td>Construction impact for local commercial or residential areas (extended construction schedule for storage facility). Opportunity to collaborate with City of Tigard to improve park.</td>
<td>Construction impact for local commercial or residential areas (extended construction schedule for storage facility). Opportunity to collaborate with City of Tigard to improve park.</td>
<td>Construction impact for local commercial or residential areas (pump station). Force main impact to roadways or existing trail system. Opportunity to collaborate with City of Tigard to improve park. Opportunity to partner with new trails in downstream gravity segments (1.5 miles) and for force main (full length).</td>
<td>Construction impact for local commercial or residential areas (pump station). Force main impact to roadways or existing trail system. Opportunity to collaborate with City of Tigard to improve park. Opportunity to partner with new trails in downstream gravity segments (1.5 miles) and for force main (full length).</td>
</tr>
<tr>
<td><strong>Risk</strong></td>
<td>Low to moderate landslide susceptibility, moderate liquefaction probability. Construction through creek corridor challenging. Opportunity to improve seismic resiliency of existing pipeline and eliminate rehab projects.</td>
<td>Low to moderate landslide susceptibility, moderate liquefaction probability at park location.</td>
<td>Low to moderate landslide susceptibility, moderate liquefaction probability. Downstream gravity improvement may consider re-route to improve construction access and minimize creek construction. Opportunity to improve seismic resiliency of 40% of existing pipeline and eliminate up to 40% rehab projects.</td>
<td>Low to moderate landslide susceptibility, moderate liquefaction probability at park location and along potential force main route.</td>
<td>Low to moderate landslide susceptibility, moderate liquefaction probability. Downstream gravity improvement may consider re-route to improve construction access and minimize creek construction. Opportunity to improve seismic resiliency of 40% of existing pipeline and eliminate up to 40% rehab projects.</td>
</tr>
<tr>
<td>Criteria</td>
<td>Gravity Pipeline</td>
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<tr>
<td>**Easements and Property Acq</td>
<td>Existing easements or additional easement through trail system. Public right-of-way for potential re-route on 74th Ave.</td>
<td>Collaboration with City of Tigard in preferred storage location or required land purchase in alternate locations. Construction easements for pipeline rehabilitation.</td>
<td>Existing easements or additional easement through trail system (pipeline). Public right-of-way for potential pipeline re-route on 74th Ave. Collaboration with City of Tigard in preferred storage location or purchase of land for alternate locations. Construction easements for pipeline rehabilitation.</td>
<td>Collaboration with City of Tigard in preferred pump station location or land purchase in alternate locations. Construction easements for pipeline rehabilitation. Existing easements or additional easement through trail system. Public right-of-way for multiple force main routing options.</td>
<td>Existing easements or additional easement through trail system for pipelines (gravity and force main). Public right-of-way for potential re-route on 74th Ave (gravity and force main). Collaboration with City of Tigard in preferred pump station/storage location or purchase of land in alternate location. Construction easements for pipeline rehabilitation.</td>
</tr>
<tr>
<td><strong>Flexibility &amp; Balance</strong></td>
<td>Opportunity to phase downstream 1.5 miles (Bonita south) first and 2 miles (Bonita north) second. Additional capacity may create additional sink for groundwater RDI/I rehab in tributary system to minimize.</td>
<td>Limited phasing opportunity for storage (sized for future conditions). Storage provides buffer for climate change and unknowns related to effectiveness of RDI/I reduction. Storage provides opportunity for real time control to optimize system capacity. Opportunity for flow equalization at treatment plant.</td>
<td>Opportunity to phase downstream gravity pipeline improvement first and storage second.</td>
<td>Additional pump slots for phasing of pump station capacity. Force main has limited phasing option. Pump station provides some redundancy if existing gravity pipeline is damaged during earthquake. Opportunity to consider dual-use pressure pipelines: wet weather pumping in winter to treatment plant, re-use pumping in the summer from the treatment plant.</td>
<td>Opportunity to phase downstream gravity pipeline improvement first and pump station/storage second. Wet well may be oversized to provide some storage capacity with direct discharge to gravity interceptor during moderate rainfall events. The storage sizing and downstream pipe lengths may be optimized to maximize flexibility and minimize other impacts or costs. The wet weather pump station will operate and bypass upper portion of gravity interceptor during larger storm events. Pump station provides some redundancy if existing gravity pipeline is damaged during earthquake. Opportunity to consider dual-use pressure pipelines with extended force main: wet weather pumping in winter to treatment plant, re-use pumping in the summer from the treatment plant.</td>
</tr>
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</table>
8.8 Metzger Trunk Evaluation

