CITY OF ST. HELENS, OR STORMWATER MASTER PLAN

REGISTERED PROFESSIONAL ENGINEER
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NOV. 13, 2018
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EXPIRES: 12/31/2023

NOVEMBER 2021

KA PROJECT NO. 220060-001 | CITY PROJECT NO. P-511

PREPARED BY:

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City of St. Helens

RESOLUTION NO. 1939

A RESOLUTION ADOPTING THE ST. HELENS STORMWATER MASTER PLAN

WHEREAS, the last update to the City's Stormwater Master Plan was in August 1999; and

WHEREAS, ORS 197.712(2)(e) requires a city to develop and adopt public facility plans for areas within their urban growth boundary containing a population greater than 2,500 persons; and

WHEREAS, the City of St. Helens Municipal Code 19.08.030 Public Services And Facilities Goals promote the development of an orderly arrangement of public facilities and services to serve as a framework for urban development, and the designing and locating public facilities so that capacities are related to future as well as present demands, that ample land is available for building and plant expansion, and that public works plants and utility structures reflect due regard for their environmental impact; and

WHEREAS, an updated St. Helens Stormwater Master Plan is needed to provide for growth and planning for future development; and

WHEREAS, Engineering consultant, Keller Associates, has prepared an updated St. Helens Stormwater Master Plan, attached as Exhibit A, and has presented said plan to the Planning Commission on October 12, 2021 and to the City Council at the November 3, 2021 Work Session; and

WHEREAS, consultant has prepared the St. Helens Stormwater Master Plan after extensive review and analysis of existing plans, policies, studies and other information, and has afforded all interested parties opportunity to review the plan.

NOW, THEREFORE, the City of St. Helens resolves that the St. Helens Stormwater Master Plan, attached as Exhibit A, is adopted and shall be used as a guide for the development and implementation of a complete, stormwater system.

APPROVED AND ADOPTED by the City Council on November 17, 2021 by the following vote:

Ayes: Morten, Topaz, Chilton, Birkle, Scholl

Nays: None

Rick Scholl, Mayor

ATTEST:

Kathy Payne, City Recorder

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ACRONYMS AND ABBREVIATIONS

AACE	Associate for the Advancement of Cost Engineering
AC	Acres
BMP	Best Management Practice
CCTV	Closed-Circuit-Television
CFS	Cubic Feet per Second
CIP	Capital Improvement Plan
CIPP	Cured-in-Place Pipe
CMP	Corrugated Metal Pipe
CWSRF	Clean Water State Revolving Fund
DEQ	Department of Environmental Quality
DI	Ductile Iron
DL	Dalton Lake Basin
DMA	Dedicated Management Agency
DOGAMI	Department of Geology and Mineral Industries
DSL	Department of State Lands
DT	Downtown Basin
d/D	Maximum depth divided by full depth
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FTE	Full Time Equivalent
GIS	Geographical Information System
GPM	Gallons per Minute
GW	Greenway Basin
HDPE	High-Density Polyethylene
HGL	Hydraulic Grade Line
LF	Linear Feet
LID	Low Impact Development
LOS	Level of Service
LWI	Local Wetlands Inventory
MI	Milton Creek Basin
MN	McNulty Creek Basin
MS4	Municipal Separate Storm Sewer System
MT	Middle Trunk Basin
NAVD88	North American Vertical Datum of 1988
NGVD29	National Geodetic Vertical Datum of 1929
NOAA	National Oceanic and Atmospheric Administration

NRCS	Natural Resources Conservation Service
NT	North Trunk Basin
ODOT	Oregon Department of Transportation
ODSL	Oregon Department of State Lands
O&M	Operations and Maintenance
PVC	Polyvinyl Chloride
PW	Public Works
ROW	Right-of-Way
SBUH	Santa Barbara Unit Hydrograph Method
SCS	Soil Conservation Service
SDC	System Development Charge
SHMC	St. Helens Municipal Code
SWMM	Stormwater Management Model
TMDL	Total Maximum Daily Load
UGB	Urban Growth Boundary
USACE	United States Army Corp of Engineers
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VCP	Vitrified Clay Pipe
WQMP	Water Quality Management Plan
WWTP	Wastewater Treatment Plant

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SECTION 1 - EXECUTIVE SUMMARY

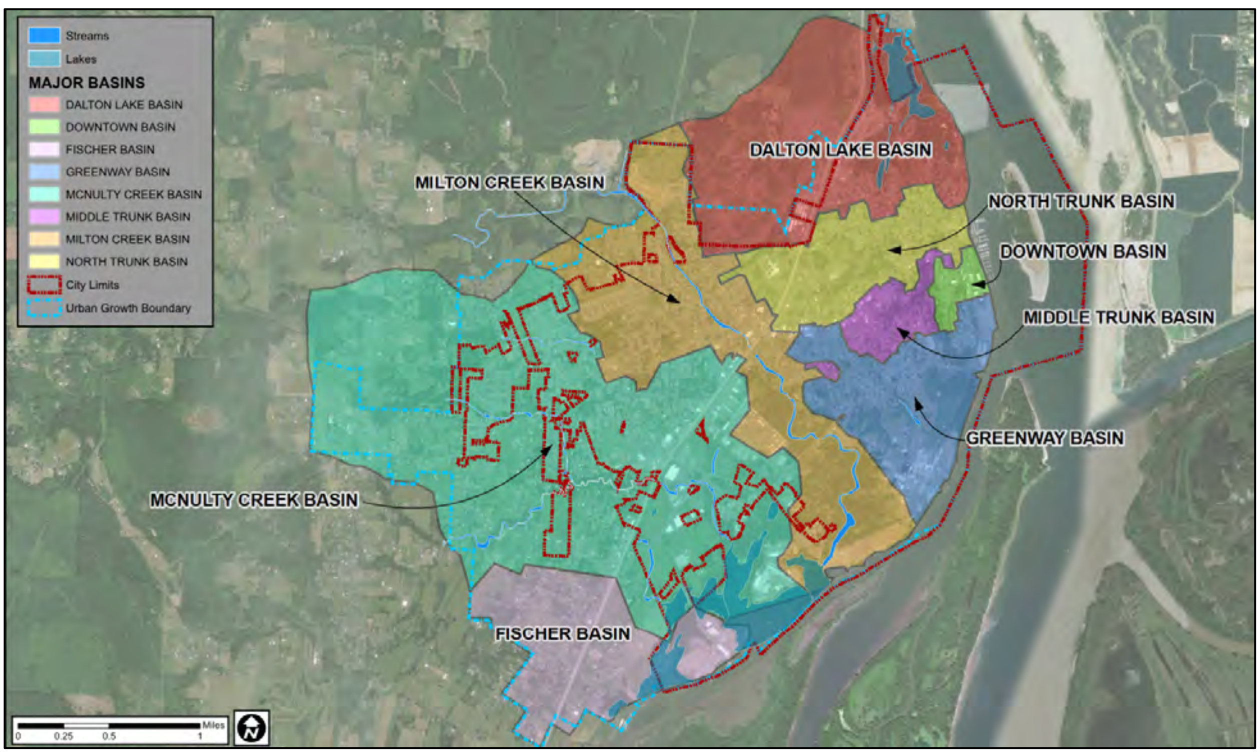
The City of St. Helens contracted with Keller Associates, Inc. to complete a stormwater master plan for the City's municipal stormwater system. This report was commissioned by the City in an effort to assess the current state of the stormwater system and plan for future needs. This section includes a summary of the stormwater planning criteria, existing system capacities, recommended improvements, and a capital improvement plan.

1.1 STUDY AREA

The study area within St. Helens is comprised of the areas within the City limits, the Urban Growth Boundary (UGB), and additional area outside of these two boundaries where stormwater runoff collects before it drains into the City's stormwater system. The City's UGB is made up of approximately 5,300 acres of land; approximately 600 acres of which is part of the Columbia River. Adding outside drainage area brings the total study area to approximately 6,000 acres and a total drainage area (excluding the Columbia River) of approximately 5,400 acres.

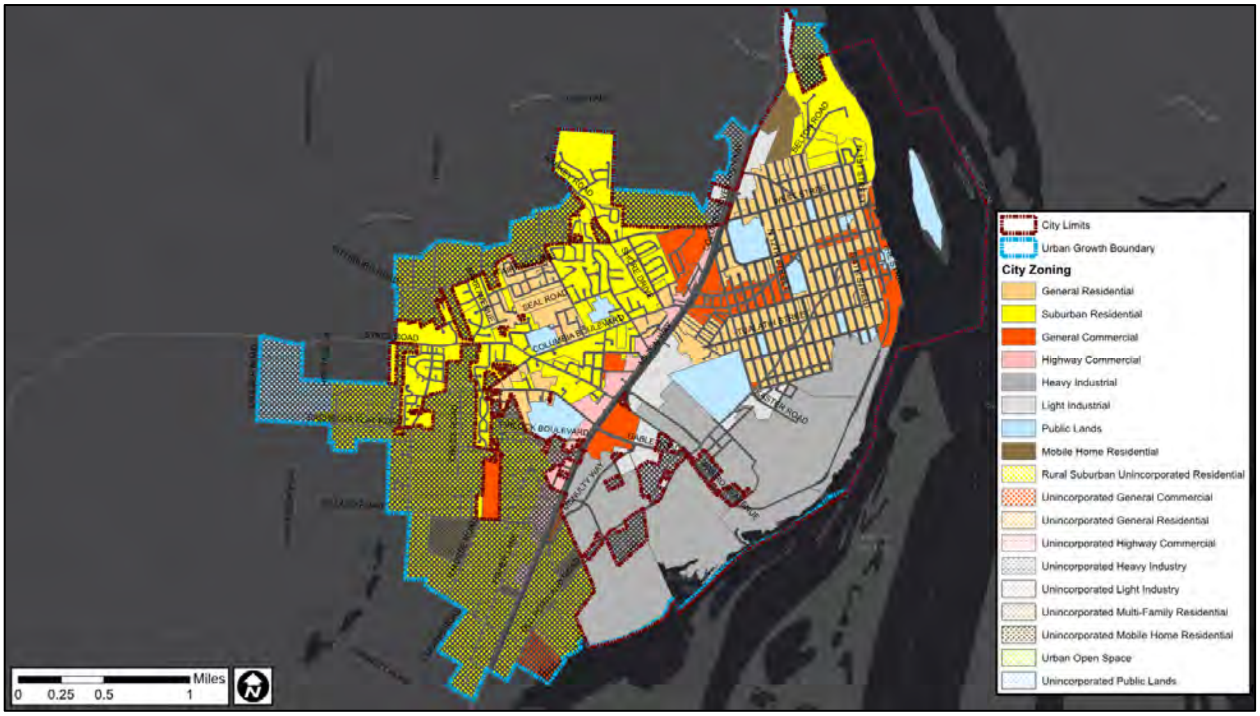
Stormwater from the study area drains into eight major drainage basins: Dalton Lake, North Trunk, Middle Trunk, Downtown, Greenway, Milton Creek, McNulty Creek, and Fischer Basin. The water collected from these major basins eventually drains into the Columbia River. The watersheds that drain across land within the UGB, as shown in Figure 1-1, are the focus in this study area.

FIGURE 1-1: STUDY AREA AND MAJOR DRAINAGE BASINS



The City's zoning areas include residential, commercial, industrial, and public zoning within City Limits. Approximately half of the zoning within City Limits is residential. Heavy and light industrial zones are concentrated in the southern portion of the City, and most commercial areas surround US Highway 30 or are located in the Houlton Business District or Riverfront District. A zoning map for the study area is shown in Figure 1-2.

FIGURE 1-2: STUDY AREA AND ZONING



1.2 PLANNING CRITERIA

Certain planning criteria were established with input incorporated from City staff. It is recommended that stormwater conveyance components be capable of passing runoff from the 25-year storm event (equal to 3.5 inches within 24-hours) without flooding or surcharging to within 0.5 feet of the rim elevation of any structure. It is also recommended that detention ponds be designed so the post-development peak release rates equal the pre-development release rates for their matching design storm event up to the 10-year design storm. The 25-year storm event peak release rate should not exceed the 10-year pre-development peak release rate.

Review and evaluation of water quality standards were not included in the scope of this study; however, water quality standards should be a consideration in any new stormwater facility. St. Helens is required to comply with the Total Maximum Daily Load (TMDL) and Water Quality Management Plan (WQMP) in the Willamette Basin and any future requirements set forth by the Oregon Department of Environmental Quality (DEQ). The City was recently named a designated management agency (DMA) for the Revised Willamette Basin Mercury TMDL and WQMP (2019). In conjunction with this stormwater master plan, the City is also developing an implementation plan to meet the revised TMDL requirements. Additionally, while the City of St. Helens is not currently regulated under a municipal separate storm sewer system (MS4) permit by the DEQ, the City will likely fall under an MS4 permit in the future. The city of St. Helens would be regulated under a MS4 Phase II General Permit which covers cities with a population of less than 100,000 people.

1.3 MODEL DEVELOPMENT

The stormwater modeling software InfoSWMM (Suite 14.7, Update #2) was used to assess stormwater runoff from the study area using the Natural Resources Conservation Service (NRCS) Unitless Hydrograph Method. Moreover, InfoSWMM was used to dynamically route the hydrologic model runoff through a hydraulic model representing the existing stormwater network of major trunklines (generally 12-

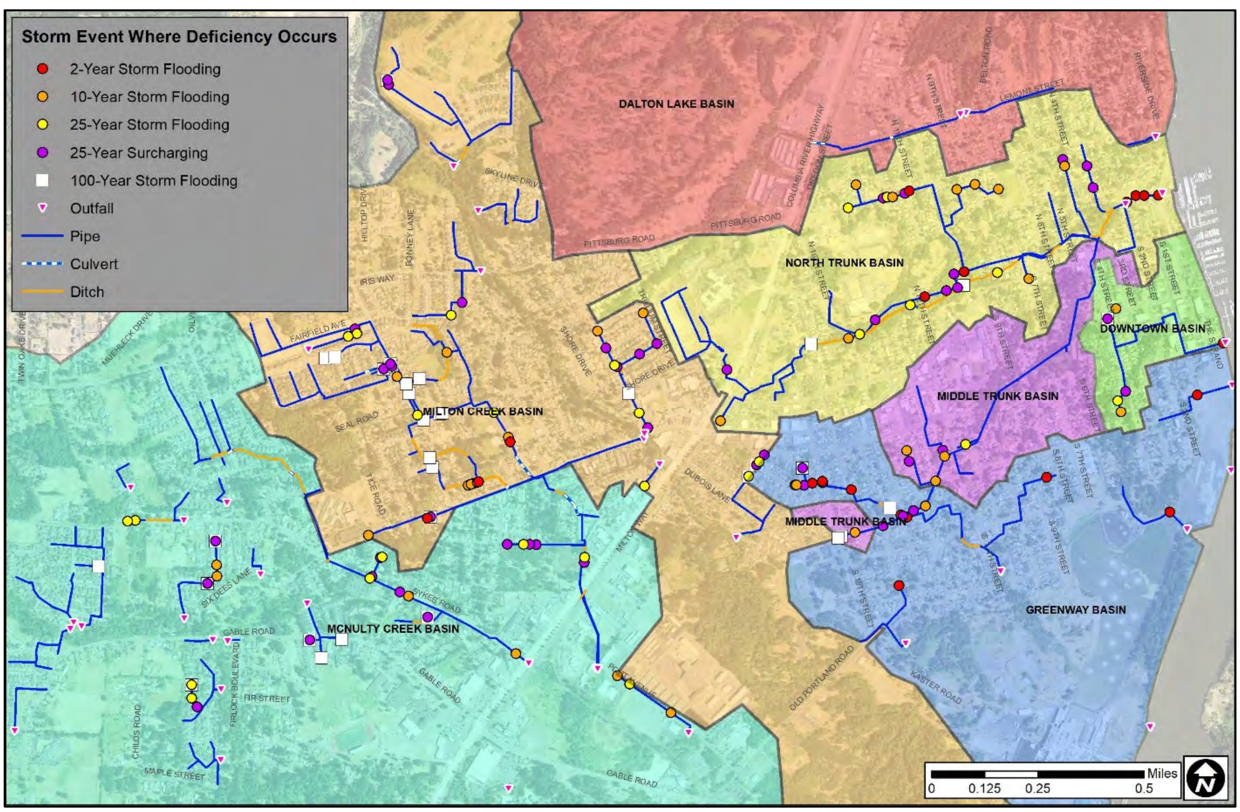
inch and larger in diameter) and connected open channels and detention facilities. Gaps in the City's GIS data were filled by surveying key stormwater structures throughout the system to develop a representative hydraulic model. The survey resulted in locating approximately 200 stormwater structures and 2,500 LF of open channel ditches, which are included in the model. The computer model was calibrated using flow monitor data collected in January 2021.

1.4 EXISTING SYSTEM EVALUATION

St. Helens' existing stormwater system includes approximately 45 miles of closed-conduit pipe ranging in diameter from 2-inches to 66-inches and approximately 6.5 miles of open channel within the study area. The system also includes about 800 manholes and 1,500 catch basins. The pipelines were evaluated based on both existing condition and capacity to convey the design storm event. Multiple pipe segments were identified as greater than 50 years old and it is recommended that these pipes be inspected and either replaced or upsized. Additional pipes were found to be aligned underneath existing building structures based on the GIS data. If the pipes are running underneath existing structures, these areas should need to be field verified and re-aligned.

Capacity related deficiencies were identified both by City staff's historical observations and by the stormwater model. Deficiencies in the model were identified for the 2-, 10-, 25-, and 100-year storm events and were used to prioritize improvements, which are included in the capital improvement plan. Flooding and surcharging were identified in each of the major drainage basins excluding the Dalton Lake Basin and Fischer Basin. A summary of the modeled flooding and surcharging within 0.5 feet of rim elevation for each storm event is shown in Figure 1-3.

FIGURE 1-3: EXISTING SYSTEM FLOODING AND SURCHARGING



1.5 STAFFING EVALUATION

A high-level evaluation of existing stormwater staffing levels, deficiencies in existing staffing levels, and staffing recommendations was completed as part of this study. The City Public Works (PW) Operations staff, who are responsible for the operations and maintenance (O&M) of the stormwater system, were interviewed to collect information on existing staffing levels, annual O&M activities, and level of service (LOS) goals for the City stormwater infrastructure. In general, St. Helens' public works staff provide support for many City activities that are not directly related to public utility O&M (i.e. building maintenance, building remodels, City events, etc.), which reduces time and O&M activities they can spend on utility infrastructure. It is recommended that either additional full-time equivalent (FTE) be budgeted for the PW staff to complete the existing workload requested, or the responsibilities of the PW staff be reduced to focus solely on utility O&M. Additionally, it is advised that staffing needs be re-evaluated every two to three years.

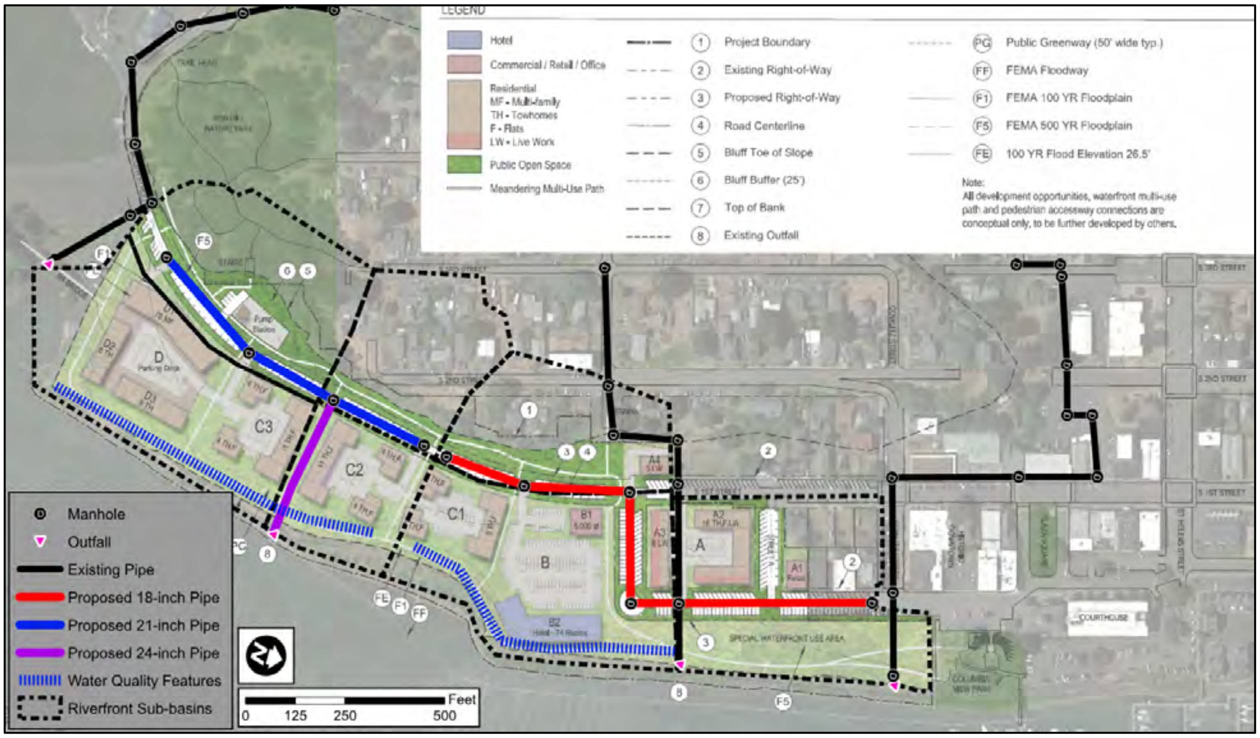
1.6 ALTERNATIVES ANALYSIS

Multiple alternatives were evaluated to address the deficiencies identified in the existing stormwater system. Some of the alternatives included rerouting flows, detaining flows, and upsizing existing pipes. The natural topography of the City was utilized where available to develop alternatives which would provide detention storage, reduce peak flows, and allow opportunities for water quality facilities. Pipes were recommended to be upsized where detention storage was not a viable option. The pros and cons of each alternative were evaluated, and a recommended alternative project was presented to the City to be included in the CIP.

1.7 FUTURE SYSTEM

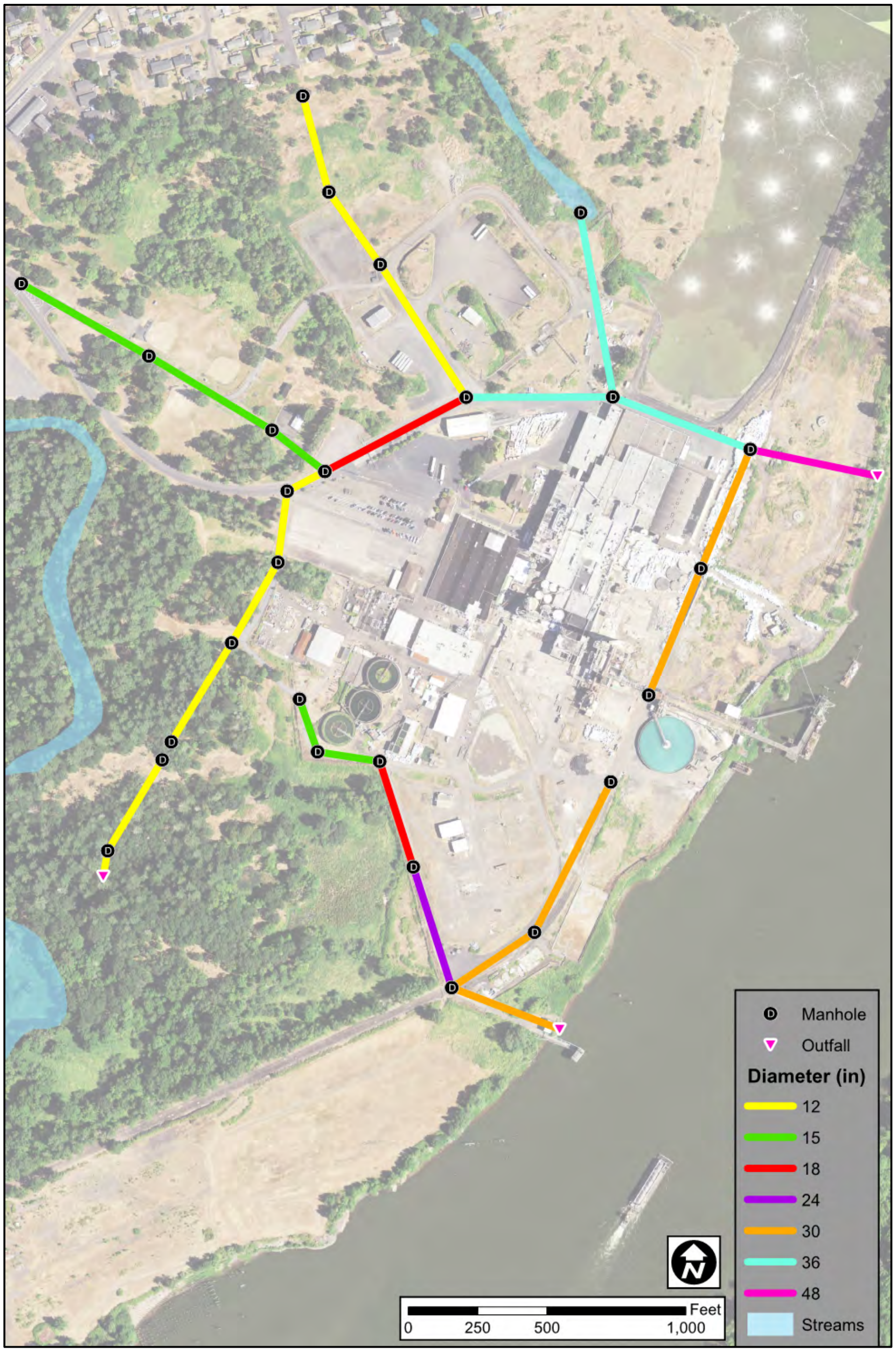
Development driven stormwater infrastructure was evaluated at a high level and drainage sub-basins for the 20-year development areas were delineated. A number of the proposed developments will likely drain to the existing stormwater network while others may drain to a new outfall location at one of the bodies of water within the study area. Stormwater conveyance infrastructure was evaluated in more detail for the City's Riverfront Development and Industrial Business Park. Stormwater piping alignment and sizes were recommended for the Riverfront Development as shown in Figure 1-4.

FIGURE 1-4: RIVERFRONT DEVELOPMENT PROPOSED STORMWATER INFRASTRUCTURE



Recommended pipe alignments and sizing for the City's Industrial Business Park are shown in Figure 1-5. The pipe alignments were based on the City's parcellation plan and pipes were aligned within the proposed rights-of-way.

FIGURE 1-5: INDUSTRIAL BUSINESS PARK PROPOSED STORMWATER INFRASTRUCTURE



1.8 ENGINEERING DESIGN STANDARDS, CODE, & COMPREHENSIVE PLAN REVIEW

The City's existing development code (Title 17), engineering design standards (Title 18), and comprehensive plan (Title 19) were reviewed as they pertain to stormwater conveyance and treatment for new development to identify potential deficiencies and provide recommendations for updates. The primary recommendations for review, updates, and additions include the following:

- Clear triggers and requirements for water quality
- Promote best management practices (BMPs) and low impact development (LID)
- Specifics of required drainage report elements and City engineering process for review and approval of plans
- Detention facility requirements
- Hydrologic analysis requirements

The City should review and assess these recommended changes to these sections to City code, standards, and comprehensive plans to match current best practices in the industry. The City should then initiate the process of proposing changes to associated City documents to maintain consistency.

1.9 CAPITAL IMPROVEMENT PLAN (CIP)

Improvements were suggested to alleviate the flooding and surcharging identified in the existing system evaluation. The capital improvement plan (CIP) was categorized into three priorities. The criteria for each priority are shown in Table 1-1.

TABLE 1-1: CAPITAL IMPROVEMENT PLAN PRIORITIZATION CRITERIA

Priority	Criteria	Implementation Timeline
1	Alleviate historically known flooding identified by the City and some 2-year flooding.	0-5 Years
2	Alleviate additional 2-year flooding identified in the model or age identified replacement.	5-10 Years
3	Alleviate deficiencies identified in 10-year and 25-year storm events.	10-20 Years

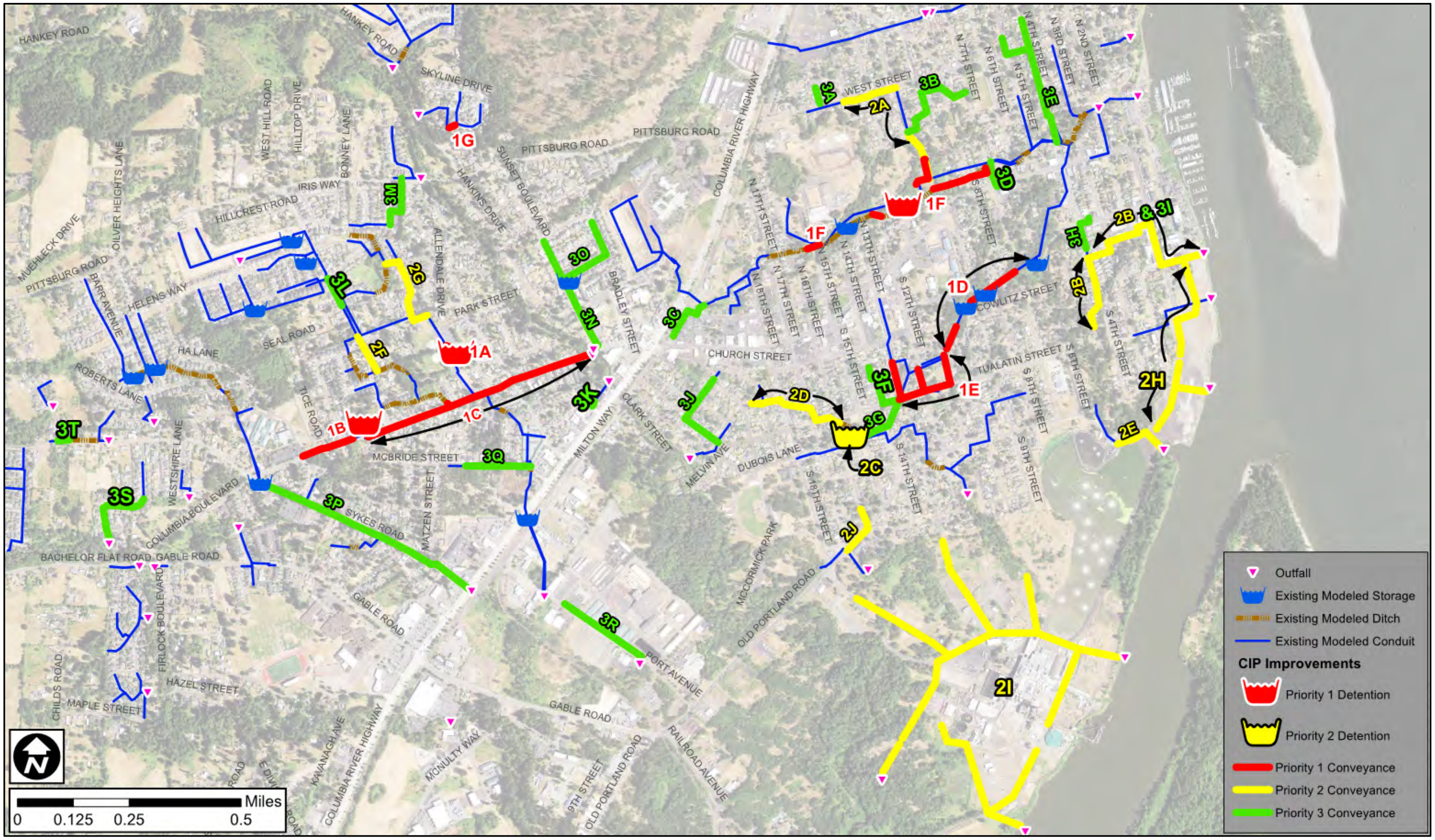
System development charge (SDC) eligibility was evaluated for each of the improvement projects recommended. The SDC improvement amount is based on the percentage of future development area within the capital improvement's contributing drainage basin. The SDC eligibility for each project is summarized in Table 1-2.

TABLE 1-2: CAPITAL IMPROVEMENT PLAN SUMMARY

Priority	Project Description	Estimated Cost	SDC Eligibility	SDC Improvement Amount	City Amount
Priority 1 Improvements					
1A	Campbell Park Detention Pond (Milton Creek)	$300,000	0%	$0	$300,000
1B	Columbia Boulevard Detention Pond (Milton Creek)	$1,100,000	66%	$727,000	$373,000
1C	Columbia Boulevard Upsize (Milton Creek)	$2,800,000	14%	$392,000	$2,408,000
1D	Middle Trunk Detention Ponds and Piping	$2,000,000	5%	$103,000	$1,897,000
1E	Upsize and Realign Tualatin Street (Middle Trunk)	$5,000,000	14%	$677,000	$4,323,000
1F	Detention Pond and Piping Between N 12th and N 7th Street (North Trunk)	$1,600,000	17%	$269,000	$1,331,000
1G	Ridgeway Loop Pipe Installation	$60,000	0%	$0	$60,000
	Total Priority 1 Improvement Costs	$12,900,000	-	$2,200,000	$10,700,000
Priority 2 Improvements					
2A	Upsize Pipes along West Street and N 10th Street (North Trunk)	$1,400,000	0%	$0	$1,400,000
2B	S 4th Street to Outfall CCTV Inspection (Downtown)	$20,000	0%	$0	$20,000
2C	Heinie Huemann Park Detention Pond (Greenway)	$200,000	26%	$52,000	$148,000
2D	Upsize from S 20th Street to Heinie Huemann Park (Greenway)	$1,100,000	29%	$318,000	$782,000
2E	Nob Hill Park CIP lining (Greenway)	$400,000	0%	$0	$400,000
2F	Franz Street (Milton Creek)	$400,000	0%	$0	$400,000
2G	Mayfair Drive CIP lining and Upsize (Milton Creek)	$400,000	0%	$0	$400,000
2H	Riverfront Development Stormwater Infrastructure	$3,300,000	100%	$3,300,000	$0
2I	Industrial Business Park Stormwater Infrastructure	$8,600,000	100%	$8,600,000	$0
2J	S 16th Street to Old Portland Road Upsize (Greenway)	$500,000	0%	$0	$500,000
2K	Stormwater Master Plan Update	$200,000	0%	$0	$0
	Total Priority 2 Improvement Costs	$16,500,000	-	$12,300,000	$4,100,000
Priority 3 Improvements					
3A	Upsize N 13th Street to West Street (North Trunk)	$200,000	0%	$0	$200,000
3B	Upsize from 6th Street Ball Park to N 10th Street (North Trunk)	$900,000	0%	$0	$900,000
3C	Upsize Milton Way at Street Helens Street (North Trunk)	$600,000	75%	$450,000	$150,000
3D	Upsize N 7th Street from Columbia Boulevard to Trunkline (North Trunk)	$400,000	0%	$0	$400,000
3E	Upsize N 4th Street south of West Street (North Trunk)	$1,400,000	0%	$0	$1,400,000
3F	Upsize and Regrade along S 14th Street (Middle Trunk)	$600,000	50%	$298,000	$302,000
3G	Upsize existing pipes from Heinie Huemann to Tualatin Street (Middle Trunk)	$400,000	0%	$0	$400,000
3H	Street Helens Street to South 4th Street Upsizing (Downtown)	$500,000	0%	$0	$500,000
3I	S 4th Street to Outfall Pipe Upsizing (Downtown)	$2,400,000	0%	$0	$2,400,000
3J	Crouse Way Upsize (Milton Creek)	$1,000,000	14%	$137,000	$863,000
3K	Eilertson Street (Milton Creek)	$100,000	0%	$0	$100,000
3L	N Vernonia Road from Oakwood to Ava Court (Milton Creek)	$400,000	0%	$0	$400,000
3M	Ethan Lane Upsizing (Milton Creek)	$600,000	0%	$0	$600,000
3N	Sunset Boulevard to Outfall Upsize (Milton Creek)	$800,000	0%	$0	$800,000
3O	Sunset Boulevard, Trillium Street and Salmon Street upsize (Milton Creek)	$1,100,000	0%	$0	$1,100,000
3P	Sykes Road Upsize from Columbia Boulevard to Outfall (McNulty Creek)	$2,700,000	0%	$0	$2,700,000
3Q	McBride Street Upsize (McNulty Creek)	$600,000	0%	$0	$600,000
3R	Port Avenue Upsize (McNulty Creek)	$900,000	0%	$0	$900,000
3S	Whitetail Avenue Upsize (McNulty Creek)	$800,000	0%	$0	$800,000
3T	Sykes Road Cuvert near Mountain View Drive Upsize (McNulty Creek)	$80,000	0%	$0	$80,000
	Total Priority 3 Improvement Costs	$16,500,000	-	$900,000	$15,600,000
	Total Capital Improvement Costs	$45,900,000	-	$15,400,000	$30,400,000

The cost estimate herin is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Keller Associates has no control over variances in the cost of labor, materials, equipment, services provided by others, contractor's methods of determining prices, competitive bidding or market conditions, practices, or bidding strategies. Keller Associates cannot and does not warrant or guarantee that proposals, bids, or actual construction costs will not vary from the cost presented herein.

FIGURE 1-6: CAPITAL IMPROVEMENT PLAN



1.10 PLANNING RECOMMENDATIONS

It is recommended that the City update their planning documents every five years because updates to the planning documents and models would allow the City to re-assess needs and properly allocate budgets to address system deficiencies. A Master Plan Update for the stormwater system has been included as a Priority 2 improvement in the CIP (Table 1-2).

1.11 OTHER ANNUAL COSTS

The stormwater conveyance system requires regular maintenance to ensure that pipelines, catch basins, and detention facilities flow freely during the storm events. Additional stormwater facilities continue to age and will eventually need to be rehabilitated or replaced.

The replacement program is based on the total amount of existing City stormwater infrastructure and its estimated useful life. The City facilities include approximately 45 miles of storm pipes, 800 manholes, and 1,500 catch basins. Assuming an average useful life of 75-years remaining life, the replacement program should target approximately 3,000 feet of pipe, 30 catch basins, and 16 manholes per year. Assuming an average pipe replacement cost of $190 per foot, a catch basin cost of $3,500 each, and a manhole cost of $11,000, the City would need an annual replacement budget of approximately $900,000. Table 1-3 summarizes the annual replacement program targets and associated costs.

TABLE 1-3: SUMMARY OF ANNUAL REPLACEMENT COSTS

Item	Lifespan	Total Quantity	Annual Cost[1] (rounded)
Lineal Feet of Storm Lines	75 Years	237,000	$600,000
Number of Catch Basins	50 Years	1,500	$110,000
Number of Manholes	50 Years	800	$180,000
		Total (Rounded)	$900,000

1) Storm pipes unit price equal to average unit price of 12" to 30". Manhole unit price equal to average of 48" and 60" manhole.

Additionally, as part of the City's maintenance program, the locations indicated in the existing evaluation as being underneath a structure should be investigated and abandoned if it is determined the pipes are actually underneath existing structures.

Currently, additional projects and work the PW staff are requested to complete will significantly decrease the budgeted FTE that can be spent on stormwater O&M. It is estimated that approximately 4.25-4.5 FTE are needed to meet the current recommended level of O&M to meet the City's LOS goals. It is recommended that either additional FTE be budgeted for the PW staff to complete the extra workload requested, or the responsibilities of the PW staff be reduced to focus solely on utility O&M. In addition, the recommended CIP projects would increase workload of the engineering division. The engineering division may need additional staff to update and maintain the GIS database, coordinate CCTV inspection and resulting work orders, and manage capital improvements. Additional workload on the engineering and PW operations divisions should be included in planning for any of the recommended improvements and projects. Generally, it is advised that staffing needs be reevaluated every two to three years.

1.12 OTHER FINANCIAL CONSIDERATIONS

The City should complete a full-rate study for the stormwater utility to evaluate the potential user rate and SDC impacts of the recommended CIP. Estimated SDC eligibility for each identified capital improvement is included in Table 1-2 for use in completing a full rate study. It is recommended the City actively pursue opportunities with funding sources for grant funds, low-interest loans, or principal forgiveness to mitigate user rate impacts. As the City begins to prepare and proceed on CIP projects, if outside funding is desired, it is recommended the City setup a one-stop meeting with Business Oregon to identify and assess the potential funding sources for stormwater projects.

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SECTION 2 - PROJECT PLANNING

This section discusses the general study area and its physical characteristics. A summary of the major drainage basins and the existing and future land use is covered as well.

2.1 LOCATION AND STUDY AREA

The study area is comprised of the areas within the City limits, the Urban Growth Boundary (UGB), and additional area outside of these two boundaries where stormwater runoff collects before it drains into the City's stormwater system. The City's UGB is made up of 5,280 acres of land; approximately 565 acres of which is over the Columbia River. Adding outside drainage area brings the total study area to approximately 6,000 acres and a total drainage area (excluding the Columbia River) of 5,435 acres. Figure 1 in Appendix A illustrates the City limits, the UGB, and the study area.

2.2 ENVIRONMENTAL RESOURCES PRESENT

The following section describes the existing environmental resources present in this area that might be impacted by stormwater facilities. The components analyzed below include land use, prime farmland, floodplains, wetlands, cultural resources, coastal resources, and socio-economic conditions. Discussion of environmental impacts on specific alternatives is covered later in the report.

2.2.1 LAND USE

The City's zoning areas include residential, commercial, industrial, and public zoning within the city limits. Approximately half of the zoning within City limits is residential. Heavy and light industrial zones are concentrated in the southern portion of the City, and most commercial areas surround US Highway 30 or are located in the Houlton Business District or Riverfront District. A zoning map for the study area is shown in Figure 2 in Appendix A.

2.2.2 FLOODPLAINS

Information on the floodplains within the study area is available from the Federal Emergency Management Agency (FEMA) Map Service Center. These maps show portions of the planning area which lie within the 100-year floodplain adjacent to the floodway of the Columbia River and several other small drainages. Figure 3 in Appendix A shows the flood areas within the study area obtained from the FEMA website. The figure is for display purposes only. For specific projects in these areas, the individual FEMA Flood Insurance Rate Map (FIRM) Panels should be referenced.

2.2.3 WETLANDS

The City completed a Local Wetlands Inventory (LWI) in 1999 that was accepted by the Department of State Lands (DSL) and is referenced in the City's Comprehensive Plan as of May 2020. In the Comprehensive Plan, the City takes inventory and maps their wetlands to assess their functions in order to determine "Locally Significant Wetlands" that contribute to wildlife habitat, fish habitat, water quality, floodwater retention, recreational opportunities, and/or educational opportunities. The Comprehensive Plan lists the following wetlands as Locally Significant Wetlands: Dalton Lake, McNulty Creek, Frogmore Slough, Jackass Canyon, Milton Creek, Unnamed Creek A, and Unnamed Creek B.

Approximately 443 acres of wetlands were identified within the study area and were classified into the following wetland types and is shown as Figure 4 in Appendix A.

- Palustrine Forested Wetland – A wetland with soil that is saturated and often inundated and is dominated by woody plants taller than 20 feet. Water-tolerant shrubs and herbaceous plants are often beneath the forest canopy.
- Palustrine Scrub/Shrub Wetland – A wetland dominated by shrubs and woody plants less than 20 feet tall. Water levels can range from permanent to intermittent flooding.

- Palustrine Emergent Wetland – Wetlands dominated by erect, rooted herbaceous plants that can tolerate flooded soil conditions, but cannot tolerate being submerged for extended periods, e.g., cattails, reeds, and pickerelweeds.
- Palustrine Rock Bottom Wetland – Wetlands with substrates having an aerial cover of stones, boulders, or bedrock 75% or greater and vegetative cover less than 30%. Water regimes are restricted to subtidal, permanently flooded, interment exposed, and semipermanent flooded.
- Lacustrine Littoral Wetland – Wetlands situated in a topographic depression or a dammed river channel and lack trees and shrubs. Wetlands are permanently flooded with extensive areas of deep water.
- Riverine Upper Perennial Wetland – Water is flowing throughout the year and includes wetlands contained within a channel unless the wetland is dominated by trees, shrubs, and emergent, or habitats with water containing ocean derived alts in excess of 0.5%. The gradient of the channel is high, and velocity is fast.
- Riverine Intermittent Wetland – Similar to Riverine Upper Perennial Wetland, except water only flows for parts of the year.

Definitions for the wetland types were retrieved from the U.S. Fish and Wildlife Service (USFWS) Classification of Wetlands and Deepwater Habitats of the United States. Additionally, to protect riparian areas of locally significant wetlands, including McNulty and Milton Creek, designated upland protection zones have been established where construction is limited or prohibited.

2.2.4 HISTORIC SITES, STRUCTURES, AND LANDMARKS

The National Register of Historic Places lists one historic site for St. Helens: The St. Helens Downtown Historic District, which is composed of approximately 101 buildings. Additionally, 23 areas and structures within the City limits which hold local significance were identified as “designated landmarks” by City Ordinance Number 3250. A map of the Downtown Historic District and locally designated landmarks can be found in Figure 5 in Appendix A.

2.2.5 BIOLOGICAL RESOURCES

The USFWS produces a database that lists endangered and threatened plants throughout the United States. A database search for Columbia County returned several types of plants and species listed as endangered or threatened. A few of these listed species are shown below and the full list can be found in Appendix B.

- Bull Trout (Fish)
- Burrington Jumping-Slug (Snails)
- Golden Paintbrush (Flowering Plant)
- Marbeled Murrelet (Bird)
- Willamette Daisy (Flowering Plant)
- Streaked Horned lark (Bird)
- Bradshaw’s Desert-Parsley (Flowering Plant)
- Water Howellia (Flowering Plant)
- Columbian White-Tailed Deer (Mammal)
- Yellow-Billed Cuckoo (Bird)
- Kincaid’s Lupine (Flowering Plant)
- Red Tree Vole (Mammal)
- Northern Spotted Owl (Bird)
- Nelson’s Checker-Mallow (Flowering Plant)

2.2.6 WATER RESOURCES

The Columbia River, Jackass Canyon, Milton Creek, McNulty Creek, the Frogmore Slough, and two unnamed creeks flow through the study area. Section 303(d) of the Clean Water Act establishes a list of impaired waters and total maximum daily load (TMDL) for pollutants in each water body. Jackass Canyon is 303(d) listed for sedimentation and has a TMDL for temperature. McNulty Creek is 303(d) listed for biological criteria. The Lower Columbia River is 303(d) listed for arsenic, DDE4, 4, fecal coliforms, and PCBs and has a TMDL for dioxins, temperature.

2.2.7 COASTAL RESOURCES

There are no coastal areas within the study area.

2.2.8 SOCIO-ECONOMIC CONDITIONS

According to the City's Housing Needs Assessment, completed in May 2019, the City has experienced a steady growth and anticipates growth to continue into the future. The median household income is $45,789, which is 33% less than the 2019 national average according to census.gov. 31.7% of the City is considered to be low-income or earning less than $30,000 per year. The assessment states that approximately 25% of households are "severely rent burdened", meaning they spend more than 50% of income on rent and utilities. Higher rates can be a challenge for economic growth.

2.2.9 CLIMATE, GEOLOGIC HAZARDS, AND SOILS

The climate of St. Helens is characterized by dry temperate summers and cool wet winters. Table 2-1 summarizes the climate data for St. Helens. The National Oceanic and Atmosphere Administration (NOAA) Monthly Normals for St. Helens were used for the mean temperatures. NOAA data for precipitation was not available for St. Helens, as such, climate normals were taken from the nearby weather station in Scappoose, Oregon.

TABLE 2-1: CLIMATOLOGICAL DATA (2006-2020)

	Jan	Feb	Mar	Apr	May	Jun	July
Precipitation (in)	6.04	4.27	4.81	2.95	2.23	1.41	0.30
Mean Temp (F)	40.2	42.2	46.1	50.3	57.6	62.2	68.2
	Aug	Sep	Oct	Nov	Dec	Sum / Average	
Precipitation (in)	0.43	1.78	3.84	6.28	6.70	41.04	
Mean Temp (F)	68.6	63.1	53.3	45.1	39.2	53.0	

Potential geologic hazards in the St. Helens area include landslides and earthquakes. There are no known volcanoes in the direct vicinity of this area to cause a volcanic hazard. The Oregon Department of Geology and Mineral Industries (DOGAMI) categorizes St. Helens in the low-to-high susceptibility range for landslides. This is corroborated by the Multi-Hazard Mitigation Plan for Columbia County. Additionally, City provided GIS shapefiles which reflect the DOGAMI findings on landslide susceptibility; only a small area bordering the northern City limits are considered high susceptibility for landslides. Figure 6 in Appendix A depicts the landslide hazard zones. The Multi-Hazard Mitigation Plan also reveals that in the past, seismic activity was fairly low, but because of more recent earthquakes, awareness of a potential problem has increased. The Multi-Hazard Mitigation Plan simulated earthquake damage produced by a magnitude 9 Cascadia Earthquake, and St. Helens fell into the light to moderate damage category. Local hazard maps show the area within City limits fall within zones A through D, with zone A indicating a very small probability of experiencing damaging earthquake effects and zone D indicating the possibility of very strong shaking, which can cause considerable damage to structures lacking special design. Figure 7 in Appendix A depicts a hazard map for seismic activity. Additional details and discussion of geologic hazards is included in the Geotechnical Planning Report completed by Shannon & Wilson, Inc. in Appendix C.

In general, the soils within the St. Helens area are either rock complex or silty loam, and the slopes vary from zero to thirty percent, according to the NRCS website. Typically, surface soil is very shallow in St. Helens, and sits on top of unfractured basalt rock. This is often a challenge for utility construction and can be a significant cost factor, particularly in pipeline projects. Figure 8 in Appendix A shows the soil map for St. Helens. See Appendix C for more details on the geology of the study area and the geologic hazards completed by Shannon & Wilson, Inc..

2.2.10 AIR QUALITY

The City does not currently lie within an Environmental Protection Agency (EPA) non-attainment area. No permanent impacts to air quality are anticipated from the recommended improvements, and best management construction practices should be employed during construction to minimize dust.

2.3 STORMWATER BASIN CHARACTERISTICS

2.3.1 VEGETATION

Vegetation is a natural method of reducing peak stormwater runoff in an urbanized area and is a potential method for low impact development because vegetation plays a significant role in the conversion of rainfall to stormwater runoff. The City of St. Helens is located in an area which historically has consisted of relatively thick vegetation with species including fir, oak, and willows with understories of brush. Developed areas have reduced the amounts of area covered with vegetation while undeveloped areas remain similar to its historical state.