The following improvement alternatives were evaluated for the Metzger Trunk:

- **Gravity Pipeline**: Up to 1.5 mile of pipeline upsizing (30-inch to 36-inch diameter). Pipeline crosses Highway 217 and commuter rail as shown in Figure 8.22. Consider trenchless construction in critical sections to minimize impacts to environment and to accommodate highway and rail crossings. The project is identified in two phases:
  - Phase 1 (0.6-0.7 miles between the Fanno Creek Interceptor and Metzger Trunk confluence to location immediately north of Highway 217 crossing):
    - Phase 1 includes trenchless construction under an existing Metro transit line and under Highway 217.
    - Potential construction through creek corridors and wetlands.
  - Phase 2 (0.6-0.7 miles north of Highway 217):
    - Phase includes significant construction through creek corridor, wetlands, and vegetation.
    - Opportunity to coordinate project with purchase of privately owned land in the Black Bull Area for environmental enhancements.

![Figure 8.22 Metzger Trunk Gravity Pipeline Alternative](image-url)
- **Wet Weather Storage**: Up to 1 million gallons of wet weather storage (offline with diversion, screening, tipping bucket flushing system, and small pump back system; or inline storage) as shown in Figure 8.23:
  - Potential site for off-line storage located in Black Bull Area (privately owned). Black Bull Area located in floodplain which may be problematic for utilizing storage during larger storm events.
  - Consider multiple smaller in-line or offline storage sites including storage at locations where City of Portland contributes flow to the Metzger system.
  - Storage minimize construction impact through creek corridor, vegetated areas, and wetlands.
  - Rehabilitation of existing Metzger Trunk included in the alternative.

- **Hybrid Gravity and Wet Weather Storage**: Up to 0.6 miles of gravity pipeline upsizing (30-inch to 36-inch). Pipeline crosses Highway 217 and commuter rail. Consider trenchless construction in critical sections to minimize impacts to environment and to
accommodate highway and rail crossings. Up to 0.5 million gallons of storage (inline or offline). The project is identified in two phases as shown in Figure 8.24:

- **Phase 1** (0.6-0.7 miles between the Fanno Creek Interceptor and Metzger Trunk confluence to location immediately north of Highway 217 crossing):
  - Phase 1 includes trenchless construction under the existing Metro transit line and under Highway 217.
  - Potential construction through creek corridors and wetlands.
- **Phase 2** (up to 0.5 million gallons of offline or inline storage).
  - Consider multiple smaller in-line or offline storage sites including storage at locations where City of Portland contributes flow to the Metzger system.
  - Storage minimize construction impact through creek corridor, vegetated areas, and wetlands.
  - Rehabilitation of existing Metzger Trunk included in the alternative for pipeline segments that are not upsized north of Highway 217.

![Figure 8.24](image_url)

**Figure 8.24** Metzger Trunk Gravity and Wet Weather Storage Hybrid Alternative

- **Wet Weather Pump Station**: 7+ mgd wet weather pump station and 1 to 1.5 miles of force main (20-inch diameter) as shown in Figure 8.25:
  - Consider force main route to avoid discharge into critical upstream segments of Fanno Creek Interceptor and environmental impact areas.
- Highway 217 and existing Metro transit line crossings may be required for the force main.
- Pump station best located 1 to 1.5 miles north of Metzger Trunk and Fanno Creek Interceptor confluence to divert flow away from capacity limited gravity pipe segments.
- Force main may operate as a gravity line under some flow conditions.
- Rehabilitation of existing Metzger Trunk included in the alternative.

Figure 8.25

**Ideal pump station location will be far enough upstream to reduce peak flow through critical pipe deficiency but far enough downstream to accommodate an adequate flow diversion.**

**Hybrid Gravity and Wet Weather Pump Station**: Up to 0.6 miles of gravity pipeline upsizing (30-inch to 36-inch). Pipeline crosses Highway 217 and commuter rail. Consider trenchless construction in critical sections to minimize impacts to environment and to accommodate highway and rail crossings. Approximately 5 mgd wet weather pump...
station and up to 1 to 1.5 miles of force main (18-inch). The project is identified in two phases as shown in Figure 8.26:

- Phase 1 (0.6-0.7 miles between the Fanno Creek Interceptor and Metzger Trunk confluence to location immediately north of Highway 217 crossing):
  - Phase 1 includes trenchless construction under the existing Metro transit line and under Highway 217.
  - Potential construction through creek corridors and wetlands.

- Phase 2 (5 mgd wet weather pump station and 1 to 1.5 miles of 18-inch force main):
  - Consider force main route to avoid discharge into critical upstream segments of Fanno Creek Interceptor and environmental impact areas.
  - In addition to gravity pipeline coordination, the force main may also need to cross the Highway 217 and under the existing Metro transit line.
  - Pump station best located 1 to 1.5 miles north of Metzger Trunk and Fanno Creek Interceptor confluence to divert flow away from capacity limited gravity pipe segments.
  - Force main may operate as a gravity line under some flow conditions.
  - Rehabilitation of existing Metzger Trunk included in the alternative for pipeline segments that are not upsized north of Highway 217.
8.8.1 Metzger Trunk Cost Analysis

Initial capital costs and life cycle costs (EUAC) were estimated for each of the Metzger Trunk alternatives. Initial capital costs are presented in Figure 8.27 and EUACs are presented in Figure 8.28. The least cost alternative for both initial capacity and life cycle was the gravity improvement option. The wet weather pump station, wet weather storage, and hybrid alternatives trended higher in cost because of the base cost of land purchase and excavation for either a storage facility or wet well. After reviewing the costs with the District, an additional 50-percent contingency (not shown) was added to the gravity option to account for environmental enhancements and trenchless construction requirements. Even with the increased cost, the gravity option was identified as the least cost solution for the Metzger Trunk.

![Figure 8.27 Metzger Trunk Initial Capital Cost Comparison of Alternatives](image-url)
8.8.2 Metzger Trunk Scoring and Preferred Alternative Selection

District staff scored each of the Metzger Trunk alternatives for the non-cost factors. A summary of each alternatives and the issues associated with each of the non-cost scoring criteria is presented in Table 8.7. The results of the group scoring are presented in Figure 8.29. Initial capital and life cycle costs vs scoring for each alternative are presented in Figures 8.30a and 8.30b respectively.

The highest scoring alternative (by a significant margin) and selected preferred alternative was the Metzger Trunk gravity pipeline upsizing which is also the least cost alternative. The alternative scored high because it provides a strategic opportunity for the District to develop environmental enhancement work in the Black Bull Area. The alternative was also considered to have the lowest O&M requirements when compared with a wet weather pump station or wet weather storage facility. There was not a clear second choice for preferred alternative.
Figure 8.29  Metzger Trunk Non-Cost Scoring of Alternatives

Figure 8.30a  Metzger Trunk Non-Cost Scoring of Alternatives vs Initial Capital Cost
Figure 8.30b Metzger Trunk Non-Cost Scoring of Alternatives vs Lifecycle Annualized Cost (EUAC)
### Table 8.7  Metzger Trunk, Non-cost Scoring Criteria and Summary Information for Alternatives