2.3.2 MAJOR DRAINAGE BASINS

Stormwater from the study area generally drains into eight major drainage basins: Dalton Lake, North Trunk, Middle Trunk, Downtown, Greenway, Milton Creek, McNulty Creek, and Fischer Basin. The water collected from these major basins eventually drains into the Columbia River. See Figure 9 in Appendix A for reference. The full aerial extent of the Milton Creek and McNulty Creek watersheds extend northwest of the drainage basins shown in Figure 9. The full extent of the two watershed boundaries encompasses a total of approximately 28,000 acres of predominantly unincorporated land within Columbia County. Runoff from the watersheds outside of the drainage basins in Figure 9, drain to the creeks prior to the City UGB. The focus of this study was on the area of the watersheds that drain across land within the UGB. The existing stormwater system in each major basin can be found in Figures 9A – 9F in Appendix A. Fischer Basin does not have any existing stormwater infrastructure and only the hydrologic model will be developed. Table 2-2 shows the contributing drainage area of each basin and the percentage of the total drainage area they encompass.

TABLE 2-2: PERCENT OF TOTAL DRAINAGE AREA FOR EACH MAJOR BASIN

	Dalton Lake	North Trunk	Middle Trunk	Downtown	Greenway	Milton Creek[1]	McNulty Creek[1]	Fischer
Area (ac)	880	333	132	59	404	970	2,181	507
Percentage of Total Drainage Area	16%	6%	2%	1%	7%	18%	40%	9%

1) Acreage only includes areas of the watersheds that drain across land within the UGB.

SECTION 3 - BASIS OF PLANNING

Stormwater system planning criteria establishes fundamental principles and performance standards to evaluate the existing system and future improvements. The planning criteria includes defining the design storm event(s), hydrologic methods, and hydraulic calculation methods. The planning criteria in this evaluation were chosen by reviewing neighboring communities, industry standards, and state and federal stormwater regulations to choose the criteria that best fit the City of St. Helens. The City's existing stormwater policies, design standards, and construction standards were reviewed, and several changes were recommended.

3.1 DESIGN STORM

Design storms were established to evaluate the existing stormwater system performance, and to assist in the design of future improvements. Characteristics of a design storm are defined by recurrence intervals, the total depth of rainfall, and duration of the storm event. Recurrence intervals are the average intervals between successive storm events and can be expressed in annual probability of occurrence. For example, a 50-year storm has a 2% chance of occurring in any given year. The total depth of rainfall will vary depending on the recurrence interval and duration of the design storm. The specific recurrence intervals and total depth of rainfall used in the evaluation of this stormwater system are shown in Table 3-1; the storm event duration was assumed to be 24-hours, which is typical of the region. The total rainfall depth for each recurrence interval and duration was taken from the National Oceanic and Atmospheric Administration (NOAA) isopluvial charts. These charts show the rainfall depths for each of the design storms used in this evaluation.

TABLE 3-1: DESIGN STORM DEPTHS (24-HOUR DURATION)

Storm Event	Precipitation (in)[1]
2-Year	2.0
10-Year	3.0
25-Year	3.5
100-Year	4.0

1) From NOAA Atlas 2, Volume 10.

The temporal distribution of the design storm is an additional characteristic that was considered because the temporal distribution is how the given amount of precipitation is distributed over the duration of the storm. The Natural Resource Conservation Service (NRCS) has developed synthetic hyetographs for regions across the United States as shown in Figure 3-1. These hyetographs are based on historical data collection and extrapolation. The Type 1A theoretical rainfall distribution (Figure 3-2) is used to approximate storm events for the St. Helens region. It should be noted that the hyetographs are an acceptable method for approximating the distribution of the design storm, however, because it is an approximation, a real storm may not have the same uniform distribution and maximum intensity shown in Figure 3-2.

FIGURE 3-1: GEOGRAPHICAL BOUNDARIES FOR NRCS (SCS) RAINFALL DISTRIBUTION

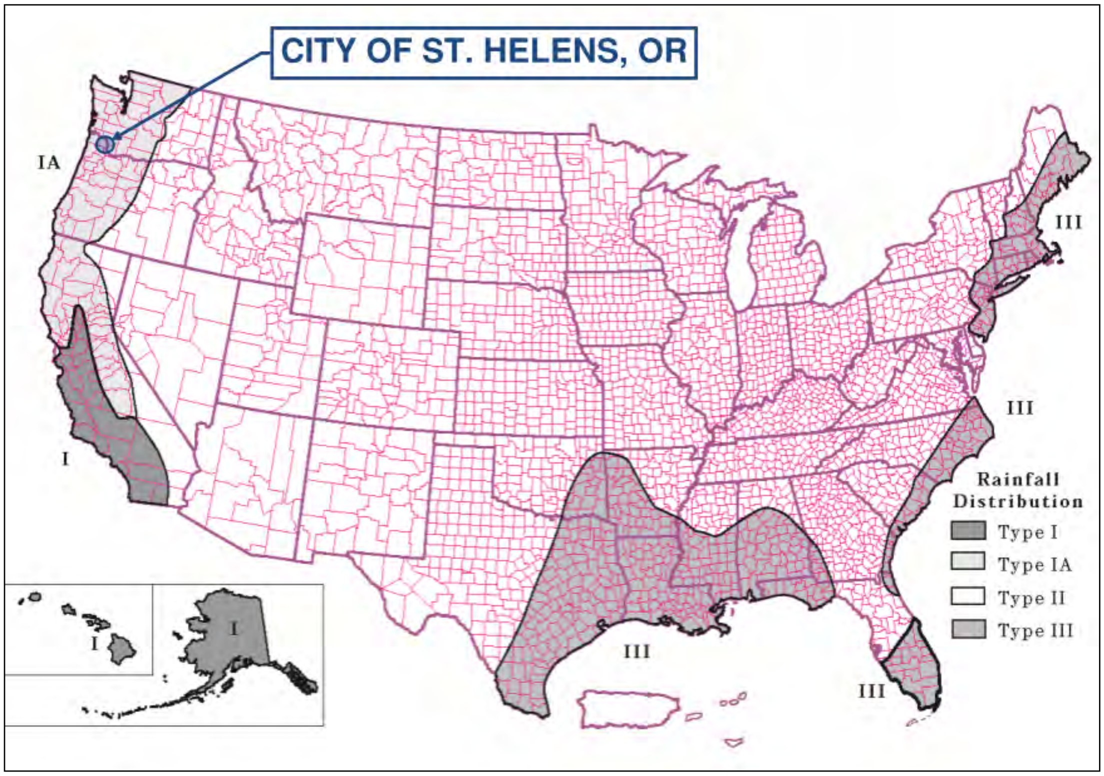
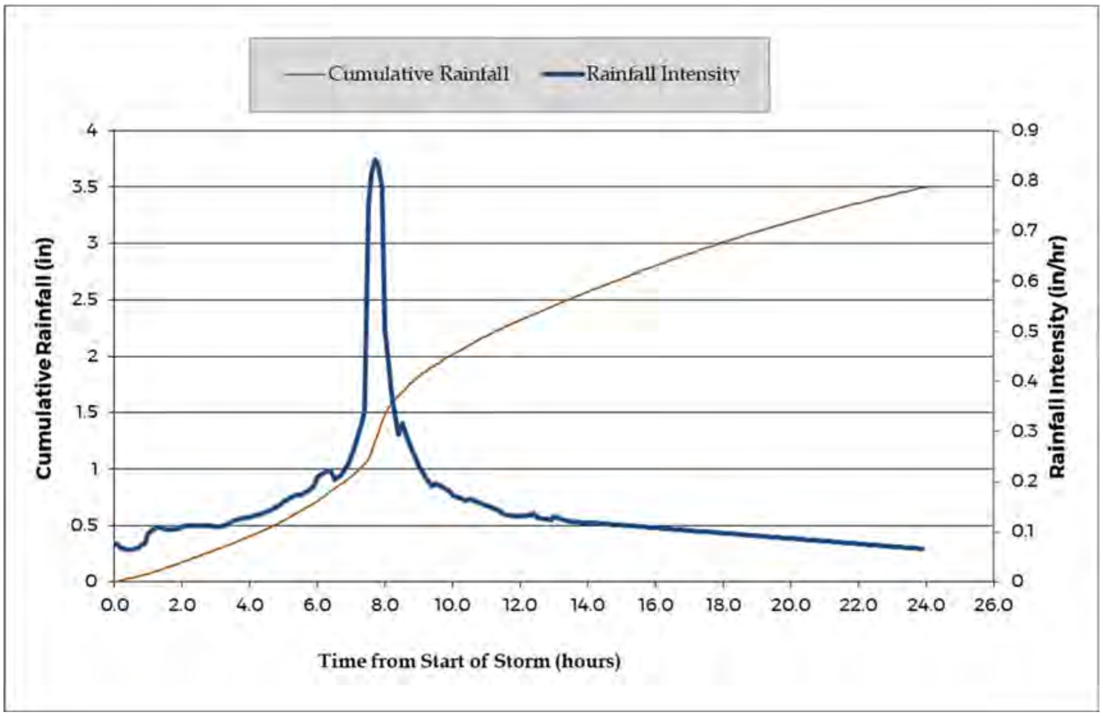


FIGURE 3-2: ST. HELENS 25-YEAR STORM HYETOGRAPH



Selection of a design storm is a matter of balancing level of service with economic feasibility. The City's existing design standard recommends that the stormwater drainage system be capable of passing runoff from the 25-year storm event without flooding or damage to existing infrastructure. For this evaluation, a system is considered flooded if the hydraulic grade line exceeds the ground elevation (rim elevation) at any point during the storm event. Detention facilities are recommended to be designed to store the runoff volume from a 25-year storm and provide safe overflow during a 100-year storm event. It is recommended that detention ponds be designed so the post-development peak release rates equal the pre-development release rates for their matching design storm event up to the 10-year design storm. The 25-year storm event peak release rate should not exceed the 10-year pre-development peak release rate.

3.2 HYDROLOGIC METHODOLOGY

The hydrologic portion of the stormwater system involves how a given area or "basin" will react to the design storm event. Hydrologic parameters are analyzed in each basin, which are then used to estimate how much rainfall from the design storm event is converted to runoff, where the runoff drains to, and how long it takes the runoff to drain to inlets in the drainage conveyance system. The hydrologic calculations are then used to put "loads" or demands into the hydraulic portion of the stormwater system.

Several hydrologic methods exist for defining basin characteristics and there is no single methodology or procedure that is universally accepted. The selection of which methodology to use in the evaluation depends on a number of factors, including geography, project area (size), and the overall purpose of the evaluation. The most common methods used in this region include the following:

- Natural Resources Conservation Service (NRCS) TR-20
- Hydrologic Modeling System (HEC-HMS)
- NRCS Soil Conservation Service (SCS) Urban Hydrograph Method (TR-55)
- Santa Barbara Urban Hydrograph Method (SBUH)
- Rational Method
- EPA Storm Water Management Model (SWMM)

These hydrologic methods have their own varying applications. NRCS TR-20 is an older methodology to the NRCS TR-55. The SBUH method is similar to the NRCS method but uses a different process to develop the hydrograph. The rational method is appropriate for smaller urban watersheds less than 200 acres in area. The HEC-HMS and EPA SWMM methodologies are not as widely used as the NRCS TR-55 method for assigning basin characteristics. It should be noted that the list of methods provided above are not independent of each other. For example, the EPA SWMM methodology used the same NRCS hyetographs as used in the NRCS TR-55 method to assign rainfall distribution throughout the design storm event.

It is recommended that the NRCS TR-55 methodology be used in the characterization of the basins because it is commonly used in the region and the characteristics of the study area fit within the methods limitations. The NRCS TR-55 method is only used in the defining hydrologic characteristics of the basins and not the hydraulic components of the model. The parameters calculated using the NRCS TR-55 method will be input into the computer modeling software, InfoSWMM. InfoSWMM uses the calculated parameters of the hydrologic basins to place "loads" or demands on the hydraulic portion of the model.

3.3 POLICIES AND STANDARDS

The policies and standards established in this evaluation will serve as the basis by which future storm drainage systems will be constructed. It will also provide guidance to developers building within St. Helens' urban growth boundary. The City's existing stormwater policies, design standards, and construction standards were reviewed as part of the master plan effort because it is imperative for these documents to be consistent with the City's goals for effective stormwater management. Deficiencies identified and recommended updates are summarized in a technical memorandum, included in Appendix F for reference.

Additional policies and standards were reviewed for neighboring communities to provide further validation of the recommended policies and standards. The following summary, shown in Table 3-2, of recommended revisions to the policies and design standards have been developed to meet the City's goal of being prepared to meet future stormwater regulatory requirements and target the specific needs of the City based on its geographic location and hydrologic conditions.

TABLE 3-2: SUMMARY OF LOCAL PLANNING CRITERIA

Planning Criteria	St. Helens Recommended	St. Helens (Existing)	ODOT	Scappoose	Newberg
Runoff Model Approach	NRCS TR-55	SBUH	NRCS TR-55	King County	NRCS TR-55
Storm Distribution	NRCS 1A	NRCS 1A	NRCS 1A	NRCS 1A	NRCS 1A
Min. T_c	5 minutes	5 minutes	NS	NS	5 minutes
24 hr. Storm Precipitation	NOAA	NOAA	NOAA	NS	NOAA
PVC "n" Value	0.013	0.013	NS	0.013	0.013
Min. Pipe Diameter	12"	12"	12"	12"	NS
Minimum Freeboard in Open Channels (ft)	1	NS	NS	NS	1
Minimum Freeboard in Detention Facility (ft)	1	1	1	NS	1
Surcharging Allowed	To within 0.5 feet of the rim elevation	NS	To within 0.5 feet of the rim elevation	To below roadway subgrade	To within 2 feet of the rim elevation
Design Storm for Conveyance	25-Year	25-Year	10-Year	50-Year	50-Year
Design Standards for Detention facilities on new developments	25-Year with overflow to bypass 100-Year	25-year with overflow to bypass 100-year	50-Year with overflow to bypass 100-year	25-Year with overflow to bypass 100-Year	25-Year

1) NS = none specified , SBUH = Santa Barbara Unit Hydrograph, ODOT = Oregon Department of Transportation.

3.3.1 PIPE SLOPES

The 10 States Standards are generally accepted in the industry when calculating minimum pipe slopes, and Keller Associates recommends adhering to these standards which account for a minimum velocity of 2 feet per second for a full pipe (assuming a roughness of 0.013). On the other hand, St. Helens Engineering Design Standards require a minimum pipe velocity of 3 feet per second when flowing full. As shown in Table 3-3, the minimum slopes defined by the 10 State Standards and City of St. Helens are equal, suggesting that the discrepancy in minimum pipe velocity originates from differing roughness values used to calculate minimum slope.

TABLE 3-3: MINIMUM SLOPE OF PIPES

Pipe Diameter (in)	10 State Standards Minimum Slope (per 100 feet)	City of St. Helens Minimum Slope (per 100 feet)
12	0.22	0.22
15	0.15	0.15
18	0.12	0.12
21" and Larger	0.10	0.10

3.3.2 ADDITIONAL POLICIES AND STANDARDS

Stormwater discharged into Waters of the State (e.g., rivers, streams, wetlands) is regulated by the DEQ and U.S. EPA. Due to the City's stormwater system consisting of outfalls to Waters of the

State, the City is required to comply with the TMDL and water quality management plan (WQMP) in the Willamette Basin and any future water quality related requirements set forth by the DEQ. The City was recently named a designated management agency (DMA) for the Revised Willamette Basin Mercury TMDL and WQMP (2019). In conjunction with this stormwater master plan, the City is also developing an implementation plan to meet the revised TMDL requirements. Additionally, while the City of St. Helens is not currently regulated under a municipal separate storm sewer system (MS4) permit by the DEQ, the City will likely fall under an MS4 permit in the future. The City will be regulated under a MS4 Phase II General Permit which covers cities with a population of less than 100,000 people. Effective as of March 1, 2019, the MS4 Phase II General Permit conditions include the following:

- ► Stormwater Management Program – a comprehensive plan designed to reduce pollutants from the MS4 to the maximum extent practical to protect water quality and satisfy the appropriate water quality requirements of the Clean Water Act.
- ► Adopt, update, and maintain adequate legal authority through ordinance(s), code(s), interagency agreement(s), contract(s), and/or other mechanisms to control pollutant discharges into and discharges from its MS4 to implement and enforce the conditions of this permit to the extent allowable pursuant to the respective authority granted under state law
- ► Stormwater Management Program Implementation which includes implementation of:
  - Public education and outreach
  - Public involvement and participation
  - Illicit discharge detection and elimination
  - Construction site runoff control
  - Post-construction site runoff for new development and redevelopment
  - Pollution prevention and good housekeeping for municipal operations
- ► Annual report evaluating the registrant's compliance with the requirements of the permit.
- ► Monitoring of stormwater establishing compliance with established TMDLs.

Review and evaluation of the conditions listed above are not included in the scope of this study. The study does not include any evaluation of the existing system's water quality facilities. Water quality was included as a consideration in the proposed stormwater infrastructure proposed in this study.

The City's current stormwater design standards do not require an evaluation of stormwater quality. It is recommended that the City review existing water quality standards and Stormwater Management Programs of surrounding local jurisdictions to assess what resources may be best suited to guide the City's water quality criteria requirements for future developments and stormwater infrastructure. Additional review and recommendations of the City's stormwater design standards and code are included in Appendix F.

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SECTION 4 - MODEL DEVELOPMENT

An accurate computer model of the stormwater system serves as a planning tool and provides the basis for a solid storm water master plan. In addition, the model provides insight into potential improvements to address existing deficiencies and can be used to effectively plan for future development within the study area. A stormwater model correlates interactions of natural events with natural and manmade systems. A well-coordinated and strategic data collection effort is required along with practical assumptions and good judgement for data that cannot be feasibly obtained because there are countless variables with broad ranges of reasonable values in each system. The software modeling package InfoSWMM (Suite 14.7, Update #2) was utilized to model the City's stormwater system. InfoSWMM is a fully dynamic model which operates in conjunction with Esri ArcGIS and allows for evaluation of complex hydraulic flow patterns.

The stormwater model consists of two components: a hydrologic model and a hydraulic model. The hydrologic model involves drainage basins, or geographic areas that drain to a specific point, and a temporal distribution of storm events (hyetograph, as discussed in Section 2). Input parameters such as area, surface slope, soil infiltration, and percent impervious surface define each of these basins. Input parameters determine how much rainfall is converted to runoff and when the runoff reaches the outlet point. The hydraulic model then routes the hydrologic model's runoff through the storm drain network of pipelines, open channels, detention ponds, and other structures. Each component of the stormwater model requires numerous input parameters to adequately simulate actual rainfall events and the resulting effects on the storm drain network. This section outlines the model construction process, including data collection and how key assumptions were incorporated to develop St. Helens existing stormwater system model.

4.1 KEY ASSUMPTIONS

Due to the nature and uncertainty of stormwater, numerous assumptions and "what if" scenarios go into the creation of a stormwater master plan. The following sections summarize the assumptions and boundary conditions that were applied to this stormwater model.

4.1.1 BASINS AND BOUNDARY CONDITIONS

The area within the St. Helens urban growth boundary was delineated into eight major drainage basins. These eight major basins were further divided into sub-basins to incorporate into the model. The major basins and sub-basins are shown in Figure 9 through 9F in Appendix A. The following assumptions were made for the basins and boundary conditions:

- All upland stormwater not draining to known storm system components in the McNulty and Milton Creek basins was assumed to drain directly to the creeks and was therefore not included in the model.
- Dalton Lake, McNulty Creek, Milton Creek, and other branches not specifically included in the modeled collection system were assumed to have sufficient capacity to handle all runoff discharged from the model outfalls. Flooding of these features was not evaluated. All outfalls to these bodies of water were modeled as free discharge (no backwater).
- Detention ponds disconnected from any downstream collection networks are assumed to have sufficient capacity to handle all runoff discharged from the model outfalls.
- Pipe networks with outfalls to the Columbia River were modeled with a fixed stage elevation of 28.34 feet above sea level (North American Vertical Datum of 1988 (NAVD88) datum). This flood elevation is equal to the high-water mark measured in February 1996. This "extraordinary high-water event (during January 15 – February 28, 1996) was the result of an atmospheric river rain period and the associated rapid increase in temperature following prolonged snow accumulation at high elevations," (United States Geological Survey's (USGS) Scientific Investigations Report 2018-5161, Assessment of Columbia, and Willamette River Flood Stage

on the Columbia Corridor Levee System at Portland Oregon, in a Future Climate). Four modeled outfalls across the North Trunk, Middle Trunk, and Downtown Basins were affected by modeling a submerged outfall. The Columbia River was not modeled, and capacity was not evaluated.

4.1.2 PIPES, PONDS, AND CHANNELS

The following assumptions were made for pipes, ponds, and channels:

- All pipes are in good repair
- All pipes and channels are free of debris
- Manning's n values for pipes are 0.013
- Manning's n values for open channels are 0.030
- All channels have been maintained on a regular schedule and reflect the sizes documented in site surveys and photos
- Natural channels have been mowed to remove excess vegetation, with only the plants intended to be used as water quality features remaining
- The ravine in the Middle Trunk Basin between South 11th Street and South 4th Street does not have any direct connections to the trunkline running through the bottom of the ravine
- Open channels and storage ponds located within areas classified as hydrologic soil group D are assumed to have no infiltration. Open channels and storage ponds located within hydrologic soil group C were given hydraulic conductivities of 1.3 inches (from NRCS Soil Survey)

4.2 DATA COLLECTION

Prior to this study, much of the stormwater system was mapped, but had significant data gaps in elevations for pipes, manholes, catch basins, channels, and other storm structures. The City GIS data base served as the basis for the hydraulic model. As a part of this project, a sub-consultant collected field survey data to supplement the City GIS data and better define modeled features. Features to be surveyed were prioritized by their importance toward developing a more accurate hydraulic model and identifying deficiencies within the stormwater system. The following criteria were used for prioritization of the stormwater structures including pipes inverts, pipe diameters, manhole and catch basin rims and inverts, pipe outlet, and outfalls:

- ► Priority 1 – No existing knowledge or reference material of elevations and serves as a critical component of the model.
- ► Priority 2 – Elevations or diameters can be estimated by using surrounding data points or does not serve as a critical component of the model.
- ► Priority 3 – Elevations or diameters can be estimated with confidence or does not serve as a critical component of the model.

In addition to the stormwater components listed above, the City's collection system also includes approximately 6,000 linear feet (LF) of open channels, which contribute to the connectivity of the stormwater system. Open channels which do not drain toward any modeled stormwater components were not considered to be surveyed. The open channels to be included in the model were also prioritized for surveying as follows:

- ► Priority 1 – Identified by the City to have capacity issues and serves as a critical component of the model.

- Priority 2 – Not identified by the City to have capacity issues and does not serve as a critical component of the model.
- Priority 3 – Not identified by the City to have capacity issues and ditch dimensions approximated by Keller Associates during site visits.

Priority 1 stormwater components were surveyed as part of this study, however the scope of surveying for the study did not cover Priority 2 and Priority 3 components. These component parameters were estimated with reasonable assumptions or excluded from the model.

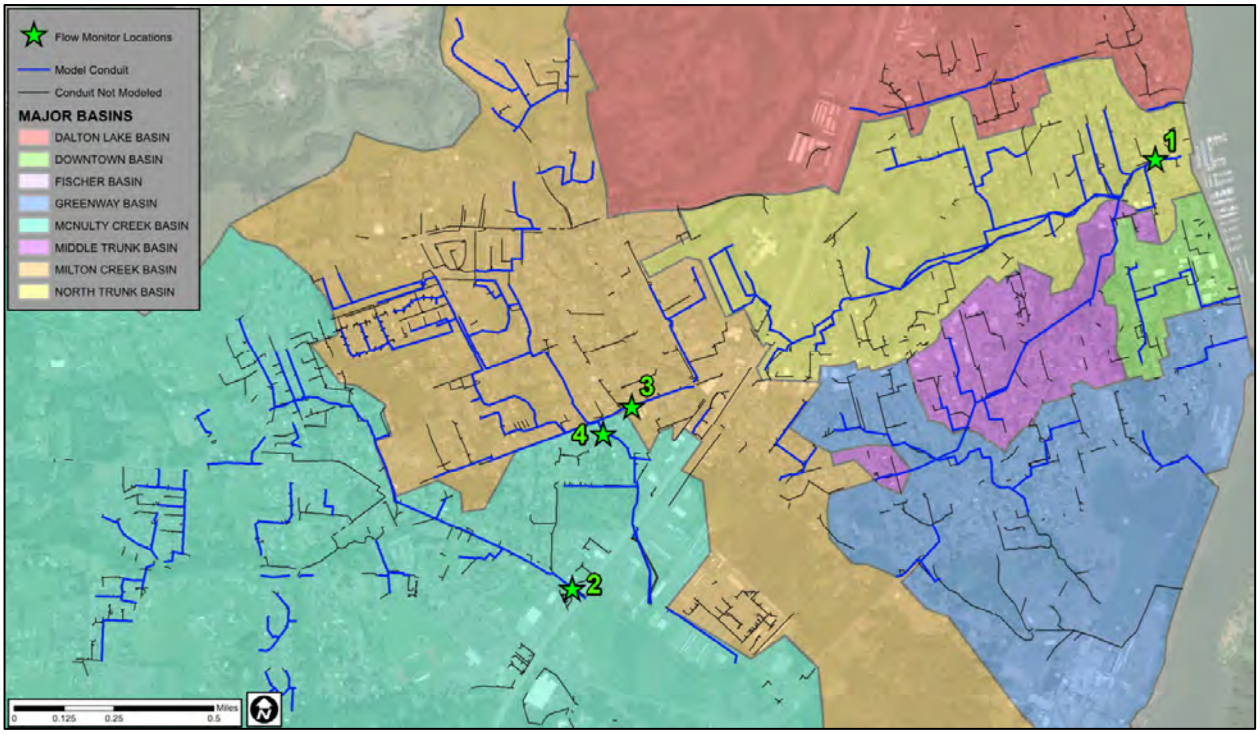
Where elevation data was available from construction drawings or previous surveys, the vertical datums for the majority of drawings and surveys were not specified. The two most common vertical datums used are National Geodetic Vertical Datum 1929 (NGVD29) and NAVD88 and the difference between the two datums in St. Helens is +3.34 feet from NGVD29 to NAVD88. Existing City GIS elevation data showed significant drops across manholes and catch basins, adverse grades in pipes, and steep slopes in pipes. Where these shifts in elevation data could not be confirmed by record drawings, survey data was collected to compare with existing elevation data. A rim elevation was surveyed for each of the referenced construction drawing sets where the datum was unknown. If the difference between the existing elevation data and the recorded survey point was approximately +3.34 feet, then the datum of the construction drawing set could be confirmed, and the elevations shifted into a single datum in the model. The stormwater model elevations are in the NAVD88 vertical datum.

4.3 FLOW MONITORING

The intent of flow monitoring is to help calibrate model parameters to reflect observed conditions for storm events. Temporary flow meters with data loggers were installed in the stormwater system to observe runoff resulting from actual storm events. Locations of flow meters were selected to isolate basins and land use types, and to better understand the interaction of the surface runoff and open channel flow with the City's pipe network. The monitors were installed in four locations and were placed at strategic points in the stormwater system to capture flows on the larger pipe networks in different basins as shown in Figure 4-1 below or see Figure 10 in Appendix A for the full size figure.

The monitoring was performed during winter months when larger storm events typically occur. The monitors were installed on December 29th and 30th, 2020 and monitored flows for three weeks before being removed in January 2021. Hach FL900AV flow monitors were used and recorded depth, velocity, and flow in 5-minute increments. The cumulative rainfall was also recorded in 15-minute increments at the wastewater treatment plant (WWTP) for the duration of the monitoring period.

FIGURE 4-1: FLOW MONITORING LOCATIONS



4.4 CALIBRATION

The goal of model calibration is to adjust model parameters, so the model results reflect observed system response during storm events. The quality and usefulness of flow monitoring data for a stormwater model is highly dependent on the magnitude of captured rain events during the monitoring period. There was a total of 9.7 inches of rainfall during the monitoring period, with two events each over 2 inches. These storms probably fall somewhere between a 2- and 10-year event as introduced in Section 3 (Table 3-1). The higher of these two events (referred to as Event 1) was used to calibrate the model with a total cumulative rainfall of 2.2 inches and the second highest storm event (referred to as Event 2) was used as a secondary source of verification that the model is calibrated and robust (able to reflect the storm system response for various rain events). These storm events provided quality flow data and system responses, which led to a high level of confidence in the successful calibration of the model. The 15-minute increment rainfall data recorded was inputted into the model to replicate the precipitation time distribution during each event. The model flows at each monitor location were compared with the observed flows.

The three main parameters adjusted in the calibration process were the initial abstraction, the curve numbers of the sub-basins, and baseflows into the pipe network. Initial abstraction is typically calculated and is dependent on the curve number. The initial abstraction in this study was calculated using the TR-55 method and then reduced by about 75%. This reduction was based on observed system response in the flow monitoring data as well as the knowledge that large storm events in St. Helens typically occur during the wet season when surface voids and depressions that contribute to initial abstraction are mostly full of previous storm events. As shown below in Table 4-1, the curve numbers were reduced for most of the flow monitoring sites by 5% to match the observed flows. Baseflows, which represent continuous groundwater infiltration during the wet season, were assigned to each of the monitoring sites based on the collected flow monitoring data. The baseflows were assigned to the pipe network upstream of flow monitoring sites that indicated base groundwater infiltration during the monitoring period.

Resulting model base flows and their relationship to the observed flows by monitoring site are shown in Table 4-1. Event 1 data was used to calibrate model parameters initially and Event 2 data was used as a second source to assess if the model calibration was robust and representative of the actual stormwater system. Peak flows in the model from Event 1 are all slightly higher than the observed values for conservative evaluation. The peak flows in the model from Event 2 are higher at Sites 1, 2, and 3, but slightly lower at Sites 4. Graphs of modeled flows versus observed flows for each flow monitor site for Events 1 and 2 can be found in Appendix D.

TABLE 4-1: CALIBRATION ADJUSTMENTS

Flow Monitor Site	CN Adjustment	Baseflow for Site (gpm)
Site 1 (Middle Trunk)	Reduce 7.5%	175
Site 2 (Sykes Road)	Reduce 5%	800
Site 3 (Harris Street)	Reduce 5%	200
Site 4 (Columbia Boulevard)	Reduce 5%	0

1) Positive value indicates modeled peak flow is higher than observed peak flows.

Figure 4-2 and Figure 4-3, show the difference between the initial model and the calibrated model results at Site 3. The magnitude of the calibrated modeled peak flows (shown in blue) line up with the observed peak flows (shown in green) during the storm event. It should be noted that the overall volume of runoff during a rain event in the model (volume under the flow curve) is less than the observed volumes because the model does not account for the prolonged infiltration and inflow in the pipe network after the rain event (typically for 24-48 hours after peak flows). The lower volumes in the model are due to limitations of the TR-55 hydrologic method which only accounts for direct surface runoff, not subsurface infiltration, and inflow to pipe networks. Peak flows are used as the primary criteria to evaluate stormwater pipe capacities, so the difference in volume over a storm event will not impact stormwater system capacity evaluations. Should regional detention facilities be evaluated as an alternative improvement, the difference in observed volume will be included in sizing considerations. Additionally, the difference in volumes will have limited impact on proposed detention ponds because they are designed primarily to reduce the impact of peak flows and not prolonged infiltration, which occurs after peak flows.

FIGURE 4-2: MODELED FLOWS VERSUS OBSERVED FLOWS PRE-CALIBRATION

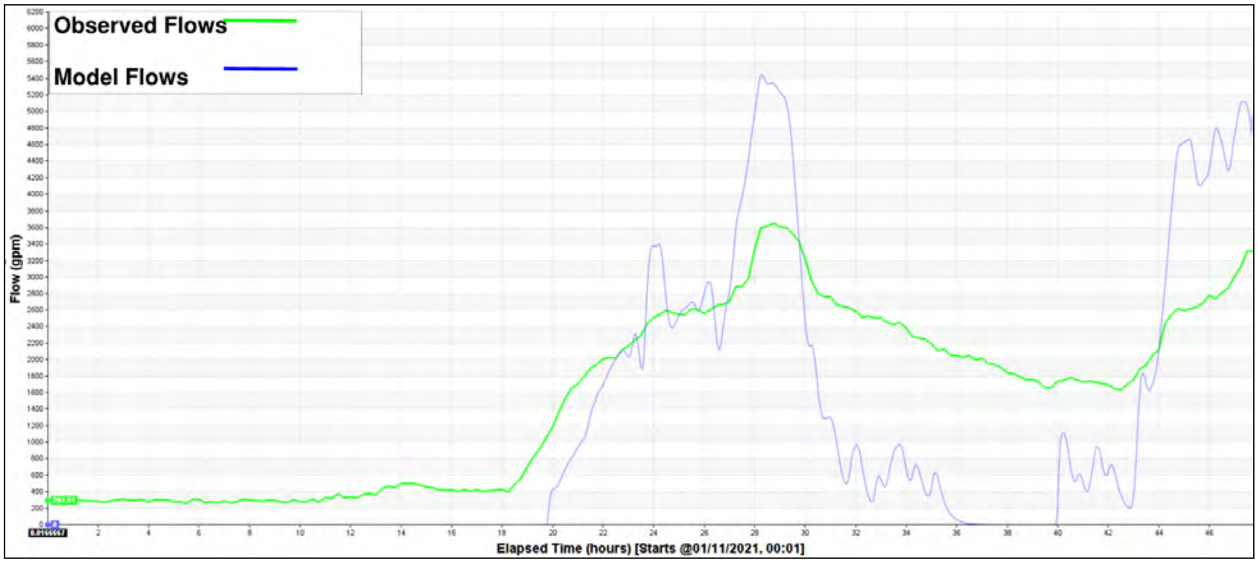
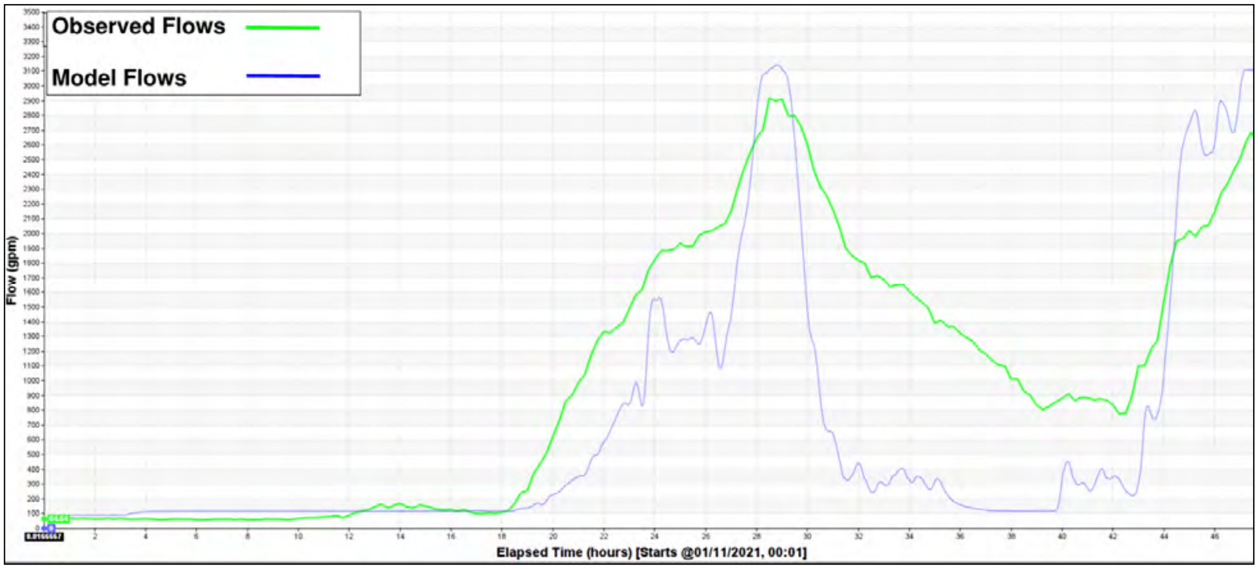


FIGURE 4-3: MODELED FLOWS VERSUS OBSERVED FLOWS POST-CALIBRATION



To calibrate the remaining sub-basins which do not contribute runoff to a flow monitor site, the characteristics were adjusted similar to the calibrated sub-basins as discussed above; CN's were reduced by 2.5% and initial abstractions were reduced to 75% of the TR-55 method value. The final step in calibrating the stormwater system model was to incorporate City staff knowledge and experience with their system. The 2-year and 10-year storm events were simulated in the model to identify areas with flooding and surcharging within the system. The areas within the system which experienced flooding were reviewed by the City to compare with the staff's historical knowledge of flooding in these areas. The final calibration produced modeled peak flows slightly higher than observed peak flows to provide a conservative evaluation of the stormwater system.

SECTION 5 - EXISTING SYSTEM EVALUATION

The stormwater system in St. Helens generally consists of stormwater surface flow to catch basins, a subsurface network of pipes, manholes, detention facilities, open channels, culverts, and outfalls. Frequent rains combined with the natural drainage characteristics of the City, result in high runoff volumes which can overwhelm the existing system. As a result, the existing system evaluation indicated flooding and ponding as common occurrences. The majority of runoff conveyed by the system drains to Milton Creek, McNulty Creek, Dalton Lake, or the Columbia River. The evaluation of the stormwater system was conducted based upon the planning criteria and model parameters established in the previous sections.

5.1 EXISTING CONVEYANCE SYSTEM CONDITIONS

The City's existing stormwater system includes approximately 45 miles of closed-conduit pipe ranging in diameter from 2-inches to 66-inches. The stormwater pipes serve multiple purposes with some being catch basin connector pipes while others serve as trunklines which convey stormwater from multiple areas throughout the City. Stormwater pipe materials in the City consist of concrete, perforated, ductile iron (DI), polyvinyl chloride (PVC), high-density polyethylene (HDPE), corrugated metal pipe (CMP), vitrified clay (VCP), and unknown materials. The City's GIS database was used to create an inventory of the existing stormwater pipe diameters and materials and is summarized in Table 5-1. The table includes both lateral and main pipelines denoted as owned by the City.

TABLE 5-1: STORMWATER PIPE INVENTORY (UNITS IN FEET)

		Pipe Material									
		Concrete	Perforated	Ductile Iron	PVC	HDPE	CMP	VCP	Unknown	Total	% of Total
Diameter (in)	≤6	600	1,330	170	380	500	0	0	1,640	**4,620**	**1.9%**
	8	1,960	60	2,660	980	1,280	100	210	4,590	**11,850**	**5.0%**
	10	2,150	0	2,130	450	2,170	250	0	3,350	**10,500**	**4.4%**
	12	10,440	500	9,410	8,320	17,380	960	160	11,800	**58,950**	**24.9%**
	15	6,370	0	1,230	2,500	1,370	0	0	2,620	**14,100**	**5.9%**
	18	4,670	0	600	1,960	3,010	0	0	1,960	**12,190**	**5.1%**
	21	2,320	0	0	0	450	0	0	350	**3,120**	**1.3%**
	24	5,820	0	1,270	720	2,780	250	0	3,170	**14,020**	**5.9%**
	30	1,060	0	0	420	180	100	0	660	**2,430**	**1.0%**
	36	730	0	190	60	630	140	0	1,300	**3,050**	**1.3%**
	>36	330	0	660	0	0	1,730	0	880	**3,590**	**1.5%**
	Unknown	260	1,650	0	130	0	0	0	96,400	**98,450**	**41.5%**
	Total	**36,720**	**3,540**	**18,310**	**15,920**	**29,740**	**3,530**	**360**	**128,730**	**237,000**	**100%**
	% of Total	**15.5%**	**1.5%**	**7.7%**	**6.7%**	**12.5%**	**1.5%**	**0.2%**	**54.3%**	**100%**	

As shown in the table, approximately 54% of the existing pipes are of an unknown material and approximately 42% of the existing pipes are of an unknown diameter. It is recommended the City continue to update their GIS database to reflect the known parameters of the stormwater system as development, surveys, and improvement projects are completed. Approximately 360 feet of VCP was converted from sanitary sewer pipelines to stormwater pipelines. The sections of VCP, which were a common material around the turn of the 20th century, are likely reaching the end of their useful life and the pipeline conditions should be evaluated.

Additionally, the age of existing stormwater pipes was summarized to assess the need for pipes to be replaced as they reach the end of their useful life. The City's GIS database was used to develop a summary of pipeline age throughout the system as shown in Table 5-2.

TABLE 5-2: PIPELINE AGE

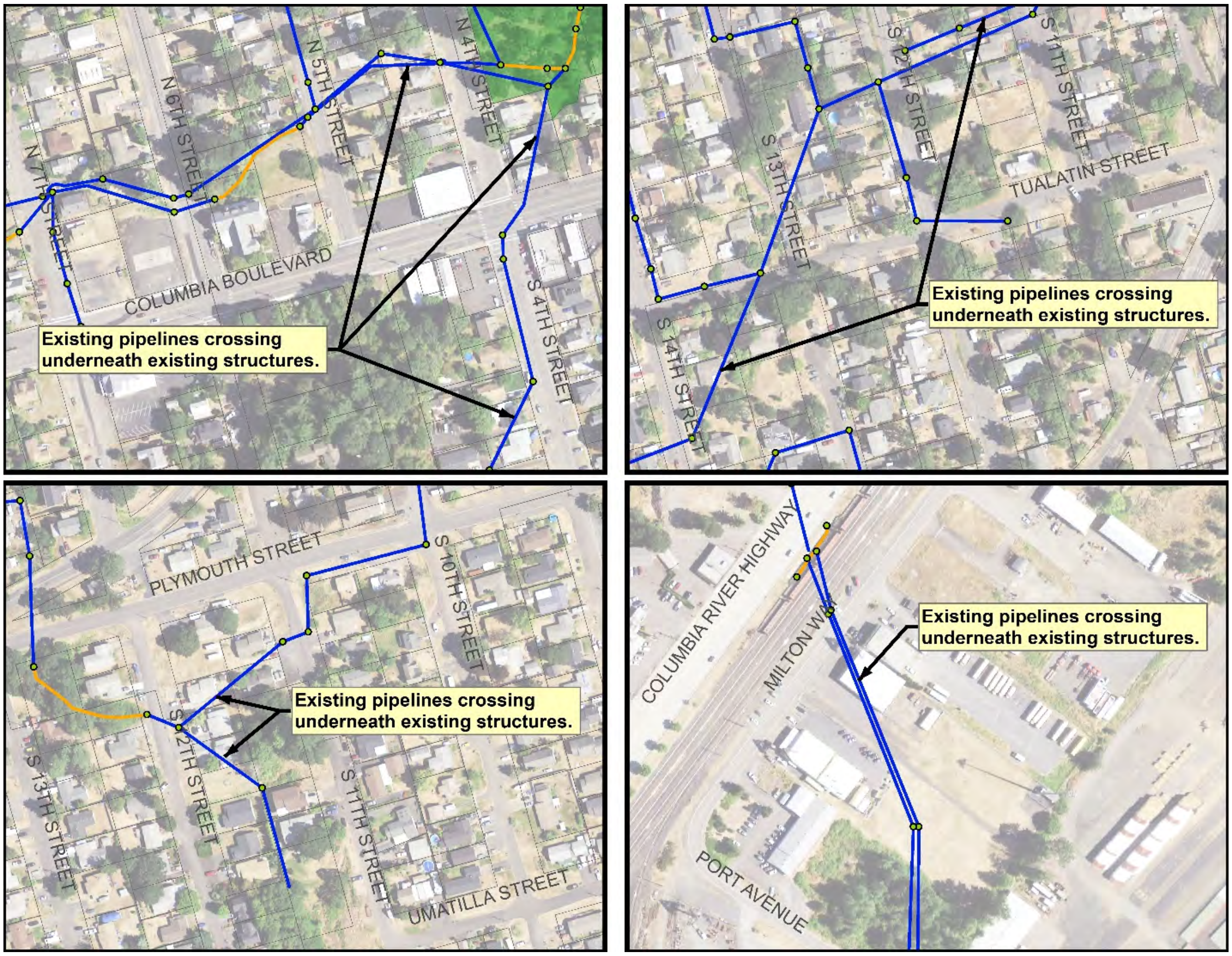
Decade Installed	Length of Pipe (ft)	% of Total
1910s	160	0.1%
1920s	0	0.0%
1930s	0	0.0%
1940s	610	0.3%
1950s	0	0.0%
1960s	5,600	2.4%
1970s	2,500	1.1%
1980s	4,100	1.7%
1990s	42,500	17.9%
2000s	34,200	14.4%
2010s	18,300	7.7%
Unknown	129,000	54.4%
Total	**237,000**	**100.0%**

Similar to the pipeline material and size, the installation date of approximately 54% of the City's stormwater system is unknown according to the current GIS database. The GIS database would benefit from being updated to reflect pipeline age and can be done by utilizing existing record drawings and historical conditions assessments. Figure 12 in Appendix A shows the existing pipeline ages. Typically, pipelines should be inspected and possibly replaced as they reach 50 years in age. For this study, pipelines installed before the 1980s should be inspected and replaced or repaired. A summary of the trunklines recommended to be inspected is provided below:

- Downtown Basin – From Parkway draining north to South 4th Street
- Downtown Basin – From South 3rd Street draining east to the outfall
- Milton Creek – Columbia Boulevard from North Vernonia Road to Milton Creek
- Milton Creek – Mayfair Drive from Sherwood Drive to Campbell Park

Deficiencies were also identified throughout the existing stormwater system where stormwater pipes appear to cross underneath existing structures. Stormwater pipes installed beneath existing structures poses a significant risk to both the City and the owner of the structures. It is recommended that any pipelines underneath structures be properly abandoned and re-aligned in the right-of-way or along property lines away from existing structures. Figure 5-1 shows eight locations where the GIS reveals pipes crossing underneath existing structures. The City should survey the existing stormwater system to assess the need to re-align these pipes.

FIGURE 5-1: EXISTING PIPELINES CROSSING UNDERNEATH STRUCTURES



5.2 DRAINAGE BASIN ASSESSMENTS

This section discusses the general capacities of the stormwater infrastructure in the City's eight major drainage basins. These assessments were based on input from City staff operators and computer modeling results of the design storm. Staff identified specific problem areas where flooding has historically occurred consisting of surcharging and flooding of existing stormwater pipes and overflowing of open channels. These problem areas typically occur where there is older stormwater infrastructure that may have been undersized or in areas where there is a lack of proper stormwater infrastructure.

Four design storm events were simulated in the model and include the 2-year, 10-year, 25-year, and 100-year storms. The following sections identify the specific areas where flooding or surcharging to within two feet of the rim elevation occur in a given storm event. The following sections also summarize historical problem areas in each major drainage basin, identify areas with projected deficiencies, and explain the reason for the deficiency. Each problem area was given a unique identifier and is listed in Tables 5-3 through 5-8 and shown in Figures 5-2 through 5-7 below. Additional model results showing which storm event first causes flooding at each identified location are shown in Figures 11A through 11F in Appendix A.

The scope of this study was to identify deficiencies and propose solutions to problems in major pipeline networks. Additional localized flooding challenges may need to be addressed as part of the City's ongoing stormwater maintenance program or as updates to the list of capital improvement projects identified later in this report.

5.2.1 DALTON LAKE BASIN

Dalton Lake Basin is located toward the northern boundary of the city limits. The land use consists mainly of residential housing with some industrial users along the east side of the Columbia River Highway. There is limited stormwater infrastructure within this drainage basin with only three modeled pipe networks.

The City reported occasional historical flooding across N 11th Street, but recent improvements were carried out to eliminate the issues. The model results do not show flooding occurring in this area with the improvements installed. Flooding or surcharging was not identified in either of the two additional modeled trunklines in Dalton Lake Basin.

5.2.2 NORTH TRUNK BASIN

Land use within the North Trunk Basin consists of a mix of residential, commercial, and public facilities. This basin relies on a significant number of open channels to convey stormwater runoff to the outfall on the Columbia River. One of the large open channels between N 15th Street and N 12th Street was modeled with natural detention as the surveyed channel ranges from 10 feet wide to approximately 100 feet wide with a low point about halfway between N 15th Street and N 12th Street.

The Godfrey Park Ravine has historically had some issues with flooding and surcharging but recent improvements have replaced the existing pipeline with open channels and check dams which have relieved some of the flooding. City staff reported the open channels at N 7th and N 8th Streets as a problem area. Staff has seen flooding at this location, but upon further investigation, staff have found it is likely due to debris build up in the channels and not a capacity deficiency. The model did not project flooding in this area until the 25-year storm, confirming City staff knowledge of the problem area. Note, flooding was shown downstream of Godfrey Park as a result of backwater from the Columbia River water surface level. The flooding is not a result of undersized pipe capacities. Table 5-3 summarizes the deficiencies shown in the model from the 25-year storm event and Figure 5-2 shows where surcharging and flooding is projected.