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Gravity Pipeline</th>
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<th>Gravity Pipe/Wet Weather Pump Station Hybrid</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operations and Maintenance</strong></td>
<td>Projected use of storage is 2 to 8 times per year. Weekly maintenance check when storage facility is not in use. Tipping bucket flushing after each use (offline storage). Minimal maintenance (inline storage).</td>
<td>Projected use of storage is 2 to 8 times per year. Weekly maintenance check when storage facility is not in use. Tipping bucket flushing after each use (offline storage). Minimal maintenance (inline storage).</td>
<td>Projected use of storage is 2 to 8 times per year. Weekly maintenance check when storage facility is not in use. Tipping bucket flushing after each use (offline storage). Minimal maintenance (inline storage).</td>
<td>Projected use of pump station is 2 to 8 times per year. Seasonal shutdown activities. Challenge of reliability with infrequent use (need to run pumps periodically to keep functioning efficiently). Standard large diameter O&amp;M (CCTV 7-year cycle) for gravity pipeline. Opportunity to improve access in stream corridor.</td>
<td>Projected use of pump station is 2 to 8 times per year. Seasonal shutdown activities. Challenge of reliability with infrequent use (need to run pumps periodically to keep functioning efficiently). Standard large diameter O&amp;M (CCTV 7-year cycle) for gravity pipeline. Opportunity to improve access in stream corridor.</td>
</tr>
<tr>
<td><strong>Environmental Impact and Permitting</strong></td>
<td>Challenging permit requirements in vegetated and wetland areas (current pipeline route). Opportunity to consider environmental enhancements (Black Bull).</td>
<td>Opportunity to minimize environmental impact and permitting requirement through use of storage. Black Bull area is located in floodplain with significant vegetation and wetland impact. Other offline storage location options will have less impact on the environment than inline storage options.</td>
<td>Opportunity to minimize environmental impact and permitting requirement through use of storage. Selection of critical pipe segments for upsizing that have less challenging environmental permitting requirements. Inline or offline storage to decrease peak flow for those areas where environmental impact and permitting is most challenging.</td>
<td>Limited environmental impact for pump station. Force main route can consider minimizing impact to environment. Pipeline rehabilitation will impact environment in select locations during construction to implement open trench or trenchless repairs.</td>
<td>Limited environmental impact for pump station. Combination of select gravity improvements and force main route can consider minimizing impact to environment. Pipeline rehabilitation will impact environment in select locations during construction to implement open trench or trenchless repairs.</td>
</tr>
<tr>
<td><strong>Public Impacts</strong></td>
<td>Construction impact to existing creek corridor. Opportunity to improve public access to stream corridor.</td>
<td>Construction impact to local commercial or residential areas (extended construction schedule for storage facility).</td>
<td>Construction impact for local commercial or residential areas (extended construction schedule for storage facility). Limits construction impact to existing creek corridor. Opportunity to improve public access to stream corridor in critical sections.</td>
<td>Construction impact for local commercial or residential areas (pump station). Force main impact to roadways or stream corridor.</td>
<td>Construction impact for local commercial or residential areas (pump station). Force main and gravity pipeline impact to roadways or existing stream corridor. Opportunity to improve public access to stream corridor.</td>
</tr>
</tbody>
</table>

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**Notes:**
- Gravity Pipeline/Wet Weather Pump Station Hybrid
- Wet Weather Storage
- Gravity Storage Hybrid
<table>
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<tr>
<th>Criteria</th>
<th>Gravity Pipeline</th>
<th>Wet Weather Storage</th>
<th>Gravity/Storage Hybrid</th>
<th>Wet Weather Pump Station</th>
<th>Gravity Pipe/Wet Weather Pump Station Hybrid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition</td>
<td>includes a challenging private landowner.</td>
<td>upstream capacity constraints and requires purchase from challenging landowner. Black Bull area in floodplain and may not be ideal for storage. Construction easements required for pipeline rehabilitation.</td>
<td></td>
<td>Pump station location requires land purchase. Black Bull area includes a challenging private landowner and is located in floodplain. Rely on existing easements or public right-of-way for multiple force main routing options.</td>
<td></td>
</tr>
<tr>
<td>Flexibility &amp; Balance</td>
<td>Potential for two phases. First phase south of Highway 217 and second phase north of Highway 217.</td>
<td>May be a challenging to find a single location for storage that is far enough upstream to eliminate full pipe capacity issue. Opportunity to phase several smaller storage sites. Storage provides buffer for climate change and unknowns related to effectiveness of RDI/I reduction including City of Portland contributions. Storage on the Metzger Trunk will decrease flow impacts to the downstream Fanno Creek Interceptor. An ideal flow diversion to minimize impacts to the Metzger Trunk is 7 mgd. This represents approximately 30-percent of the total required flow diversion for the Fanno Creek Interceptor.</td>
<td>May be a challenging to find a single location for storage that is far enough upstream to eliminate full pipe capacity issue. Opportunity to phase several smaller storage sites and combine with strategic pipeline upgrades. Opportunity to phase pipe improvements first and storage improvements second.</td>
<td>Force main has limited phasing option. Pump station provides some redundancy if existing gravity pipeline is damaged during earthquake.</td>
<td>Opportunity to phase gravity pipeline improvement first and pump station/force main second. Wet well may be oversized to provide some storage capacity with direct discharge to gravity interceptor during moderate rainfall events. The wet weather pump station will operate and bypass upper portion of gravity interceptor during larger storm events. Pump station provides some redundancy if existing gravity pipeline is damaged during earthquake.</td>
</tr>
</tbody>
</table>
8.9 King City Growth Area Alternatives

Two alternatives and several hybrid alternatives were identified as highlighted below to expand service in the west portion of the East Basin (north of the Tualatin River). By 2025, one of the improvement options is required to alleviate capacity limitations in the River Terrace South Pump Station and to serve development in Cooper Mountain (Beaverton), River Terrace South (Tigard), and the King City Urban Expansion Area (King City). In the future, improvements will also serve urban reserve areas including the Roy Rogers Road East Urban Reserve and the Roy Rogers Road West Urban Reserve as the City of Tigard continues to expand. The improvements options include:

- **Alternative 1** – Construct the King City Trunk (24-inch, 11,000 feet) extending from the Trunk on Roy Rogers Road to the Bull Mountain Trunk on SW Fischer Road (see Figure 8.31). The interceptor aligns with a proposed roadway project through King City. The gravity trunk provides flexibility to intercept future flows from Cooper Mountain, River Terrace South, River Terrace North, Roy Rogers East Urban Reserve, and Roy Rogers West Urban Reserve limiting the impact to the River Terrace South Pump Station and avoiding the River Terrace North Force Main Extension (Alternative 2). This alternative avoids local pumping in the southeast portion of the King City Urban Expansion Area and allows for decommissioning of the Bull Mountain Pump Station.

- **Alternative 2** – Extend the River Terrace North Force Main (16-inch, 10,300 feet), south on Roy Rogers Road and east on Beef Bend Road (see Figure 8.32). This alternative is required if the gravity alternative (Alternative 1) cannot be constructed by 2025 and development in Cooper Mountain, River Terrace North, River Terrace South, and the west portion of the King City Urban Expansion Area exceed the capacity of the River Terrace South Pump Station. This alternative includes a smaller gravity sewer through the King City Urban Expansion Area that would be constructed when development occurs and up to three small local pump stations and force mains discharging to the local sewer.

- **Hybrid(s)** – There are multiple hybrid alternatives that may be considered based on the timing of development and location of future roadway projects in King City. For example, if a roadway project moves forward north of SW Fischer Road in the near-term, the King City Trunk from Alternative 1 may be constructed in an alignment further north and the River Terrace North Force Main extension may still be avoided. The northerly alignment of the King City Trunk requires local pump stations and force mains to serve the southeast area of the King City Urban Expansion Area.

District staff chose to move the combination of Alternatives 1 and 2 into the Capital Improvement Program as documented in TM 9, Conveyance Implementation Plan. Timing of development and coordination with the City of King City will drive the ultimate decision on which alternative is implemented.
Figure 8.31 Improvement Alternative 1 (Gravity Trunk) for King City Growth Area
Figure 8.32 Improvement Alternative 2 (River Terrace North Force Main Extension) for King City Growth Area
8.10 Chicken Creek Pump Station Alternative

In 2017, the District evaluated alternatives to determine improvements to the Upper Tualatin Interceptor (Upper Tualatin Interceptor Project, March 2017). As part of the project, alternatives were considered to serve growth in the City of Sherwood and in particular opportunities to serve the West Urban Reserve. The Chicken Creek Pump Station and Force main project as shown in Figure 8.33 was selected as a preferred alternative to avoid improvements to the lower portion of the Sherwood Trunk and the Sherwood Pump Station and Force Main. The project includes a new pump station with a capacity of 10.5-11.0 mgd and a new 18,000 feet, 24-inch force main near SW Roy Rogers Road. The force main will extend from the pump station location along SW Pacific Highway (Hwy 99W) and discharge into the Upper Tualatin Interceptor bypassing the Sherwood Pump Station. The Chicken Creek Pump Station project will include multiple options to also optimize the use of the Sherwood Pump Station for a smaller service area including replacement of existing pumps with smaller pumps. The Chicken Creek Pump Station project will also allow the District to abandon sections of the Sherwood Trunk located in the Tualatin River National Wildlife Refuge.