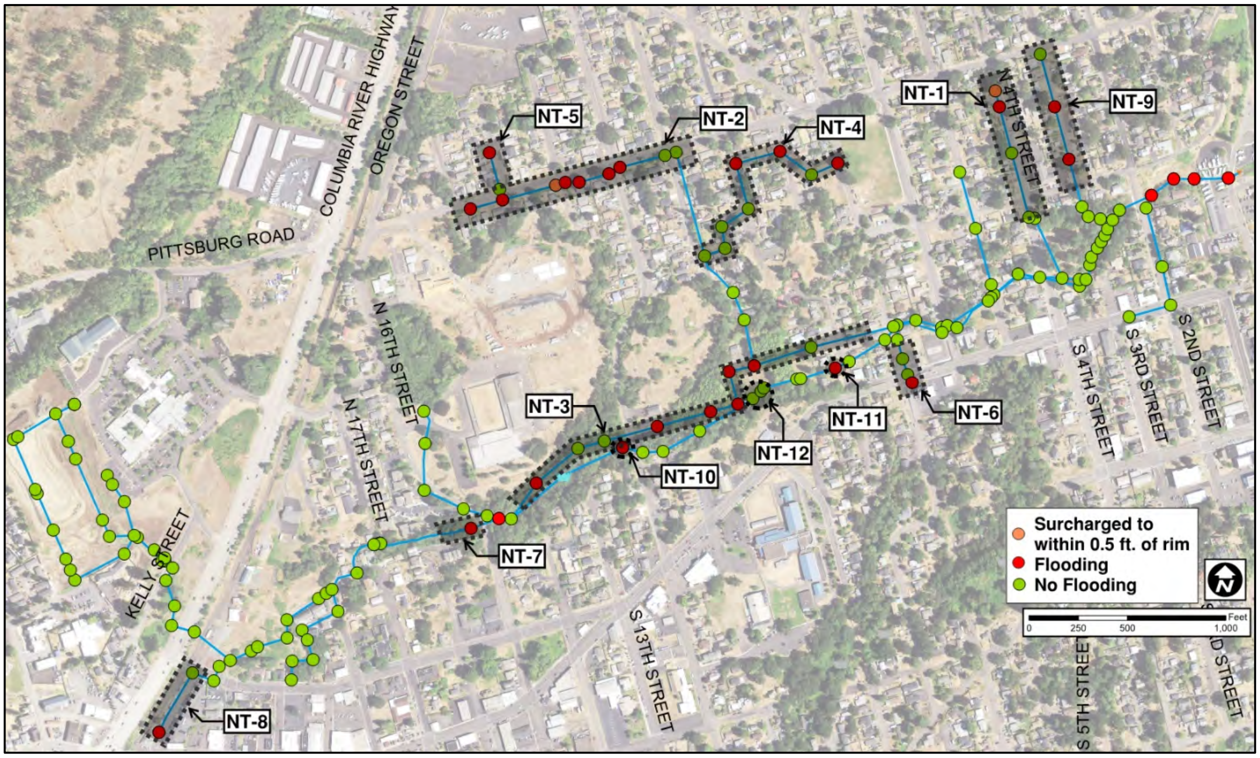
TABLE 5-3: NORTH TRUNK BASIN SUMMARY OF EXISTING DEFICIENCIES

Problem Area ID	Location Description	First Storm Event with Surcharging[1,2]	First Storm Event with Flooding
NT-1	N. 4th Street	-	10-Year
NT-2	West Street to N. 10th Street	-	2-Year
NT-3	N. 14th Street to 7th Street	-	2-Year
NT-4	6th Street Park to N. 10th Street	2-Year	10-Year
NT-5	N. 13th Street to West Street	-	10-Year
NT-6	N. 7th Street and Columbia Boulevard	-	10-Year
NT-7	N. 17th Street to N. 15th Street Ditch	-	10-Year
NT-8	Milton Way	-	10-Year
NT-9	N. 3rd Street to Wyeth Street	25-Year	-
NT-10	N. 12th Street Culvert	-	25-Year
NT-11	N. 8th Street Culvert	-	25-Year
NT-12	N. 10th Street Culvert	-	100-Year

1) First storm event with surcharging only includes where the hydraulic grade reaches within 0.5 feet of the rim elevation.

2) If left blank, surcharging was not projected before the flooding event.

FIGURE 5-2: NORTH TRUNK BASIN 25-YEAR MODEL RESULTS



Explanation of Deficiencies:

- **NT-1, NT-2, NT-4, NT-5, NT-6, NT-8, and NT-9**: Downstream capacity limitations cause flooding and/or surcharging in the upstream pipe networks. The hydraulic grade line (HGL) in these pipe networks is steeper than the pipe slope, which indicates the pipes are undersized for the existing peak flows.
- **NT-3:** Flow splits just east of N 15th Street where water drains through open channels and enters a 24-inch trunkline, which runs parallel to the open channels. The inlet to the trunkline could not be found in the field, therefore it is unknown how the flow splits between the two networks. It was assumed the inlet elevation to the 24-inch trunkline was one-half foot higher than the open channel invert which results in about 2/3rds of the runoff draining to the open channel and about 1/3rd draining into the 24-inch trunkline. The inlet to the trunkline should be surveyed, and the evaluation updated before moving forward with any improvements in the connected network.
- **NT-7, NT-10, and NT-11**: Culverts draining the Columbia Boulevard ditch are backing up and ponding at the inlet. Flooding of these culverts is defined as once the culvert becomes submerged (hydraulic grade line (HGL) exceeds top of pipe elevation).

5.2.3 MIDDLE TRUNK BASIN

The Middle Trunk Basin is south of the North Trunk Basin and runoff converges with the North Trunk Basin just upstream of Godfrey Park. The Middle Trunk Basin consists mainly of residential land use with various commercial facilities along the Columbia River Highway and Columbia Boulevard. The main trunkline flows to the northeast through the bottom of a large ravine. The ravine slowly contributes runoff to the trunkline through infiltration, but the peak runoff flows are reduced through natural detention in the ravine.

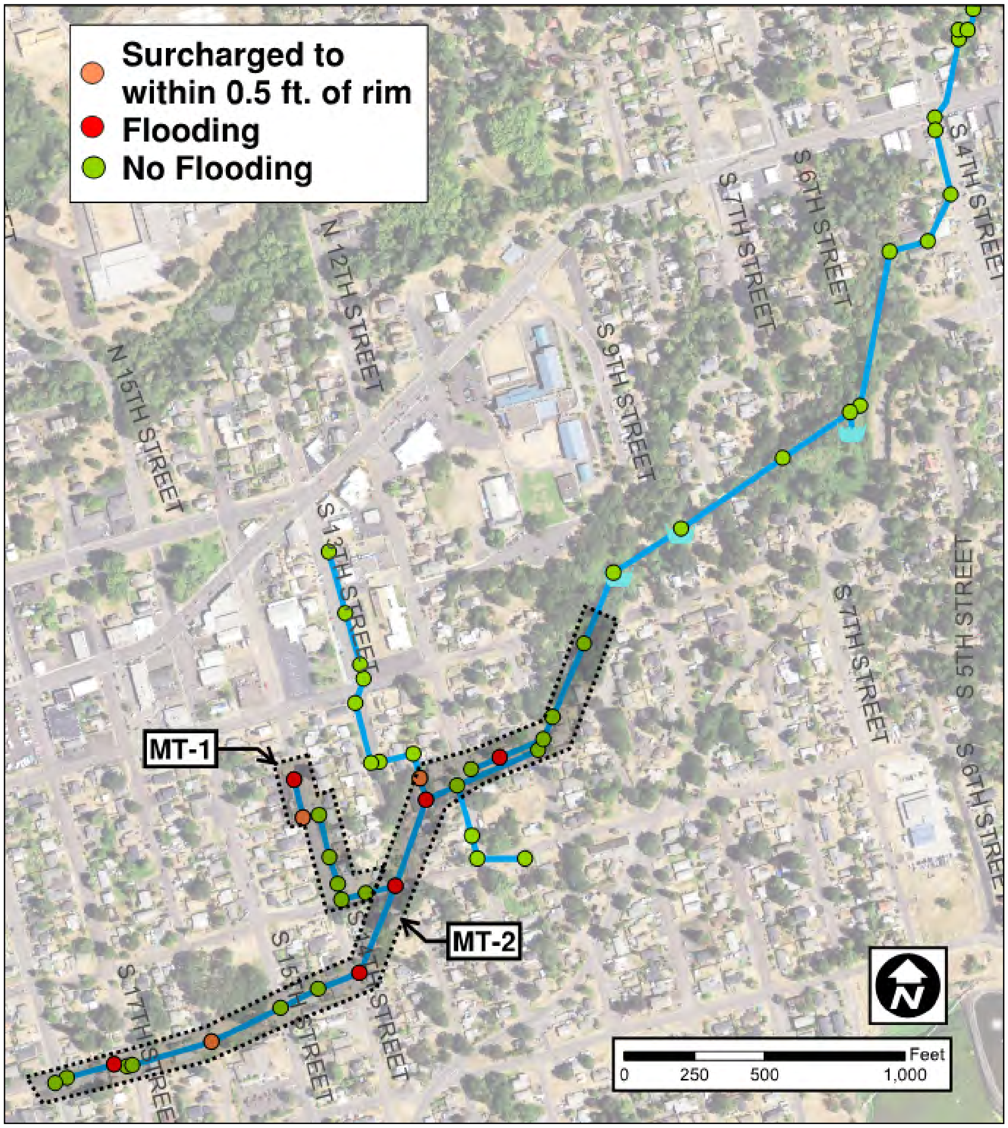
The City has identified two areas along the trunkline that have had historical flooding. The model outputs are consistent with the City observations and shows surcharging and flooding at locations MT-1 and MT-2. Table 5-4 and Figure 5-3 summarize the deficiencies and when the first flooding and surcharging will occur.

TABLE 5-4: MIDDLE TRUNK BASIN SUMMARY OF EXISTING DEFICIENCIES

Problem Area ID	Location Description	First Storm Event with Surcharging[1,2]	First Storm Event with Flooding
MT-1	S. 14th Street to Tualatin Street	2-Year	10-Year
MT-2	S. 18th Street to S. 10th Street	2-Year	10-Year

1) First storm event with surcharging only includes where the hydraulic grade reaches within 0.5 feet of the rim elevation.
2) If left blank, surcharging was not projected before the flooding event.

FIGURE 5-3: MIDDLE TRUNK 25-YEAR MODEL RESULTS



Explanation of Deficiencies:

- **MT-1:** The pipes just south of Cowlitz Street are relatively flat (0.1% – 0.2%), and water is backing up into the manholes. There are three segments of pipe that do not meet the recommended minimum pipe slopes in the City standards.
- **MT-2:** The flooding in these areas was attributed to undersized pipes for peak modeled flows. Water backs up from the 18-inch pipe crossing Cowlitz Street to the most upstream modeled manhole on S 18th Street.

5.2.4 DOWNTOWN BASIN

The Downtown Basin is the smallest of the major drainage basins in area and consists of only one modeled pipe network. The City is not aware of any drainage issues within this basin. The Downtown Basin is a mix of residential and commercial land use. Similar to the North Trunk Basin, there is flooding in the manhole upstream due to outfall because of backwater from the Columbia River water surface elevation. Deficiencies observed in the model are summarized below in Table 5-5 and labeled in Figure 5-4.

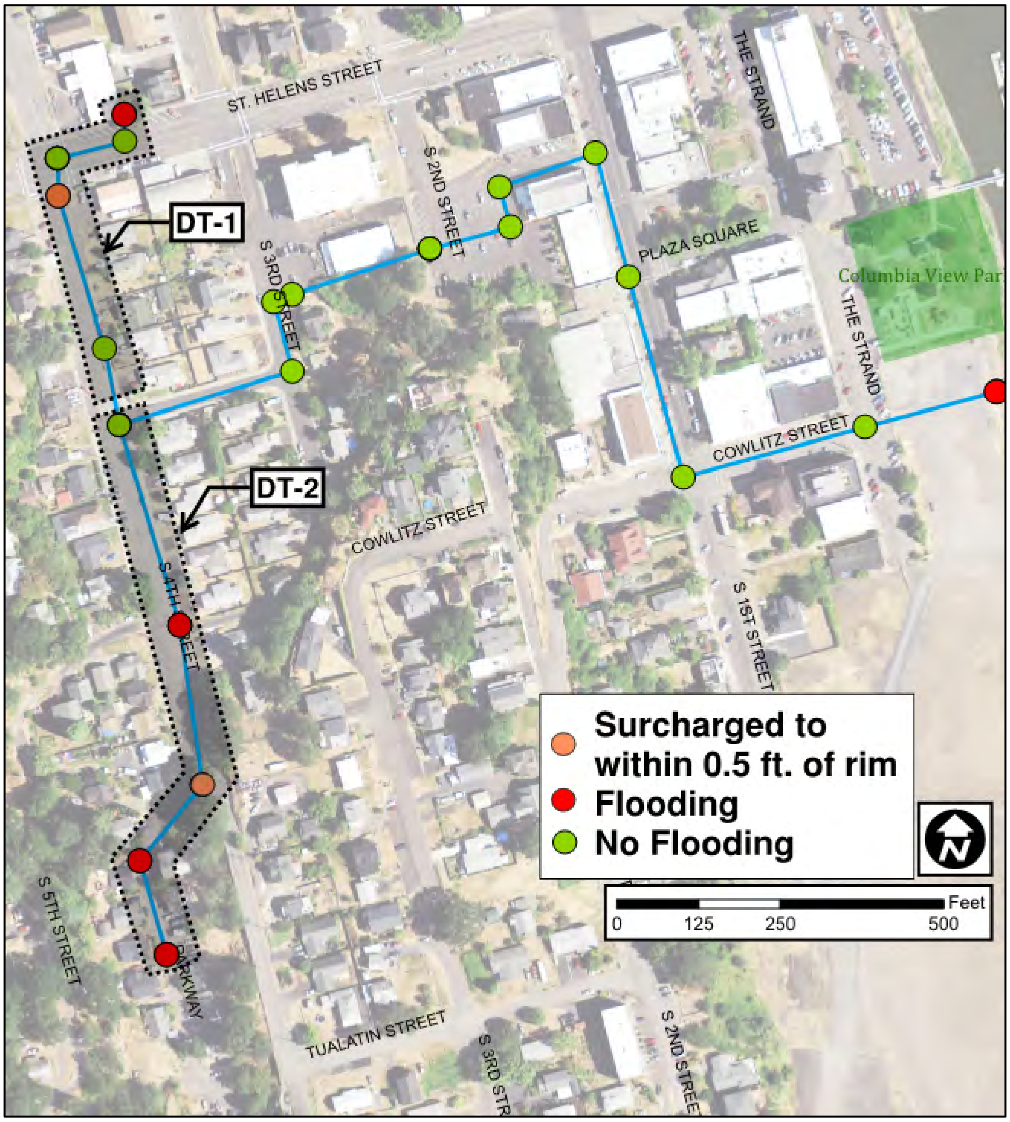
TABLE 5-5: SUMMARY OF DOWNTOWN BASIN EXISTING DEFICIENCIES

Problem Area ID	Location Description	First Storm Event with Surcharging[1,2]	First Storm Event with Flooding
DT-1	St Helens Street and S. 4th Street	-	10-Year
DT-2	Park Way to S. 4th Street	-	10-Year

1) First storm event with surcharging only includes where the hydraulic grade reaches within 0.5 feet of the rim elevation.

2) If left blank, surcharging was not projected before the flooding event.

FIGURE 5-4: DOWNTOWN BASIN 25-YEAR STORM EVENT MODEL RESULTS



Explanation of Deficiencies:

► **DT-1, DT-2:** Most of the surcharging and flooding appears to be caused by the undersized 24-inch pipeline draining east from S 4th Street to the outfall. The HGL suggests resolving this capacity deficiency would alleviate the existing flooding and surcharging identified in the model results.

5.2.5 GREENWAY BASIN

The Greenway Basin is located toward the southeast corner of the City and consists of almost all residential land use. The main pipe network drains into an open channel which drains toward the wastewater treatment pond. An earthen dam is located in the channel to keep stormwater from draining into the treatment pond and into a piped outlet which routes stormwater around the pond and into the Columbia River. In addition, three modeled pipe networks also drain to the Columbia River.

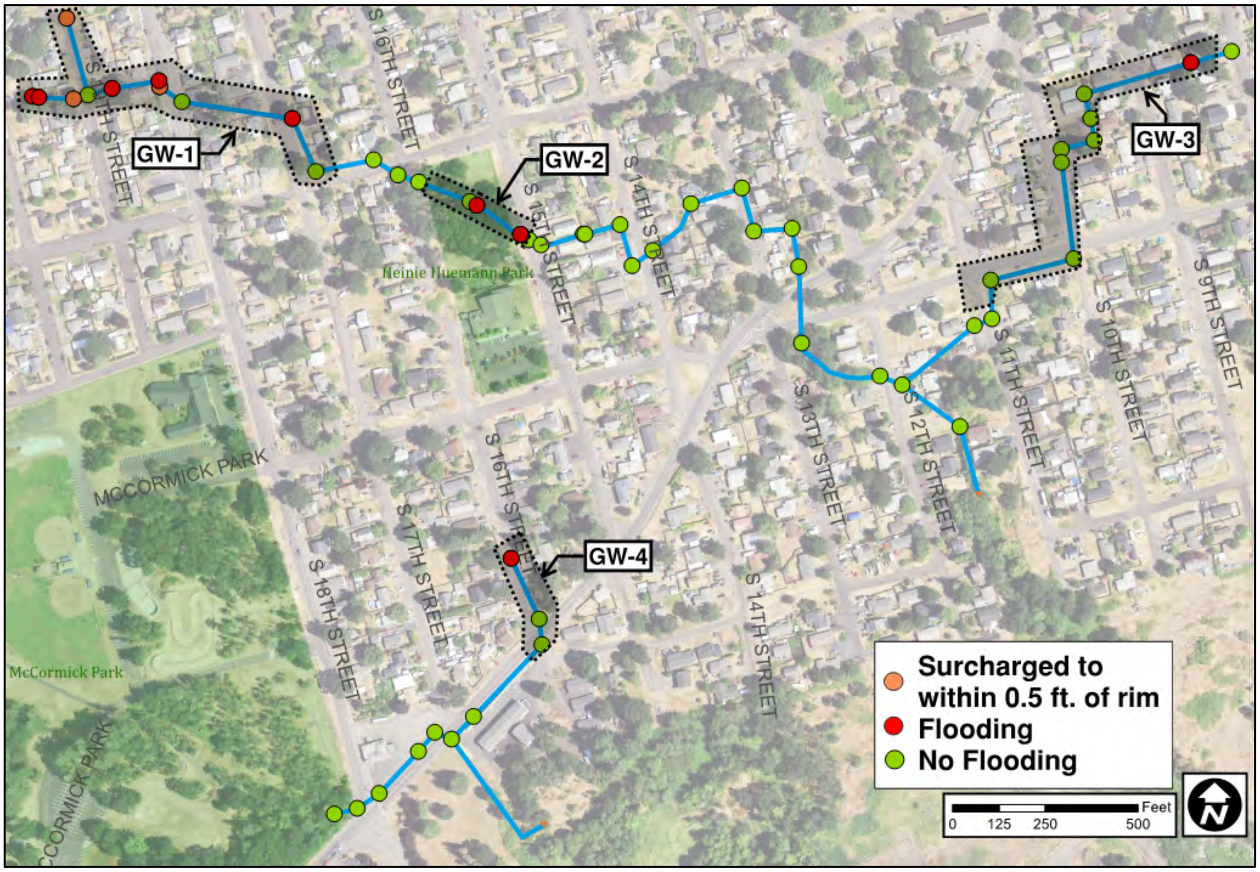
The City reported one known problem area within the Greenway basin, where a stormwater pump station was not able to keep up with peak flows. The pump station has recently been removed, and gravity pipelines now drain stormwater to the outfall, however, flooding is seen in the model upstream of the improvements. Furthermore, the City has reported several square junction boxes, which are preventing normal channelized flows, and it is recommended that each junction box be replaced with standard manholes or manholes with grated lids. It is important to note how two of the three additional modeled pipe networks from the intersection of S 3rd Street and Tualatin Street, as well as the pipe network at Nob Hill Park, are not shown in the figure extents below because flooding only occurs due to backwater from the Columbia River. The current pipe networks are not undersized for the design storm peak runoff flows, and the modeled networks can be seen in Figure 11D in Appendix A. Table 5-6 and Figure 5-5 summarize the identified deficiencies in the basin.

TABLE 5-6: SUMMARY OF GREENWAY BASIN EXISTING DEFICIENCIES

Problem Area ID	Location Description	First Storm Event with Surcharging[1,2]	First Storm Event with Flooding
GW-1	S 20th Street to Heinie Huemann Park	-	2-Year
GW-2	Heinie Huemann Park	-	2-Year
GW-3	S 8th Street to S 9th Street	-	2-Year
GW-4	S 16th Street	-	2-Year

1) First storm event with surcharging only includes where the hydraulic grade reaches within 0.5 feet of the rim elevation.
2) If left blank, surcharging was not projected before the flooding event.

FIGURE 5-5: GREENWAY BASIN 25-YEAR STORM EVENT MODEL RESULTS



Explanation of Deficiencies:

- **GW-1:** Flooding in this area is likely because of undersized pipes. Specifically, the 15-inch pipe parallel to S 17th Street, and the Tualatin Street intersection, is undersized and produces a bottleneck in the network.
- **GW-2:** Heinie Huemann Park acts as a natural detention pond with a slide gate at the east end of the park restricting discharge flows. Flooding in this park is intentional and is known by City staff, however, during the 25-year storm, there was approximately 300,000 gallons that flooded at the slide gate. A detailed survey of the whole park was not completed for this project.
- **GW-3:** At this catch basin, a significant amount of stormwater drains to the area and it is a local low point. The catch basin measures to be about 4 feet deep and on residential property. The pipe segments upstream of the recent stormwater improvements were not installed at recommended minimum pipe slopes according to the invert data provided by the City GIS. Undersized downstream pipes at this low and shallow catch basin end up causing backwater and flooding. It is important to mention that the City has not observed historical flooding in this area.
- **GW-4:** The highest upstream modeled manhole is where three un-modeled pipelines combine into a 12-inch pipe. The downstream pipes are undersized, which in return causes flooding at the upstream manhole.

5.2.6 MILTON CREEK BASIN

The Milton Creek Basin boundary expands north past the City's UGB and consists of a significant number of residential developments. The developments' stormwater infrastructure either discharges directly into Milton Creek or connects with the City's stormwater system which also drains into Milton Creek.

The City indicated two problem areas within this drainage basin, and both were confirmed with model results. The first problem area is located along North Vernonia Road between Oakview Drive and Eddies Way, which the City recently completed a project to improve the sidewalk and stormwater drainage on the west side of North Vernonia Road in hopes to improve stormwater drainage and reduce flooding. To improve drainage and reduce flooding, the open channels and culverts along this stretch of road were replaced with 18-inch pipe. There are multiple residential developments contributing flows to this segment of stormwater pipes, and each development has detention facilities to limit the peak flow along North Vernonia Road. The peak discharges from each of the detention facilities were compared to the peak flows from the detention pond design reports and are relatively similar.

The second area where there is known flooding indicated, is near the intersection of Columbia Boulevard and Cherrywood Drive. There is a low-lying area south of Columbia Boulevard which drains to the east and enters the stormwater system through a concrete headwall. The model projects flooding in this area because the downstream pipe network does not have sufficient capacity for peak runoff flows draining to this section of the stormwater system. Table 5-7 and Figure 5-6 summarize the deficiencies observed in the model.

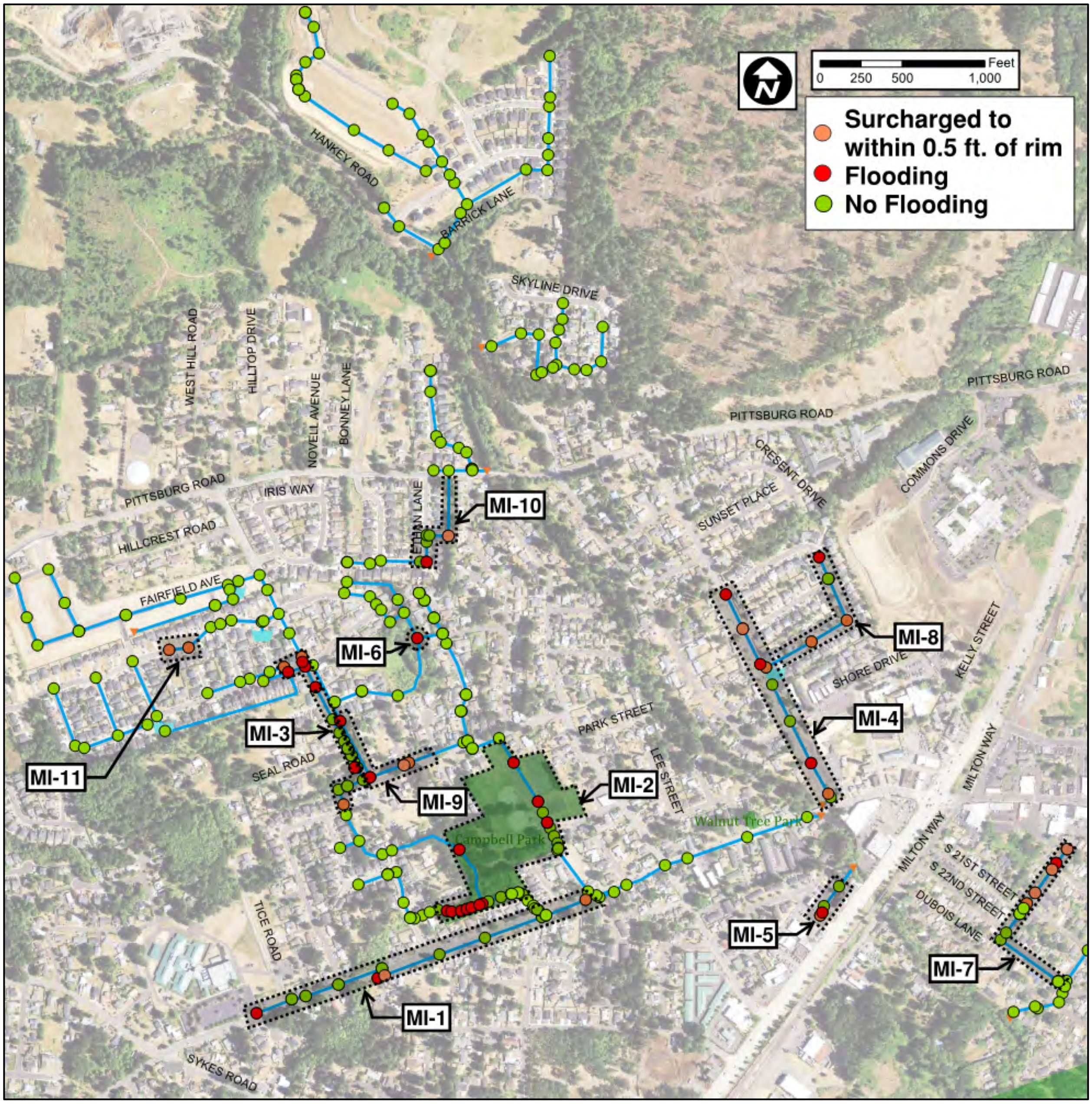
TABLE 5-7: MILTON CREEK BASIN SUMMARY OF EXISTING DEFICIENCIES

Problem Area ID	Location Description	First Storm Event with Surcharging[1,2]	First Storm Event with Flooding
MI-1	Columbia Boulevard	-	2-Year
MI-2	Campbell Park	-	2-Year
MI-3	North Vernonia Road (West Side)	-	10-Year
MI-4	Sunset Boulevard	-	10-Year
MI-5	Eilerston Street	-	25-Year
MI-6	West of Mayfair Drive	-	10-Year
MI-7	Crouse Way	-	25-Year
MI-8	Trillium Street to Salmon Street	-	10-Year
MI-9	Jakobi Street and Ethan Lane	-	25-Year
MI-10	Helens Way	25-Year	100-Year

1) First storm event with surcharging only includes where the hydraulic grade reaches within 0.5 feet of the rim elevation.

2) If left blank, surcharging was not projected before the flooding event.

FIGURE 5-6: MILTON CREEK 25-YEAR MODEL RESULTS



Explanation of Deficiencies:

- **MI-1:** The 15-inch and 18-inch pipes along Columbia Boulevard do not have sufficient capacity to drain peak runoff flows, and junctions are either backing up or flooding. The City identified the problem area as the local low point where majority of the flooding occurs.
- **MI-2:** Campbell Park floods and acts as a natural detention pond. There is a slide gate in the inlet to the pipe system which restricts flow and backs up stormwater in the park. The open channel to the west of the park is also undersized and floods that side of the park.
- **MI-3:** The pipe system north of Seal Road is too undersized to convey peak flows resulting in floods south of Oakview Drive. Significant runoff drains from the residential development

areas north of these pipe segments. The residential developments have detention ponds designed to reduce peak flows, but the outflows from the ponds still overwhelm the downstream pipe network. The new pipe system south of Seal Road and parallel with Edie's Way, to the pipe draining south under Edie's Way, both appear to be too undersized for the model predicted flows.

- **MI-4:** The pipe network south of Salmon Street is undersized and was originally intended to back up into the detention pond at the corner of Sunset Boulevard and Salmon Street, however, the City has not seen any detained water in this pond. In order to properly detain the water, the outlet control structure should be inspected and retrofitted as needed. Another pipe is present with an adverse grade south of Shore Drive, and there are pipes with 0% slope to the outfall, which causes stormwater to back-up within the trunkline.
- **MI-6:** At this catch basin, the stormwater drains to an open area south of Oakwood Road. Runoff enters through the catch basin and drains east to the trunkline along Mayfair Drive. The pipe appears to have an adverse grade and flows back toward the open area.
- **MI-5, MI-7, MI-8, MI-9, and MI-10:** These locations all have undersized pipes when it comes to peak flows. Since the pipes are too small, stormwater backs-up in upstream pipes and surcharging or flooding can occur because of the undersized pipes downstream.

5.2.7 MCNULTY CREEK BASIN

McNulty Creek Basin also extends north, outside of the UGB, and is primarily comprised of residential developments on the north half of the basin as well as commercial and industrial land use toward the southern half. Many of the residential developments have independent stormwater systems which discharge directly into McNulty Creek or into large channels that lead to McNulty Creek. There is only one long pipe network draining from Pittsburg Road in the north to a large wetland area on the eastern side of the Columbia River Highway. The City identified two areas in McNulty Creek Basin where historical flooding has previously occurred.

The first area where flooding occurred took place south of Columbia Boulevard and Sykes Road intersection. Model evaluation demonstrates how the trunkline was surcharged and flooded locally at a low point in the system. This historical flooding reportedly decreased after the outfall east of the Columbia River Highway was recently cleared out. However, the model projects flooding occurring in this area even with free discharge at the outfall.

The second area where flooding has occurred was between Harris Street and Elm Street, which in this area, stormwater is discharged from a pipe network, through an open channel, and back into the pipe network. Overall, flooding was not projected in the model and both the open channel and pipe network appear to be adequately sized for peak flows. Table 5-8 and Figure 5-7 show the observed deficiencies.

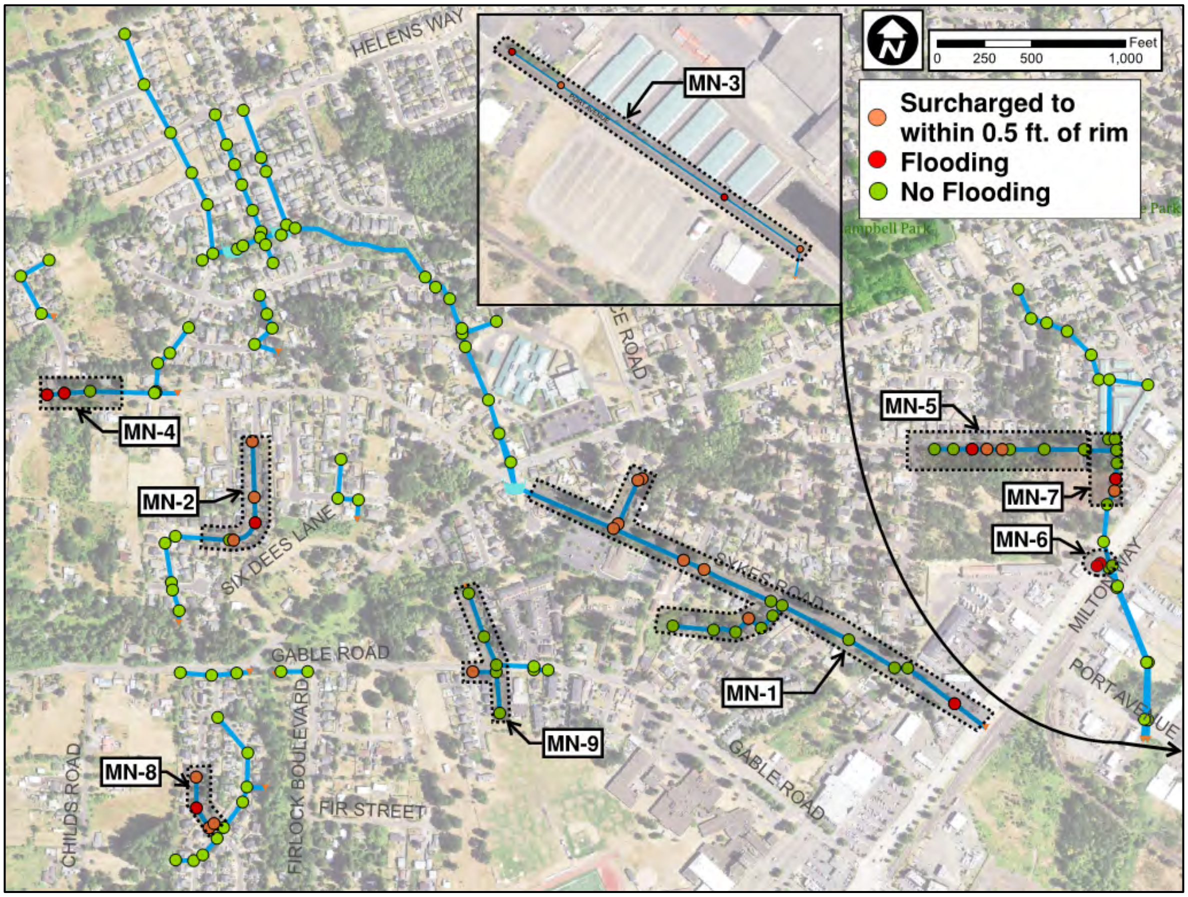
TABLE 5-8: SUMMARY OF MCNULTY CREEK BASIN EXISTING DEFICIENCIES

Problem Area ID	Location Description	First Storm Event with Surcharging[1,2]	First Storm Event with Flooding
MN-1	Sykes Road	-	10-Year
MN-2	Whitetail Avenue	-	10-Year
MN-3	Port Avenue	-	10-Year
MN-4	Sykes Road and Mountain View Drive	-	25-Year
MN-5	McBride Street	-	25-Year
MN-6	Columbia River HWY Ditch	-	25-Year
MN-7	McBride Street and Columbia River HWY		25-Year
MN-8	Evergreen Loop	-	25-Year
MN-9	Gable Road and Elizabeth Lane	25-Year	100-Year
MN-10	Ridgecrest Subdivision	-	100-Year

1) First storm event with surcharging only includes where the hydraulic grade reaches within 0.5 feet of the rim elevation.

2) If left blank, surcharging was not projected before the flooding event.

FIGURE 5-7: MCNULTY CREEK BASIN 25-YEAR MODEL RESULTS



Explanation of Deficiencies:

- ► **MN-1:** The Sykes Road stormwater pipes are 24-inch in diameter south of Columbia Boulevard intersection and increase after to 27-inch in diameter near Matzen Street intersection. The pipeline then reduces to a 24-inch diameter pipe right before its outfall on the east side of the Columbia River Highway. The 24-inch diameter pipes are undersized, causing flooding through the whole pipe network, including its smaller branches.
- ► **MN-2, MN-3, MN-4, MN-7, and MN-9:** These pipes are undersized for peak flows and causes both surcharging and flooding in the upstream pipe network to occur.
- ► **MN-5:** The first two pipes east of the McBride Street and Matzen Street intersection were installed as detention storage and the model indicates the existing storage volume is not sufficient. Surcharging and flooding occurs at the manholes with the lowest rim elevations.
- ► **MN-6:** Upstream pipes discharge into an open channel on the southeast side of the Columbia River Highway and drain along the road for approximately 100 feet before entering the pipe network through two 24-inch inlets. This open channel is relatively flat and is overtopping its approximately 3-foot channel walls.
- ► **MN-8:** An adverse grade in a small segment of pipes crossing Evergreen Loop restricts flow and causes surcharging in the upstream pipe network.

5.3 STAFFING EVALUATION

The following section summarizes existing stormwater staffing levels, identifies deficiencies in existing staffing levels, and provides staffing recommendations for the City of St. Helens.

5.3.1 GENERAL

The City Public Works (PW) Operations staff are responsible for the operations and maintenance (O&M) of the stormwater system in St. Helens. On February 25th, 2021, PW Operations staff was interviewed by Keller Associates to assess existing levels of stormwater staffing and annual O&M activities, identify deficiencies in staffing and equipment, and provide recommendations to assist the City in meeting level of service (LOS) goals for the local stormwater system. To summarize, the PW Operations staff currently provide support for many City activities that are not directly related to public utility O&M (i.e., building maintenance, building remodels, City events, etc.). The sections below provide more detail regarding existing stormwater system staffing and recommendations based on the findings from the PW Operations staff interviews.

5.3.2 EXISTING STORMWATER STAFFING

During staff interviews, the general roles and responsibilities of PW Operations for the stormwater system O&M was reviewed. A list of O&M activities and approximate time, frequency, and size of crew was developed to evaluate the approximate annual labor hours spent on stormwater O&M. The primary O&M activities include responding to areas of historical flooding during large rain events, cleaning facilities, maintaining ditches and detention facilities, in-house stormline replacement or extensions, street sweeping, responding to reported problems, and construction permitting and inspections. It is estimated that approximately 3.0 full time employee (FTE) is spent annually on stormwater collection O&M activities.

The current budgeted FTE for stormwater collection systems O&M is approximately 4.20 FTE, which includes 0.75 FTE from the engineering department for construction, inspection, and permitting support, as well as in-house replacement and extension project support. Additional discussions with the PW Operations and engineering staff made clear the fact that they are being requested to complete significant tasks and projects outside of utility O&M. Some of these tasks include, but are not limited to, building maintenance; building remodels and renovations; City events setup, takedown, and traffic control; park projects and maintenance; and groundwork for City projects. It is estimated that the PW Operations staff spend 30%-40% or more of their time completing work that is not directly related to utility O&M. These additional tasks pull the PW staff away from utility maintenance activities and prevent them from spending the allocated FTE on utility O&M. Existing maintenance practices on the stormwater system tend to be reactive because of the additional projects the PW Operations staff must complete, and as a result, the time they can spend on utility O&M is minimized.

5.3.3 RECOMMENDED STORMWATER O&M AND STAFFING

LOS goals were discussed with PW Operations staff for the stormwater system. The desired LOS goals are summarized below.

- No excessive flooding in stormwater system
- No property damage from stormwater
- Address reported problems in a timely manner to prevent interruptions to service
- Complete regular maintenance, repairs, and replacements to minimize interruptions and failures (perform proactive O&M in lieu of reactive O&M)

A summary of recommended general O&M activities to achieve these LOS goals and follow industry good practices are listed below.

- Clean and CCTV inspect storm lines once every two years (approximately 1/2 system annually)
- Repair or replace defects as identified
- Clean catch basins and manholes every two years (approximately 1/2 of system annually)
- Clean and inspect 100% of ditches and inlet/outlet grates annually
- Sweep all roadways approximately twice per year
- Perform general detention facility maintenance annually
- Respond to problems as they are identified or reported
- Install minor in-house storm line replacements and extensions (similar to existing practice)
- Facilitate public education and outreach
- Complete construction inspection and permitting
- Comply with new Mercury TMDL implementation plan and complete annual reporting

Using similar expected labor hours for activities as the existing staffing evaluation, it is estimated that approximately 4.25-4.5 FTE are needed to meet the O&M and LOS goals described above. A mercury TMDL implementation plan is being developed parallel to this master plan and staffing needs should be re-evaluated after DEQ approval of the implementation plan for the developed mitigation strategies.

As budgeted, the existing stormwater FTE staff appears to be adequate. However, the additional projects and work the PW Operations staff are currently requested to complete, significantly decreases the budgeted FTE that can be spent on stormwater O&M. The recommendation would be that either additional FTE be budgeted for the PW Operations staff to complete the existing workload requested, or the responsibilities of the PW Operations staff be reduced to focus solely on utility O&M. The staffing evaluation for this report is a high-level, initial estimate. The City would benefit from tracking the number of hours the PW Operations staff spend on various activities and utilities throughout the year to assess how best to budget and allocate resources in order to provide recommended O&M on utilities. It is also recommended that staffing needs be reevaluated every two to three years.

In addition to annual O&M discussed above, an annual replacement program should be maintained. Stormwater infrastructure replacement and rehabilitation needs will increase as the system ages, so it would be beneficial for CCTV inspection reports to be reviewed to prioritize rehabilitation and replacement efforts. An annual replacement program is an important part of proactively maintaining the stormwater system. Staffing FTE and construction cost for an annual replacement program were not included in the staffing evaluation, but construction costs are discussed and estimated in Section 8. If the PW Operations staff are asked to be responsible for and complete some of the rehabilitation or replacement work, the budgeted FTE for the PW Operations staff would be increased.

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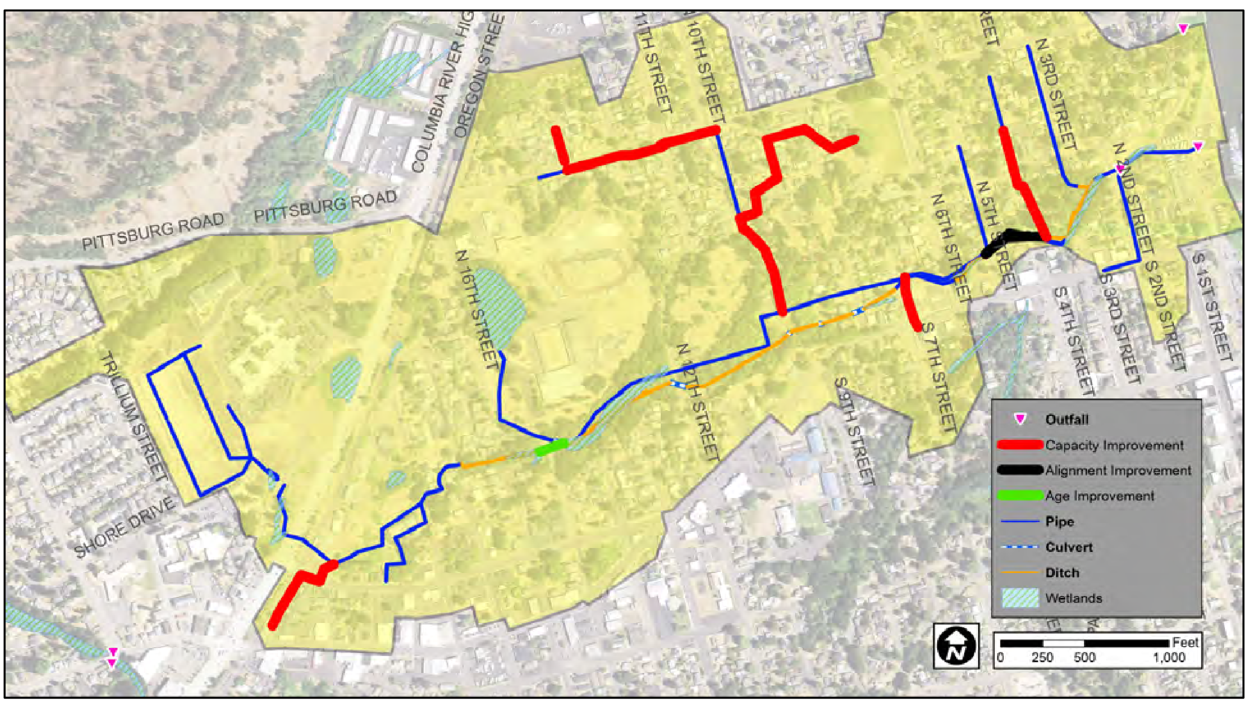
SECTION 6 - ALTERNATIVES ANALYSIS

The following section discusses solutions intended to resolve system deficiencies identified in Section 5. To summarize, one to two alternatives were evaluated for each of the identified problem areas. A detailed description of the recommended solutions for areas with only one alternative considered were not included in this section, however, a description of the proposed solution is provided in Section 7. Alternatives considered in this evaluation included parallel or replacement of conveyance systems, flow rerouting, and detention or retention storage facilities. While the primary focus of this alternatives analysis was to address deficiencies in the existing system's condition and capacity, improvements to address water quality were also considered at a conceptual level. Detailed cost estimates for the proposed alternatives can be found in Appendix C. Also included in this section, is the recommended alignment of the City's future stormwater system incorporating the new riverfront development property and future growth areas as identified by the City for the 20-year planning period.

6.1 NORTH TRUNK BASIN ALTERNATIVES

The deficiencies identified in the North Trunk Basin included surcharging and flooding in the upstream pipe networks due to undersized pipes. The majority of these deficiencies are to be resolved by increasing the capacity of the pipe networks and no additional alternatives were identified as feasible or cost saving. Additionally, a section of pipes between N 5th Street and N 4th Street appear to have been installed underneath existing structures and it is recommended to confirm the alignment of these pipes. If the pipes are located beneath existing structures, it is recommended to abandon and realign these pipes out from under existing structures. As discussed in Section 5, pipes installed before the 1980s are likely reaching the end of their useful life and should be inspected and replaced or inspected and repaired. Multiple alternatives for these pipes were not evaluated in the North Trunk Basin. The pipes recommended to be replaced to increase capacity (shown in red), adjusted location and alignment (shown in black), or to be replaced due to age (green) are highlighted below in Figure 6-1.

FIGURE 6-1: NORTH TRUNK REPLACEMENT PIPES

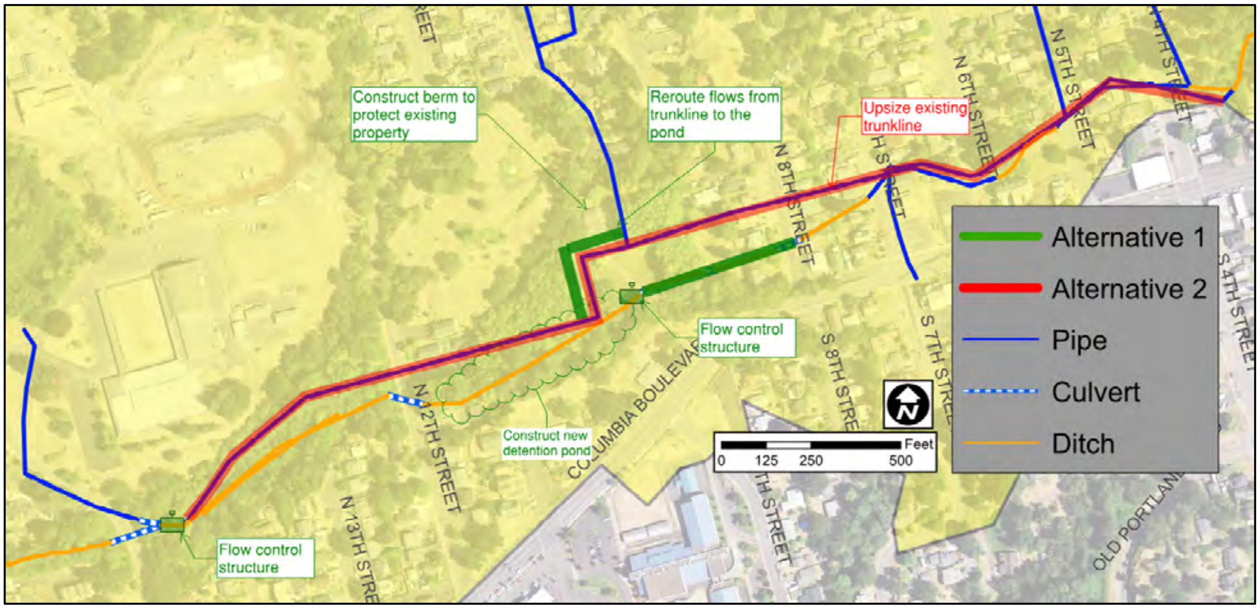


The primary focus area in the North Trunk Basin alternatives analysis was from N 17th Street, draining northeast, to Godfrey Park. The existing stormwater system is comprised of two parallel stormwater networks which split on the east side of N 15th Street between a 21-inch and 24-inch pipeline (to be referred to as Columbia Boulevard Trunkline) and a network consisting of closed pipe (varying in diameter), open ditches, and culverts (to be referred to as Columbia Boulevard Ditch Network). Both systems run from N15th Street to Godfrey Park. Deficiencies were identified in the Columbia Boulevard Trunkline in the existing system evaluation and the trunkline appears to be too undersized for the projected model flows because the hydraulic grade line overtops the rim elevation. Deficiencies were also identified in the Columbia Boulevard Ditch Network and include four undersized culverts. The Columbia Boulevard Ditch Network drains through an existing wetland between N 16th Street to N 5th Street as shown in the City's LWI (1999). The wetlands were identified as Palustrine Forested Wetlands and are characterized by steep side slopes with a broad flat area between N 15th Street and N 12th Street.

Two alternatives were considered to address the deficiencies north of Columbia Boulevard which are illustrated in Figure 6-2 and summarized below:

- Alternative 1: Install a flow control structure on the east side of N15th Street to control the flow split between Columbia Boulevard Trunkline and Columbia Boulevard Ditch Network. The flow control structure will divert most of the flows to the Columbia Boulevard Ditch Network. Alternative 1 utilizes open space and natural topography allowing for a new detention storage to be constructed in the area between N 12th Street and N 10th Street by installing a new flow control structure at the outlet culvert on the west side of N 10th Street. The purpose of this flow control structure is to detain water in the new detention pond and limit peak flows to the downstream network. The detention pond would need a storage volume of approximately 7 acre-feet. Note, a berm will likely need to be constructed at the northeast border of the pond to prevent stormwater from draining across the existing property within the ravine. The flows from the existing trunklines draining south along N 10th Street would need to be rerouted to discharge into the new detention pond, which would relieve flooding in the Columbia Boulevard Trunkline.
- Alternative 2: Install a flow control structure on the east side of N 15th Street (similar to Alternative 1) and direct most of the flows down the Columbia Boulevard Trunkline. Upsize the existing Columbia Boulevard Trunkline from 21- and 24-inches to 36-inches from North 15th Street to Godfrey Park.

FIGURE 6-2: NORTH TRUNK ALTERNATIVES



Both Alternatives 1 and 2 are viable options to address deficiencies identified in the North Trunk Basin. Alternative 1 utilizes the natural topography and available open space to reduce stormwater impacts downstream and also provides the City with opportunities to install features to improve water quality. Alternative 2 may eliminate the need to replace the existing culverts on the Columbia Boulevard Ditch Network but in response, it will increase peak flows at Godfrey Park and Alternative 2 does not provide any easy options for addressing water quality. A summary of the pros and cons to each of the alternatives is provided in Table 6-1.