![Chicken Creek Pump Station Improvement](image-url)
8.11 Additional Projects Identified for the Capital Improvement Program

Many local pipeline upsizing and new pump station improvements were considered in the East Basin to eliminate local capacity constraints and accommodate future growth. The pipeline projects focused on increased sizing of existing assets based on projected flows. The pump station projects focused on local pumping requirements to serve future development. These improvement projects in most cases considered single alternatives for improvement or borrowed selected projects from adopted member city master plans. These additional projects, in addition to the preferred improvement alternatives presented in this TM, are documented in TM 9, Conveyance Implementation Plan. The project documentation includes recommended sizing, phasing, project timing, project drivers, targeted design flow rates, and estimate project capital costs.
Appendix 8A
COST ESTIMATING APPROACH AND UNIT COST REFERENCE

8A.1 Background

Capital improvement cost estimates are consistent with Class 5 budget estimates, as established by the American Association of Cost Engineers (AACE). This preliminary estimate class is used for conceptual screening and assumes project definition maturity level below two percent. The expected accuracy range is -20 to -50 percent on the low end, and +30 to +100 percent on the high end. Cost estimates are intended to be used as guidance in establishing funding requirements at the project planning level based on information available at the time of the estimate. All costs estimates are developed in 2020 dollars.

Costing data utilize the RS Means cost database (www.rsmeans.com) and were checked against District and other local bid tab data to adjust labor and construction unit costs.

8A.2 Cost Markups

Construction cost markup assumptions are presented in Table 8A.1 and are included for engineering, legal, administration (ELA), and contractor general conditions, contract overhead and profit, and construction contingencies. Low and high-end markups were applied to the estimated construction cost for each project. The range of markups is based on a cost envelope developed from District bid-tabs and other regional industry data. The highest markups include increased values for engineering and construction contingency to account for challenging construction risks and environmental mitigation requirements. For projects in environmental corridors, creek corridors, and heavily vegetated areas, a separate environmental mitigation factor of 1.4 was applied to the project unit costs for linear assets in addition to the indirect cost markups.

High-end and low-end markups were applied to direct costs (labor, materials, construction) to develop capital cost estimates for the District capital improvement program.

Table 8A.1 Markups and Factors for Capital Improvement Cost Estimates

<table>
<thead>
<tr>
<th>Markup Category</th>
<th>Markup Range</th>
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<tr>
<td>Indirect: Contractor General Conditions</td>
<td>10% 10%</td>
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<tr>
<td>Indirect: Contractor Overhead and Profit</td>
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<td>Indirect: Engineering, Legal, Admin</td>
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<td>Total Indirect</td>
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<td>Construction Contingency</td>
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<td>Additional Markup</td>
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<td>Environmental Restoration</td>
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8A.3 Conveyance Unit Costs

8A.3.1 New Pump Station Costs

A summary of new pump station direct unit costs (labor and materials) are provided in Table 8A.2 and Figure 8A.1. Pump station costs were identified using District Pump Station projects up to 5 mgd. RS Means data and other regional projects were used to check extrapolated pump station costs beyond 5 mgd. Bid tabs used from the District include the River Terrace North Pump Station, Butternut Pump Station, and River Terrace South Pump Station.

<table>
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<tr>
<th>Firm Capacity (mgd)</th>
<th>Direct Unit Cost, No Markup ($)</th>
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Figure 8A.1  Pump Station Direct Unit Cost Data

8A.3.2 New Force Main Costs

A summary of force main direct unit costs (labor and materials) is provided in Table 8A.3. The cost basis was developed for force mains with diameters ranging from 4 to 24 inches. It was assumed that the force mains would be installed at no more than 10-foot depths. The costs include pipe materials, installation costs and surface restoration. Force main costs are based on AWWA C900 pipe with restrained joints. Force main bid tabs used from the District to refine force main unit costs include the River Terrace North Pump Station, Butternut Pump Station, and River Terrace South Pump Station.
Table 8A.3  Force Main Direct Unit Costs

<table>
<thead>
<tr>
<th>Pipe Diameter (inch)</th>
<th>Pipe Material ($/linear foot)</th>
<th>Installation ($/linear foot)</th>
<th>Surface Restoration</th>
<th>Direct Unit Cost (no markup)</th>
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<td>Local ($/linear foot)</td>
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8A.3.3 New Gravity Sewer Costs

A summary of gravity pipeline direct unit costs (labor and materials) is provided in Table 8A.4. The gravity sewer cost basis was calculated for diameters from 10 to 84 inches, installed at depths from 0 to 30 feet. The unit costs include pipe material, installation, manholes at an average interval of 400 feet, and surface restoration. The pipe material costs are based on Portland and Ogden Oldcastle (for 48-inch diameter and larger pipes). District bid tabs were reviewed for multiple projects including the Bull Mountain Trunk, Cedar Mill (Walker and Murray), Onion Flats, Upper Tualatin Interceptor. A cost envelope showing the range of potential capital costs for gravity sewers referencing available bid tabs and including the high-end and low-end indirect markups and environmental mitigation markup is shown in Figure 8A.2.
Table 8A.4  Gravity Sewer Direct Unit Costs

<table>
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<tr>
<th>Diameter (inch)</th>
<th>Depth (foot)</th>
<th>Pipe Material ($/linear foot)</th>
<th>Installation ($/linear foot)</th>
<th>Surface Restoration</th>
<th>Manhole Costs ($/each at 400 foot spacing)</th>
<th>Bypass Pumping ($/linear foot)</th>
<th>Direct Unit Cost (no markup)</th>
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<td>Surface Restoration</td>
<td>Manhole Costs ($/each at 400 foot spacing)</td>
<td>Bypass Pumping ($/linear foot)</td>
<td>Direct Unit Cost (no markup)</td>
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Figure 8A.2  Gravity Conveyance Capital Cost Envelope and Bid Tab Reference
8A.3.4 Pipeline Rehabilitation Costs

A summary of CIPP lining and pipe bursting direct unit costs (labor and materials) are provided in Tables 8A.5 and 8A.6. Costs were developed from local and regional rehabilitation projects bid tabs and cost indexes from the City of Portland Bureau of Environmental Services. Lateral direct costs are assumed to be $6000 per lateral. CIPP lining unit costs were applied to rehabilitation projects larger than 18-inches in diameter. Pipe bursting unit costs were applied to rehabilitation projects 18-inches and smaller.

Table 8A.5 CIPP Lining Pipeline Rehabilitation Unit Costs

<table>
<thead>
<tr>
<th>Pipe Diameter (inch)</th>
<th>Direct Unit Cost (no markup) ($)/linear foot</th>
<th>Lateral per linear foot of Mainline</th>
<th>Lateral ($)/mainline linear foot</th>
<th>Direct Cost (no markup) with Laterals ($)/linear foot</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>206</td>
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<td>90</td>
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Table 8A.6  Pipe Bursting Pipeline Rehabilitation Unit Costs

<table>
<thead>
<tr>
<th>Pipe Diameter (inch)</th>
<th>Depth (foot)</th>
<th>Burst Cost ($/linear foot)</th>
<th>Bypass Pumping ($/linear foot)</th>
<th>Pre-Install Clean/TV ($/linear foot)</th>
<th>Post-Install Clean/TV ($/linear foot)</th>
<th>MH (1 per 400 linear foot)</th>
<th>Direct Unit Cost (no markup) ($/linear foot)</th>
<th>Laterals per linear foot of Mainline</th>
<th>Lateral ($/mainline linear foot)</th>
<th>Direct Cost (no markup) with Laterals ($/linear foot)</th>
</tr>
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<td>90</td>
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8A.3.5 Pipeline Trenchless Costs

A summary of trenchless construction direct unit costs (labor and materials) is provided in Table 8A.7. Costs were developed from local and regional trenchless project cost indexes and bid tabs for large diameter conveyance projects. Trenchless technologies on the low-end of the estimates include pipe ramming and auger boring. Trenchless technologies on the high-end of the estimates include micro-tunneling.

Table 8A.7 Trenchless Construction Pipeline Unit Costs

<table>
<thead>
<tr>
<th>Diameter (inch)</th>
<th>Low Direct Cost (no markup) $/linear foot</th>
<th>High Direct Cost (no markup) $/linear foot</th>
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<td>9250</td>
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</table>

8A.3.6 Operation and Maintenance Costs

Operation and maintenance cost assumptions are provided below.

- Annual O&M costs:
  - Gravity Sewer = $0.25 per inch diameter per linear foot of pipeline per year.
  - Force Main = $0.25 per inch diameter per linear foot of pipeline per year.
  - Pump Station = $50,000 per pump station per year.

- Annual Energy costs:
  - $0.06 per kilowatt-hour.
  - 2,200 hours of pump run time average per year.
  - 0.7 pump efficiency.

8A.4 Equivalent Uniform Annual Cost Methodology

The Equivalent Uniform Annual Cost Methodology (EUAC) calculates the annualized present value of constructing, operating, and maintaining components of a system. The EUAC for multiple components of a system can be summed to develop an EUAC for an entire system or combination of improvements that make up an alternative. The EUAC includes the initial and replacement cost of capital, annual operations and maintenance (O&M) costs, and annual energy costs. The approach also considers varied life spans for infrastructure replacement.