TABLE 6-1: NORTH TRUNK BASIN ALTERNATIVES COMPARISON

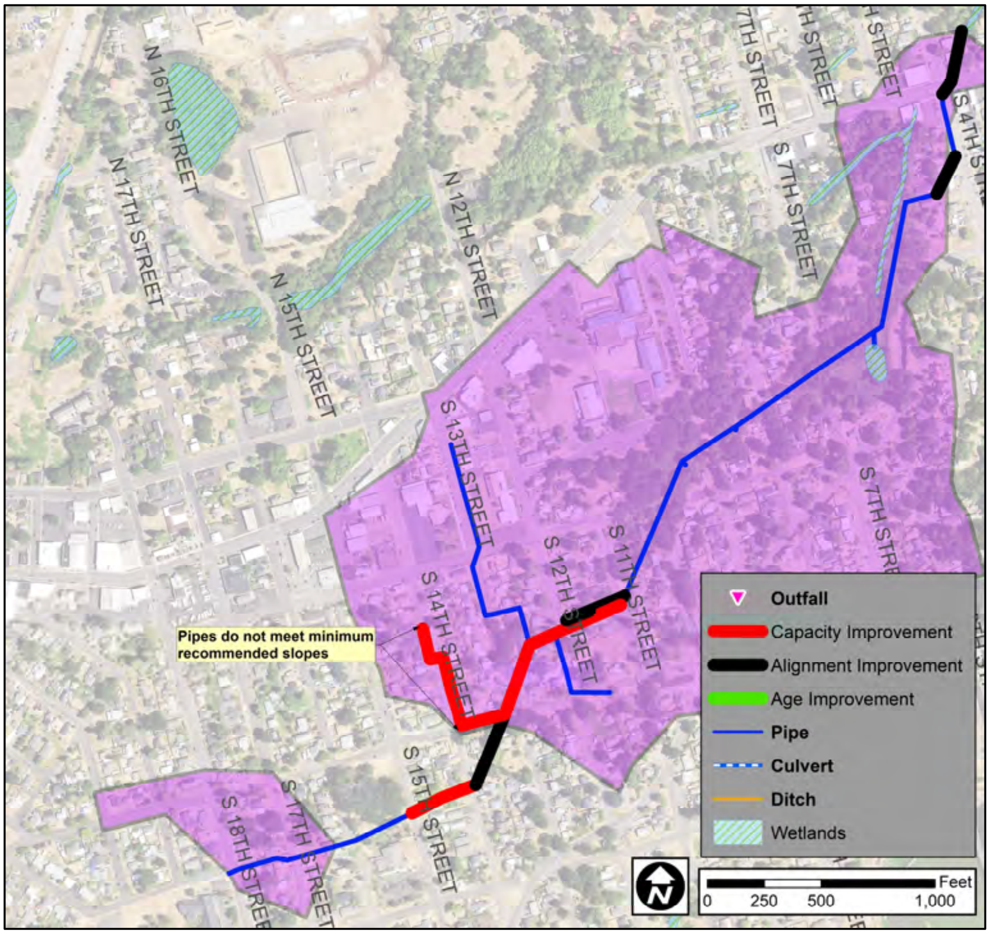
	Pros	Cons	Estimated Cost
Alternative 1	- Utilizes natural detention - Opportunities to increase water quality - Minimal pipelines to be upsized	- Requires acquisition of property to detain flows - Neighborhood impacts - Requires wetland delineation	$1,200,000
Alternative 2	- Lower maintenance - No wetland delineation - Reduces flows through existing Ditch Network	- Higher capital costs - Potential bedrock excavation - Increases peak flows at Godfrey Park	$2,800,000

- ► Recommendation: Alternative 1 is recommended based on the information provided above. Alternative 1 utilizes natural detention and topography to reduce peak flows to the downstream network and increases water quality discharging into the Columbia River. Alternative 1 also has lower capital costs to Alternative 2 as seen in Appendix E.

6.2 MIDDLE TRUNK BASIN

Deficiencies identified in the Middle Trunk Basin include surcharging and flooding of the main trunkline running from N 18th Street to Godfrey Park as well as the trunkline draining from N 14th Street and connecting to the main trunkline. There are pipes in the basin that do not meet the recommended minimum pipe slopes. It is recommended that these pipes be replaced to provide minimum pipe slopes to reduce localized flooding and surcharging. Additionally, there were multiple pipes identified where the GIS alignment indicated pipes crossing underneath existing structures, and the pipe alignments should be investigated. If the alignments are found to cross under existing structures, it is recommended the City abandon or remove and relocate any pipes from underneath those existing structures. The pipes identified to be upsized would benefit from being realigned in order to reduce the number of crossings through private property and eliminate crossings underneath existing structures. Figure 6-3 highlights the pipes recommended to be replaced.

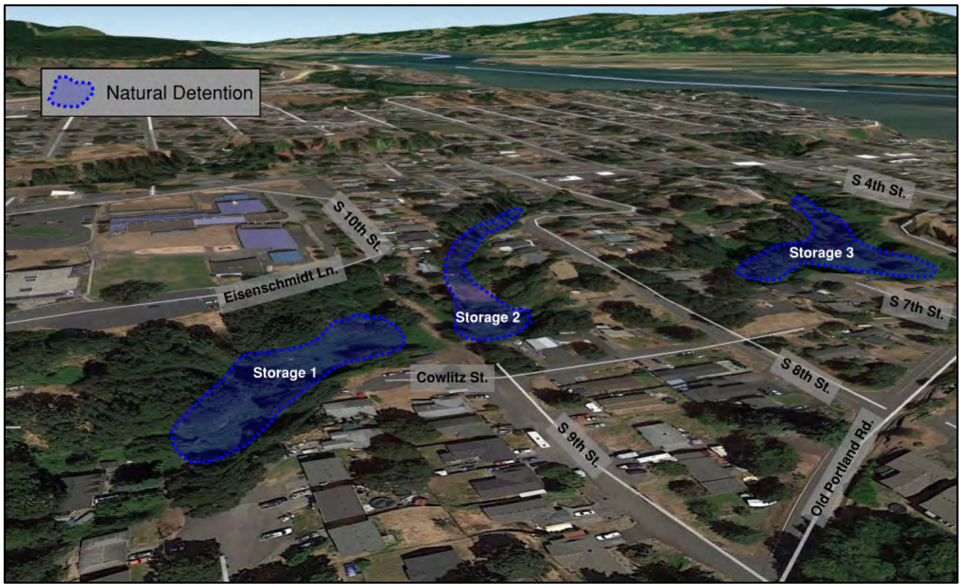
FIGURE 6-3: MIDDLE TRUNK BASIN REPLACEMENT PIPES



Alternatives considered in the Middle Trunk Basin focused on solutions to alleviate flooding in the trunkline starting at N 18th Street and ending at Godfrey Park. This trunkline conveys stormwater from southwest to northeast where it discharges into Godfrey Park. The trunkline runs through three ravines which could potentially serve as natural detention and provide a solution to the existing flooding and surcharging. The first natural storage location (Storage 1) can be found between Cowlitz Street, the northeast side of S 10th Street, and Eisenschmidt Lane from S 10th Street to S 9th Street. Part of the natural ravine is located south of Cowlitz Street between S 11th Street and S 10th Street. There are existing residential structures located within the ravine. These dwellings reduce the usable detention storage volume in the ravine, although use of the natural topography for detention storage is still an option. The second natural storage location (Storage 2) is located between S 9th Street and S 8th Street. The third storage location (Storage 3) is east of S 8th Street and west of S 4th Street. Storage 3 consists of two identified wetlands: an approximately

0.3-acre Palustrine Scrub-shrub wetland and an approximately 0.8-acre Palustrine Forested wetland. The three potential storage locations are shown in Figure 6-4.

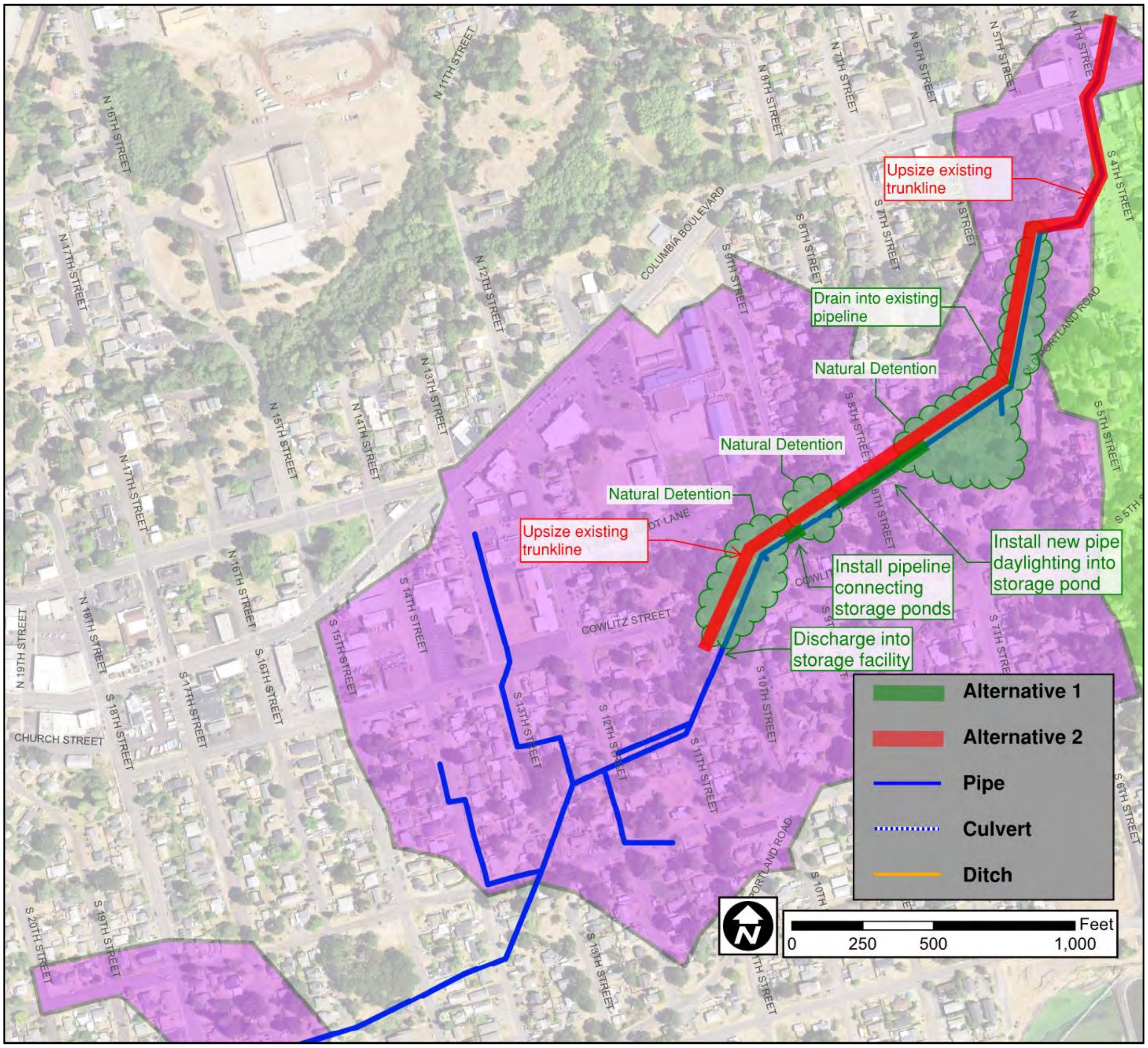
FIGURE 6-4: MIDDLE TRUNK NATURAL DETENTION STORAGE LOCATIONS



Two alternatives were evaluated to address the deficiencies, and descriptions of the two alternatives considered are included below. Figure 6-5 shows the two evaluated alternatives.

- Alternative 1: Upsize the existing 18-inch pipe to 36-inch pipe along S 13th Street to a new outlet at Storage 1. A berm should be constructed, or Storage 1 should be excavated down to protect the existing structures in the ravine because Storage 1 needs approximately 3 acre-feet of available volume. Install an outlet under S 9th Street from Storage 1 to Storage 2, and Storage 2 would need a volume of approximately 3 acre-feet. Install a new pipe to drain water from Storage 2 to Storage 3. Water quality will need to be addressed before discharging to Storage 3 because the area is identified as a wetland. Additional efforts will be required to incorporate the wetlands into Storage 3 and will likely include wetland delineation, permitting from United States Army Corps of Engineers (USACE) and DSL, and a hydrologic study on the impact of additional flows discharging to the wetlands. Storage 3 needs approximately 8 acre-feet of storage. Install an inlet to the existing 18-inch pipeline which drains to S 4th Street and Godfrey Park.
- Alternative 2: Upsize the existing pipeline from 18-inches to 36-inches from S 13th Street to the outlet at Godfrey Park.

FIGURE 6-5: MIDDLE TRUNK ALTERNATIVES



The pros and cons for the two alternatives are relatively similar to the alternative comparison in the North Trunk Basin. Alternative 1 provides stormwater detention which decreases downstream peak flows and increases water quality. Alternative 2 has lower capital costs but will likely increase the existing flows through Godfrey Park. The two alternatives' pros and cons are summarized in Table 6-2.

TABLE 6-2: MIDDLE TRUNK BASIN ALTERNATIVES COMPARISON

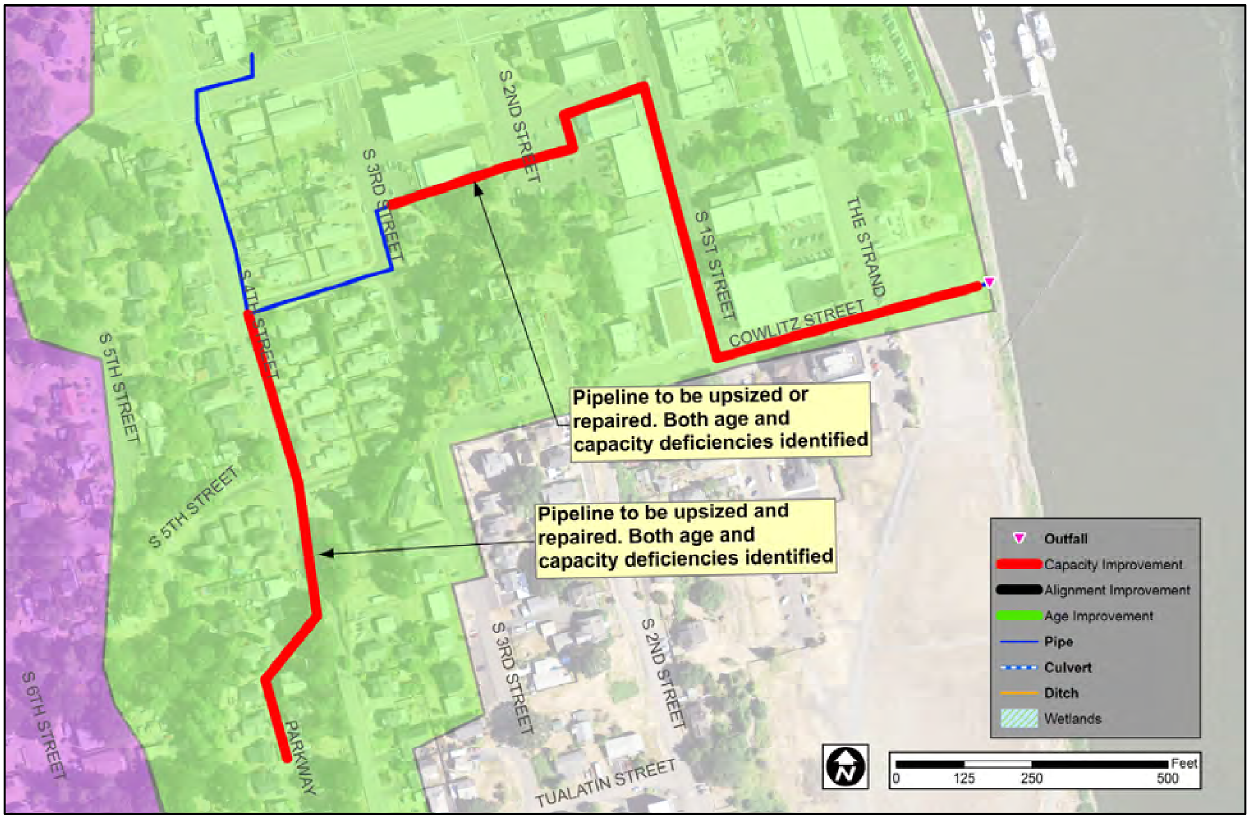
	Pros	Cons	Estimated Cost
Alternative 1	- Utilizes natural detention and wetlands - Opportunities to increases water quality - Minimal pipelines to be upsized	- Requires acquisition of property to detain flows - Requires enviromental permitting and analysis - Additional maintenance efforts	$2,000,000
Alternative 2	- Lower maintenance - Simplified construction	- Potential bedrock excavation - Increases peak flows at Godfrey Park	$3,400,000

► Recommendation: Given the opportunities for detention provided by the natural topography throughout the Middle Trunk Basin, Alternative 1 is recommended and will result in lower peak flows through Godfrey Park, provide opportunities to increase water quality, and minimize the amount of pipe to be replaced or upsized.

6.3 DOWNTOWN BASIN

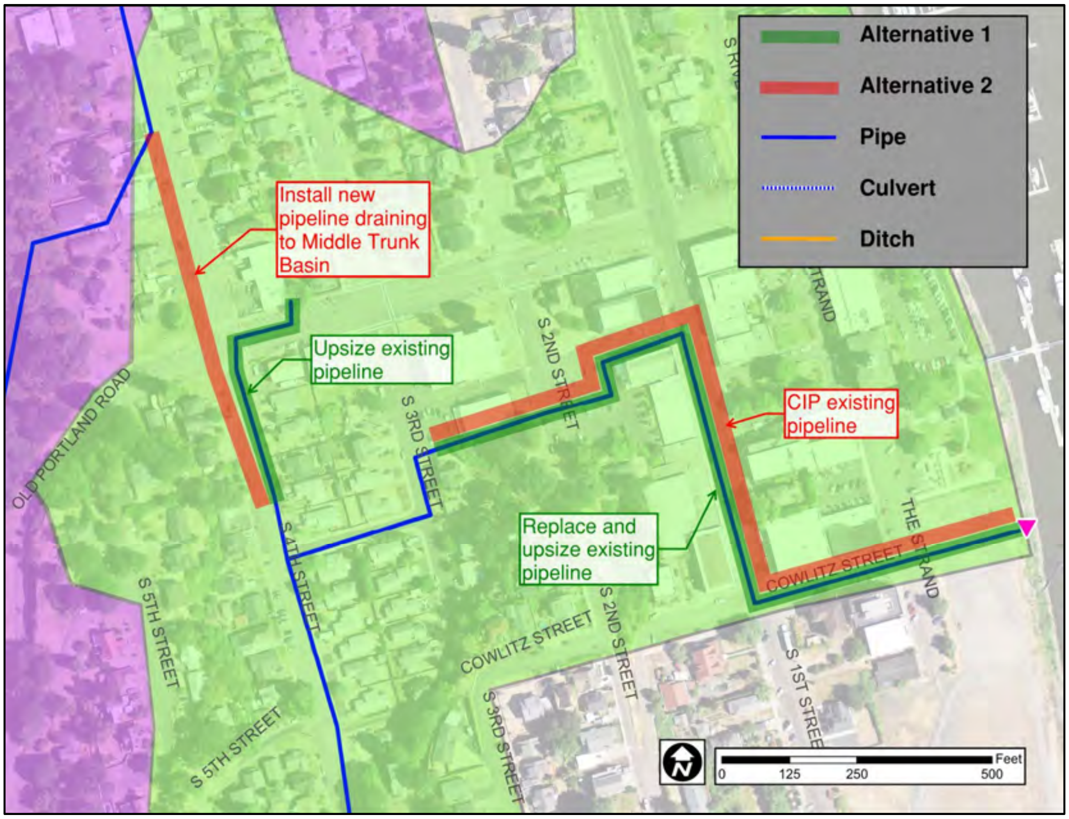
The City is not currently aware of any surcharging or flooding in the Downtown Basin. The model evaluation identified two deficiencies (details in Section 5) where flooding and surcharging occurred in the upstream branches of the pipe network. One of the deficiencies identified (DT-2) included multiple segments of concrete pipe, which were installed in the late 1960s, and only one alternative was evaluated for this segment of pipeline: replace pipeline as it reaches the end of its useful life. Additionally, the 24-inch pipeline from S 3rd Street to the outfall was concrete installed around the same time. The upper segments of this pipeline were also identified as being undersized and should be upsized at the time of replacement. Pipe condition assessments will need to be completed in order to provide information on pipe segments in the area that should be replaced based on physical condition. Two alternatives were considered to address the identified deficiencies and are discussed later in this section. Figure 6-6 shows the two pipe segments that are advised to be inspected and replaced or repaired.

FIGURE 6-6: DOWNTOWN BASIN REPLACEMENT PIPES



The two alternatives evaluated in this basin are targeted toward alleviating flooding in the pipe network along S 4th Street, which was identified through modeling, and to address the aged 24-inch pipes draining east to the outfall. The two alternatives considered are illustrated in Figure 6-7 and the improvement descriptions are provided below. Both alternatives include upsizing the pipe along Parkway as shown in Figure 6-7.

FIGURE 6-7: DOWNTOWN BASIN ALTERNATIVES



► Alternative 1: Replace the 24-inch concrete pipeline with 36-inch pipe from S 3rd Street to the outfall. Upsize the existing 12-inch pipeline from the north side of Old Portland Road to the existing 24-inch pipe to the south. Note, this alternative will require acquiring additional permitting (USACE 404 Permit and DSL Removal-Fill Permit) for the replacement of pipelines at the outfall to the Columbia River.

► Alternative 2: Install cured-in-place pipe (CIPP) through the existing 24-inch concrete pipe from S 3rd Street to the outfall. Install new 18-inch pipeline along S 4th Street draining north and connect to the existing 18-inch trunkline discharging to Godfrey Park.

Alternative 1 increases the capacity of the trunkline draining to the outfall which would provide the City with an opportunity to connect additional connector pipelines through this outfall. However, as discussed above, this alternative will result in a need for additional environmental permitting. Alternative 2 utilizes CIPP to reduce the overall capital costs of repairing the old pipeline, but it could result in minor capacity reduction of the trunkline. Alternative 2 requires the installation of a new pipeline along S 4th Street, and a new connection to the Middle Trunk Basin draining to Godfrey Park, therefore, the improvements to the Middle Trunk Basin must be completed before making this connection. The hydrologic impact of adding stormwater flows to Godfrey Park should also be evaluated in this Alternative. Lastly, Alternative 2 would include a conditions assessment of the existing outfall, and if outfall improvements are needed, the additional environmental permitting required for Alternative 1 would also be required for Alternative 2. The pros and cons of the two alternatives are summarized below in Table 6-3.

TABLE 6-3: DOWNTOWN BASIN ALTERNATIVES COMPARISON

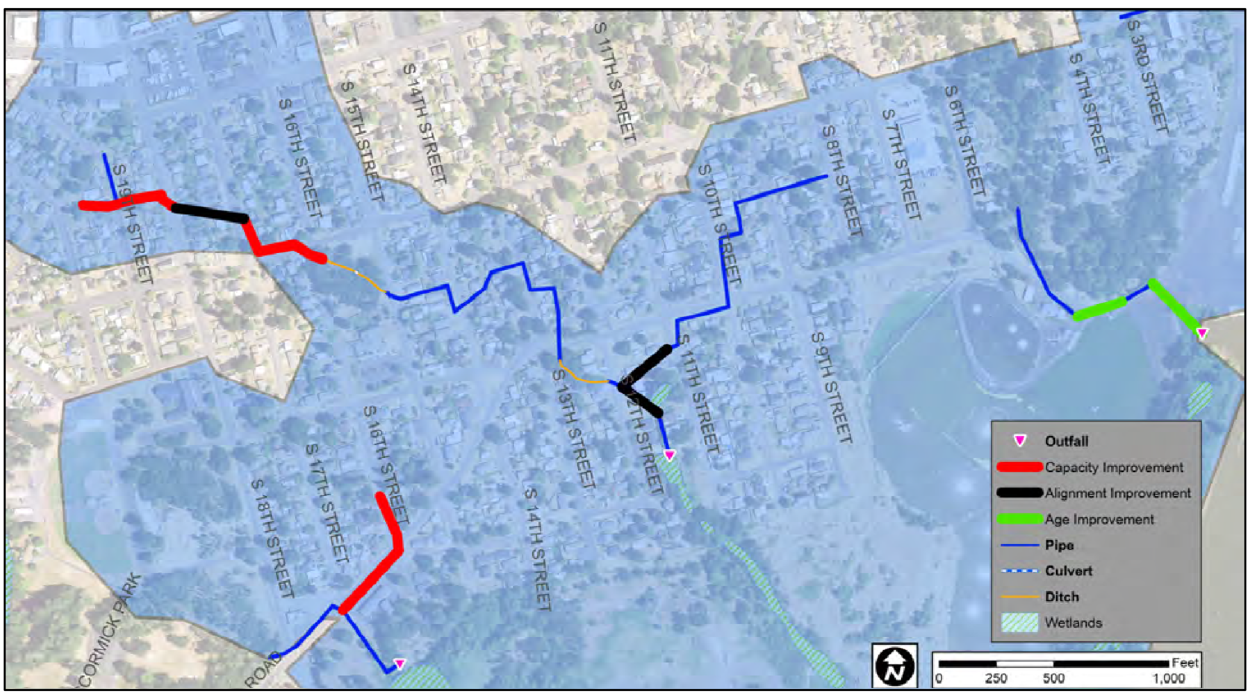
	Pros	Cons	Estimated Cost
Alternative 1	- Keeps existing stormwater drainage in the same basin - Increases capacity of trunkline	- Requires environmental permitting - Higher capital costs	$2,400,000
Alternative 2	- Lower Capital Costs - Minimize pipeline upsizing	- Requires upsizing of Middle Trunk pipes - Reduces capacity of the existing trunkline	$1,200,000

► Recommendation: Alternative 1 is recommended over Alternative 2 because it would provide the City with more of an opportunity to both collect stormwater and convey stormwater through existing pipeline to the outfall location.

6.4 GREENWAY BASIN

Deficiencies in the Greenway Basin were identified in four locations throughout the existing stormwater system. Two of the four deficiencies were evaluated with only one alternative, which consisted of upsizing the existing pipe. There are also two CMP segments that were installed in the early 1970s near Plymouth Street outfall. It is recommended that these pipelines be evaluated and replaced if the pipe conditions require it. Figure 6-8 shows the pipes recommended to be replaced based on capacity or age deficiencies.

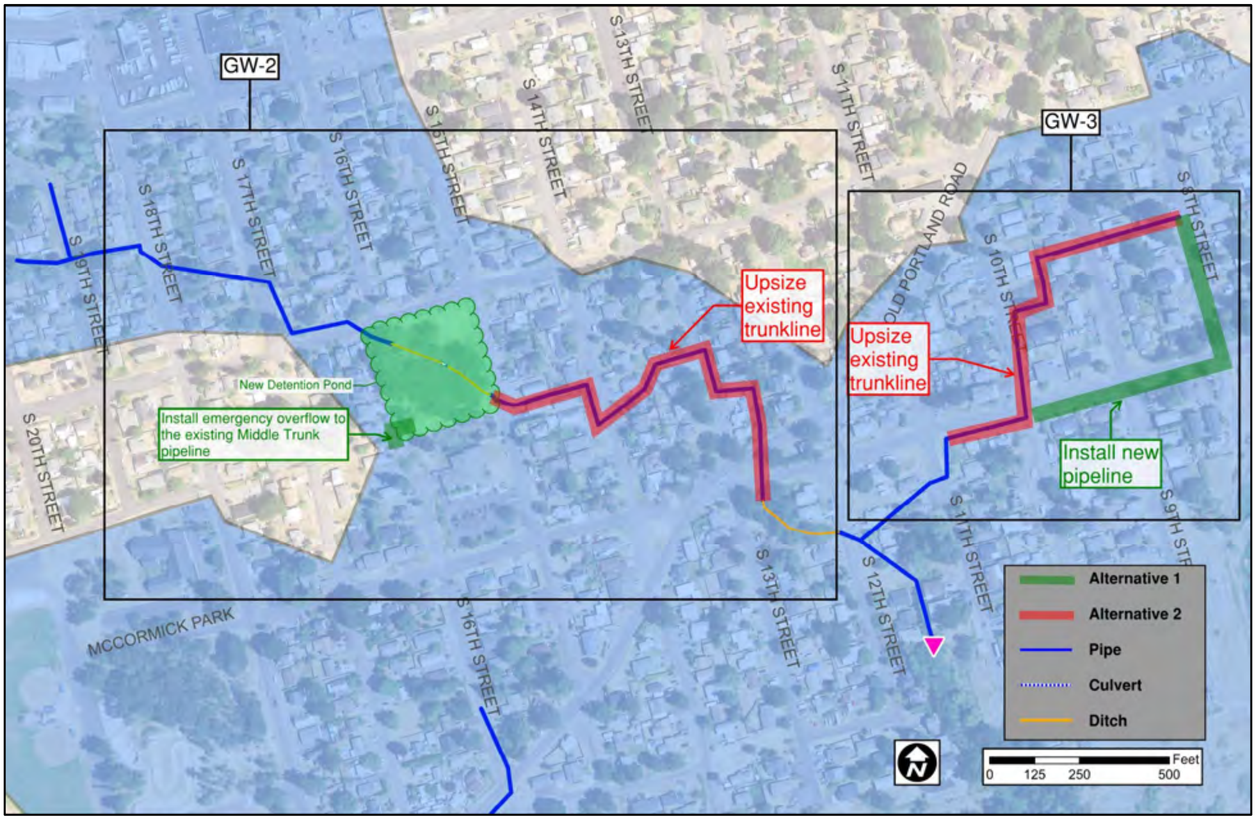
FIGURE 6-8: GREENWAY BASIN REPLACEMENT PIPES



Two alternatives were evaluated for the remaining two deficiencies identified in the Greenway Basin (GW-2 and GW-3). GW-2 consisted of flooding at Heinie Huemann Park because stormwater flows back up into the park causing unofficial detention before discharging downstream. A detailed survey was not completed of Heinie Huemann Park, but it is assumed the park contains the volume of detention required to handle the 25-year storm because according to the model, the required storage to pass the 25-year storm is approximately 1.7 acre-foot. GW-3 includes a 12-inch pipeline in lieu of a stormwater pump station, and the 12-inch line does not have the capacity to convey the design storms. Two alternatives were evaluated to address the identified deficiency. Two alternatives for each deficiency are described in the paragraphs and Figure 6-9 below.

- Alternative 1 (GW-2): Improve the existing detention pond in Heinie Huemann Park designed to pass the 25-year storm event. Improvements would include installing an outlet control structure at the southeast end of the park and construction of a berm on the south and west borders to prevent the detained volume from flowing onto S 16th Street or causing damage to the St. Helens Senior Center. Recommended improvements also include installing a sediment forebay to collect sediment and leaves from the oak trees throughout the park. Based on model calculations, the storage pond would need to have a peak storage of approximately 1.7 acre-feet to prevent upsizing pipes downstream.
- Alternative 2 (GW-2): Upsize the existing pipelines to 36 inches downstream of Heinie Huemann Park to discharge into a ditch south of Plymouth Street and east of S 13th Street.
- Alternative 1 (GW-3): Install a new pipeline to drain flows from S 8th Street to Plymouth Street and southwest along Plymouth Street to connect to an existing manhole at the S 10th Street Intersection Abandon the pipe segment through private property between South 8th Street and South 9th Street.
- Alternative 2 (GW-3): Upsize the existing pipeline from 12 inches to 18 inches for S 8th Street to Plymouth Street.

FIGURE 6-9: GREENWAY BASIN ALTERNATIVES



(GW-2): The two alternatives shown above are both potential solutions. Alternative 1 eliminates the need to upsize downstream pipes and the detention pond could provide aesthetic qualities to Henie Huemann Park as well as water quality functions. However, constructing a pond in the park could decrease usable space and increase maintenance requirements. Alternative 2 would provide the City with the option to realign the pipelines to reduce the length of pipe draining through private property as well as allow for piped to be moved away from existing structures. Alternative 2 would increase peak flows at the outfall but would not result in additional maintenance efforts or reduce usable space at Heinie Huemann Park.

(GW-3): Alternative 1 provides additional opportunity to capture stormwater runoff along Plymouth Street but would likely require installing curb and gutter along S 8th Street and Plymouth Street resulting in higher capital costs. Alternative 2 addresses pipes installed at lower than recommended minimum slopes and results in a slight reduction in pipe length to maintain. The pros and cons of the alternatives are summarized below in Table 6-4.

TABLE 6-4: GREENWAY BASIN ALTERNATIVES COMPARISON

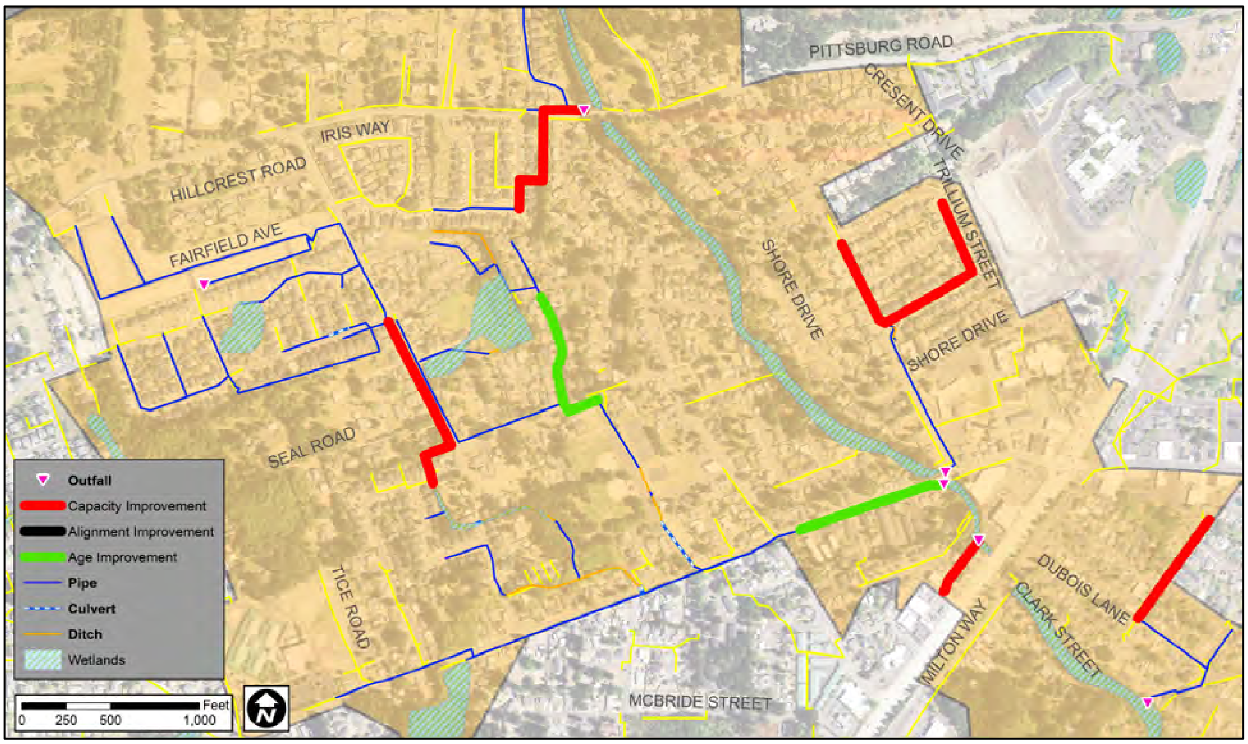
	GW-2		GW-3		
	Pros	Cons	Pros	Cons	Estimated Cost
Alternative 1	- Minimal pipe upsizing - Increased water quality - Opportunity for public park improvements	- Additional maintenance efforts - Reduced useable park area	- Additional opportunity to capture and convey runoff - Pipeline installed in right-of-way	- Additional curb and gutter recommended - Higher capital costs	$1,200,000
Alternative 2	- Lower Maintenance - Opportunity to adjust pipe alignment away from structures	- Higher capital costs - Replacement of relatively new pipe	- Less pipeline to maintain - Re-grade to recommended minimum pipe slopes	- Replacement of relatively new pipe - Construction through private property	$1,900,000

- Recommendation: Alternative 1 for GW-2 is recommended to address the deficiencies discussed above. Heinie Huemann Park is located at a strategic point in the Greenway Basin that would allow for storage to be provided, water quality to be improved, and impacts of stormwater downstream to be reduced. Neither alternatives will be recommended for GW-3 because the pipeline was recently installed to alleviate historical flooding in the area, which resolved the deficiency according to City staff. Therefore, no improvements are recommended at this time.

6.5 MILTON CREEK

Milton Creek Basin consists of multiple pipe networks which outfall into Milton Creek. Several pipe networks were identified as undersized and are recommended to be replaced with larger pipes. There are also two segments of existing pipe network that are recommended to be replaced because each are reaching the end of their useful life. The pipes recommended to be replaced or repaired are shown in Figure 6-10.

FIGURE 6-10: MILTON CREEK BASIN REPLACEMENT PIPES

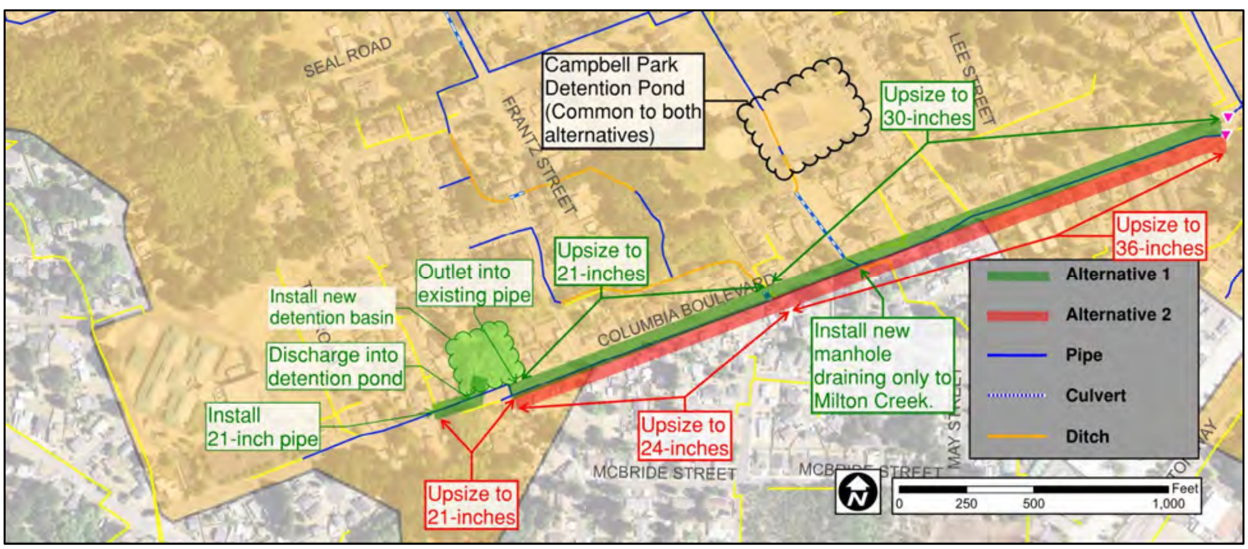


Milton Creek Basin provides opportunity for stormwater detention and storage in order to address the deficiencies not included in Figure 6-11. Two potential locations for stormwater detention were identified in this basin. The first location, Campbell Park, has already been identified by the City for a future detention pond and preliminary design of the pond is currently underway. The second location is north of Columbia Boulevard and east of Cherrywood Drive. An area south of the second location was identified by the City as a problem area because flooding occurs at the inlet to the trunkline along Columbia Boulevard. Improvements here could alleviate flooding at the inlet and reduce peak stormwater flows downstream in the trunkline.

Two alternatives were evaluated to address the deficiencies: one utilizes both the Campbell Park Detention Pond and the detention pond north of Columbia Boulevard and east of Cherrywood drive while the other alternative uses only Campbell Park to detain stormwater flows. Model calculations show the proposed detention pond at Campbell Park to be approximately 2.0 acre-feet and assumes a 0.65-acre footprint with two feet of water operating depth and an outlet structure. Pipelines installed in place of the existing ditch through Campbell Park are assumed to have the same slopes and invert elevations as the surveyed ditches. The alternatives are summarized below and illustrated in Figure 6-11.

- Alternative 1: Install a new 21-inch pipeline from Cherrywood Drive draining east and discharging off of Columbia Boulevard into a new storage pond north of Columbia Boulevard. Construct an outlet structure to drain into the existing trunkline and install an orifice to limit flows downstream. Upsize the downstream pipes on the south side of Columbia Boulevard to 21-inches from the new detention pond to the existing junction box at the intersection of Matzen Street and Columbia Boulevard. Upsize the pipes from the junction box to the outfall at Milton Creek to 30-inch pipes. Additionally, replace the existing junction box south of Campbell Park, where flows split between Milton Creek and McNulty Creek, with a manhole and then cap the pipe draining to McNulty Creek to alleviate downstream deficiencies in McNulty Creek Basin. Model calculations project the storage pond along Columbia Boulevard to be a similar approximate volume of 2.0 acre-feet with a 1.0-acre footprint, two feet of operating depth, and an orifice outlet structure. It is assumed the bottom of the detention pond is at least three feet below the road surface elevation and approximately equal to the existing invert elevation of the 18-inch pipeline crossing to the south of Columbia Boulevard. A detailed survey of this area is recommended to assess the actual natural storage volume and bottom of pond elevation. The open area south of Columbia Boulevard could be considered for additional detention if the proposed location does not provide sufficient storage. The detention pond should be designed to limit peak flows discharged to Milton Creek to be equal to the existing peak flows with the flow split.
- Alternative 2: Upsize the trunkline along Columbia Boulevard to 24-inch pipes from Cherrywood Drive to Matzen Street. Upsize the existing pipes from Matzen Street to the outfall at Milton Creek with 36-inch pipes. Similarly, install a new manhole at the flow split of Milton Creek Basin and McNulty Creek Basin then cap the pipeline draining south to McNulty Creek Basin.

FIGURE 6-11: MILTON CREEK ALTERNATIVES



Alternative 1 will add two additional detention ponds to the City's stormwater system requiring additional maintenance efforts. However, by installing these ponds, the City would be provided with opportunities to implement water quality features. Also, the pipes along Columbia Boulevard will not require as large of upsizing compared to alternatives without detention. Alternative 1 provides the City with an opportunity to upsize the existing pipelines using trenchless methods such as pipe bursting. Alternative 2 requires less long-term maintenance and does not add pipe length to the system. A summary of the pros and cons of the two alternatives is provided below in Table 6-5.

TABLE 6-5: MILTON CREEK ALTERNATIVES COMPARISON

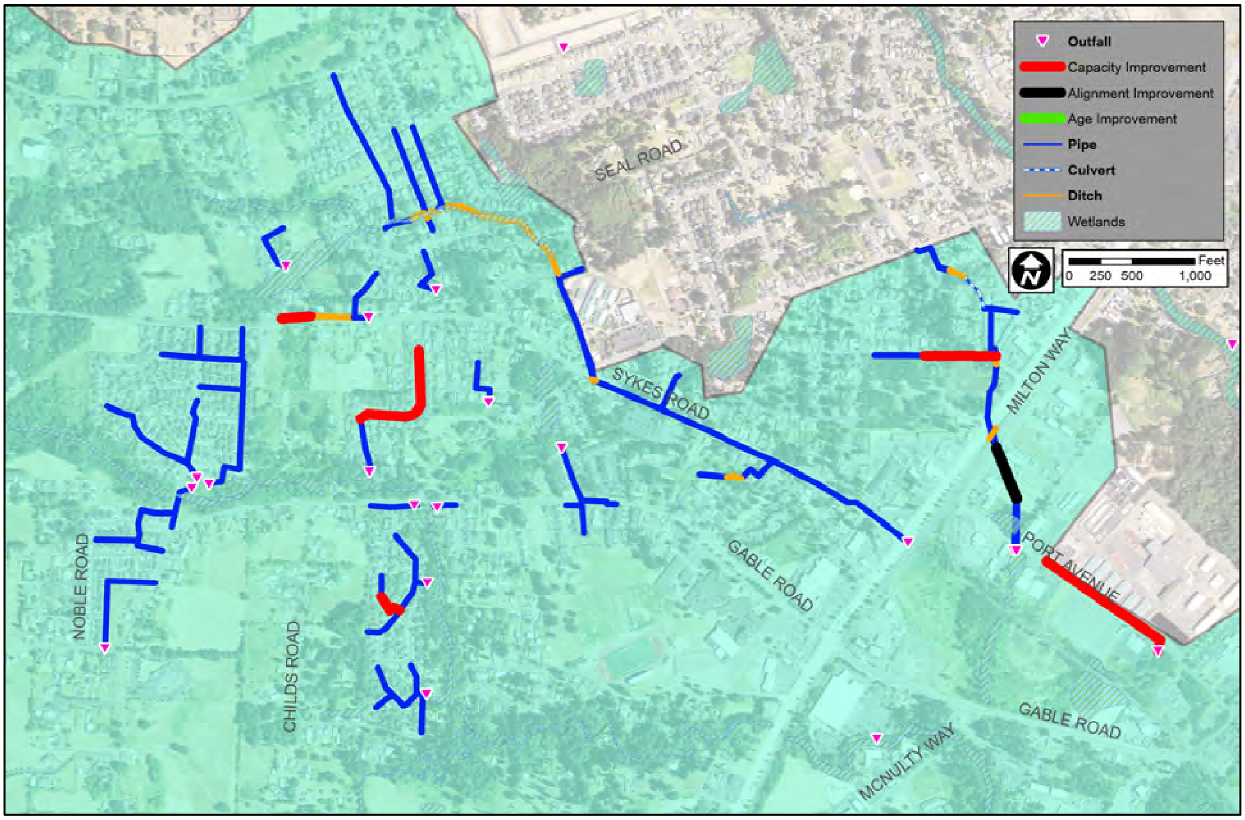
	Pros	Cons	Estimated Cost
Alternative 1	- Utilizes natural detention and wetlands - Increases water quality at Milton Creek - Alleviates flooding downstream in McNulty Creek Basin	- Requires acquisition of property to detain flows - Neighborhood impacts - Additional maintenance efforts	$3,500,000
Alternative 2	- Lower maintenance - Decreased need for additional environmental permitting	- More length of pipeline to be replaced - Higher capital costs	$3,600,000

► Recommendation: Alternative 1 provides options to complete both capacity and water quality improvements to the existing stormwater system. The available open area in the Milton Creek Basin is a unique part of the stormwater system and can be utilized using Alternative 1.

6.6 MCNULTY CREEK

McNulty Creek Basin has five locations with observed deficiencies recommended for upsized piping. Note, the flooding identified at the Columbia River Highway Ditch (MN-6) and between McBride Street and Columbia River Highway (MN-7) are alleviated based on the recommended alternative in Milton Creek Basin. No pipes were identified for replacement because of age, however, the trunkline along Sykes Road was installed in the 1980s and may need to be replaced or repaired in the next 10-15 years.

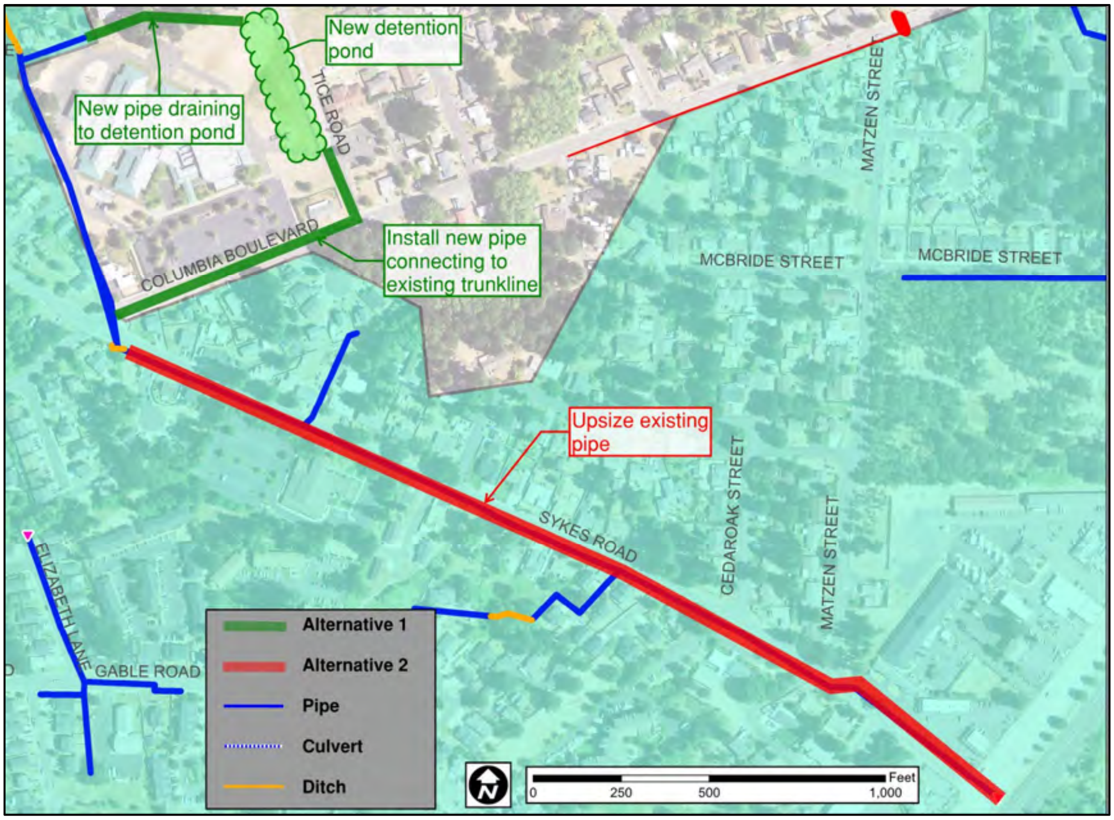
FIGURE 6-12: MCNULTY CREEK REPLACEMENT PIPES



There are several developments within McNulty Creek Basin with on-site detention facilities, however, deficiencies in the capacity of the Sykes Road trunkline were identified. An opportunity is present here to provide regional detention that would reduce peak flows through this trunkline. One of the alternatives described below outlines the installation of a regional detention facility at McBride Elementary School, which it is important to note how schools can be a strategic location to consider the construction of a detention pond as they are publicly owned and often have enough open space. Generally, ponds can be designed for multiple uses in these situations, so the school can still utilize the space during dry seasons. The second alternative would be to increase the capacity of the trunkline along Sykes Road. The two alternatives are described below and illustrated in Figure 6-13.

- ► Alternative 1: Reroute flows from the existing conveyance system at the intersection of Douglas Drive and Aubuchon Drive to a new detention pond at McBride Elementary School. Install new pipe draining south from McBride Elementary School to Columbia Boulevard. Install pipe draining west along Columbia Boulevard and connect it to the existing trunkline along Sykes Road.
- ► Alternative 2: Upsize the existing pipeline along Sykes Road to 30 inches from Columbia Boulevard to Mango Street. Upsize the remaining pipeline to 36 inches from Mango Street to the outfall.

FIGURE 6-13: MCNULTY CREEK ALTERNATIVES



Alternative 1 uses the open space at McBride Elementary school, providing detention, which mitigates the need to upsize the Sykes Road trunkline and also provides an opportunity to address water quality. However, the approximate volume required to alleviate surcharging and flooding is not likely feasible given the estimated footprint of the detention pond at the McBride Elementary School property. Alternative 2 provides the City with the opportunity to replace infrastructure reaching the end of its useful life. Additionally, upsizing the pipe could provide the City with opportunities to connect future stormwater networks to the trunkline. A summary of the pros and cons of the two alternatives is provided in Table 6-6.

TABLE 6-6: MCNULTY CREEK BASIN ALTERNATIVES COMPARISON

	Pros	Cons
Alternative 1	- Opportunities to increase water quality	- Additional maintenance efforts
Alternative 2	- Opportunties to connect to new trunkline - Replaces aged pipelines	- More length of pipeline to be replaced - Higher capital costs

- ► Recommendation: Alternative 12 is recommended because the approximate storage volume needed to alleviate flooding along Sykes Road without upsizing the pipes is not likely achievable at the McBride Elementary School proposed site location.

6.7 FUTURE INFRASTRUCTURE

The City identified anticipated growth areas in the 20-year planning period (Figures 6-14 and 6-15). Major basin boundaries were assessed with the proposed development locations to identify potential boundary modifications from development. Each of the future development locations identified by the City were reviewed and the area draining to the development property was delineated. The likely connection to the existing infrastructure or new outfall locations were identified for each of the developments and are shown by the black arrows in the figures below.

Figure 6-14 shows the identified development areas and the area draining onto the development property (white boundary) in the northern part of the City and UGB. The developments will not result in major basin boundary changes and the post-development flows will be routed to the nearest existing trunkline or a future outfall location if no existing trunklines are present. Development in the Houlton Business District (east of U.S. Highway 30 along Columbia Boulevard) could result in drainage boundary modifications. The Houlton Business District sits on the boundary of Milton Creek, Greenway, Middle Trunk, and North Trunk Basins. Depending on the details of the development, the flows could be routed to any one of the major basins listed. However, it is likely development on the north side of Columbia Boulevard will be routed to the North Trunk Basin while the development on the south side of Columbia Boulevard will be routed to either the Greenway or Middle Trunk Basin as shown in Figure 6-14.

FIGURE 6-14: FUTURE DEVELOPMENT BASINS (NORTH)

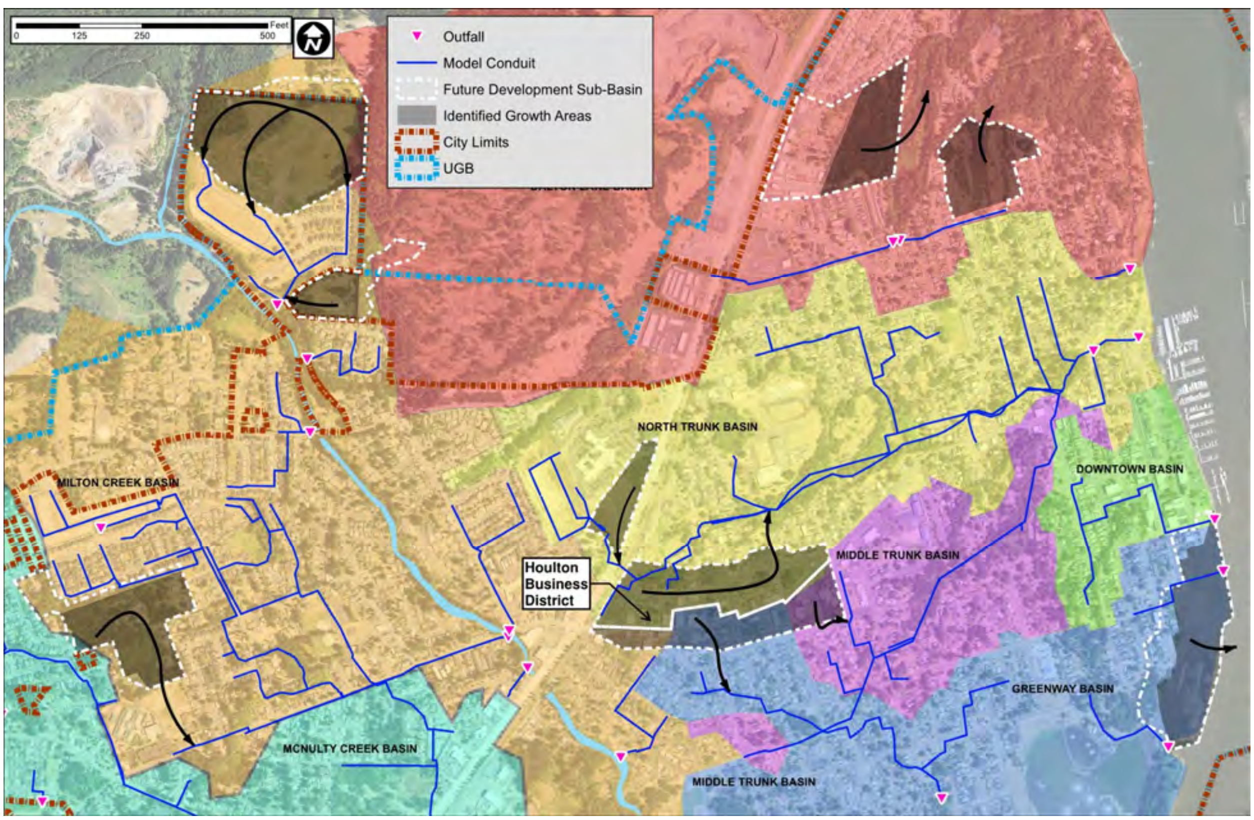
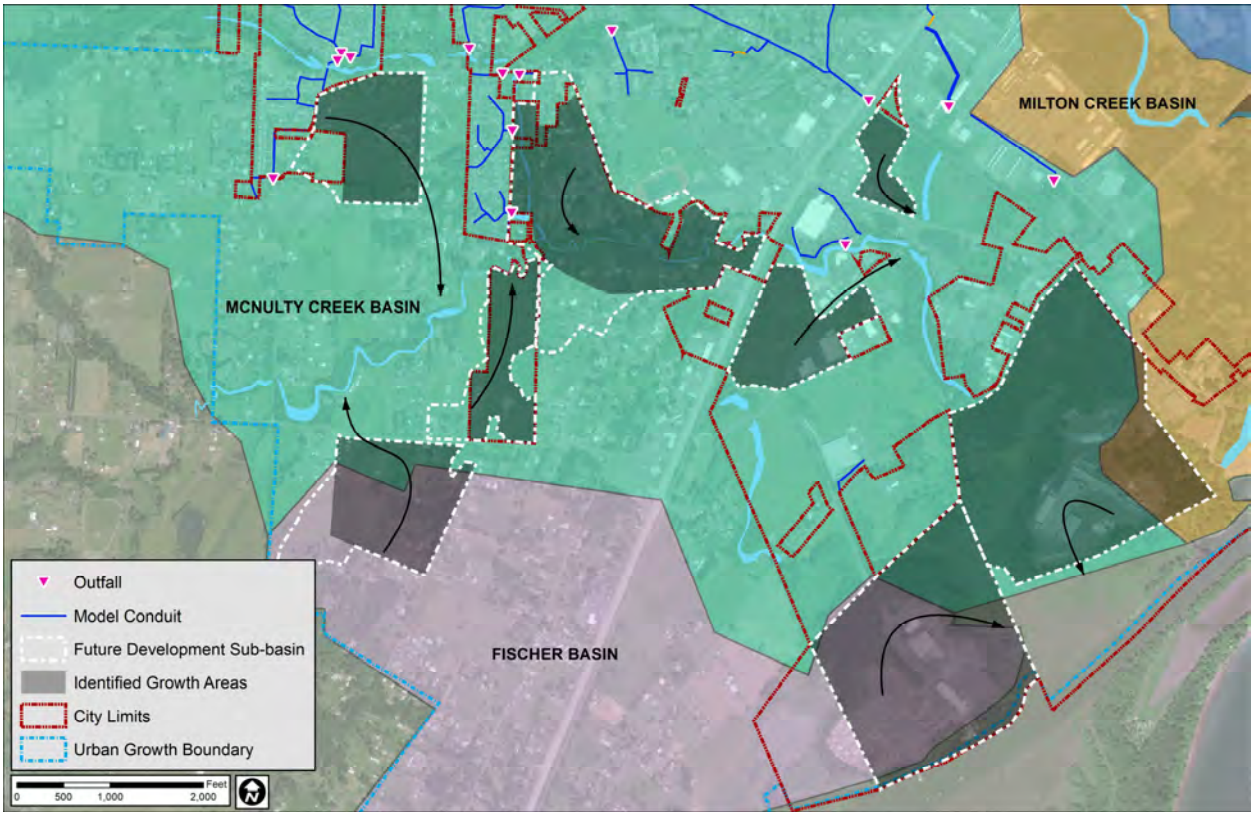


Figure 6-15 illustrates the future developments in the southern part of the City and UGB. The majority of developments shown below are in areas that lack existing stormwater infrastructure, and the developments will likely discharge to new outfalls. The boundary between McNulty Creek and Fisher Basin may be modified by the two developments located on the border of the two basins. Additionally, the industrial development on the border of Milton Creek and McNulty Creek Basin may adjust drainage basins as facilities are constructed.

FIGURE 6-15: FUTURE DEVELOPMENT BASINS (SOUTH)



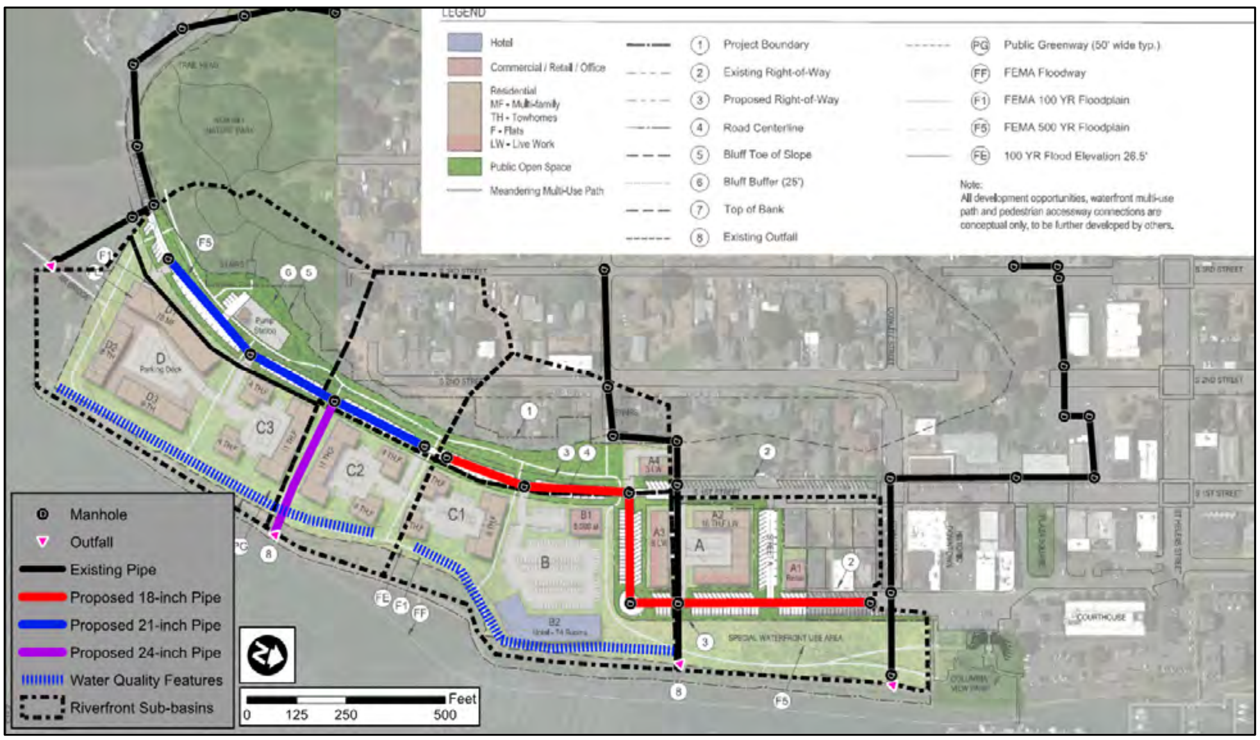
6.8 RIVERFRONT DEVELOPMENT

The Riverfront Development is a commercial and residential development property situated on the bank of the Columbia River. The conceptual layout of the development property is illustrated below in Figure 6-16. The property is divided into seven sub-basins, each ultimately draining to existing outfalls. The northern basins drain to an existing 20-inch trunkline which outfalls to the Columbia River and note that this existing pipe may need to be upsized. Further evaluation would be required during development planning and predesign. The southern sub-basins drain to an existing outfall of unknown diameter and elevation. The proposed pipe diameters and sub-basin boundaries are shown in Figure 6-16 (full size figure in Appendix A).

Curb and gutter should be installed on each side of Plymouth Street and South 1st Street to route runoff into the proposed trunklines. Catch basins should be installed at the corner of each of the major intersections and where appropriate in order to meet City design standards. The runoff from the impervious surfaces on the east side of Plymouth Street and S 1st Street should be captured by water quality conveyance features on the east side of the development while curb and gutter should be constructed to capture and direct flows to the proposed features. These water quality features limit the amount of overland flow discharging directly into the Columbia River and provides the ability to include water quality facilities before discharging to the river. These water quality facilities are to be designed and installed at the time of development and should be the responsibility of the developer. A significant portion of the development is located within the 100-year and 500-year floodplain. Based on contour information, the stormwater manhole rim elevations are below the fixed stage flood elevation of the Columbia River. As discussed in Section 4, the fixed stage flood elevation in the model is equal to the high-water mark measured from February 1996, which was described as an "extraordinary high-water event." For initial modeling and sizing purposes, the outfalls were assumed to be free flowing.

It is assumed the property will be developed in accordance with the City's development code regarding stormwater conveyance, treatment, and detention requirements and that the post-development flows for the design storm will not exceed the pre-development peak flows for the 10-year storm event. This would likely be achieved by installing detention facilities such as new detention basins with outlet control structures, underground detention piping, or other low impact development approaches. The Riverfront development area provides opportunities to address water quality upstream of the two existing outfalls. Water quality opportunities and requirements should be coordinated with the developer to achieve a mutually beneficial stormwater system for the new waterfront development.

FIGURE 6-16: RIVERFRONT DEVELOPMENT PROPOSED PIPE DIAMETERS



6.9 INDUSTRIAL BUSINESS PARK

The City's Industrial Business Park is situated along the Columbia River and has historically been used by industries for wood products (formerly the Boise White Paper, LLC mill operations site). The City has acquired the 225-acre property and is seeking new opportunities for the business park. Stormwater infrastructure should be planned for appropriately to implement effective and strategic facilities to manage runoff from the development.

There is an existing Stormwater Pollution Control Plan dividing the site into four quadrants (shown in Figure 6-17). Quadrant 1 does not contain any mill process area and drains to an outfall in the Multnomah Channel. There is reported to be a pipe from the bottom of the earthen dam at the end of the northeast wetlands in Quadrant 1 that connects to the main pipeline in the quadrant. Flows from this pipe are largely unquantified and should be evaluated for a complete assessment of the existing stormwater infrastructure capacity. The full contributing drainage area for the two main ditches in Quadrant 1 extend beyond the site boundary, and as a result, the full Greenway drainage basin area draining to the site should be included in the stormwater analysis. Quadrant 2 does not contain any mill process area and drains to an outfall in Milton Creek. Quadrants 3 and 4 are process areas and are treated onsite prior to discharging to the Columbia River.

Existing stormwater infrastructure is collected and conveyed through a series of ditches, catch basins, and stormwater pipes onsite. Majority of the stormwater pipe network is assumed to be privately owned, and the City will install new pipes within the proposed rights-of-way. Stormwater infrastructure was mainly modeled within the proposed right-of-way. The condition and suitability of existing private infrastructure should be evaluated further during the preliminary design stages. Stormwater pipe alignments were modeled based on the City's Industrial Park Industrial Business Parcellation plan and the proposed pipes are shown in Figure 6-18 below and in Figure 15 in Appendix A. A total of approximately 10,000 linear feet of trunklines ranging in size from 12-inches to 48-inches in diameter were modeled within the business park. The trunklines were modeled to convey the pre-development 25-year storm event runoff. A total of three new outfalls are proposed; One would drain a small area and discharge into Milton Creek. The second proposed outfall would drain Quadrant 3 and discharge into the Multnomah Channel. The third outfall would be near an unknown/private existing outfall draining the Greenway Basin, Quadrant 1, and Quadrant 4 and discharge into the Multnomah Channel. A significant portion of the development is located within the 100-year and 500-year floodplain. Based on contour information, ground elevations at the proposed stormwater manholes are below the fixed stage flood elevation of the Columbia River. For initial modeling purposes, the outfalls were assumed to be free flowing. This assumption should be re-evaluated at the predesign phases.

As shown below, some of the modeled sub-basins naturally drain away from any proposed right-of-way and drain directly into Milton Creek or into the Multnomah Channel. Developers will be responsible for complying with the City's design standards, including peak discharge flow rates and stormwater treatment prior to discharging into the waters. Stormwater treatment for future development could be handled by individual parcels or with a regional stormwater treatment facility. Providing a regional stormwater treatment facility could help facilitate proper and regular maintenance of stormwater facilities and make parcels more attractive to developers. A regional facility located near the waterfront would allow existing drainage patterns to be utilized without the addition of a stormwater pump station.

FIGURE 6-17: INDUSTRIAL BUSINESS PARK STORMWATER QUADRANTS

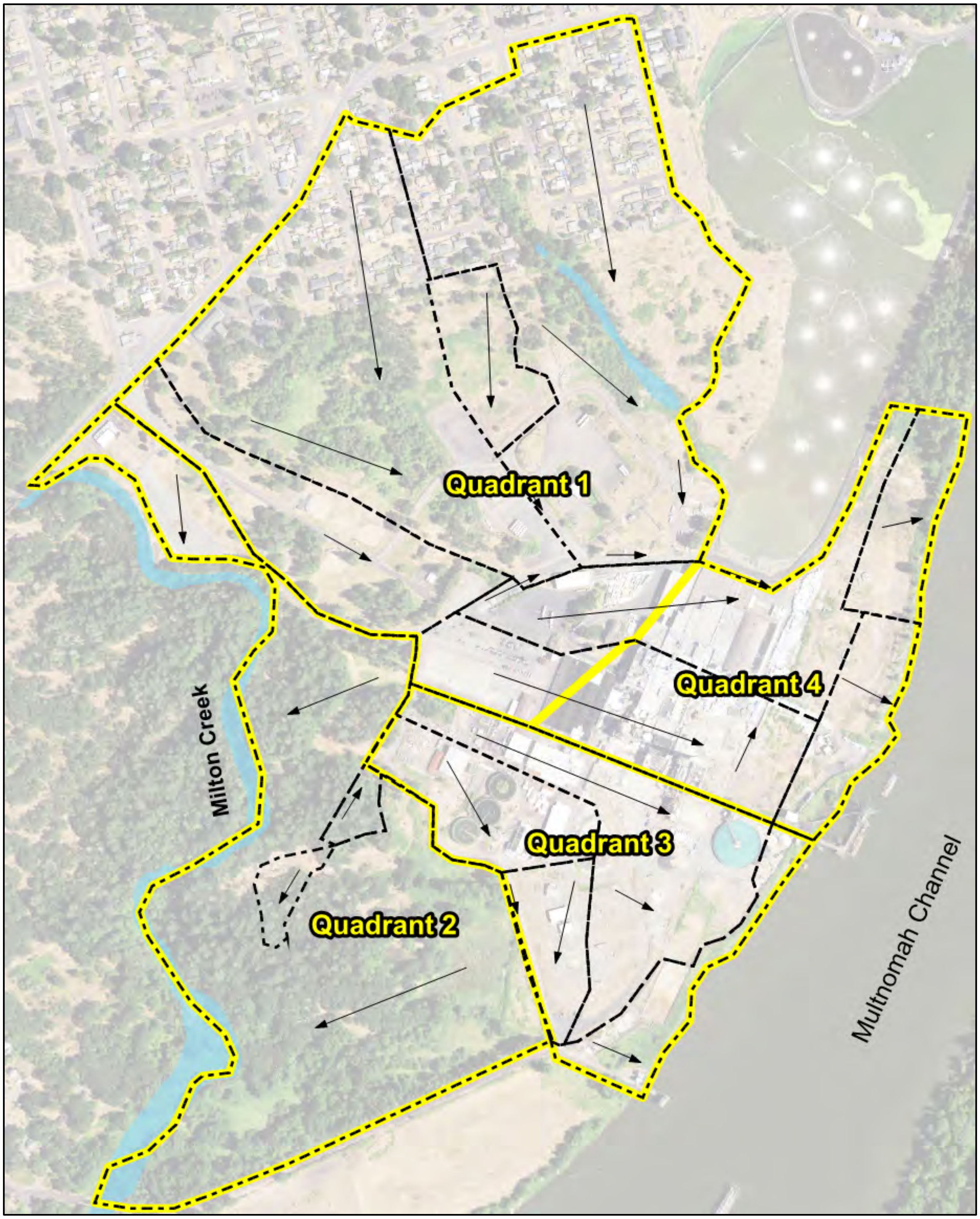
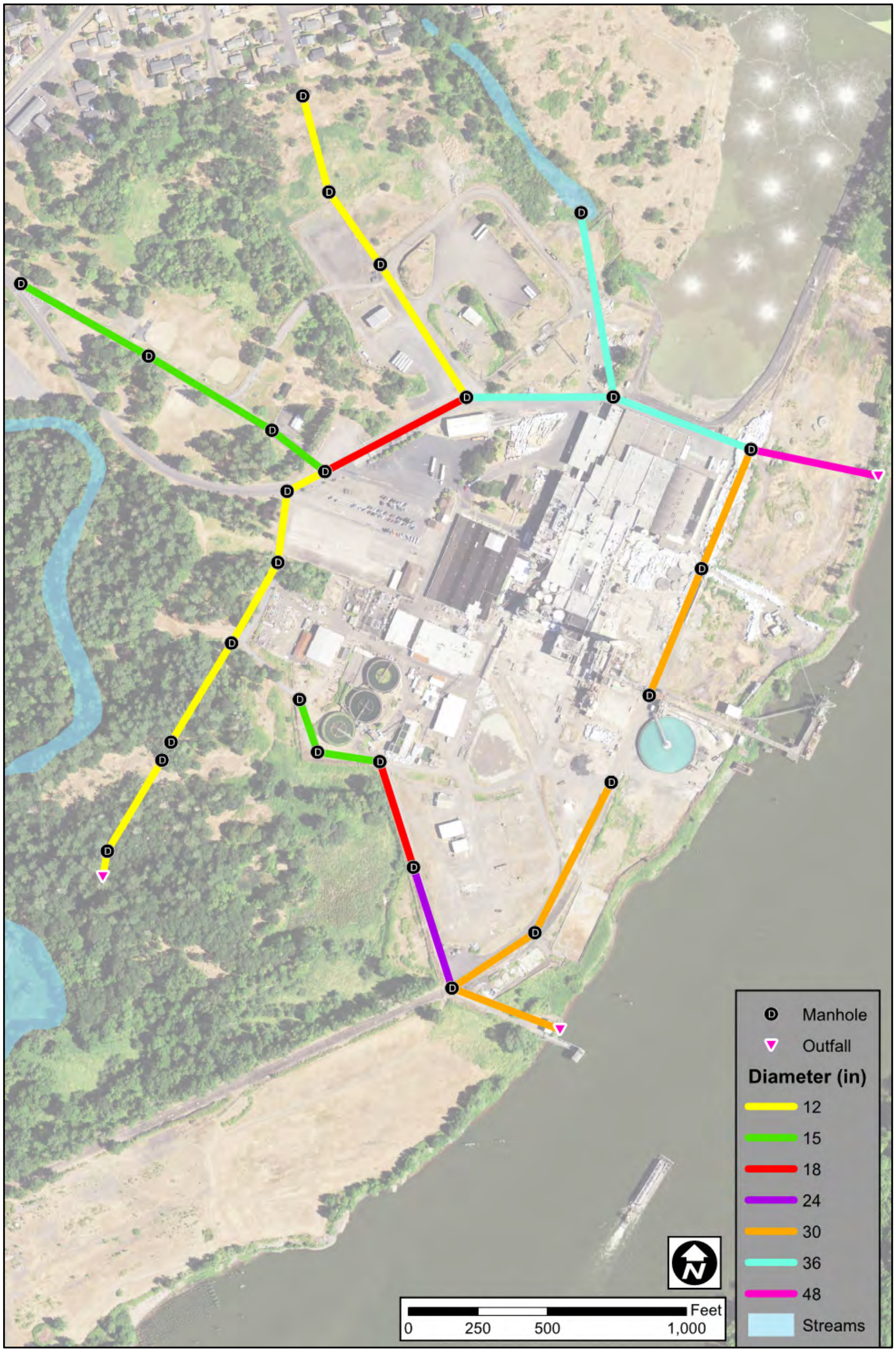


FIGURE 6-18: INDUSTRIAL PARK PROPOSED STORMWATER INFRASTRUCTURE



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SECTION 7 - ENGINEERING DESIGN STANDARDS AND COMPREHENSIVE PLAN

The City's existing development code (Title 17), engineering design standards (Title 18), and comprehensive plan (Title 19) were reviewed for new development as they pertain to stormwater conveyance and treatment to identify potential deficiencies and provide recommendations for updates.

7.1 ENGINEERING STANDARDS & COMPREHENSIVE PLAN REVIEW

The following documents were examined during this review effort.

- St. Helens Municipal Code (SHMC) Title 17 Community Development Code
- St. Helens Municipal Code (SHMC) Title 18 Engineering Standards Manual
- St. Helens Municipal Code (SHMC) Title 19 Comprehensive Plan

General observations and recommendations to update the City's policies and standards are summarized in the technical memorandum in Appendix F. The City should review the recommendations presented in the memo and assess if they agree with the proposed changes and additions to City Municipal Code, standards, and comprehensive plan. If the City agrees with some or all of the recommendations, the process to propose changes to the documents listed above should be initiated.

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SECTION 8 - CAPITAL IMPROVEMENT PLAN

This section summarizes recommended capital improvements with associated planning level cost estimates. Recommended improvements are illustrated in Figure 16 in Appendix A, and the details of each improvement are presented in Appendix H. This section also summarizes system development charge (SDC) eligibility of each of the projects and the annual operation and maintenance impacts for the proposed improvements.

8.1 BASIS FOR ESTIMATE OF PROBABLE COST

Capital costs developed for the recommended improvements are Class 4 estimates as defined by the Association for the Advancement of Cost Engineering (AACE). Actual construction costs may differ from the estimates presented, depending on specific design requirements and the economic climate when a project is bid. An AACE Class 4 estimate is normally expected to be within -50 and +100 percent of the actual construction cost. As a result, the final project costs will vary from the estimated presented in this document. The range of accuracy for a Class 4 cost estimate is broad, but these are typical accuracy levels for planning work.

The costs are based on experience with similar recent stormwater system improvement projects. Equipment pricing from manufactures of the flow measuring equipment items was also used to develop the estimates. The total estimated probable project costs include contractor markups and 30% contingencies, which is typical of a planning-level estimate. Overall project costs include total construction costs, costs for engineering design, permitting, construction management services, inspection, as well as administrative costs. For the system projects, the contractor's overhead and profit are worked into the line items.

8.2 SUMMARY OF COSTS (20-YEAR CIP)

The capital improvement plan (CIP) consists of improvements necessary to alleviate identified flooding and surcharging in the 25-year storm event. The projects identified in this study were prioritized by their urgency to mitigate the identified deficiencies. The prioritization criteria are shown in Table 8-1.

TABLE 8-1: CIP PRIORITIZATION CRITERIA

Priority	Criteria	Implementation Timeline
1	Alleviate historically known flooding identified by the City and some 2-year flooding.	0-5 Years
2	Alleviate additional 2-year flooding identified in the model or age identified replacement.	5-10 Years
3	Alleviate deficiencies identified in 10-year and 25-year storm events.	10-20 Years

8.2.1 PRIORITY 1 IMPROVEMENTS

Priority 1 improvements consist of areas where both the City and the model have identified flooding in storm events with lower recurrence intervals (e.g., 2-year storm event). These projects are recommended to be implemented within 0-5 years of the completion of this study.

Campbell Park Detention Pond (Milton Creek): 1A – Construct a new detention pond in Campbell Park with a footprint of approximately 0.65 acres and storage volume of 2.0 acre-feet. This results in approximately two feet of operating depth. An outlet structure should be installed to control the peak flows discharged downstream.

Columbia Boulevard Detention Pond (Milton Creek): 1B - Install a new 21-inch pipeline from Tice Road draining east and discharging off Columbia Boulevard to a new detention storage pond north of Columbia Road. Construct an outlet structure to drain into the existing trunkline and install an orifice to limit flows downstream. The storage pond should have a footprint of approximately 1-acre and storage volume of approximately 2.0 acre-feet. It is assumed the bottom of the detention pond is at least three feet below the road surface elevation and approximately equal to the existing invert elevation of the 18-inch pipeline crossing to the south of Columbia Boulevard. A detailed survey of this area is recommended to assess the actual natural storage volume and bottom of pond elevation. The open area south of Columbia Boulevard could be considered for additional detention if the proposed location does not provide sufficient storage.

Columbia Boulevard Upsize (Milton Creek): 1C- Upsize the pipes on the south side of Columbia Boulevard to 21-inches from the new detention pond (CIP Project 1C) to the existing junction box at the intersection of Matzen Street and Columbia Boulevard. Upsize the pipes from this junction box to the outfall at Milton Creek to 30-inch pipes. Additionally, replace the existing junction box south of Campbell Park where flows split between Milton Creek and McNulty Creek with a manhole and then cap the pipe draining to McNulty Creek to alleviate downstream deficiencies in McNulty Creek Basin.

Middle Trunk Detention Ponds and Piping: 1D – Utilize naturally occurring detention through the Middle Trunk Basin, and construct three new detention storage ponds along the existing stormwater pipe alignment from Cowlitz Street to S 4th Street. Storage 1 is located from Cowlitz Street to S 9th Street, Storage 2 is located from S 9th Street to S 8th Street, and Storage 3 is located from S 7th Street to S 4th Street. A berm should be constructed, or Storage 1 should be excavated down to protect the existing structures in the ravine. Storage 1 needs approximately 3 acre-feet of available volume. Install an outlet under S 9th Street from Storage 1 to Storage 2. Storage 2 needs a volume of approximately 3 acre-feet. Install a new pipe to drain water from Storage 2 to Storage 3. Additional efforts will likely be required to assess impact to any existing wetlands within the proposed storage locations. The project will likely include wetland delineation, permitting from USACE and DSL, and an analysis to show improvements will not damage the function of any existing wetlands. Storage 3 needs approximately 8 acre-feet of storage. Install an inlet to the existing 18-inch pipeline which drains to S 4th Street and Godfrey Park. A detailed survey of each of the proposed storage locations should be completed to assess the potential storage volume in each of the natural ravines.

Upsize and Realign Tualatin Street (Middle Trunk): 1E– The pipes in the Middle Trunk Basin from Tualatin Street to S 11th Street are currently shown in the GIS as draining underneath existing structures, and these pipes are also hydraulically undersized. This project assumes the pipes are underneath the structures and should be realigned, the true alignment of these pipes should be field verified. Abandon the existing 15-inch pipes and install new 36-inch pipes from the intersection of Tualatin Street and S 13th Street draining east and then north along S 11th Street where it discharges into the new natural detention off Cowlitz Street (CIP Project 2C). Install a new 12-inch pipe along S 13th Street to drain into the new 36-inch pipe along Tualatin Street.

Detention Pond and Piping Between N 12th Street and N 10th Street (North Trunk): 1F- Replace the existing 28-inch rectangular culvert with a 36-inch culvert or similar because the 28-inch culvert is reaching the end of its useful life and is hydraulically undersized. Install a flow control structure on the east side of N 15th Street to control the flow split between the Columbia Boulevard Trunkline and the Columbia Boulevard Ditch Network. The flow control structure will divert most of the flows to the Columbia Boulevard Ditch Network. This alternative utilizes open space and natural topography to construct a new detention storage in the area between N 12th Street and N 10th Street by installing a new flow control structure at the outlet culvert on the west side of N 10th Street. The purpose of this flow control structure is to detain water in the new detention pond and limit peak flows to the downstream network. The detention pond will need a storage volume of approximately 7 acre-feet. Note, a berm will likely need to be constructed at the northeast border of the pond to prevent stormwater from draining across the existing property within the ravine. The flows from the existing trunklines draining south along N 10th Street should be rerouted to discharge into the new detention pond, which would relieve flooding in the Columbia Boulevard Trunkline.

Replace Ridgeway Loop Ditch with Pipe: 1G – Install a new 12-inch pipe off of Ridgecrest Loop where an existing ditch/grassy swale flood adjacent property.

8.2.2 PRIORITY 2 IMPROVEMENTS

Priority 2 improvements include areas where flooding was identified in the model during the lower recurrence intervals (e.g., 2-year storm event) but the City has not historically seen flooding in yet. The following projects are recommended to be implemented within 5-10 years of this study.

Upsize Pipes along West Street and N 10th Street (North Trunk): 2A – Upsize the existing pipes along West Street from N 12th Street to the new detention pond along Columbia Boulevard (CIP Project 1A). There is an existing bottleneck from N 11th Street to N 10th Street where pipes go from 21-inches to 18-inches. This project replaces the 21-inch and 18-inch pipes with 30-inch pipes from N 12th Street to N 10th Street. The existing 24-inch pipe along N 10th Street should also be upsized to 30-inches and discharge into the new detention pond along Columbia Boulevard (CIP Project 1A). Some flow should be diverted away from the detention pond and into the existing 24-inch trunkline draining toward Godfrey Park.

S 4th Street to Outfall (Downtown): 2B – The pipes in the main Downtown Basin Trunkline are reaching the end of their useful life and should be inspected with CCTV to assess their condition. If the pipes show significant deterioration, the pipes should be replaced. CIP Project 3I should be considered if the condition assessment recommends that the pipes need to be repaired or replaced.

Heinie Huemann Park Detention Pond (Greenway): 2C – Improve the existing detention pond in Heinie Huemann Park to be capable of passing the 25-year storm event. Improvements would include installing an outlet control structure at the southeast end of the park and constructing a berm on the south and west borders of the park to prevent the detained volume from flowing onto S 16th Street or causing damage to the St. Helens Senior Center. Improvements should also include installing gates to catch debris and leaves from the oak trees throughout the park. Based on model calculations, the storage pond would need to have a peak storage of approximately 1.7 acre-feet to prevent upsizing pipes downstream. Any existing junction boxes downstream of Heinie Huemann Park should be replaced with standard manholes.

Upsize from S 20th Street to Heinie Huemann Park (Greenway): 2D – Upsize the existing 12-inch, 15-inch, and 18-inch pipes from S 20th Street and Cowlitz Street to Heinie Huemann Park. The upsized pipes should be 18-inches from S 20th Street to S 19th Street, 21-inches from S 19th Street to S 18th Street, and 30-inches from S 18th Street to Heinie Huemann Park. Replace any existing junction boxes along this trunkline with standard manholes.

Nob Hill Nature Park CIP lining (Greenway): 2E – The 48-inch pipes along Plymouth Street near the wastewater treatment plan have reached the end of their useful life. The pipes should be inspected to determine the actual conditions of the pipe. The pipes are likely submerged part of the year from the Columbia River water surface level. The brackish water from the Columbia River may increase the deterioration of the pipe.

Franz Street (Milton Creek): 2F – Install a new 18-inch pipe at the intersection of North Vernonia Road and Franz Street draining south along Franz Street and discharging on the east side of Alderwood Court in the ditch draining through Campbell Park. Divert flows from North Vernonia Road to this new pipe and away from the existing pipes along Edie’s Way.

Mayfair Drive CIP lining and Upsize (Milton Creek): 2G– The 12-inch pipe to the west of Mayfair Drive should be upsized to 18-inches and the pipe segment of 12-inch pipe along Mayfair Drive near Sherwood Drive should also be upsized to 18-inches. The existing 18-inch pipeline along Mayfair Drive from Sherwood Drive to Campbell Park has reached the end of its useful life and should be inspected to determine the actual condition of the pipe. CIP lining of this pipe needs to be completed if the inspection determines the pipe is in need of repairs.

Riverfront Development Stormwater Infrastructure: 2H – As discussed in Section 6, install approximately 3,000 LF of stormwater pipe to drain the proposed Riverfront Development. Pipe diameters range in size from 18-inches to 24-inches. See Section 6 and Figure 13 in Appendix A for pipe alignment.

Industrial Business Park Stormwater Infrastructure: 2I – As discussed in Section 6, install approximately 10,000 LF of stormwater pipe to drain the proposed Industrial Business Park. Pipe diameters range in size from 12-inches to 48-inches. See Section 6 and Figure 15 in Appendix A for pipe alignment.

S 16th Street to Old Portland Road Upsize (Greenway): 2J – Upsize the existing 12-inch and 15-inch pipes along S 16th Street to Old Portland Road to 18-inches and 21-inches.

Stormwater Master Plan Update: 2K – Update the stormwater master plan to re-assess needs and properly allocate budgets to address system deficiencies.

8.2.3 PRIORITY 3 IMPROVEMENTS

Priority 3 improvements include areas where flooding was identified in the model during the 10-year and 25-year storm event and where the City has not historically seen flooding. These projects are recommended to be completed within 10-20 years of this study.

Upsize N 13th Street to West Street (North Trunk): 3A – Upsize the existing 12-inch pipe along N 13th Street (north of West Street) to 21-inches.

Upsize from 6th Street Ball Park to N 10th Street (North Trunk): 3B – Upsize the existing 12-inch and 15-inch trunkline from 6th Street Park to N 10th Street. The pipes should be upsized to 18-inches from 6th Street Park to N 8th Street and upsize to 21-inches from N 8th Street to N 10th Street.

Upsize Milton Way at St. Helens Street (North Trunk): 3C – Upsize the pipes along Milton Way from 12-inches to 18-inches from Columbia Boulevard to north of St. Helens Street.

Upsize N 7th Street from Columbia Boulevard to Trunkline (North Trunk): 3D – Upsize the existing 12-inch pipes to 21-inches from the intersection of Columbia Boulevard and N 7th Street to the existing 36-inch trunkline draining to Godfrey Park.

Upsize N 4th Street south of West Street (North Trunk): 3E – Install new 15-inch pipes along N 4th Street between Lemont Street and West Street to drain localized ponding. Also install new 15-inch pipe along West Street and on N 5th Street (between West Street and Lemont Street) to drain the localized low point. The capacity of the downstream network should be evaluated further with the increased runoff, which would be captured by the new stormwater network. The existing 12-inch pipe network will likely need to be upsized along N 4th Street (south of West Street) to 18-inches along the outlet into Godfrey Park

Upsize and Regrade along S 14th Street (Middle Trunk): 3F – Upsize the existing 12-inch pipes along S 14th Street (south of Cowlitz Street) to 18-inches and re-install at recommended minimum slopes.

Upsize existing pipes from Heinie Huemann to Tualatin Street (Middle Trunk): 3G – Upsize the existing 12-inch pipes from Heinie Huemann Park to Tualatin Street with 15-inch pipes. Trenchless pipe installations, such as pipe bursting, could be considered here because the pipes are increasing only one nominal pipe size.

St. Helens Street to S 4th Street Upsizing (Downtown): 3H – Upsize the existing 12-inch trunkline to 18-inches from St. Helens Street and S 3rd Street to where the pipe increases to 24-inches along S 4th Street.

S 4th Street to Outfall Pipe Upsizing: 3I - Upsize the existing 24-inch pipes in the main Downtown Basin Trunkline from S 4th Street to the outfall off Strand Street because these pipes are undersized and cause flooding in the upstream pipe networks. Upsize the existing 12-inch and 18-inch pipes along Parkway, since the pipes are undersized, from Tualatin Street to between Cowlitz Street and St. Helens Way where pipes increase to 30-inches (CIP Project 2E).

Crouse Way Upsize (Milton Creek): 3J – Upsize the existing 16-inch pipes along Crouse Way to 18-inches. Trenchless pipe installation could be considered for this upsizing. Upsize the existing 18-inch pipe to 21-inches along S 22nd Street from Crouse Way to Cowlitz Street.

Eilertson Street (Milton Creek): 3K – Upsize the existing 8-inch pipes off Eilertson Street (near Little Street) to 12-inches and connect to the existing 12-inch pipes.

N Vernonia Road from Oakwood Drive to Ava Court (Milton Creek): 3L – Upsize the existing 15-inch pipes to 18-inches along N Vernonia Road from Oakview Drive to the recently upsized 18-inch pipes (south of Ava Court). Trenchless pipe installation could be considered for this upsizing.

Ethan Lane Upsizing (Milton Creek): 3M – Upsize the existing 18-inch pipe to 21-inches along Ethan Lane from Jakobi Street to Sykes Road. Trenchless pipe installation could be considered for this upsizing.

Sunset Boulevard. to Outfall Upsize (Milton Creek): 3N – Upsize the existing 15-inch and 18-inch pipes to 21-inches along Sunset Boulevard from Salmon Street to the outfall near Sykes Road. The 18-inch pipes along Sunset Boulevard were surveyed at an adverse grade, so the upsized pipes should be installed at minimum recommended pipe slopes.

Sunset Boulevard, Trillium Street and Salmon Street upsize (Milton Creek): 3O – Upsize the existing 12-inch pipe to 15-inches along Sunset Boulevard from Red Cedar Street to Salmon Drive. Also, upsize the existing 12-inch pipes along Trillium Street and Salmon Street to 15-inches. Trenchless pipe installations could be considered for this project.

Sykes Road. Upsize from Columbia Boulevard to Outfall (McNulty Creek): 3P – Upsize the existing 24-inch trunkline along Sykes Road to 30-inches from Columbia Boulevard to the outfall south of Highway 30.

McBride Street Upsize (McNulty Creek): 3Q – Upsize the existing 12-inch pipe along McBride Street (east of Matzen Street) to the existing 30-inch pipeline draining south toward Highway 30.

Port Ave. Upsize (McNulty Creek): 3R – Upsize the existing pipes along Port Avenue to 15-inches and 21-inches to the outfall.

Whitetail Avenue Upsize (McNulty Creek): 3S – Upsize the existing 12-inch pipe to 18-inches along Whitetail Avenue (southwest of Archer Drive) to the outfall.

Sykes Road Culvert near Mountain View Drive Upsize (McNulty Creek): 3T – Upsize the existing 12-inch pipe along Sykes Road (east of Mountain View Drive) to 15-inches.

A summary of the recommended improvements and associated capital costs are organized by priority in Table 8-2. Planning level cost estimates were developed using 2021 dollars. A detailed summary sheet for each improvement is provided in Appendix H.

TABLE 8-2: CAPITAL IMPROVEMENT PLAN

Priority	Project Description	Estimated Cost	SDC Eligibility	SDC Improvement Amount	City Amount
Priority 1 Improvements					
1A	Campbell Park Detention Pond (Milton Creek)	$300,000	0%	$0	$300,000
1B	Columbia Boulevard Detention Pond (Milton Creek)	$1,100,000	66%	$727,000	$373,000
1C	Columbia Boulevard Upsize (Milton Creek)	$2,800,000	14%	$392,000	$2,408,000
1D	Middle Trunk Detention Ponds and Piping	$2,000,000	5%	$103,000	$1,897,000
1E	Upsize and Realign Tualatin Street (Middle Trunk)	$5,000,000	14%	$677,000	$4,323,000
1F	Detention Pond and Piping Between N 12th and N 7th Street (North Trunk)	$1,600,000	17%	$269,000	$1,331,000
1G	Ridgeway Loop Pipe Installation	$60,000	0%	$0	$60,000
	Total Priority 1 Improvement Costs	$12,900,000	-	$2,200,000	$10,700,000
Priority 2 Improvements					
2A	Upsize Pipes along West Street and N 10th Street (North Trunk)	$1,400,000	0%	$0	$1,400,000
2B	S 4th Street to Outfall CCTV Inspection (Downtown)	$20,000	0%	$0	$20,000
2C	Heinie Huemann Park Detention Pond (Greenway)	$200,000	26%	$52,000	$148,000
2D	Upsize from S 20th Street to Heinie Huemann Park (Greenway)	$1,100,000	29%	$318,000	$782,000
2E	Nob Hill Park CIP lining (Greenway)	$400,000	0%	$0	$400,000
2F	Franz Street (Milton Creek)	$400,000	0%	$0	$400,000
2G	Mayfair Drive CIP lining and Upsize (Milton Creek)	$400,000	0%	$0	$400,000
2H	Riverfront Development Stormwater Infrastructure	$3,300,000	100%	$3,300,000	$0
2I	Industrial Business Park Stormwater Infrastructure	$8,600,000	100%	$8,600,000	$0
2J	S 16th Street to Old Portland Road Upsize (Greenway)	$500,000	0%	$0	$500,000
2K	Stormwater Master Plan Update	$200,000	0%	$0	$0
	Total Priority 2 Improvement Costs	$16,500,000	-	$12,300,000	$4,100,000
Priority 3 Improvements					
3A	Upsize N 13th Street to West Street (North Trunk)	$200,000	0%	$0	$200,000
3B	Upsize from 6th Street Ball Park to N 10th Street (North Trunk)	$900,000	0%	$0	$900,000
3C	Upsize Milton Way at Street Helens Street (North Trunk)	$600,000	75%	$450,000	$150,000
3D	Upsize N 7th Street from Columbia Boulevard to Trunkline (North Trunk)	$400,000	0%	$0	$400,000
3E	Upsize N 4th Street south of West Street (North Trunk)	$1,400,000	0%	$0	$1,400,000
3F	Upsize and Regrade along S 14th Street (Middle Trunk)	$600,000	50%	$298,000	$302,000
3G	Upsize existing pipes from Heinie Huemann to Tualatin Street (Middle Trunk)	$400,000	0%	$0	$400,000
3H	Street Helens Street to South 4th Street Upsizing (Downtown)	$500,000	0%	$0	$500,000
3I	S 4th Street to Outfall Pipe Upsizing (Downtown)	$2,400,000	0%	$0	$2,400,000
3J	Crouse Way Upsize (Milton Creek)	$1,000,000	14%	$137,000	$863,000
3K	Eilertson Street (Milton Creek)	$100,000	0%	$0	$100,000
3L	N Vernonia Road from Oakwood to Ava Court (Milton Creek)	$400,000	0%	$0	$400,000
3M	Ethan Lane Upsizing (Milton Creek)	$600,000	0%	$0	$600,000
3N	Sunset Boulevard to Outfall Upsize (Milton Creek)	$800,000	0%	$0	$800,000
3O	Sunset Boulevard, Trillium Street and Salmon Street upsize (Milton Creek)	$1,100,000	0%	$0	$1,100,000
3P	Sykes Road Upsize from Columbia Boulevard to Outfall (McNulty Creek)	$2,700,000	0%	$0	$2,700,000
3Q	McBride Street Upsize (McNulty Creek)	$600,000	0%	$0	$600,000
3R	Port Avenue Upsize (McNulty Creek)	$900,000	0%	$0	$900,000
3S	Whitetail Avenue Upsize (McNulty Creek)	$800,000	0%	$0	$800,000
3T	Sykes Road Cuvert near Mountain View Drive Upsize (McNulty Creek)	$80,000	0%	$0	$80,000
	Total Priority 3 Improvement Costs	$16,500,000	-	$900,000	$15,600,000
	Total Capital Improvement Costs	$45,900,000	-	$15,400,000	$30,400,000

The cost estimate herin is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Keller Associates has no control over variances in the cost of labor, materials, equipment, services provided by others, contractor's methods of determining prices, competitive bidding or market conditions, practices, or bidding strategies. Keller Associates cannot and does not warrant or guarantee that proposals, bids, or actual construction costs will not vary from the cost presented herein.

8.3 SYSTEM DEVELOPMENT CHARGES

The City of St. Helens establishes stormwater SDCs per Resolution 1796 effective August 2017. The current improvement SDCs for single family residences, duplexes, non-residential, and commercial developments are based every 2,500 square feet of impervious surface area. The current SDC amount per 2,500 square feet of impervious surface is $821.

The proposed improvement projects were allocated a percentage of the total cost that is eligible for funding by collected SDC funds. Each capital improvement project that will service areas identified by the City as anticipated growth within the 20-year planning period were reviewed. The SDC improvement amount is based on the percentage of future development area within the capital improvement's contributing drainage basin. The SDC eligibility for each project is summarized in Table 8-2.

8.4 PLANNING RECOMMENDATIONS

It is recommended that the City update their planning documents every five years because updates to the planning documents and models allow the City to re-assess needs, priorities, and properly allocate budgets to address system deficiencies. A Master Plan Update for the stormwater system has been included as a Priority 2 improvement in the CIP with an estimated cost of $200,000.

8.5 OTHER ANNUAL COSTS

The stormwater conveyance system requires regular maintenance to ensure that pipelines, catch basins, and detention facilities flow freely during the storm events. Additional stormwater facilities continue to age and will eventually need to be rehabilitated or replaced. The sections below summarize recommended maintenance as well as replacement activities and budgets.