Steps to performing the EUAC methodology and examples are presented below.
**STEP 1** – Define life span for infrastructure components based on industry data, construction materials, and O&M feedback.

*Examples:*
- Gravity Interceptors – 80 years.
- Force mains – 50 years.
- Diversion Structures – 50 years.
- Wet Wells – 50 years.
- Pump Station Mechanical and Electrical – 20 years.

**STEP 2** – Define unit costs and markups to apply to improvement options. Unit costs are established for capital and replacement, annual O&M, and annual energy categories. Costs are generated from project bid tabs and O&M records. Annual O&M costs are defined by standard activities and exclude infrastructure replacement.

**STEP 3** – Select discount rates and inflation rates for present worth and annual replacement cost calculations.

*Definitions:*
- Discount Rate: Interest rate used to determine the present value of future cash. The present value approach assumes that a dollar invested today equals a greater value at time \( t \). A good assumption for a discount rate is to use a long-term average return for a low risk investment such as the United States Treasury Bill Rate ([https://www.treasury.gov/resource-center/data-chart-center/interest-rates/pages/TextView.aspx?data=yieldAll](https://www.treasury.gov/resource-center/data-chart-center/interest-rates/pages/TextView.aspx?data=yieldAll)).
- Inflation Rate(s): Rate at which the cost of capital projects, O&M, and energy increases over time. The inflation rate(s) may be the long-term historical inflation rate based on the Consumer Price Index as reported by the United States Bureau of Labor Statistics ([https://www.bls.gov/cpi/](https://www.bls.gov/cpi/)) or something much more specific to the municipal market such as the change in the Municipal Cost Index, Construction Cost Index, and/or Energy Costs Index over time ([https://www.americancityandcounty.com/municipal-cost-index/](https://www.americancityandcounty.com/municipal-cost-index/), [https://www.eia.gov/electricity/wholesale/#history](https://www.eia.gov/electricity/wholesale/#history)). Modeled future inflation rates may also be used and tend to be lower (more conservative).

The following were applied to the EUAC evaluation for the East Basin Master Plan:
- 4-percent discount rate.
- 2-percent inflation rate.

**STEP 4** – Calculate real discount rates to use in converting one-time capital costs to annualized costs. In addition to use in the annual replacement cost calculation, the real discount rates are applied in **STEP 5** to convert delayed or phased improvement life cycle costs to present value. Real discount rates can be calculated uniquely for capital, O&M, and energy categories using specific inflation rates for each category.

*Definition:*
Real Discount Rates are used to convert one-time capital costs to annualized costs, where:
- Real Discount Rate = \([(Discount Rate – Inflation Rate) / (1 + Inflation Rate)]\).
- Annualized Cost (%) = \((Real Discount Rate)(Real Discount Rate + 1)/(1 - (1 + Real Discount Rate)\(-Life Span\)))\).
STEP 5 – Apply unit costs to infrastructure components for capital, O&M, and energy costs. Translate costs to EUAC. Capital EUAC includes annualized replacement. Sum capital EUAC, annual O&M, and annual energy cost for total life cycle cost.

Definition:

Capital EUAC including multiplier for replacement based on life span of infrastructure component:

- Capital Cost (capital, $) = Unit Cost Capital x Quantity.
- Capital EUAC ($/year, discounted for time, t) = \[\text{Capital Cost}/((1+ \text{Real Discount Rate for Capital})^t)] x \text{Annualized Replacement Cost}.

Annual O&M Cost:

- Annual O&M Cost ($/year) = Annual Unit Cost O&M x Quantity.
- Annual O&M Cost ($/year, discounted for time, t) = \[\text{Annual O&M Cost}/((1+ \text{Real Discount Rate for O&M})^t)].

Annual Energy Cost:

- Annual Energy Cost ($/year) = Annual Unit Cost Energy x Quantity.
- Annual Energy Cost ($/year, discounted for time, t) = \[\text{Annual Energy Cost}/((1+ \text{Real Discount Rate for Energy})^t)].

Where t is time in years to improvement implementation; for near-term improvements, \(t = 0\)

- Total EUAC ($/year, discounted for time, t) = Capital EUAC + Annual O&M Cost + Annual Energy Cost.

STEP 6 – The EUAC for individual infrastructure components of an alternative are summed for the alternative EUAC. Alternative EUACs are compared for lowest overall life cycle cost.