8.5.1 MAINTENANCE PROGRAM AND STAFFING

The recommended level of service, O&M, and staffing for the stormwater system is summarized in Section 5. As discussed in Section 5, it is estimated that approximately 4.25-4.5 FTE are needed to meet the recommended level of O&M to meet the City's LOS goals. As budgeted, the existing stormwater FTE staff appears to be adequate. However, the additional projects and work the PW Operations staff are currently requested to complete significantly decreases the budgeted FTE that can be spent on stormwater O&M. It is recommended that either additional FTE be budgeted for the PW Operations staff to complete the extra workload requested, or the responsibilities of the PW Operations staff be reduced to focus solely on utility O&M. In addition, the recommended CIP projects would increase workload of the engineering division. The engineering division may need additional staff to update and maintain the GIS database, coordinate CCTV inspection and resulting work orders, and manage capital improvements. Additional workload on the engineering and PW operations divisions should be included in planning for any of the recommended improvements and projects. Generally, it is advised that staffing needs be reevaluated every two to three years.

8.5.2 STORMWATER REPLACEMENT PROGRAM

In addition to regular maintenance, it is suggested that an annual pipeline replacement program be established because stormwater infrastructure and rehabilitation needs will only increase as the stormwater conveyance system ages.

The replacement program is based on the total amount of existing City stormwater infrastructure and its estimated useful life. The City facilities include approximately 45 miles of storm pipes, 800 manholes, and 1,500 catch basins. Assuming an average useful life of 75-years remaining life, the replacement program should target approximately 3,000 feet of pipe, 30 catch basins, and 16 manholes per year. Assuming an average pipe replacement cost of $190 per foot, a catch basin cost of $3,500 each, and a manhole cost of $11,000, the City would need an annual replacement budget of approximately $900,000. Table 8-3 summarizes the annual replacement program targets and associated costs.

TABLE 8-3: SUMMARY OF ANNUAL REPLACEMENT COSTS

Item	Lifespan	Total Quantity	Annual Cost[1] (rounded)
Lineal Feet of Storm Lines	75 Years	237,000	$600,000
Number of Catch Basins	50 Years	1,500	$110,000
Number of Manholes	50 Years	800	$180,000
		Total (Rounded)	$900,000

1) Storm pipes unit price equal to average unit price of 12" to 30". Manhole unit price equal to average of 48" and 60" manhole.

Additionally, as part of the City's maintenance program, the locations indicated in Section 5 as being located underneath existing structures should be investigated and abandoned if it is determined the pipes, are beneath existing structures.

8.6 OTHER FINANCIAL CONSIDERATIONS

The City is recommended to complete a full-rate study for the stormwater utility to evaluate the potential user rate and SDC impacts of the recommended CIP. Estimated SDC eligibility for each identified capital improvement is included in Table 8-2 for use in completing a full rate study. The City is advised to actively pursue opportunities for grant funds, low-interest loans, or principal forgiveness funding sources to mitigate user rate impacts. As the City begins to prepare and proceed on CIP projects, if outside funding is desired, it is recommended the City setup a one-stop meeting with Business Oregon to identify and assess potential funding sources for the stormwater projects. Another funding source for the City to explore is the federal-state partnership Clean Water State Revolving Fund (CWSRF).

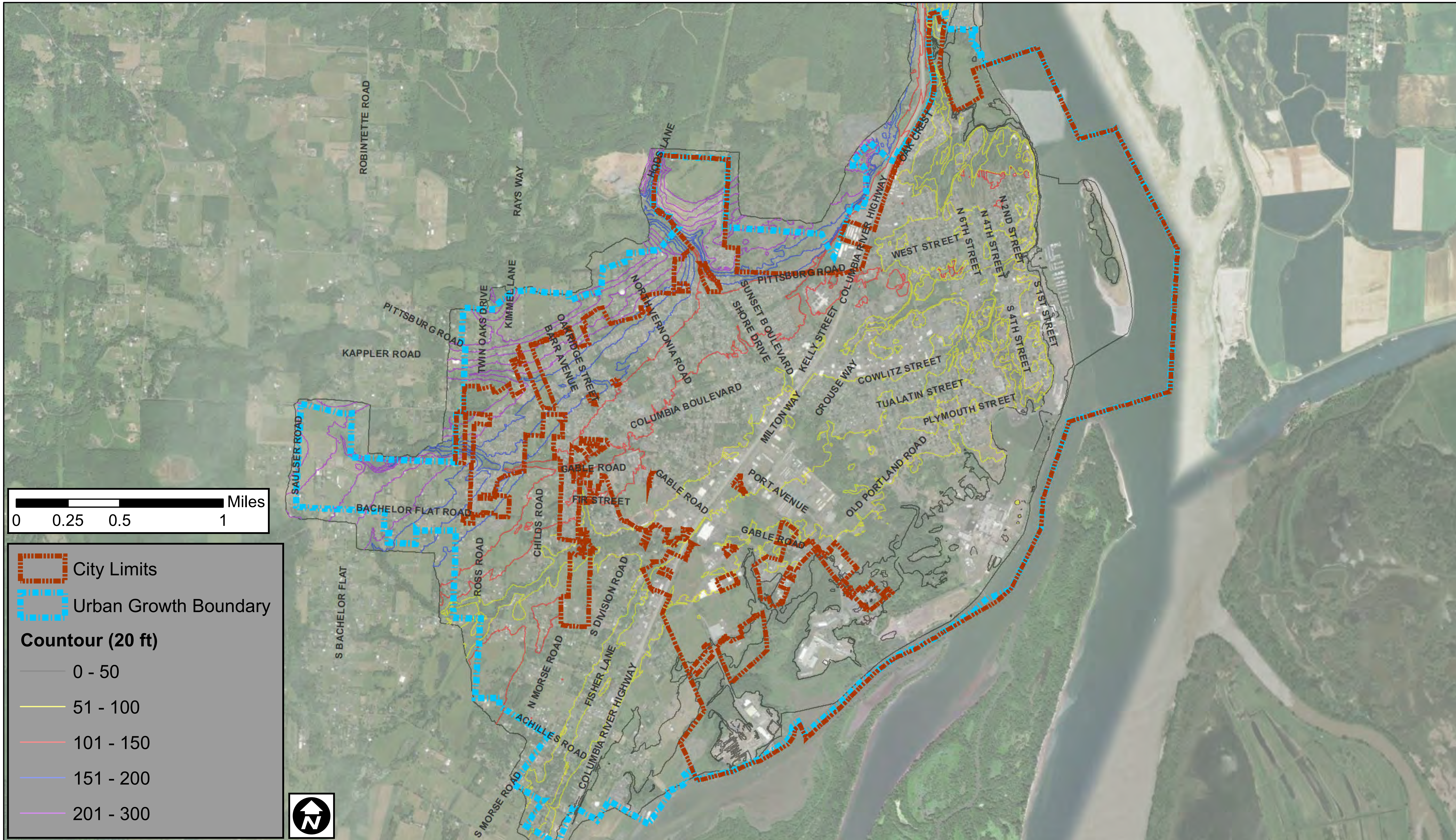
APPENDIX A

Figures

KELLER ASSOCIATES

LIST OF FIGURES

KELLER ASSOCIATES



KELLER ASSOCIATES

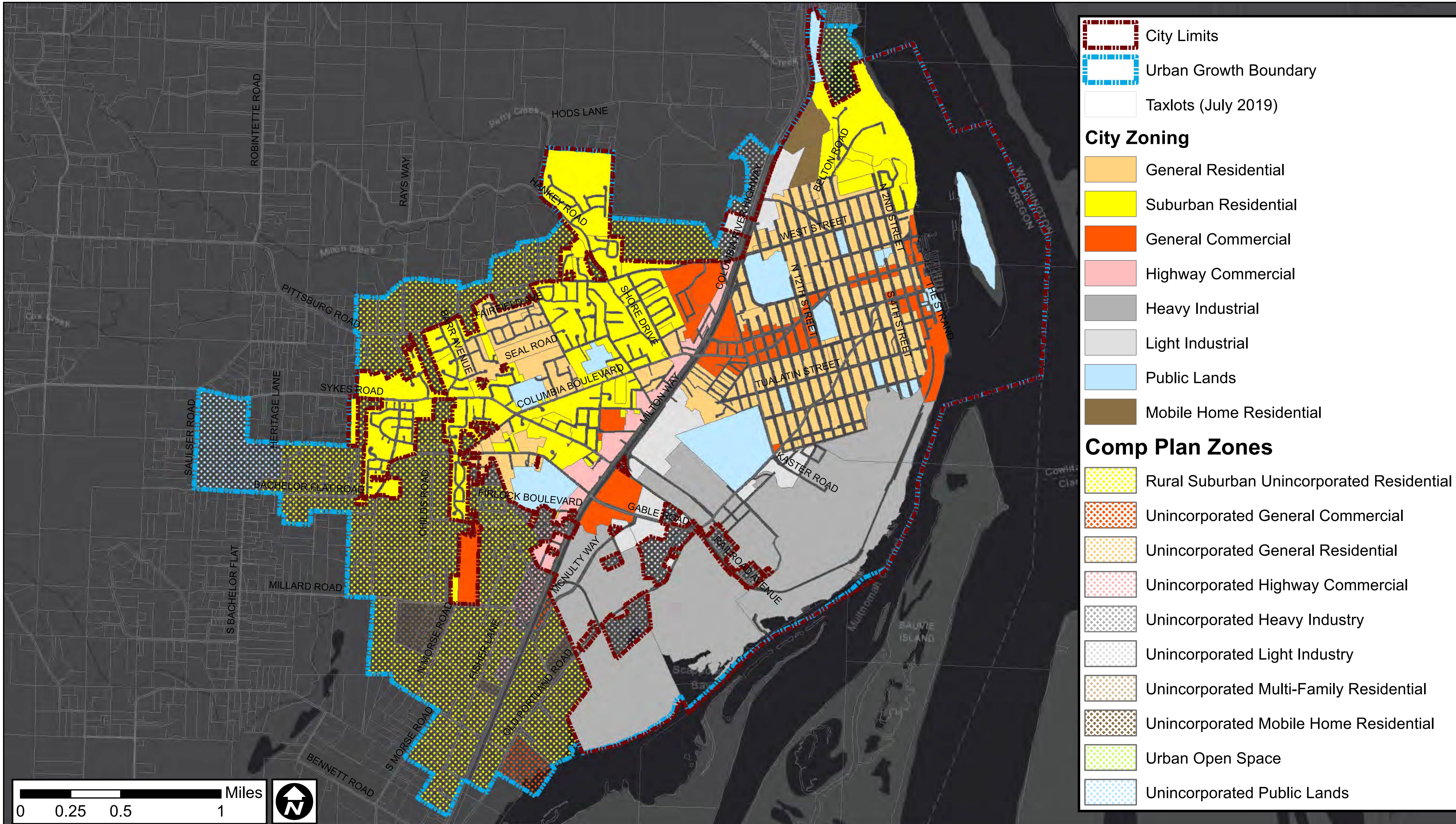
City Limits, UGB, and Topography

Stormwater Master Plan

City of St. Helens
FOUNDED 1850
Oregon

Figure 1

City of St. Helens



KELLER ASSOCIATES

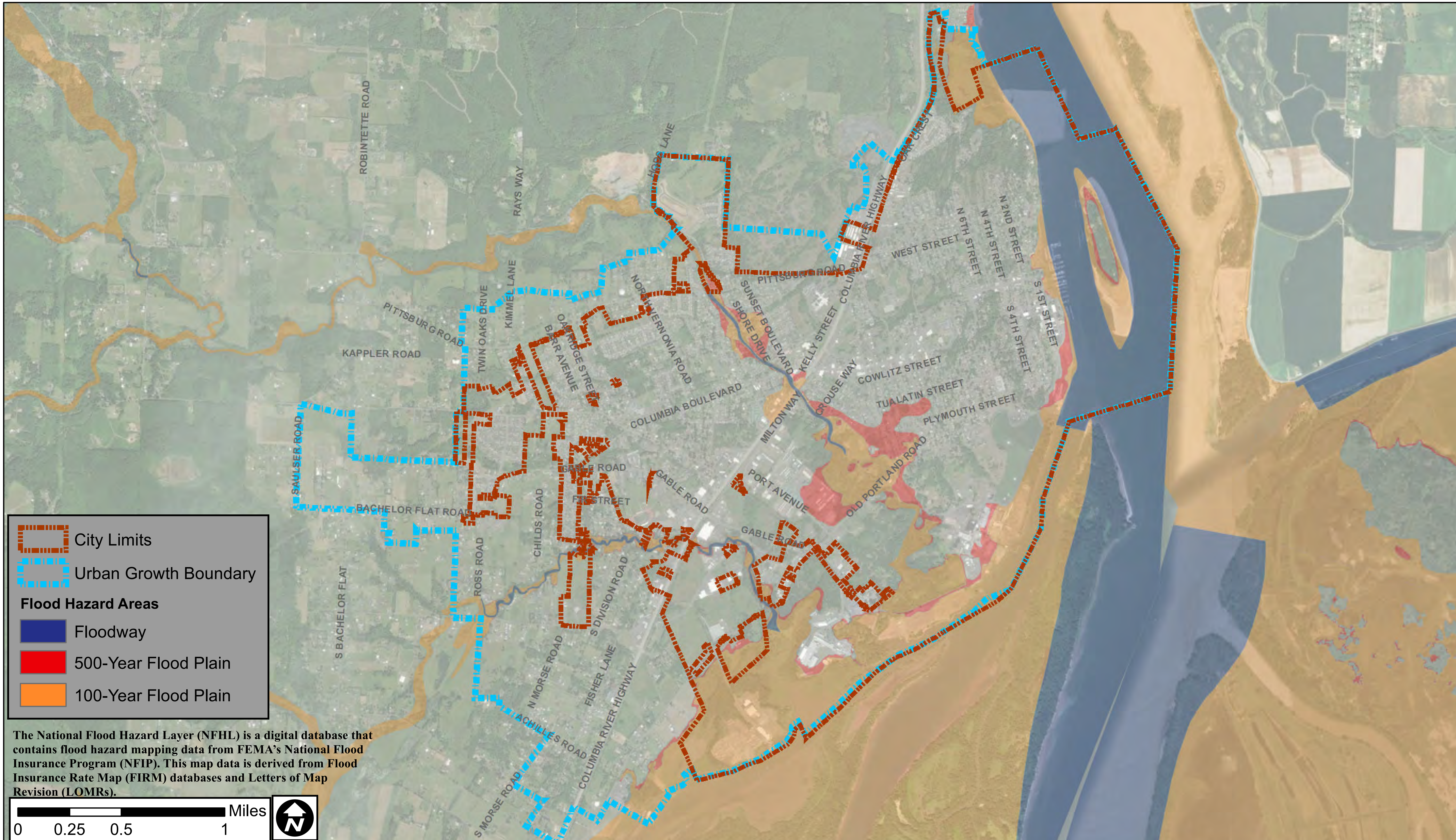
Zoning

Stormwater Master Plan

City of St. Helens Founded 1850 Oregon

Figure 2

City of St. Helens

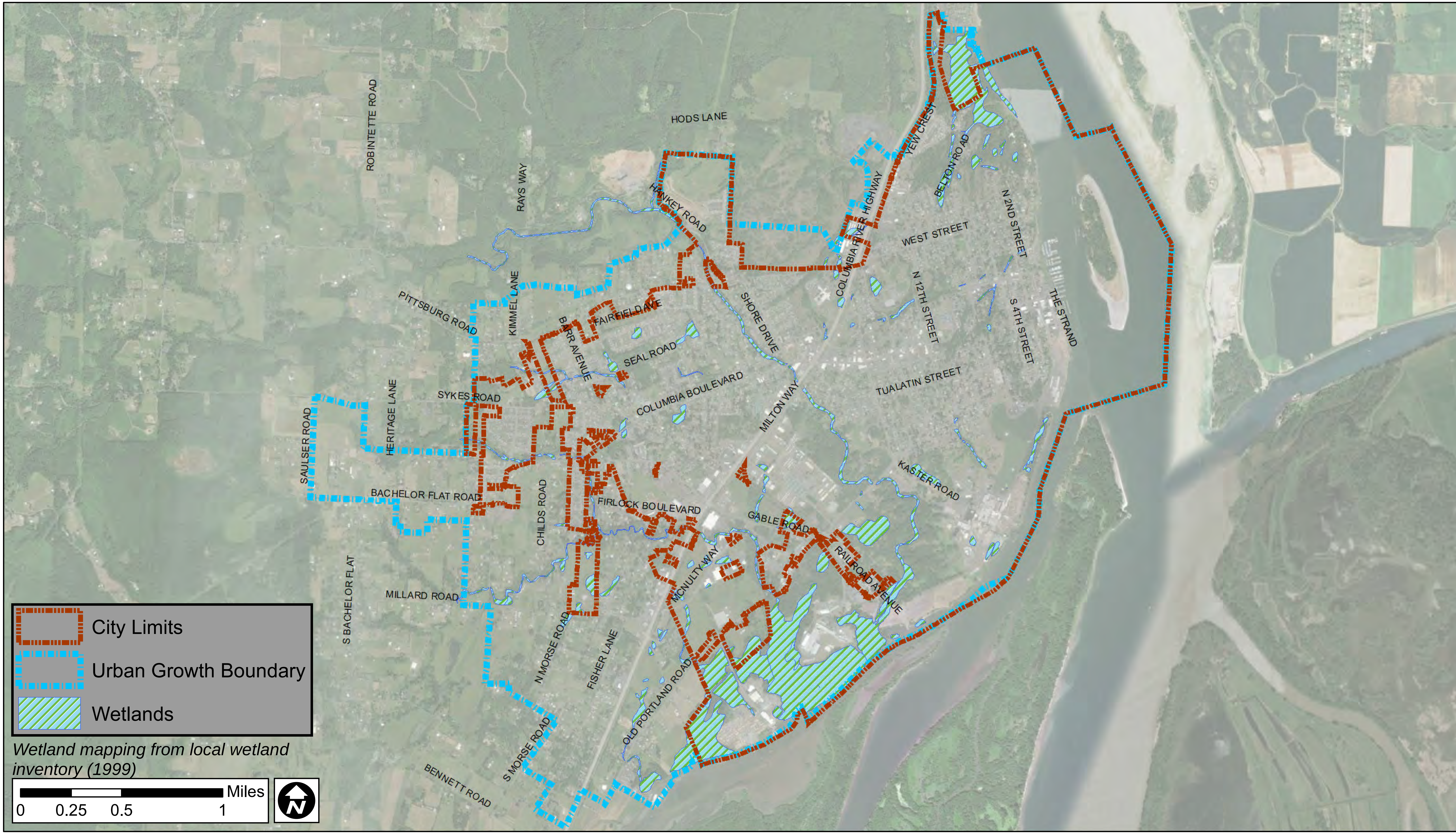


Flood Hazard Zones

Stormwater Master Plan

Figure 3

City of St. Helens



Wetlands

Stormwater Master Plan

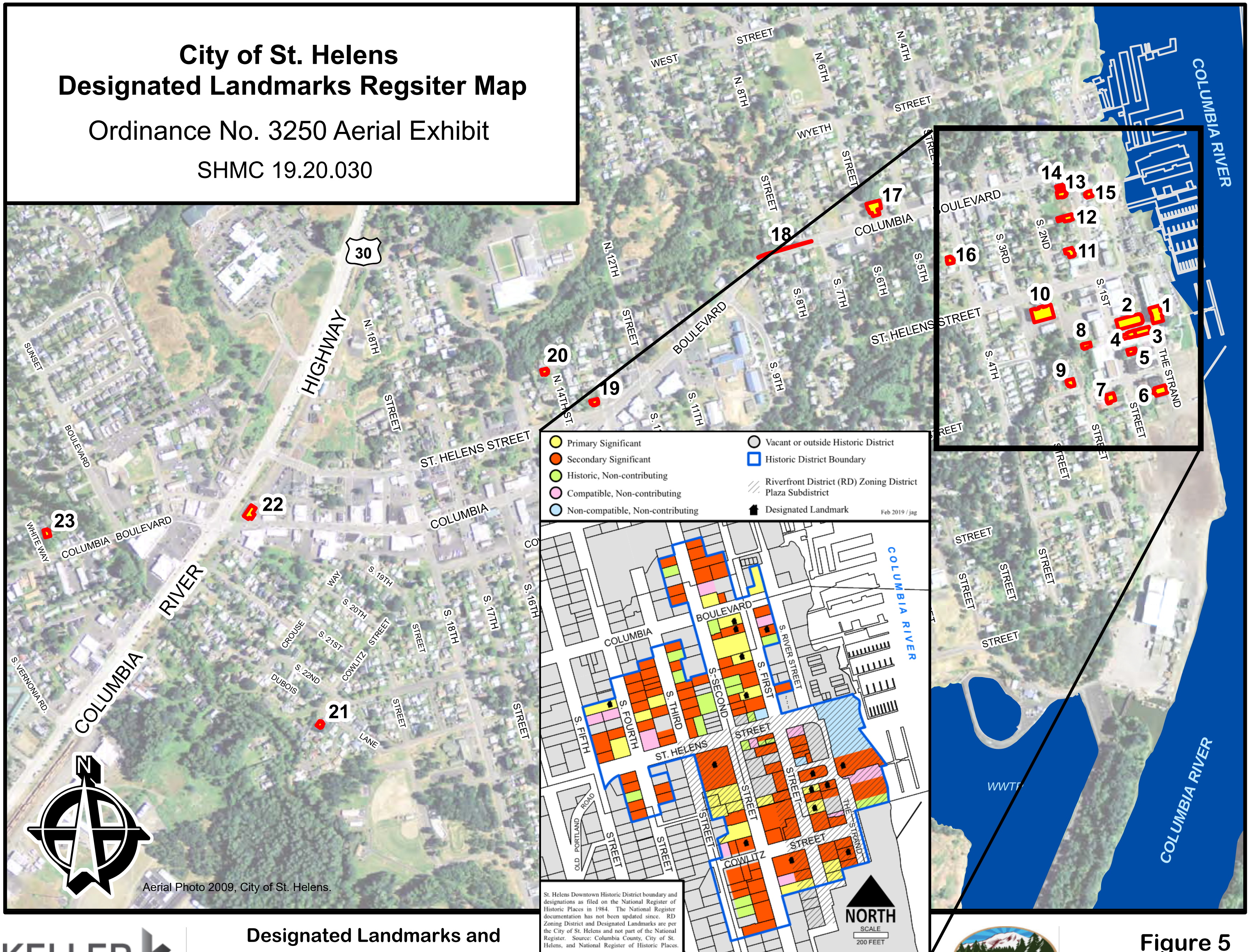
Figure 4

City of St. Helens

City of St. Helens
Designated Landmarks Regsiter Map

Ordinance No. 3250 Aerial Exhibit

SHMC 19.20.030



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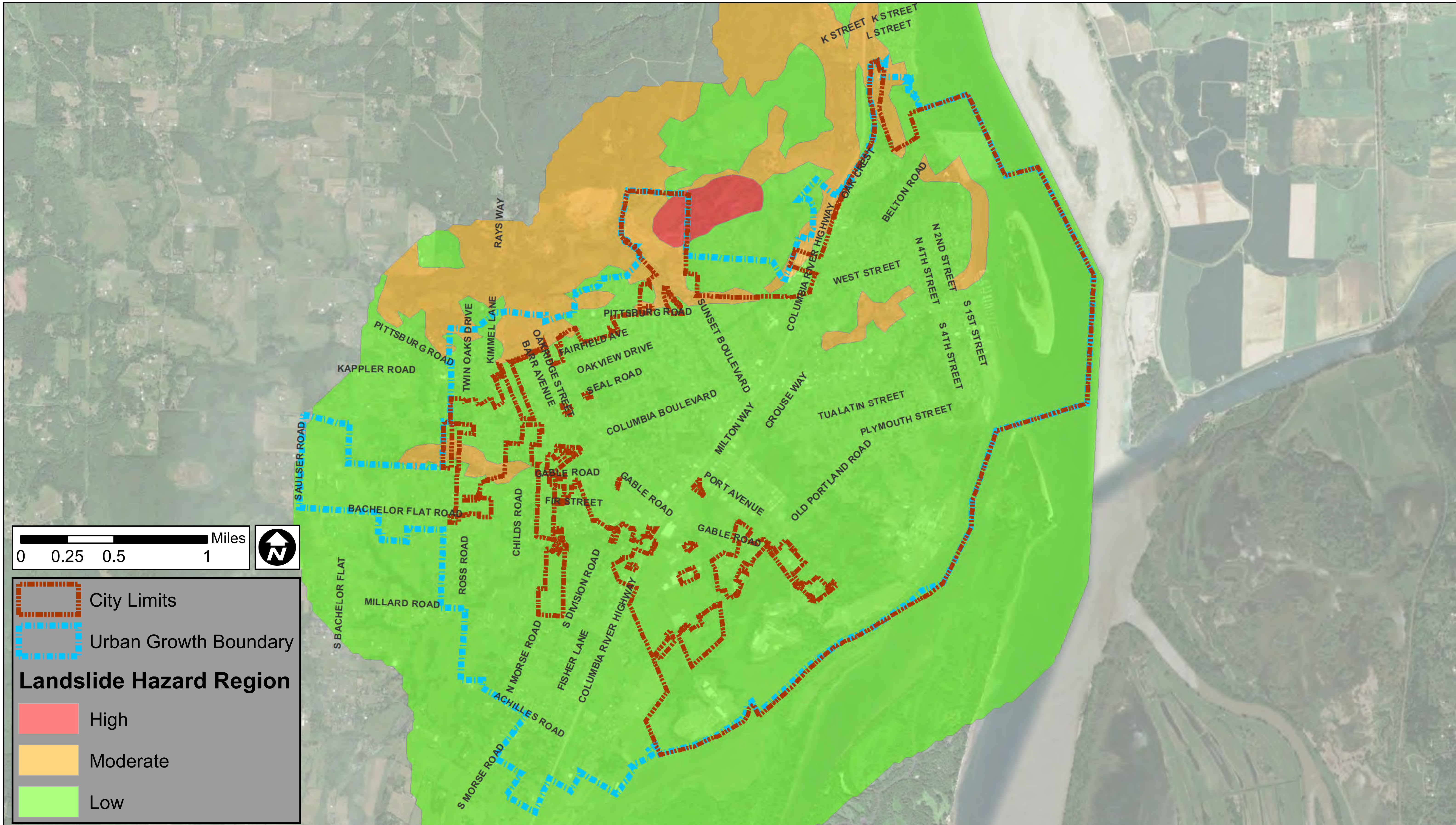
Designated Landmarks and Downtown Historic District

Stormwater Master Plan

City of St. Helens Founded 1850 Oregon

Figure 5

City of St. Helens



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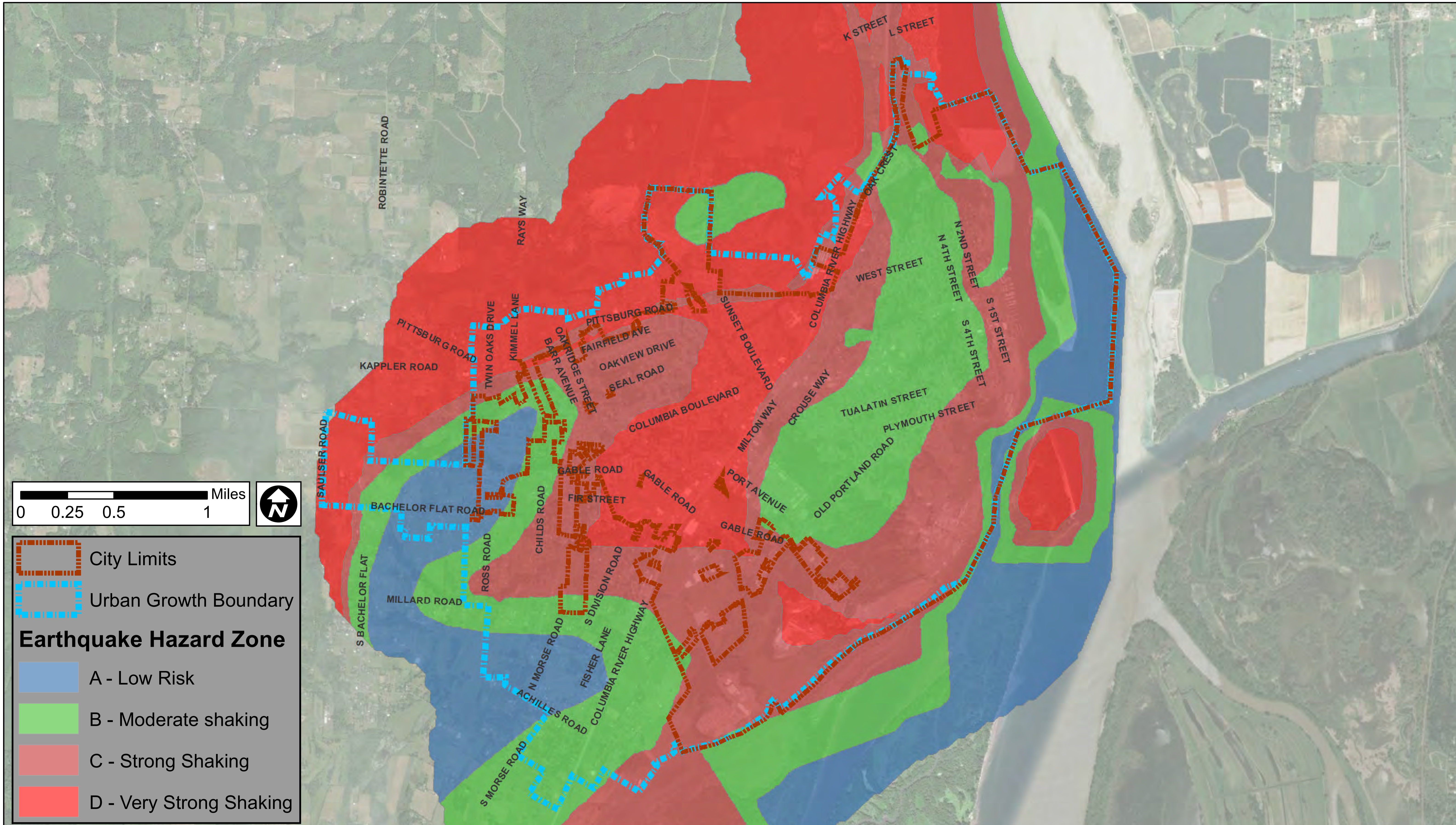
Landslide Hazards

Stormwater Master Plan

City of St. Helens FOUNDED 1850 Oregon

Figure 6

City of St. Helens



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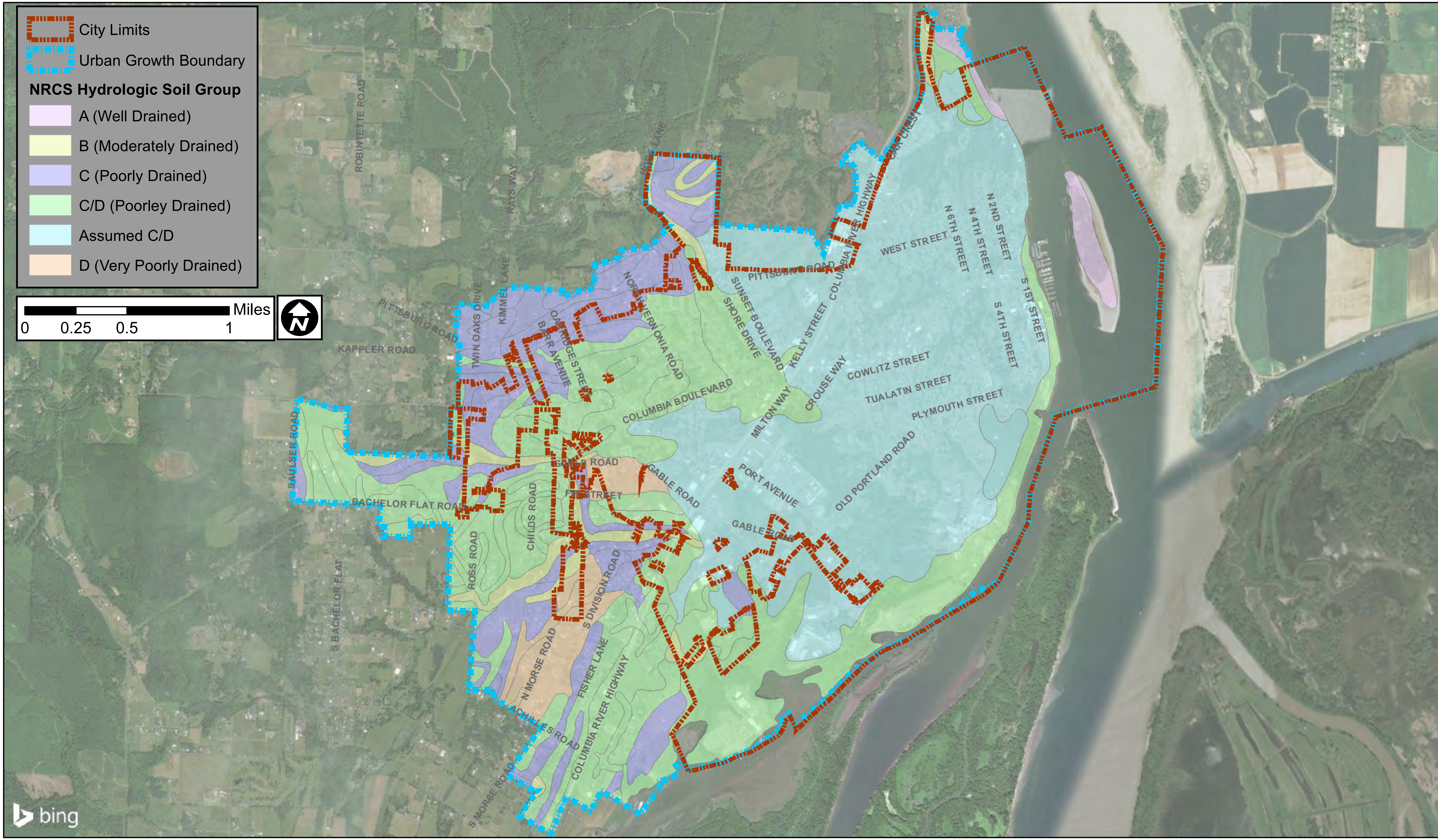
Earthquake Hazards

Stormwater Master Plan

City of St. Helens
FOUNDED 1850
Oregon

Figure 7

City of St. Helens



KELLER ASSOCIATES

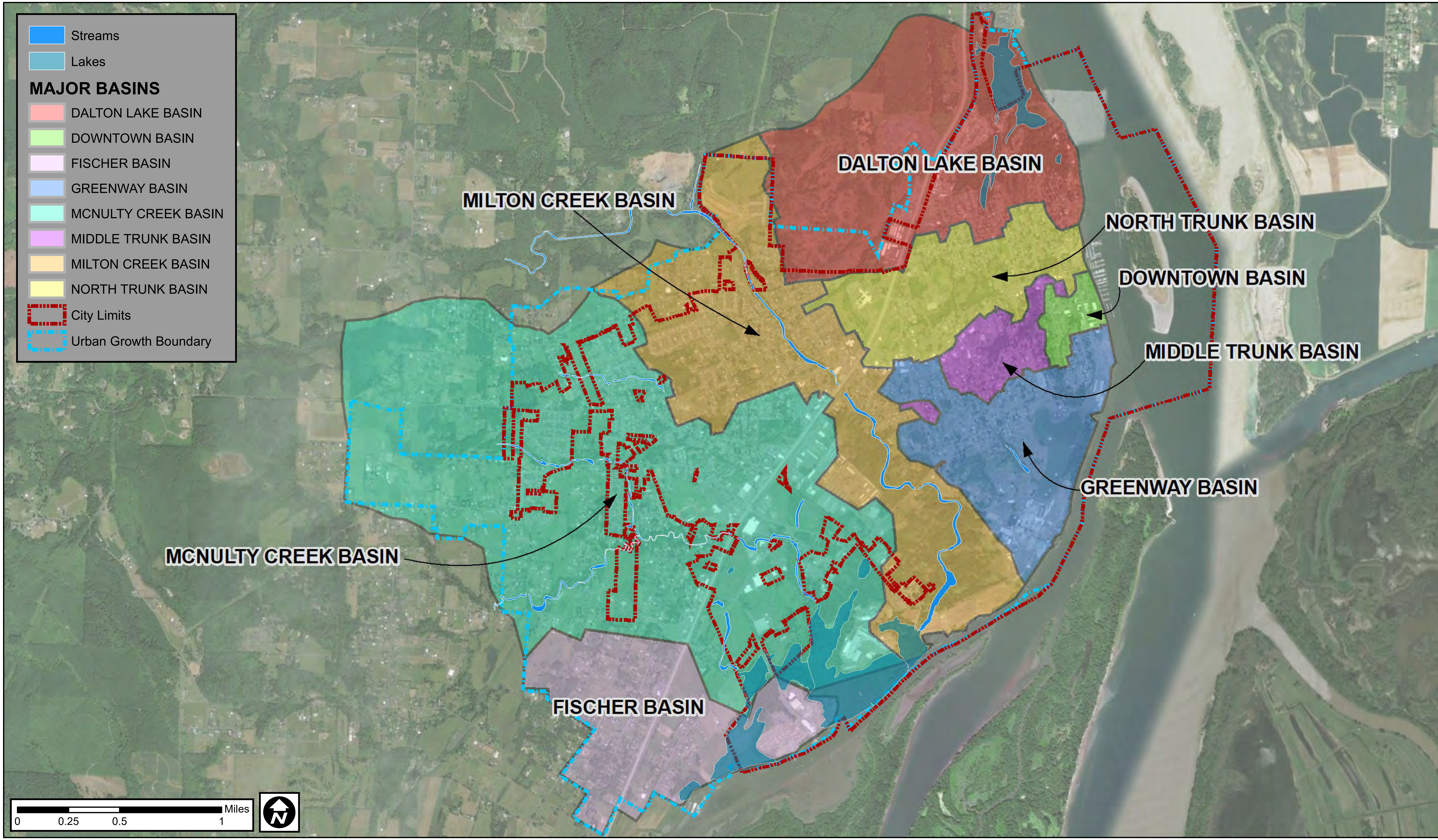
NRCS Hydrologic Soil Categories

Stormwater Master Plan

City of St. Helens Oregon

Figure 8

City of St. Helens



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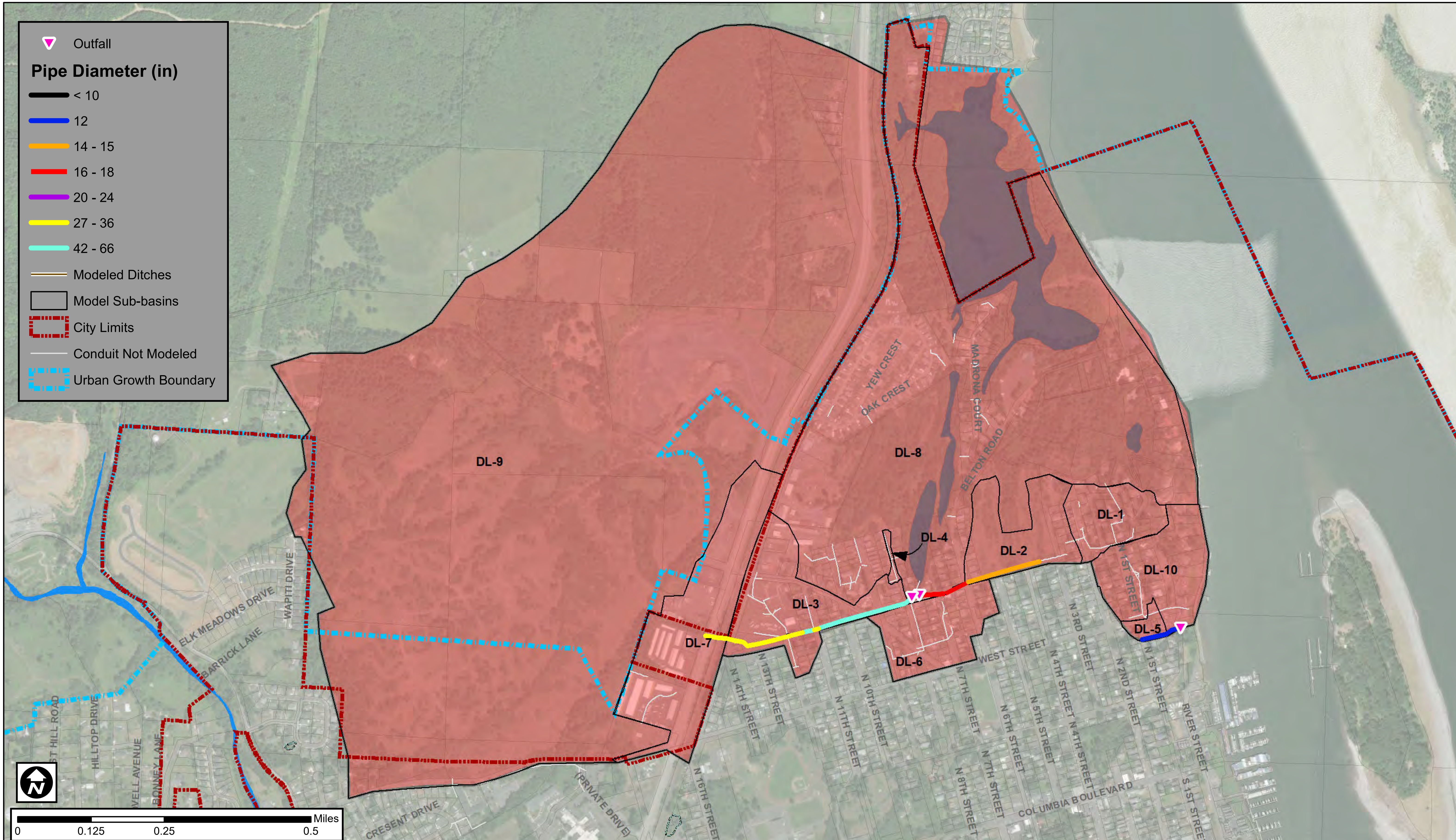
Major Stormwater Basins

Stormwater Master Plan

Figure 9

City of St. Helens



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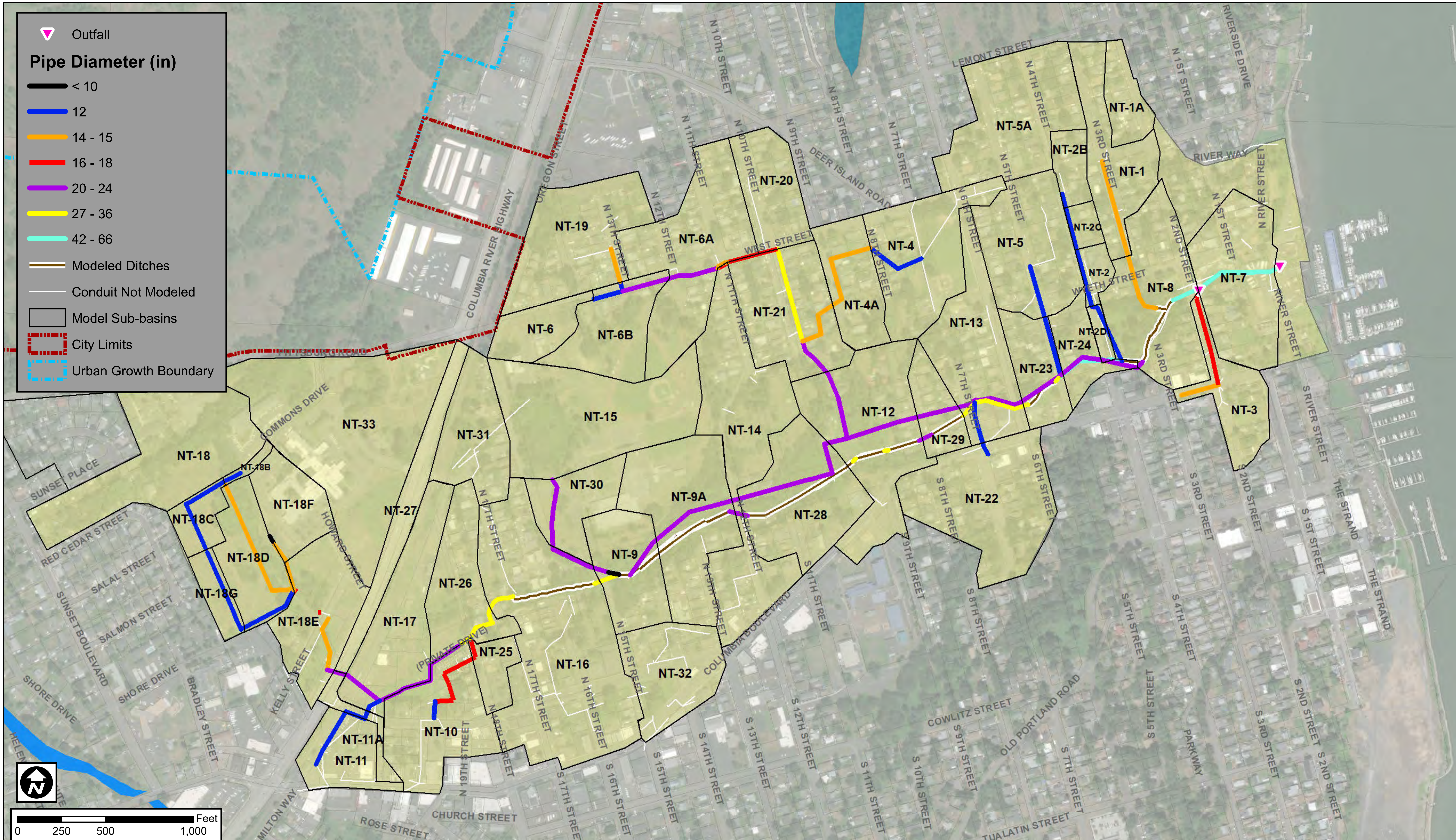
Dalton Lake Basin Modeled Pipes

Stormwater Master Plan

City of St. Helens Founded 1850 Oregon

Figure 9A

City of St. Helens

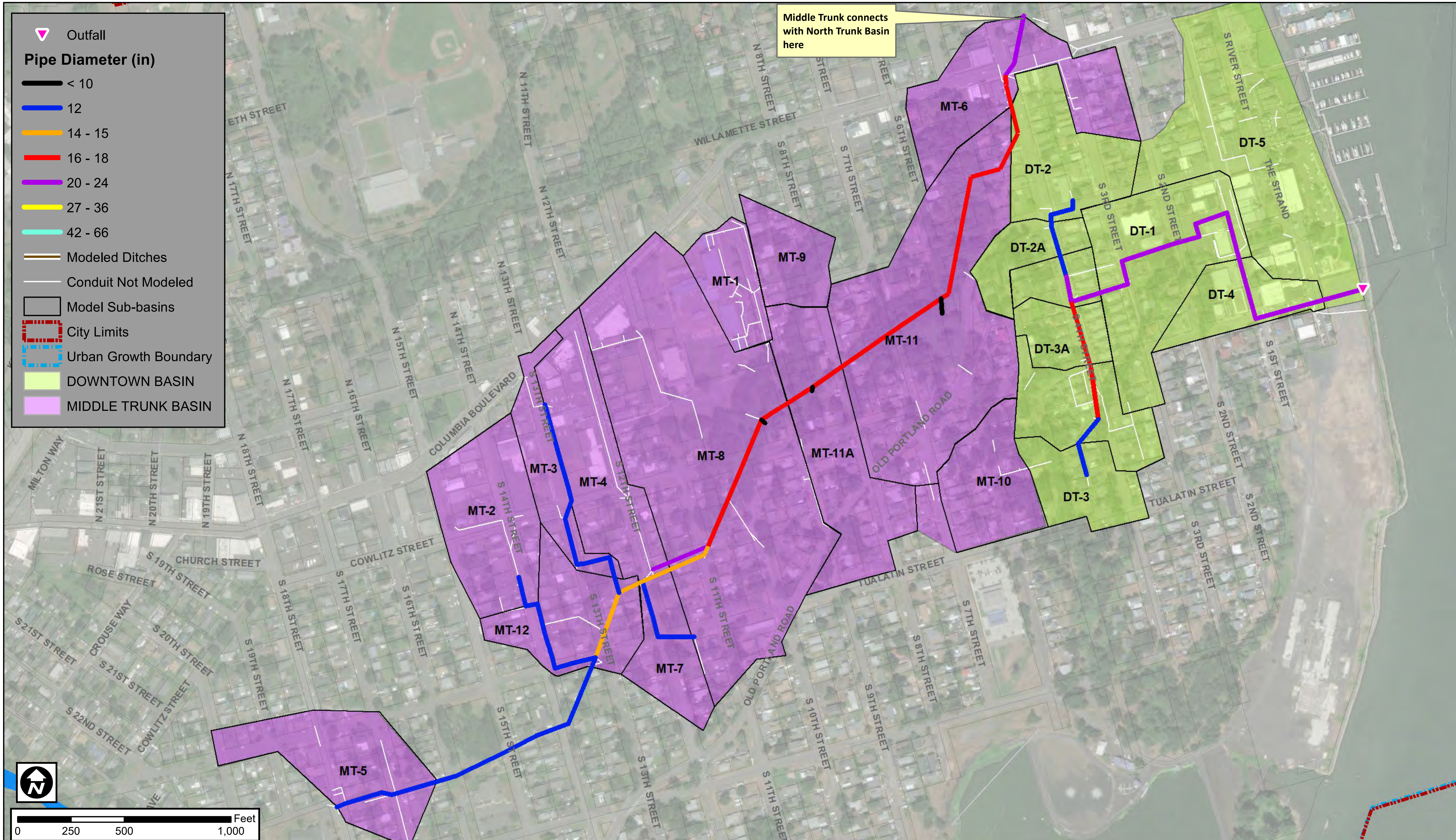


North Trunk Basin Modeled Pipes

Stormwater Master Plan

Figure 9B

City of St. Helens



Middle Trunk and Downtown Basin Modeled Pipes

Stormwater Master Plan

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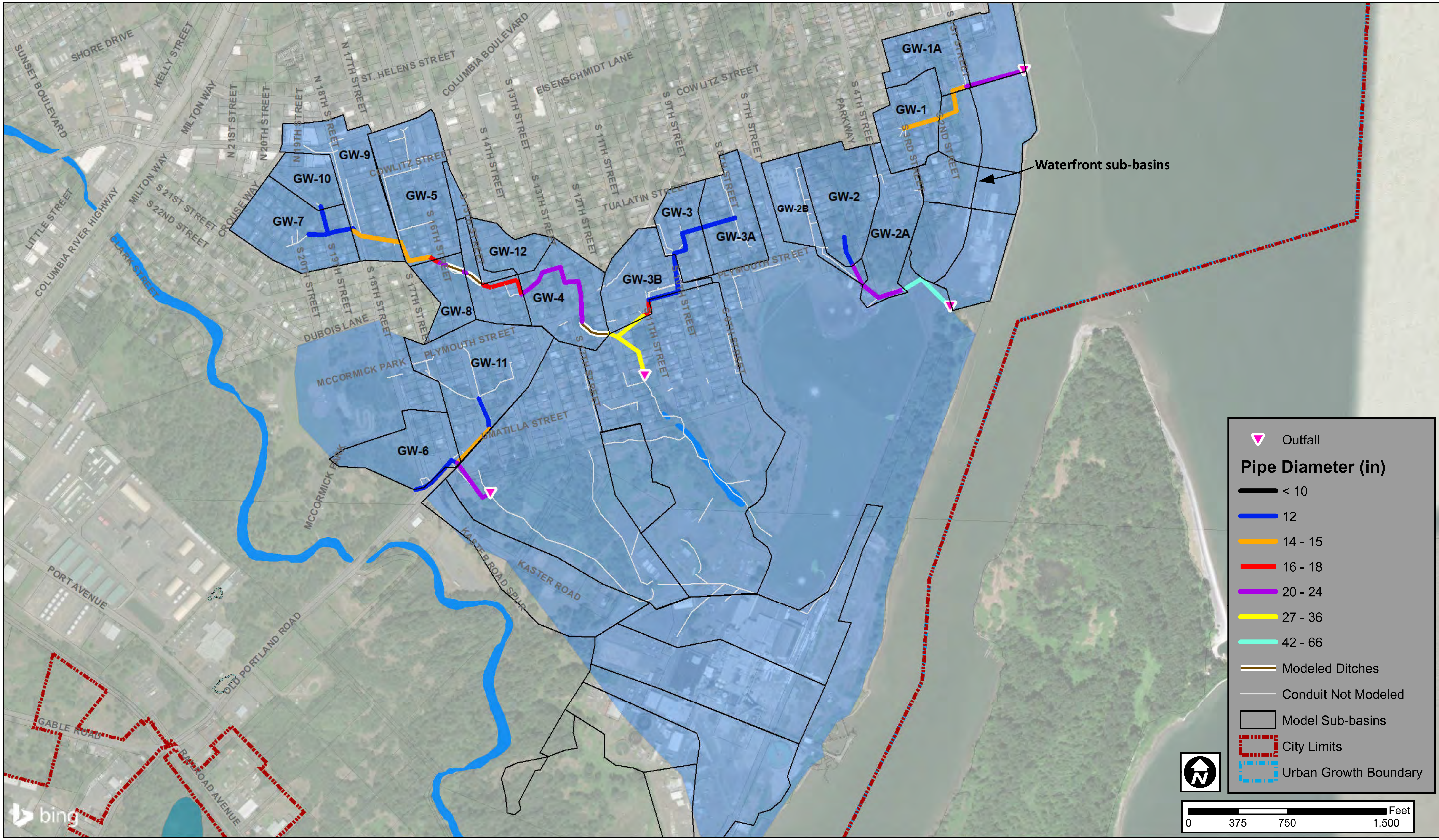
City of St. Helens Founded 1850 Oregon

Figure 9C

City of St. Helens

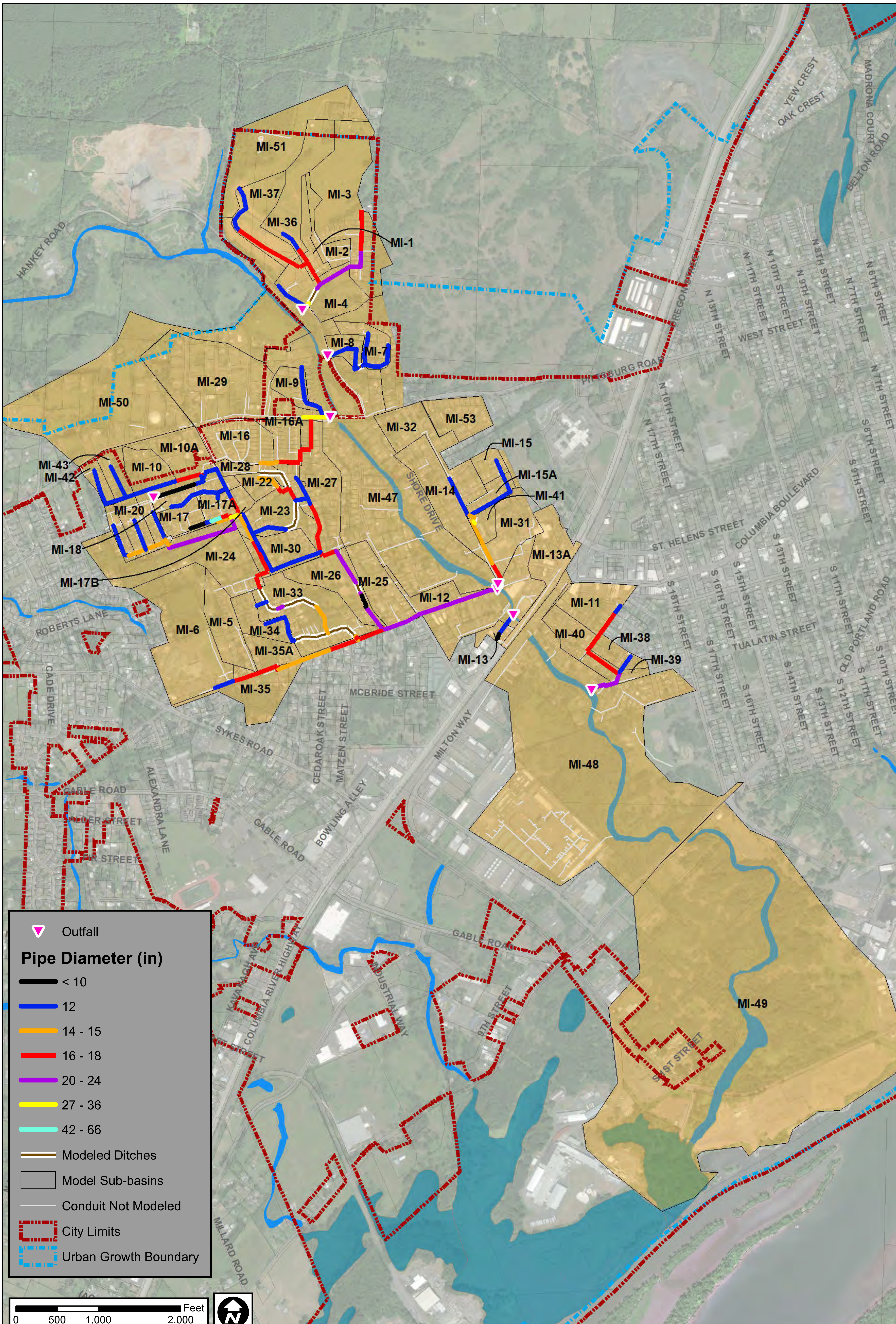


Greenway Basin Modeled Pipes

Stormwater Master Plan

Figure 9D

City of St. Helens



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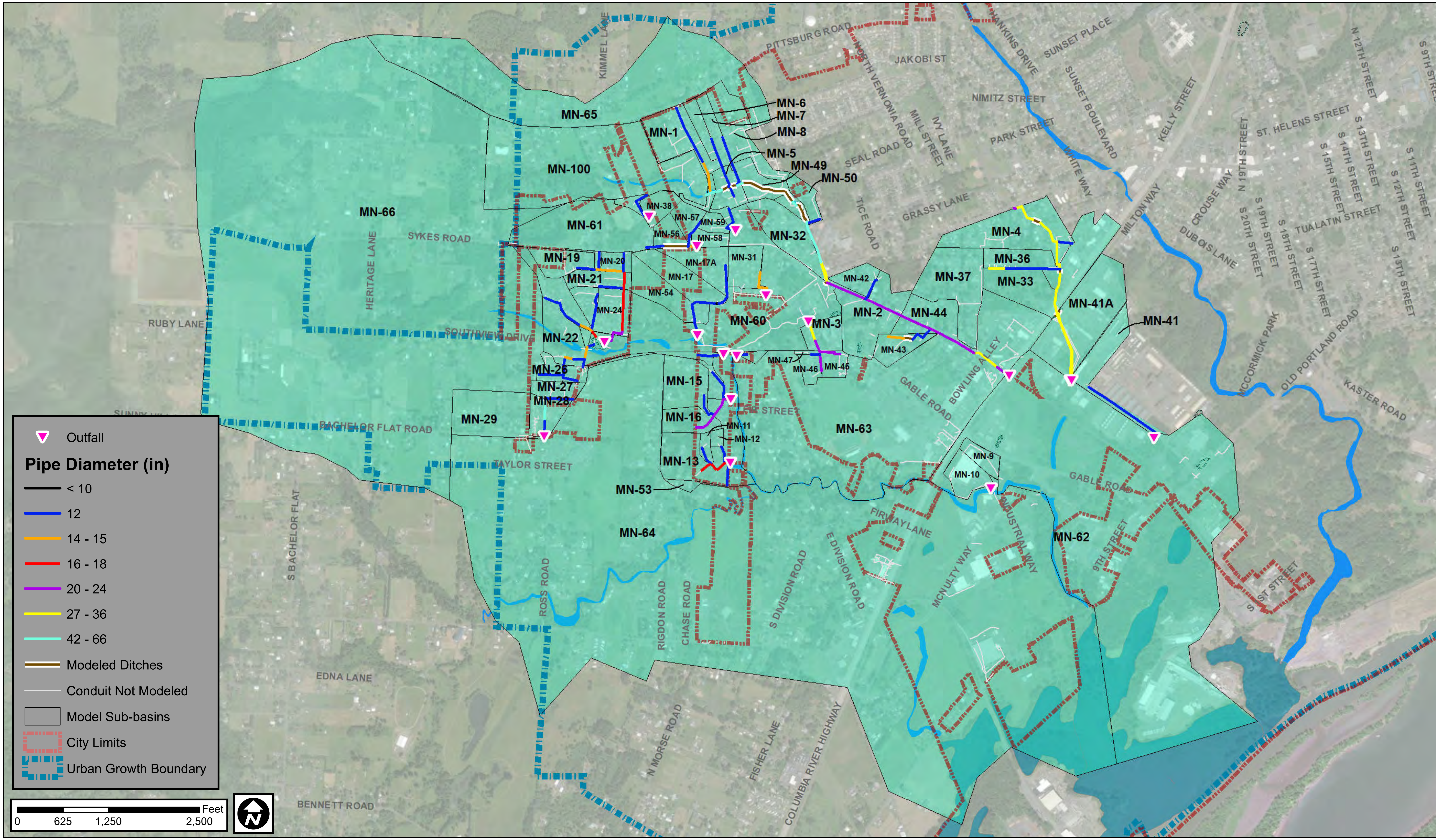
Milton Creek Basin Modeled Pipes

Stormwater Master Plan

City of St. Helens FOUNDED 1850 Oregon

Figure 9E

City of St. Helens



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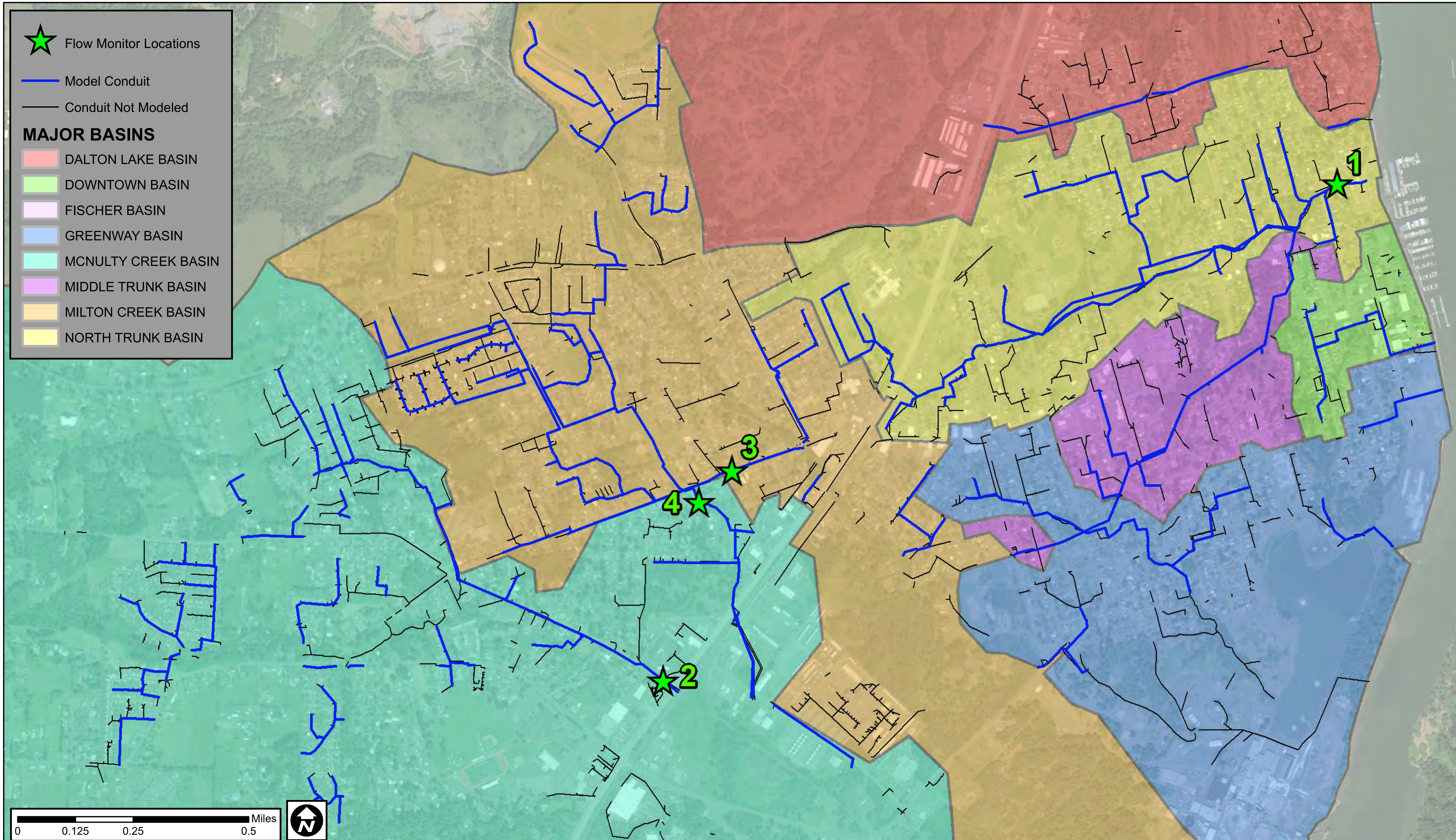
McNulty Creek Basin Modeled Pipes

Stormwater Master Plan

City of St. Helens FOUNDED 1850 Oregon

Figure 9F

City of St. Helens



KELLER ASSOCIATES

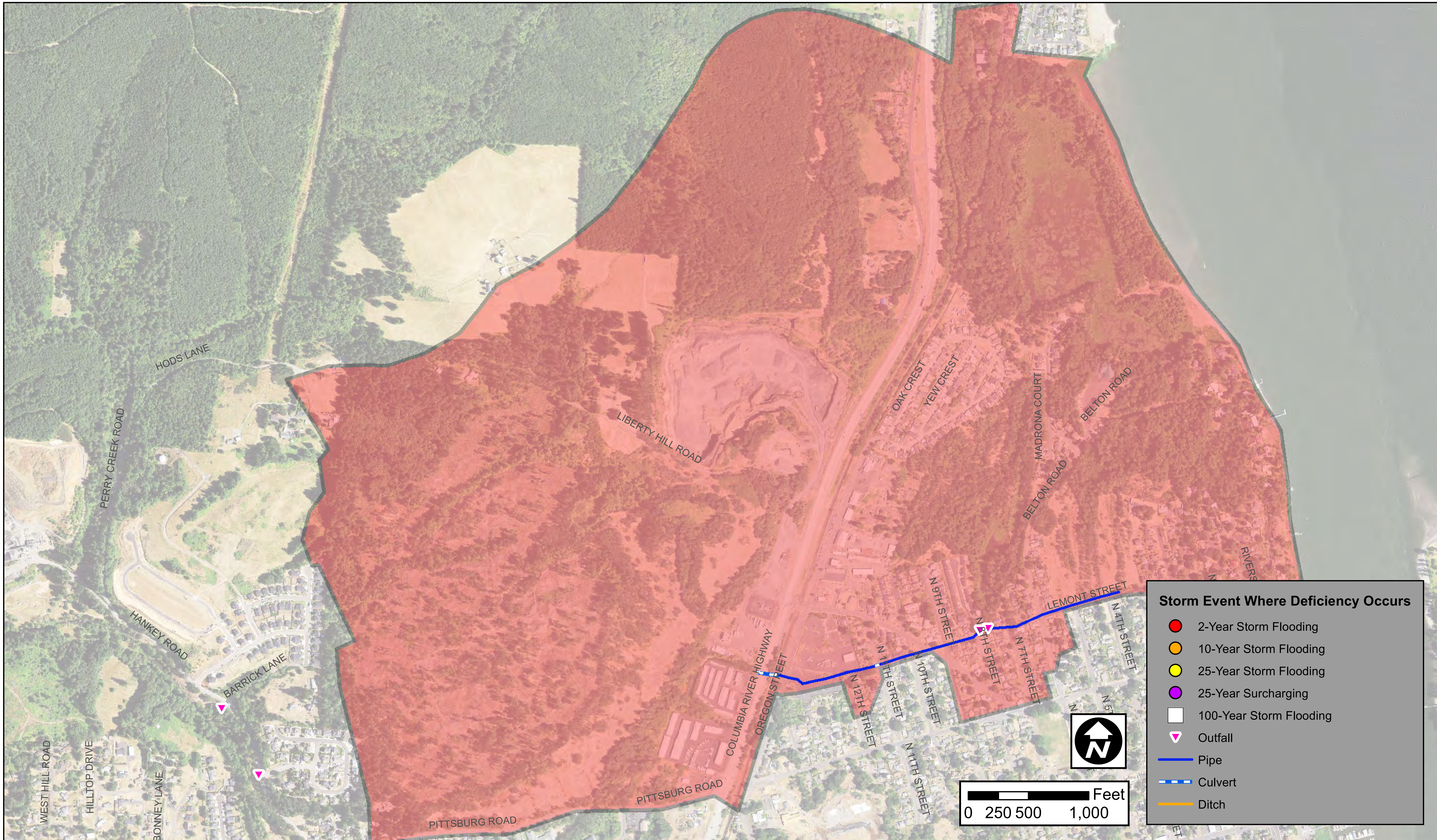
Stormwater Flow Meter Locations

Stormwater Master Plan

City of St. Helens FOUNDED 1850 Oregon

Figure 10

City of St. Helens



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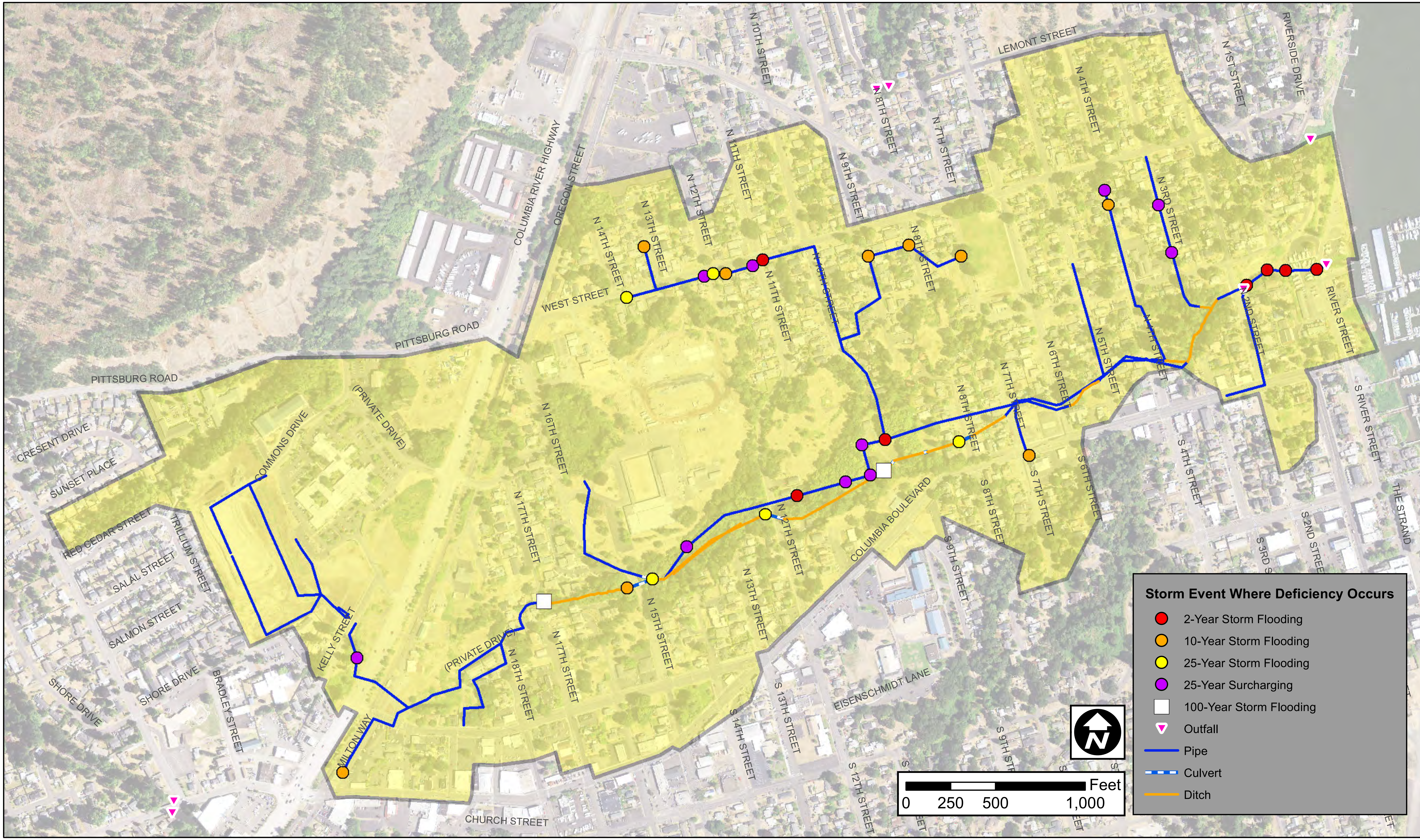
Dalton Lake Basin - Existing Conditions

Stormwater Master Plan

City of St. Helens Founded 1850 Oregon

Figure 11A

City of St. Helens



North Trunk Basin - Existing Conditions

Stormwater Master Plan

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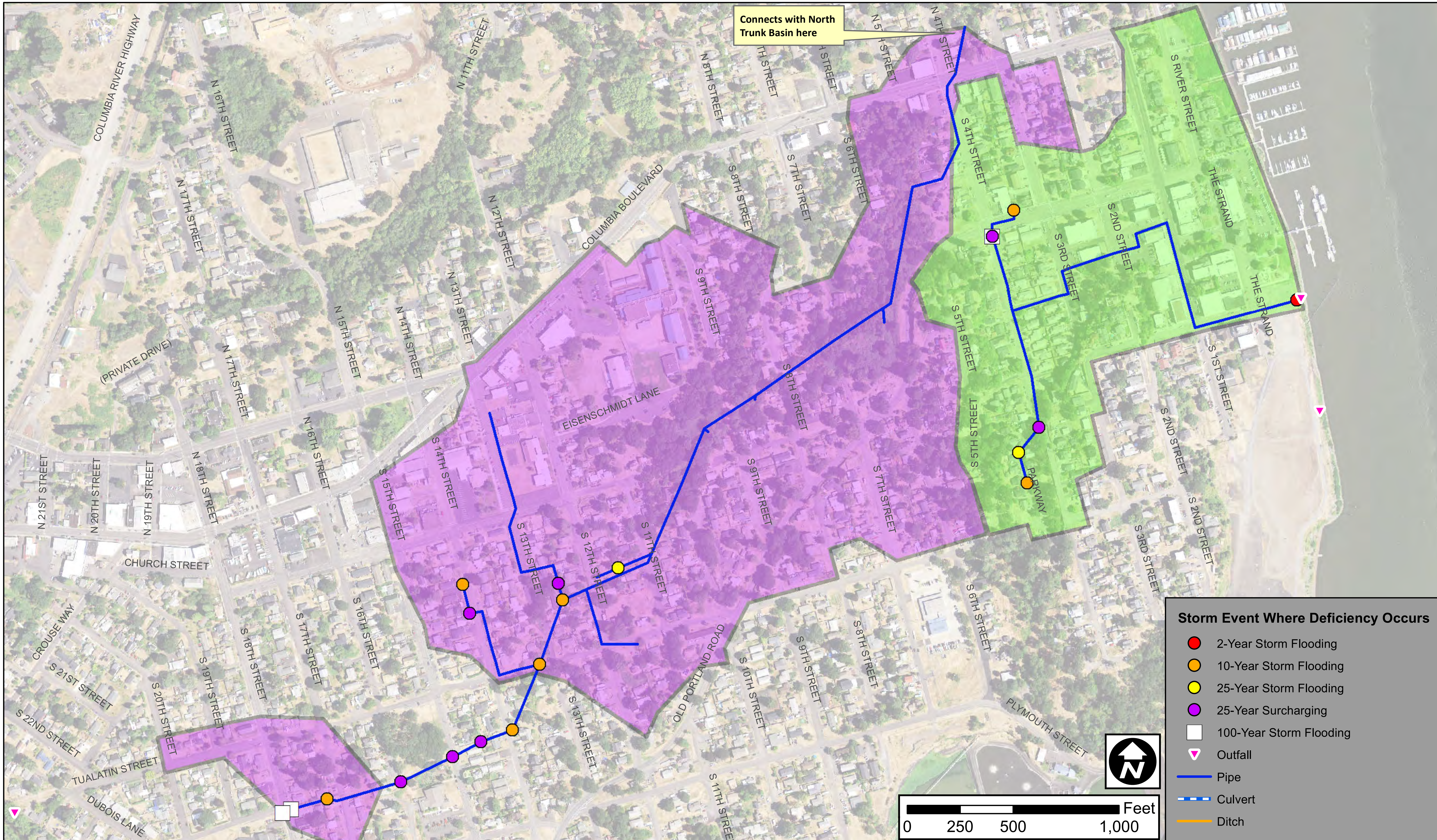
City of St. Helens
FOUNDED 1850
Oregon

Figure 11B

City of St. Helens

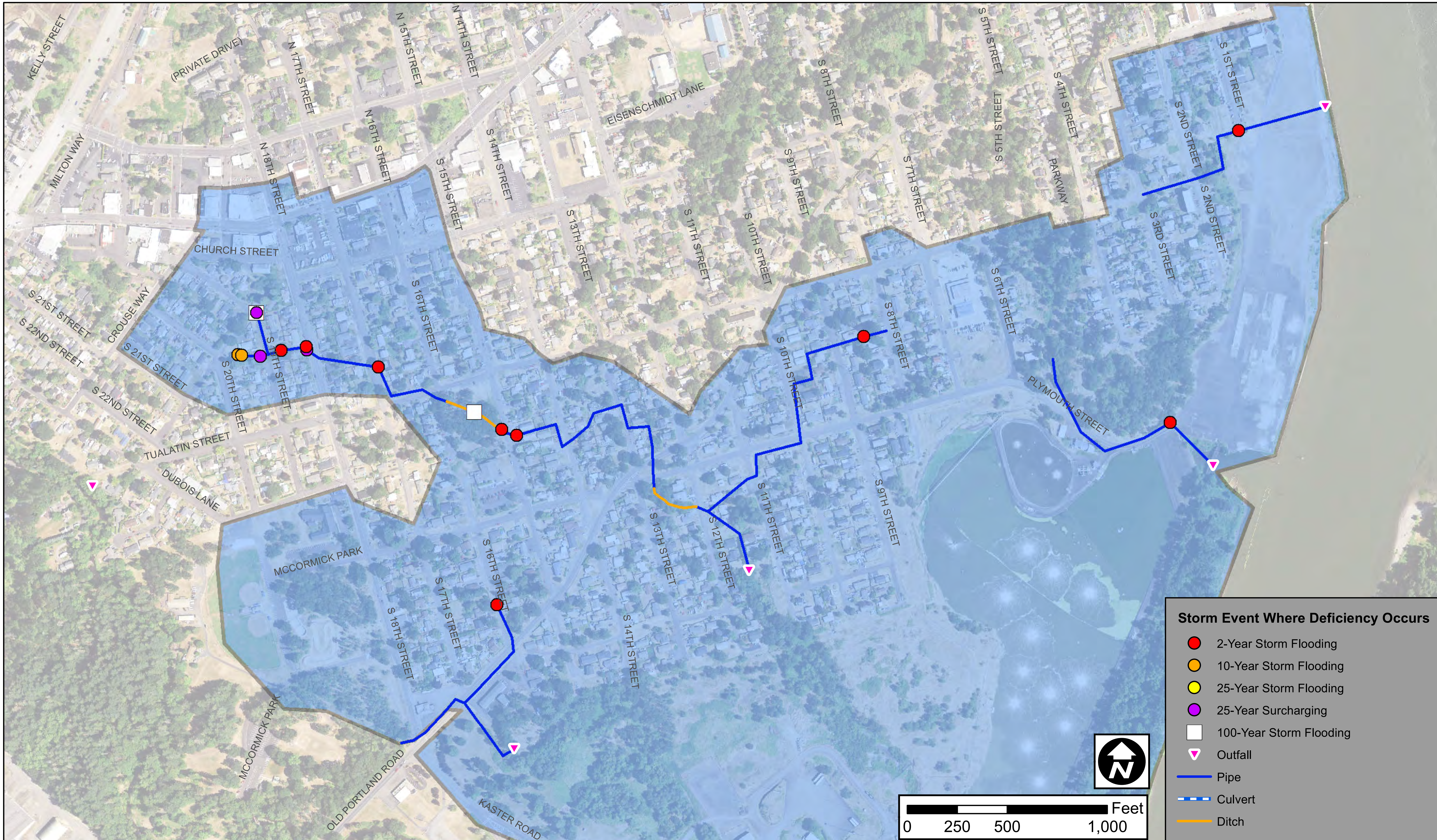


Middle Trunk and Downtown Basins - Existing Conditions

Stormwater Master Plan

Figure 11C

City of St. Helens

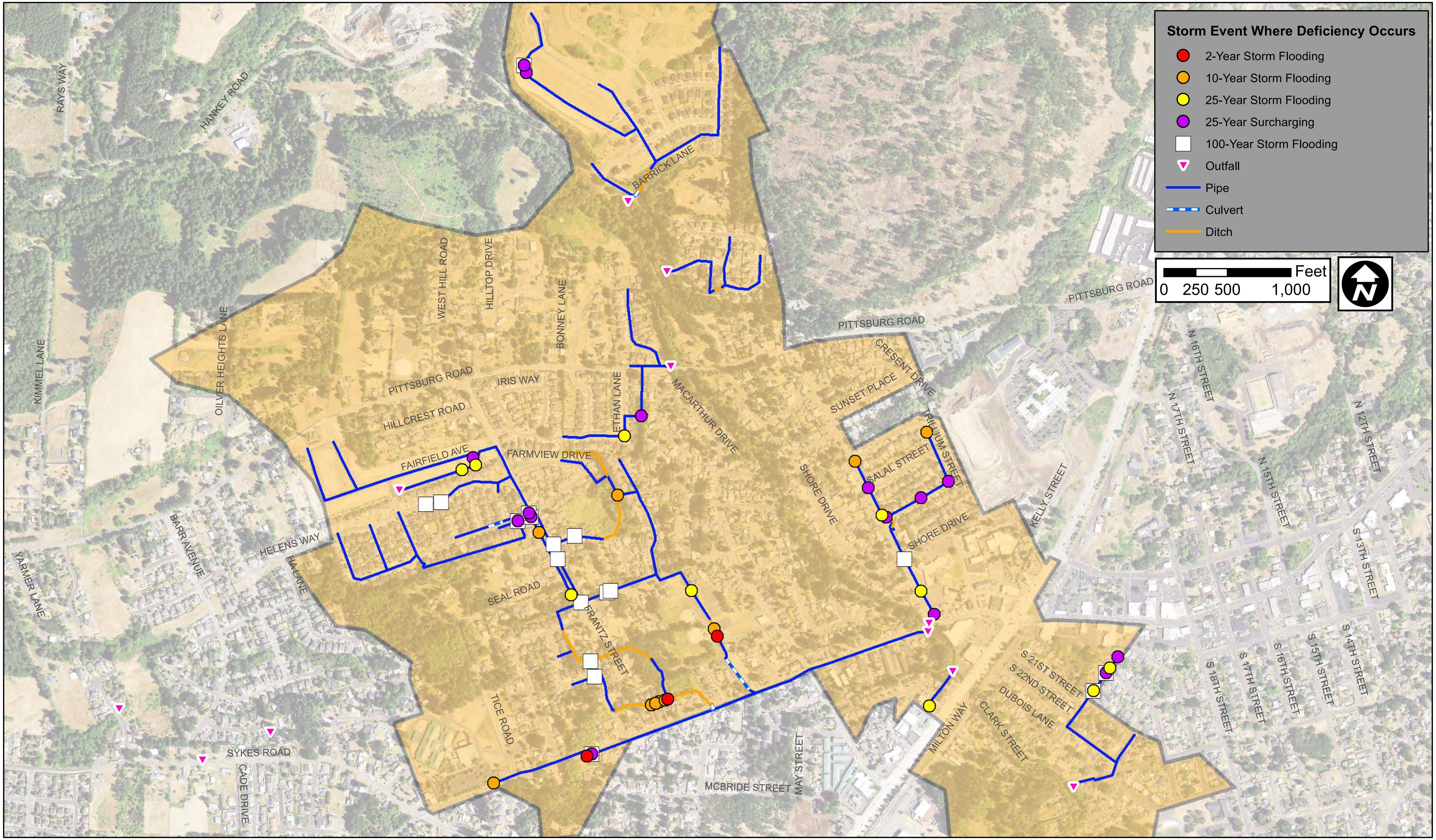


Greenway Basin - Existing Conditions

Stormwater Master Plan

Figure 11D

City of St. Helens



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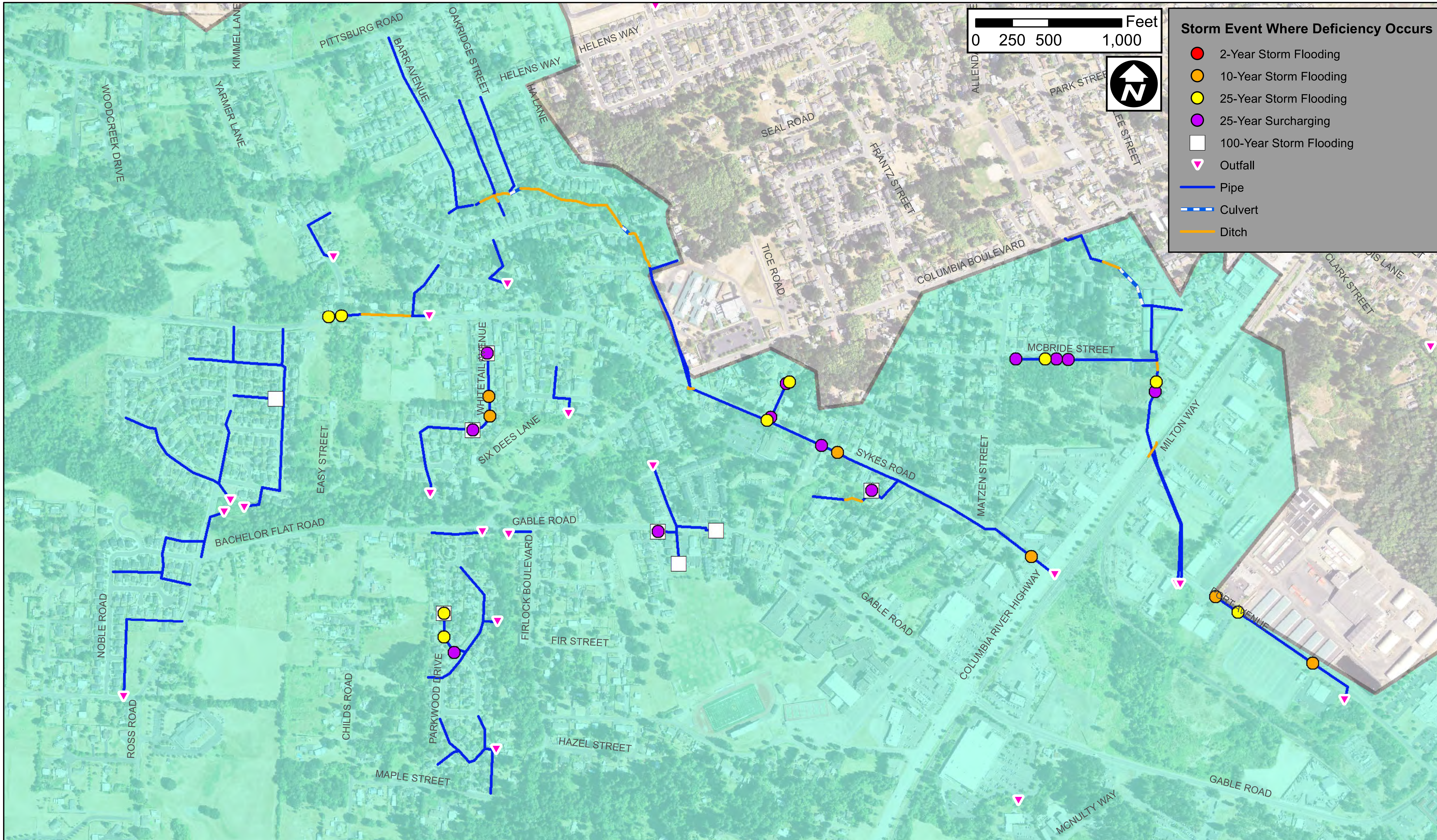
Milton Creek Lake Basin - Existing Conditions

Stormwater Master Plan

City of St. Helens Founded 1850 Oregon

Figure 11E

City of St. Helens



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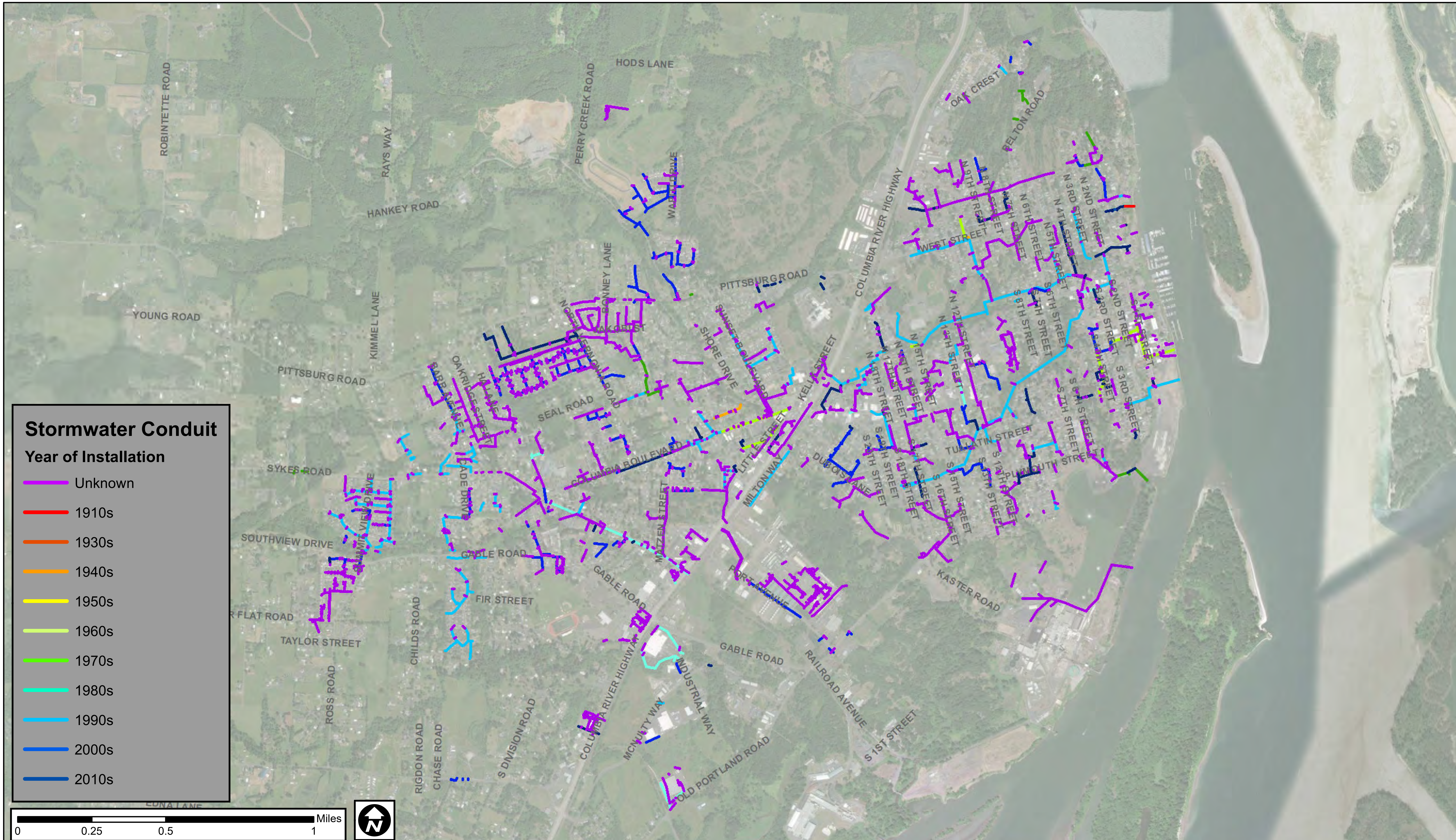
McNulty Creek Basin - Existing Conditions

Stormwater Master Plan

Figure 11F

City of St. Helens



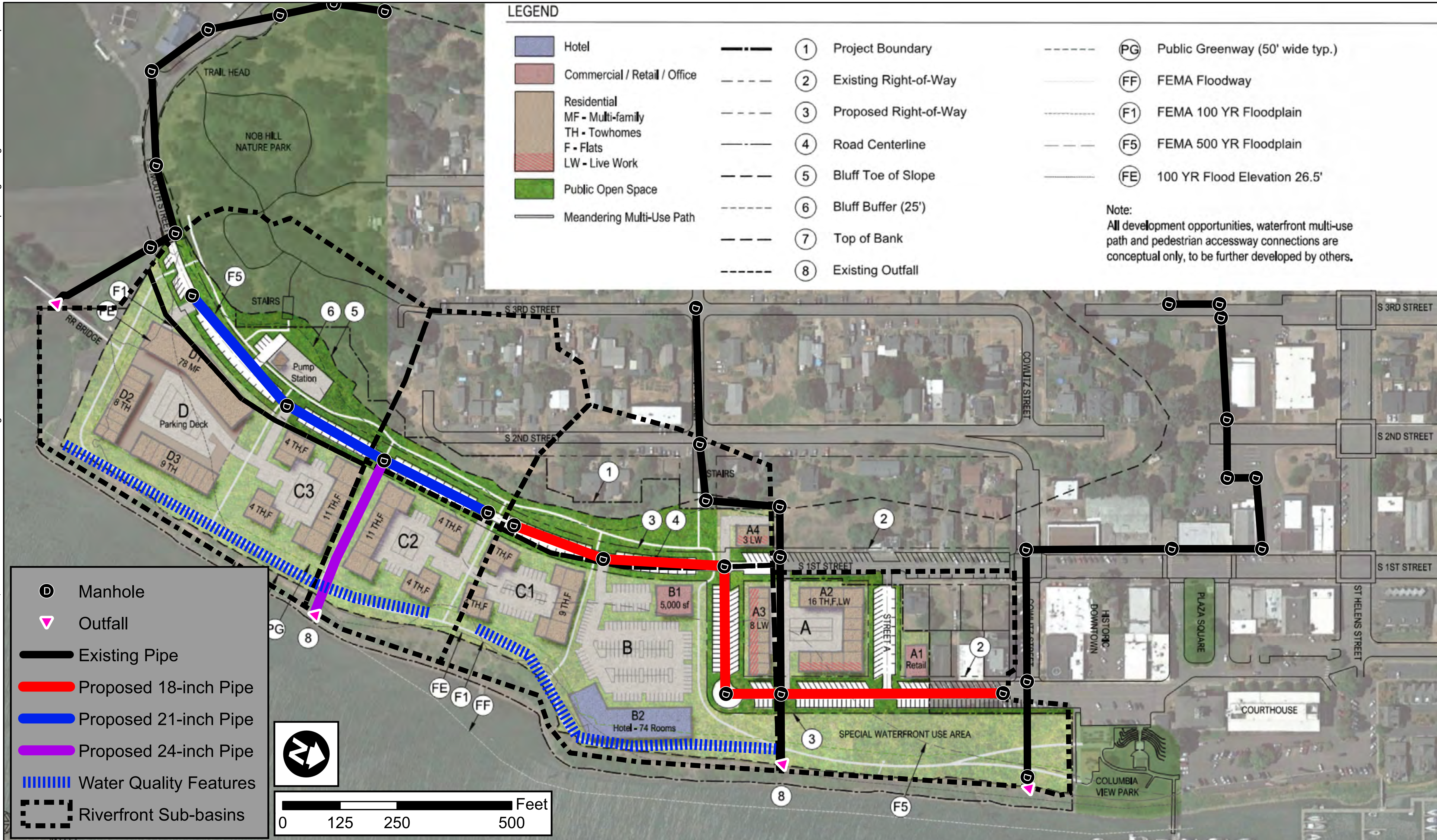
Pipelines by Age

Stormwater Master Plan

Figure 12

City of St. Helens

Document Path: C:\Users\buster\KELLER ASSOCIATES, INC\220060 St Helens Master Planning - Documents\General\SWMP\zGIS\MXDs\Report Figures\Figure 12 - Waterfront Development.mxd



Riverfront Development Property Proposed Alignment

Stormwater Master Plan

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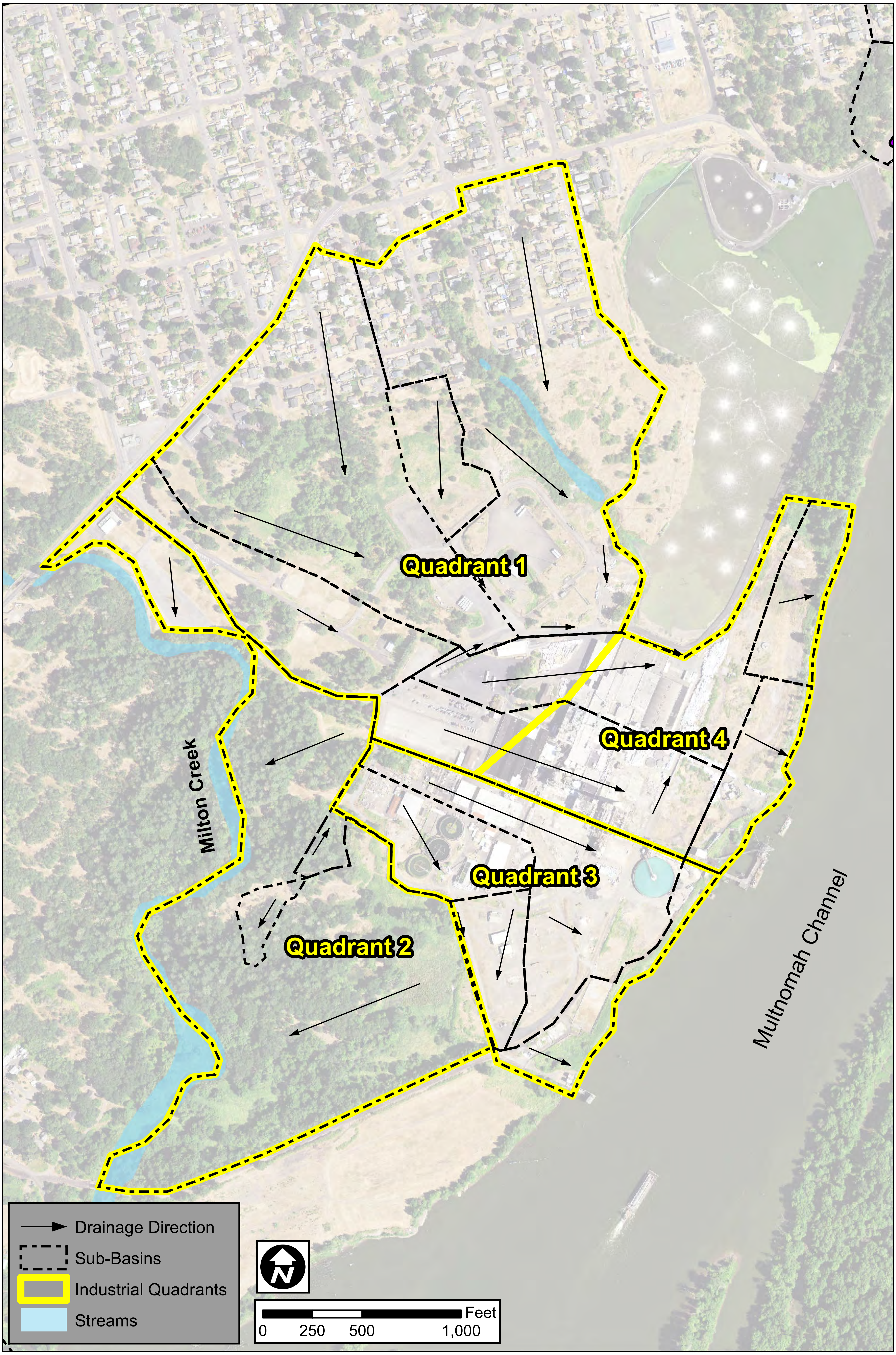
City of St. Helens Founded 1850 Oregon

Figure 13

City of St. Helens



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Industrial Business Park Drainage

Stormwater Master Plan

City of St. Helens FOUNDED 1850 Oregon

Figure 14

City of St. Helens

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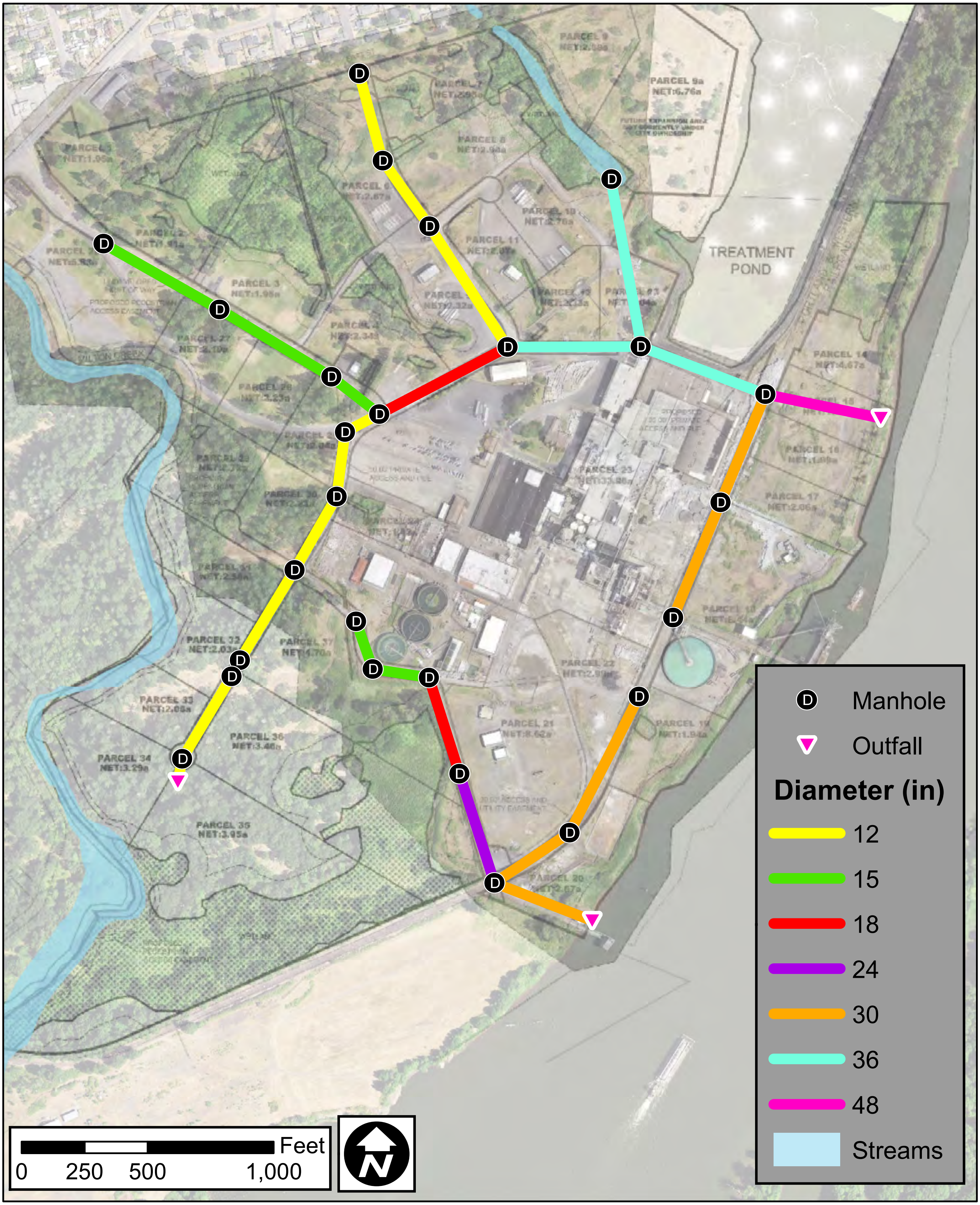

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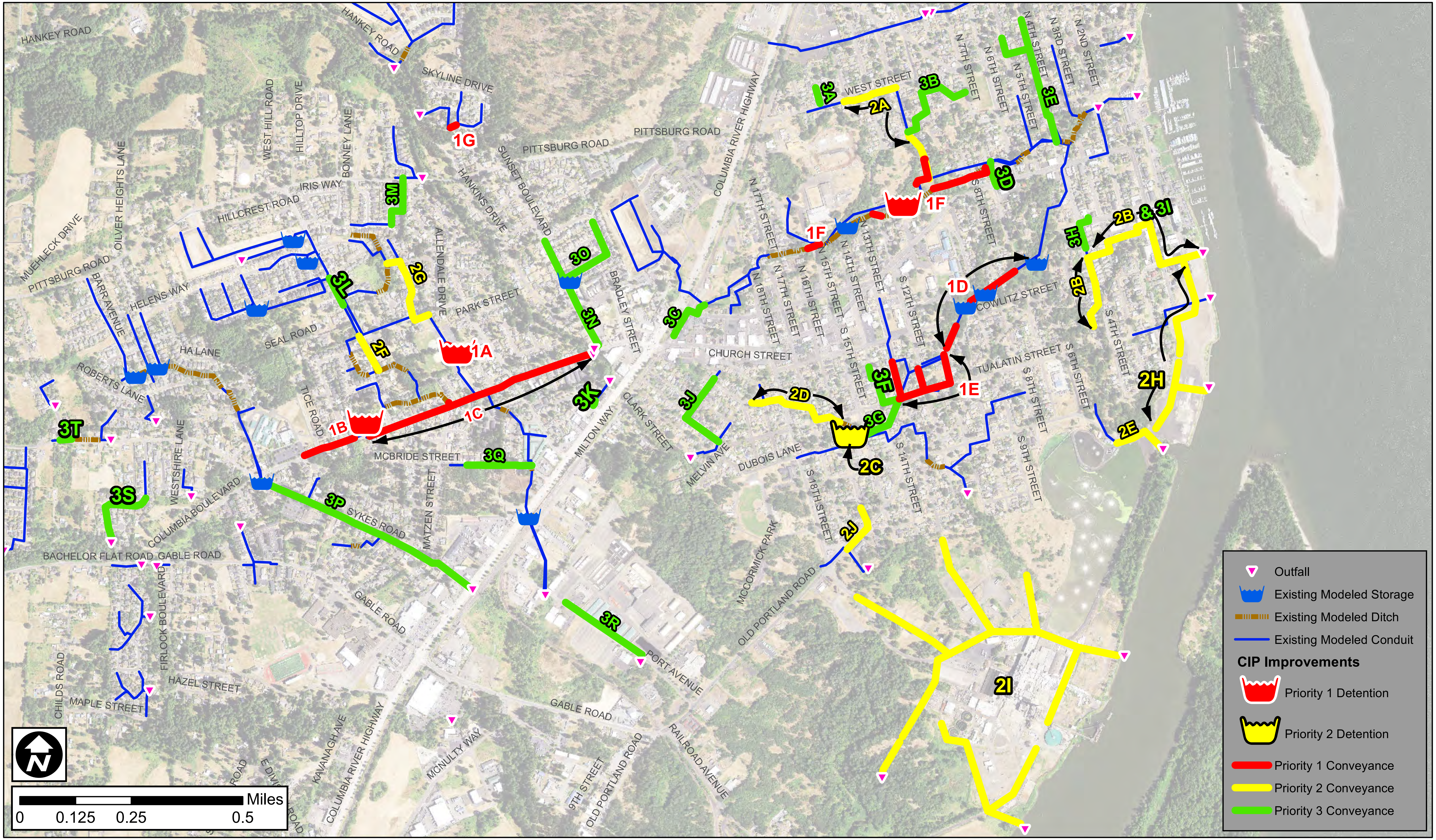
Industrial Business Park Proposed Alignment

Stormwater Master Plan

City of St. Helens Founded 1850 Oregon

Figure 15

City of St. Helens



Capital Improvement Plan

Stormwater Master Plan

Figure 16

City of St. Helens

APPENDIX B

Planning Documents

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Columbia County Endangered Species

Source: Oregon Fish and Wildlife IPaC Online Database

Group	Name	Population	Status	Lead Office	Recovery Plan	Recovery Plan Action Status
Snails	Burrington jumping-slug (Hemphillia burringtoni)	Wherever found	Under Review	1		
Fishes	Bull Trout (Salvelinus confluentus)	U.S.A., conterminous, (lower 48 states)	Threatened	1	Coastal Recovery Unit Implementation Plan for Bull Trout (Salvelinus confluentus)	Implementation Progress
Fishes	Bull Trout (Salvelinus confluentus)	U.S.A., conterminous, (lower 48 states)	Threatened	1	Columbia Headwaters Recovery Unit Implementation Plan for Bull Trout (Salvelinus confluentus)	Implementation Progress
Fishes	Bull Trout (Salvelinus confluentus)	U.S.A., conterminous, (lower 48 states)	Threatened	1	Klamath Recovery Unit Implementation Plan for Bull Trout (Salvelinus confluentus)	Implementation Progress
Fishes	Bull Trout (Salvelinus confluentus)	U.S.A., conterminous, (lower 48 states)	Threatened	1	Mid-Columbia Recovery Unit Implementation Plan for Bull Trout (Salvelinus confluentus)	Implementation Progress
Fishes	Bull Trout (Salvelinus confluentus)	U.S.A., conterminous, (lower 48 states)	Threatened	1	Recovery Plan for the Coterminous United States Population of Bull Trout (Salvelinus confluentus)	Implementation Progress
Fishes	Bull Trout (Salvelinus confluentus)	U.S.A., conterminous, (lower 48 states)	Threatened	1	St. Mary Recovery Unit Implementation Plan for Bull Trout (Salvelinus confluentus)	Implementation Progress
Fishes	Bull Trout (Salvelinus confluentus)	U.S.A., conterminous, (lower 48 states)	Threatened	1	Upper Snake Recovery Unit Implementation Plan for Bull Trout (Salvelinus confluentus)	Implementation Progress
Mammals	red tree vole (Arborimus longicaudus)	North Oregon Coast population	Resolved Taxon	1		
Birds	Northern spotted owl (Strix occidentalis caurina)	Wherever found	Threatened	1	Revised Recovery Plan for the Northern Spotted Owl	Implementation Progress
Flowering Plants	Nelson's checker-mallow (Sidalcea nelsoniana)	Wherever found	Threatened	1	Final Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington	Implementation Progress
Flowering Plants	Kincaid's Lupine (Lupinus sulphureus ssp. kincaidii)	Wherever found	Threatened	1	Final Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington	Implementation Progress
Flowering Plants	golden paintbrush (Castilleja levisecta)	Wherever found	Threatened	1	Recovery Plan for the Golden Paintbrush (Castilleja levisecta)	Implementation Progress
Birds	Marbled murrelet (Brachyramphus marmoratus)	U.S.A. (CA, OR, WA)	Threatened	1	Recovery Plan for the Threatened Marbled Murrelet (Brachyramphus marmoratus) in Washington, Oregon, and California	Implementation Progress
Flowering Plants	Willamette daisy (Erigeron decumbens)	Wherever found	Endangered	1	Final Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington	Implementation Progress
Birds	Streaked Horned lark (Eremophila alpestris strigata)	Wherever found	Threatened	1	Draft Recovery Plan for the Streaked Horned Lark	Implementation Progress
Flowering Plants	Bradshaw's desert-parsley (Lomatium bradshawii)	Wherever found	Endangered	1	Final Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington	Implementation Progress
Flowering Plants	Water howellia (Howellia aquatilis)		Threatened	6	Water Howellia (Howellia aquatilis) Recovery Plan, Public and Agency Review Draft	Implementation Progress
Mammals	Columbian white-tailed deer (Odocoileus virginianus leucurus)	Columbia River (Clark, Cowliz, Pacific, Skamania, and Wahkiakum Counties, WA., and Clatsop, Columbia, and Multnomah Counties, OR.)	Threatened	1	Columbian White-tailed Deer Revised Recovery Plan	Implementation Progress
Birds	Yellow-billed Cuckoo (Coccyzus americanus)	Western DPS: U.S.A. (AZ, CA, CO (western), ID, MT (western), NM (western), NV, OR, TX (western), UT, WA, WY (western)); Canada (British Columbia (southwestern); Mexico (Baja California, Baja California Sur, Chihuahua, Durango (western), Sinaloa, Sonora)	Threatened	2		

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APPENDIX C

Geotechnical Report

KELLER ASSOCIATES

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Suite 210
Salem, Oregon, 97301

BY:
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3990 SW Collins Way, Ste 100
Portland, Oregon,

503-210-4764
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GEOTECHNICAL PLANNING REPORT

St. Helens Wastewater and Stormwater Master Plan Update

ST. HELENS, OREGON

November 2021

Shannon & Wilson No: 104961

SHANNON & WILSON

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Submitted To: Keller Associates
245 Commercial St SE,
Suite 210
Salem, Oregon, 97301
Attn: Peter Olsen, PE

Subject: GEOTECHNICAL PLANNING REPORT, ST. HELENS WASTEWATER AND STORMWATER MASTER PLAN UPDATE, ST. HELENS, OREGON

Shannon & Wilson prepared this report and participated in this project as a subconsultant to Keller Associates. Our scope of services was specified in our contracted dated March 18, 2021 for Keller project number 220060. This report presents the geotechnical planning-related findings based on a review of publicly available documents and was prepared by the undersigned.

We appreciate the opportunity to be of service to you on this project. If you have questions concerning this report, or if we may be of further service, please contact us.

Sincerely,

SHANNON & WILSON, INC.

Elliott Mecham, PE
Senior Associate

DSJ:ECM:JLJ/:myw

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1 GENERAL

The City of St. Helens provides sanitary sewer collection services to businesses and residences within the City limits. The sanitary sewer collection system is a combination of 60 miles of gravity and force mains, 9 lift stations, and over 1,700 sanitary sewer manholes, vaults, and cleanouts. All sewage flows are conveyed to the City's wastewater treatment facility. The last complete update to the City's sanitary sewer master plan was in 1989.

The intent of the sanitary sewer master plan is to perform an assessment of the existing sewer system; evaluate the sewer system for its capacity to convey existing and future waste discharges; identify deficiencies, capacity issues, areas for improvement, and identify resiliency issues for critical facilities; and determine and propose solutions.

2 SCOPE OF SERVICES

The purpose of Shannon & Wilson's task is to prepare and provide GIS maps of the service area with the mapped site geology and the State of Oregon Department of Geology and Mineral Industries' (DOGAMI) mapped seismic hazards, and document the findings in a brief report. The backbone wastewater and stormwater facilities selected and digitized into GIS format by others will be shown on the maps. Our specific scope of work includes the following:

- Mapped site geology;
- Mapped landslides included in DOGAMI's landslide inventory (if any) along the proposed pipeline alignments or at the treatment plant sites;
- Mapped United States Geology Survey (USGS) Class A or Class B faults that cross pipeline alignments or are located within a 5-mile radius of treatment plant locations;
- Mapped relative earthquake liquefaction hazard based on DOGAMI maps (high, medium, or low hazard);
- Mapped relative landslide risk based on DOGAMI maps (very high, high, moderate, or low hazard); and
- Submitting a brief memo or letter report presenting the geologic maps and a brief discussion summarizing our findings, including a discussion on probable areas where rock excavation could be required, and the potential need to mitigate seismic hazards. The discussions will be limited by the uncertainties and assumptions made during the development of the geologic maps and DOGAMI hazard layers.

3 DESCRIPTION OF PROVIDED MAPS

3.1 Provided Data

Shannon & Wilson was provided GIS files for the City of St. Helens stormwater and wastewater facilities. An overview map of these facilities can be found on Figure 2, Site Plan. Within the files provided were attributes which allowed for the identification of vulnerable assets. The vulnerable pipelines can be found on Figure 3, Pipeline Vulnerabilities.

3.2 Available Mapping

DOGAMI has developed several publications which were used in our assessments related to the stormwater and wastewater facilities. These included site geology, landslide hazard, and peak ground accelerations associated with a Cascadia Subduction Zone earthquake. Datasets of interest for this project include the following:

- Geology: Oregon Geologic Data Compilation release 6 (OGDC-6);
- Landslide Hazard: DOGAMI Open-File Report O-16-02; and
- Cascadia Peak Ground Accelerations: DOGAMI Open-File Report O-13-06.

3.3 Geology

The City of St. Helens is at the northern end of the Portland Basin, a structural depression created by complex folding and faulting of the basement rocks. The most prevalent basement rock of the Portland Basin is a sequence of lava flows called the Columbia River Basalt Group (CRBG), which flowed into the area between about 17 million and 6 million years ago (Beeson and others, 1991). Due to the wet and mild climate of the Pacific Northwest, intense chemical weathering of the geologic units has taken place (Evarts, 2004). This has resulted in the development of soil horizons as thick as 10 m. In some instances, the rocks of the CRBG have been completely converted to soil, destroying all primary rock textures.

The Columbia and Willamette Rivers converge within the Portland Basin and, with their tributaries, have contributed to an extensive sedimentary fill which overlies the basement rock formations. Beeson and others (1991) mapped the local Portland Basin fill sediments as Sandy River Mudstone, overlain by Troutdale Formation. The Troutdale Formation locally consists of well-consolidated friable to moderately well-cemented conglomerate and sandstone, deposited in the Miocene to Pliocene epochs (about 12.5 million to 1.6 million years ago).

The Troutdale Formation is locally overlain by sediments deposited during a series of catastrophic glacial outburst floods. During the late stages of the last great ice age, between about 18,000 and 15,000 years ago, a lobe of the continental ice sheet repeatedly blocked and dammed the Clark Fork River in western Montana, which then formed an immense glacial lake called Lake Missoula. The lake grew until its depth was sufficient to buoyantly lift and rupture the ice dam, which allowed the entire massive lake to empty catastrophically. Once the lake had emptied, the ice sheet again gradually dammed the Clark Fork Valley and the lake refilled, leading to 40 or more repetitive outburst floods at intervals of decades (Allen and others, 2009). During each short-lived episode, floodwaters washed across the Idaho panhandle, through the eastern Washington scablands, and through the Columbia River Gorge. When the floodwater emerged from the western end of the gorge, it spread out over the Portland Basin and up the Willamette Valley as far south as Junction City, depositing a tremendous load of sediment (O'Conner and others, 2001).

The geologic map presented on Figure 4 comes directly from the Oregon Geologic Data Compilation release 6 (OGDC-6).

3.3.1 Regional Seismological Setting

Earthquakes in the Pacific Northwest occur largely as a result of the subduction of the Juan de Fuca plate beneath the North American plate along the Cascadia Subduction Zone (CSZ). The CSZ is located approximately parallel to the coastline from northern California to southern British Columbia. The compressional forces that exist between these two colliding plates cause the oceanic Juan de Fuca plate to descend, or subduct, beneath the continental plate at a rate of about 1.5-inches per year (DeMets and others, 1990). This process leads to volcanism in the North American plate and stresses and faulting in both plates throughout much of the western regions of southern British Columbia, Washington, Oregon, and northern California. Stress between the colliding plates is periodically relieved through great earthquakes at the CSZ plate interface.

Within the regional tectonic framework and historical seismicity, three broad earthquake sources are identified:

- Subduction Zone Interface Earthquakes originate along the CSZ, which is located 25 miles beneath the coastline. Paleoseismic evidence and historic tsunami records from Japan indicate that the most recent subduction zone interface event was in 1700 AD and was an approximately magnitude 9 earthquake that likely ruptured the full length of the CSZ.
- Deep-Focus, Intraplate Earthquakes originate from within the subducting Juan de Fuca oceanic plate as a result of the downward bending and tension in the subducted plate. These earthquakes typically occur 28 to 38 miles beneath the surface. Such events on the

CSZ are estimated to be as large as magnitude 7.5. Historic earthquakes include the 1949 magnitude 7.1 Olympia earthquake, the 1965 magnitude 6.5 earthquake between Tacoma and Seattle, and the magnitude 6.8 2001 Nisqually earthquake. The highest rate of CSZ intraslab activity is beneath the Puget Sound area, with much lower rates observed beneath western Oregon.

- Shallow-Focus Crustal Earthquakes are typically located within the upper 12 miles of the earth's surface. The relative plate movements along the CSZ cause not only east-west compressive strain but dextral shear, clockwise rotation, and north-south compression of the leading edge of the North American Plate (Wells and others, 1998), which is the cause of much of the shallow crustal seismicity of engineering significance in the region. The largest known crustal earthquake in the Pacific Northwest is the 1872 North Cascades earthquake with an estimated magnitude of about 7. Other examples include the 1993 magnitude 5.6 Scotts Mill earthquake and magnitudes 5.9 and 6.0 Klamath Falls earthquakes. According to the USGS Quaternary Fault and Fold database (USGS, 2021), there are no Class A features within approximately 5 miles of the project site.

3.4 Liquefaction Hazard

The statewide liquefaction map of the state is a compilation of liquefaction susceptibility maps from other DOGAMI publications. Within the St. Helens area, this is IMS-7 (Madin and Wang, 1999). While this is a purpose-made liquefaction hazard map for the area, it was based primarily on aerial photo interpretation, geologic mapping from 1946, and water well data. Since the development of IMS-7, new geologic mapping was conducted (Evarts, 2004). In order to allow for a liquefaction hazard map based on the updated geologic mapping, we employed the Youd and Perkins 1978 methodology to convert the mapped geology to liquefaction susceptibility. The resulting map can be seen on Figure 5.

3.5 Landslide Hazard

The landslide hazard map presented on Figure 6 comes from the DOGAMI Open-File Report O-16-02. This overview map encompasses the entire state of Oregon and was designed to be used for regional planning. Susceptibility categories are broken into four categories (low, moderate, high, and very high), where very high denotes areas of mapped landslides.

The relative landslide hazard risk was developed by DOGAMI by creating a generalized geology-landslide intersect map and a percent slope map. Spatial statistics were then used to determine the mean and standard deviation of slope angles within landslides per geologic unit. Thirty percent of the area within the statewide hazard map consists of High or Very High hazard slopes and 80 percent of the landslides are located within this area.

Limitations of the input and modeling mean that the map should only be used for general planning purposes, and the map cannot be used as a substitute for geotechnical explorations, laboratory testing, and detailed site-specific analyses.

4 SUMMARY OF FINDINGS

The majority of the pipelines in need of replacement are located in areas mapped as rock. However, pipeline assets on the western portion of the basin are also mapped in Missoula Flood Deposits with small areas of alluvium. Assets within approximately 500 to 600 feet of the Willamette River pipeline, are located in recent alluvium and fill. The primary geologic hazard in the areas mapped as rock is strong ground motions.

Potential seismic hazards outside of the areas mapped as rock are expected to be related to liquefaction, and liquefaction-related phenomena such as settlement, lateral spreading, and post-seismic soil strength reduction. The risk of other seismic hazards, such as fault rupture, is low within the study area. Additionally, the potential need for rock excavation will be discussed in the following sections.

4.1 Landslides

According to the Department of Geology and Mineral Industries (DOGAMI), the existing pipelines are located within zones of low to high landslide hazard. While none of the mapped facilities are located within a mapped landslide, select stormwater facilities at the northernmost extent of the project area are adjacent to areas of very high landslide hazard indicating there are existing landslides.

4.2 Liquefaction and Lateral Spread

Soil liquefaction occurs in susceptible subsurface soils below the groundwater level. It is a phenomenon in which excess pore water pressure of loose to medium dense, saturated, granular soils increases during ground shaking to a level near the initial effective stress. The increased excess pore pressure results in a reduction of soil shear strength. Given that sands were observed at the ground surface and likely underlie a large portion of the project area, liquefaction is a potential hazard within the project area. A map of liquefaction susceptibility prepared using the Oregon Geologic Data Compilation release 6 (OGDC-6) and the Youd and Perkins, 1978 methodology, and included as Figure 5, indicates that much of the project area has no liquefaction hazard as the area is mapped as rock. However, select pipelines at the westernmost extent of the project area and on the eastern outfalls have moderate to high liquefaction risks. Again, the effects of liquefaction typically include lateral spreading, slope instability, ground settlement, and strength reductions, such as lower allowable soil bearing.

We note that this hazard assessment is based solely on soil type and does not consider ground water presence or the absence of groundwater. If groundwater is not present at the site, the DOGAMI hazard map is likely overestimating the liquefaction potential. The relative density also impacts the liquefaction potential of the sands. Obtaining site specific borings or Cone Penetrometer Tests (CPTs) and laboratory tests on collected soil samples to assess the density of the sand was outside the scope of this study, but we recommend that they be performed during design to further assess the extent of the liquefaction hazard.

Lateral spreading hazards can exist in areas with mild slopes adjacent to a much steeper slope or vertical face. Lateral spreading failure can occur if soil liquefaction develops during a seismic event and the ground acceleration (inertial force) briefly surpasses the yield acceleration (shear strength) of the liquefied soil. This can cause both the liquefied soil and an overlying non-liquefied crust of soil to displace laterally down mild slopes towards an embankment face, or the banks of streams, rivers, and other bodies of water. The displacements are cumulative and permanent in nature. If liquefaction occurs there is risk of post seismic slope instability and potential lateral displacement towards the existing slope to the northeast.

4.2.1 Liquefaction Induced Post-Seismic Settlement

Settlement will likely occur in cohesionless soil below the groundwater table that undergo liquefaction and pore pressure development during ground shaking. The settlement is related to densification and rearrangement of particles during ground shaking, as well as volume change, as the excess pore pressure dissipates after ground shaking. Seismic ground settlement does not typically occur uniformly over an area, and differential settlement may impact existing or proposed structures and infrastructure supported by liquefied soil and/or within the liquified zones. Differential settlement is often estimated to range between 50 and 80 percent of the total settlement. Consequences of seismic-induced settlement would be subsequent settlement of shallow foundations overlying the liquefied soil.

4.2.2 Fault Rupture

Quaternary crustal faults and folds throughout Oregon and Washington have been located and characterized by the United States Geological Survey (USGS). The USGS provides approximate fault locations and a detailed summary of available fault information in the USGS Quaternary Fault and Fold Database. The database defines four categories of faults, Class A through D, based on evidence of tectonic movement known or presumed to be associated with large earthquakes during Quaternary time (within the last 2.58 million years). For Class A faults, geologic evidence demonstrates that a tectonic fault exists and that it has likely been active within the Quaternary period. For Class B faults, there is equivocal geologic evidence of Quaternary tectonic deformation, or the fault may not extend deep enough to be considered a source of significant earthquakes. Class C and D faults lack convincing geologic evidence of Quaternary tectonic deformation or have been studied carefully enough to determine that they are not likely to generate significant earthquakes.

The closest Class A or Class B fault to the site is the Portland Hills Fault, mapped more than 5 miles from the project location, and is shown on the Fault Vicinity Map, Figure 7. In our opinion the risk of fault rupture at the site is low.

4.3 Rock Excavation

Rock excavation may be necessary where buried improvements are located outside or deeper than the existing utility trenches that are planned in areas mapped as rock. In the past, the City of St. Helen's has successfully used pipe bursting. However, the effectiveness and ease of pipe bursting has been a function of the existing trench width, pipe upsize, and depth of cover. We understand the City does not recommend pipe bursting for any pipes with less than 5-6 feet of cover. The City's historical experience with pipe bursting has been successful for increases of 1 to 2 pipe size diameters. The City has also reported successfully using Horizontal Directional Drilling (HDD) in solid basalt rock at depths over 16 feet below ground surface.

Pipe bursting to replace existing pipe where sewer lines are constructed over the top of shallow rock may not be feasible if adequate cover is not present. Additionally, rock or decomposed rock is relatively incompressible. If pipe bursting is performed in areas where pipes are buried in rock, any change in the density of the material surrounding the pipe that is required for upsizing will need to occur within the trench backfill. As was presented in Figure 4, Geologic Map, the majority of city assets are constructed within areas mapped as basalt. Where pipe bursting is considered as a possible remediation or where new sewers will be constructed outside of the existing trench, a review of as-built construction information, historic geotechnical information, or new geotechnical explorations should be considered to identify and mitigate the potential risk of rock related constructability issues in areas mapped as rock.

5 LIMITATIONS

This letter report was prepared for the exclusive use of the Keller and the City of St. Helens and their representatives for the purpose of planning-related geotechnical site evaluation for wastewater facilities. The assessments contained in this letter are based on the information and data provided to us, and information that is publicly available. This letter report should not be viewed as a warranty of conditions described in this report, such as those interpreted from published maps. The maps should be used for planning level purposes only and not a substitute for geotechnical explorations and laboratory testing that will be required for design. Our findings are based on the limitations of our approved scope, schedule, and budget; and our understanding of the project and information provided by Keller Associates.

For any site located on or near a slope, there are slope instability risks that are present and future owners have to accept, including, but not limited to:

- Natural factors: soil and groundwater conditions, steep topography, heavy rainfall events, erosion, and vegetation conditions; and
- Human-related factors: water leaks, pipe breaks, improper drainage, lack of maintenance of vegetation or drainage facilities, fill or debris placement, excavation and/or removal of trees/vegetation.

Similar circumstances or other unknown conditions may also affect slope stability. Our evaluation and planning level assessments described herein are not a guarantee or warranty of slope stability conditions, nor current and future risks.

Please note that our scope of services did not include any environmental assessment or evaluation regarding the presence or absence of hazardous or toxic materials in the soil, surface water, groundwater, or air, on or below the site.

Shannon & Wilson has prepared the attached, "Important Information About Your Geotechnical/Environmental Report," to assist you and others in understanding the use and limitations of our reports.

6 REFERENCES

Allen, J.E., Burns, M., and Burns, S., 2009, Cataclysms on the Columbia: The Great Missoula Floods (2nd ed.): Portland, Oregon, Ooligan Press, 204 p.

Beeson, M.H., Tolan, T.L., and Madin, I.P., 1991, Geologic Map of the Portland Quadrangle, Multnomah and Washington Counties, Oregon, and Clark County, Washington: Oregon Department of Geology and Mineral Industries, Geological Map Series GMS-75, scale 1:24,000.

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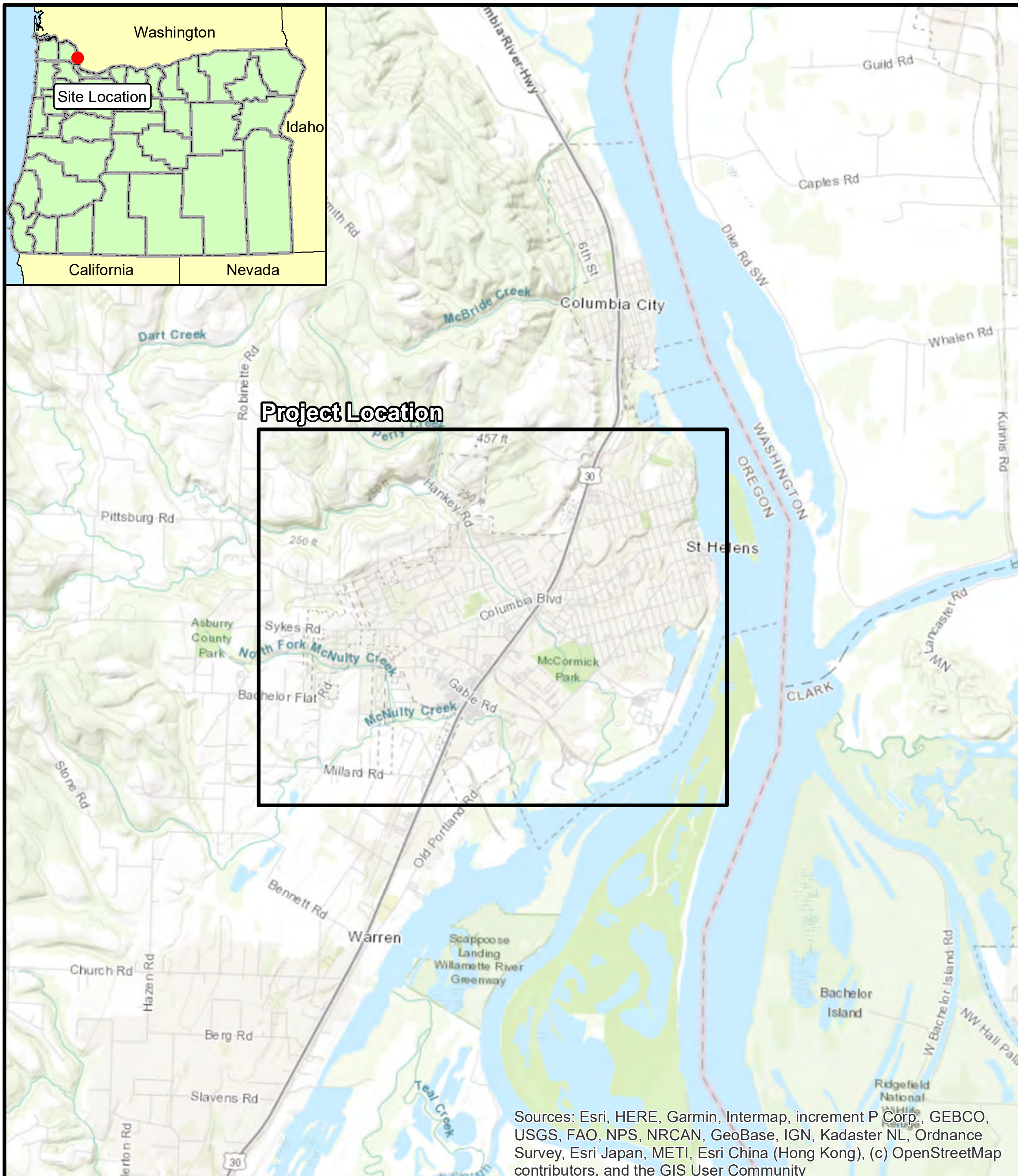

0 0.5 1 2

Scale in Miles

N

St. Helens' Wastewater and Stormwater Master Plan Update
St. Helens, Oregon

VICINITY MAP

November 2021 104961

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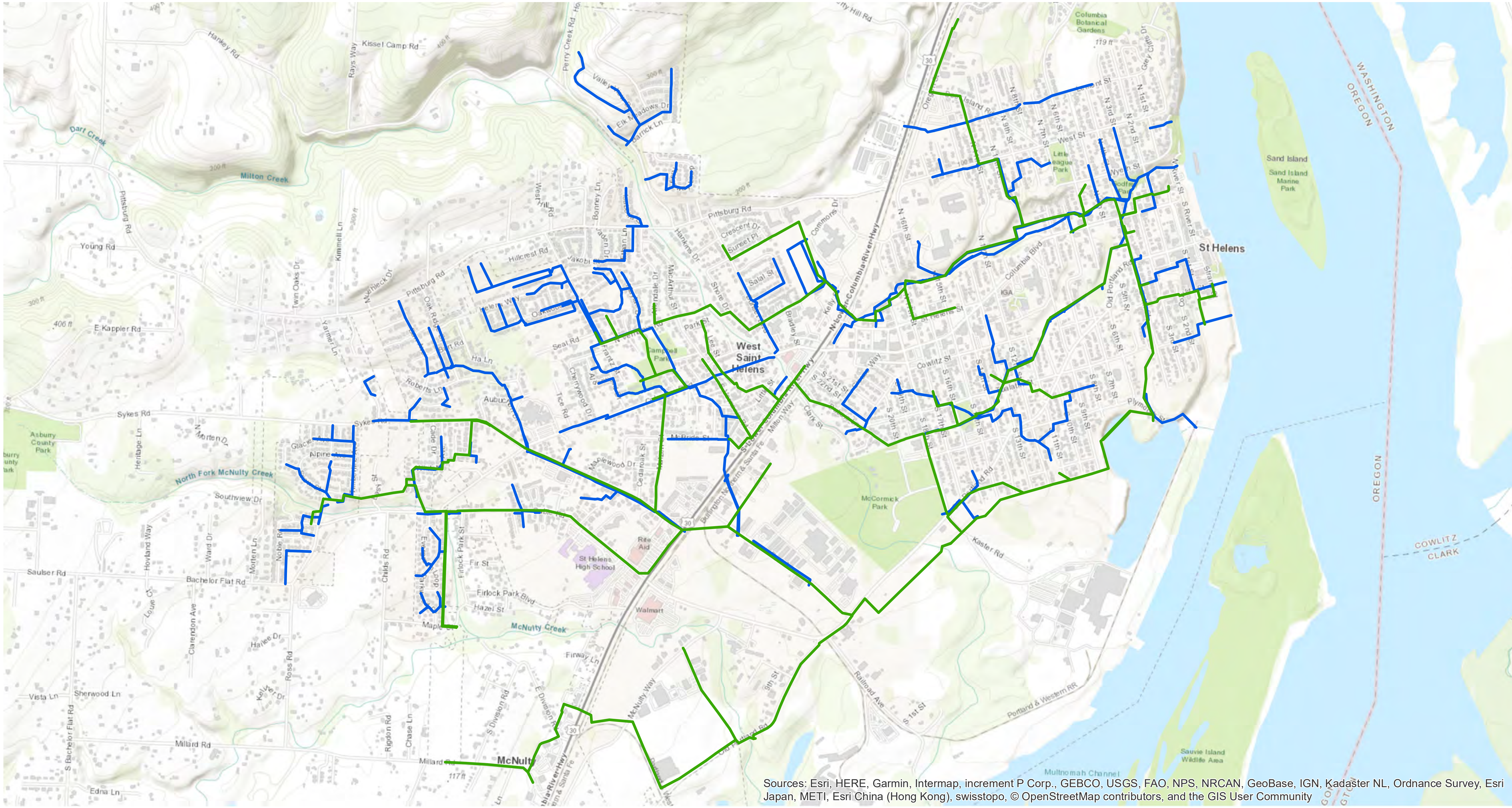
FIG. 1

Filename: I:\EF\PDX\104000s\104961 St. Helen's Sto\GIS Files\2015 Vicinity Map_OR.mxd Date: 6/28/2021 Login: ECM



LEGEND

- Sewer Pipelines
- Stormwater Conduits

0 800 1,600 3,200

Scale in Feet

NOTES

1. Stormwater and sewer assets provided by Keller Associates on June 14, 2021.

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St. Helens, Oregon

SITE PLAN

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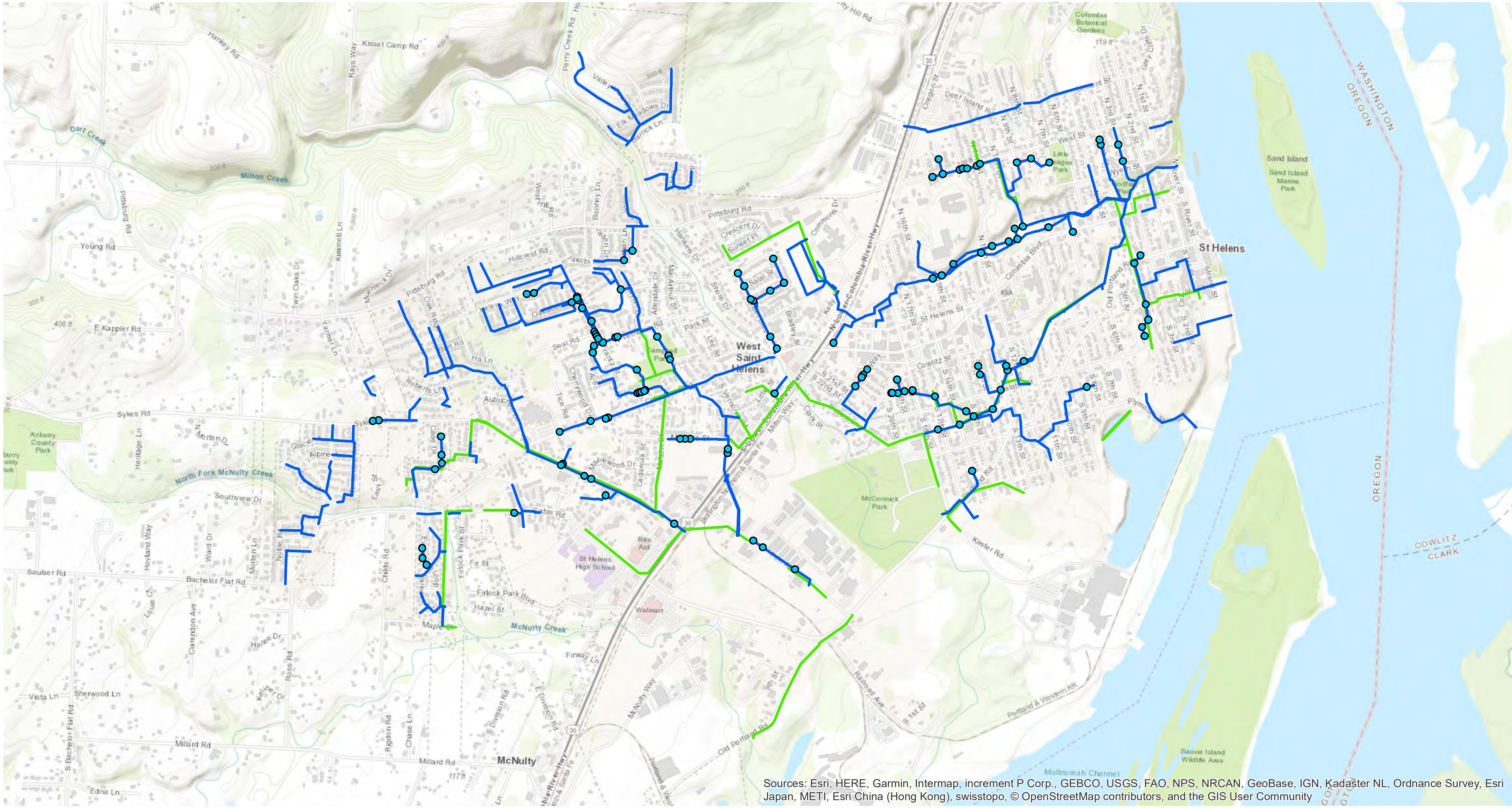
FIG. 2



LEGEND

- Stormwater Junctions Indicating Need of Improvement
- Sewers in need of Improvement
- Stormwater Conduits

0 800 1,600 3,200

Scale in Feet

NOTES

1. Stormwater and sewer assets provided by Keller Associates on June 14, 2021.

St. Helens Stormwater and Wastewater Master Plan Update
St. Helens, Oregon

PIPELINE VULNERABILITIES

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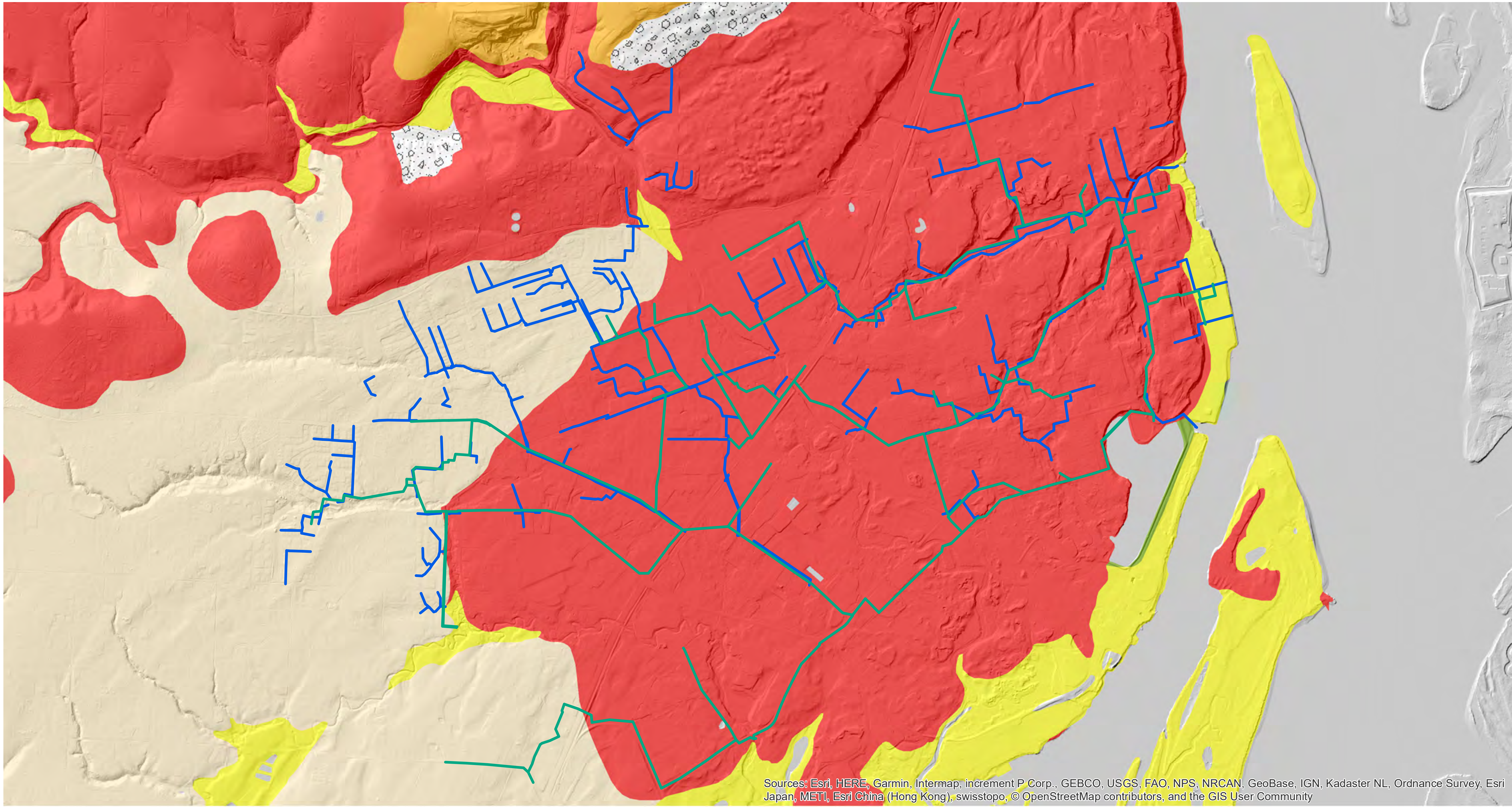
FIG. 3

Filename: T:\Projects\PDX\104000s\104961 - St Helens\Pipeline Vulnerabilities.mxd Date: 6/30/2021 Login: DSJ



LEGEND

Geologic Map Unit

- Alluvial deposits
- Grande Ronde Basalt
- Landslide deposits
- Man-made fill deposits
- Missoula Flood deposits
- Troutdale Formation

- Sewer Pipelines
- Stormwater Conduits

0 800 1,600 3,200

Scale in Feet

NOTES

1. Geologic map from Oregon Geologic Data Compilation release 6 (OGDC-6).
2. LiDAR hillshade from Oregon Lidar Consortium (OLC)

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St. Helens, Oregon

GEOLOGIC MAP

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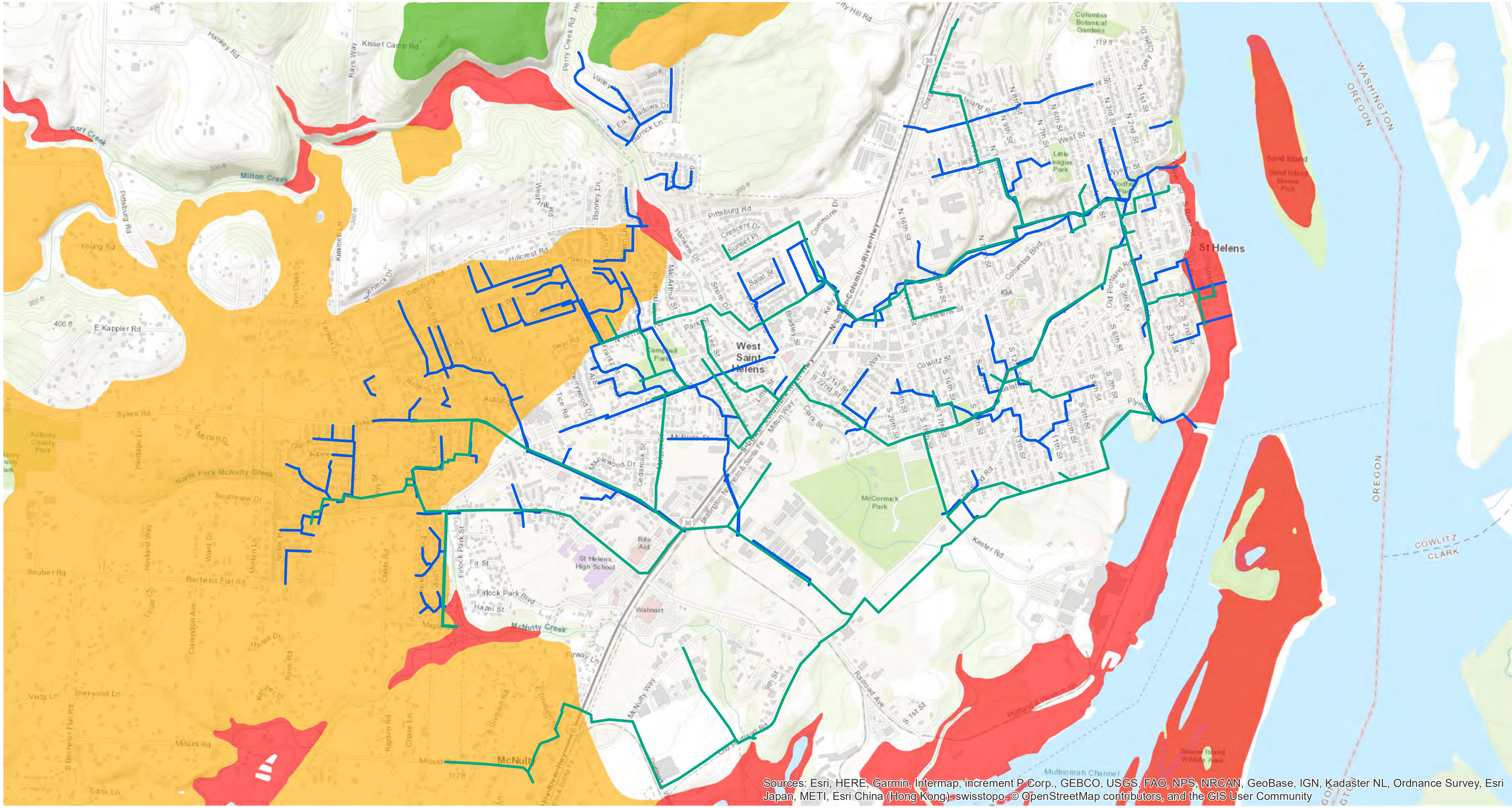
FIG. 4

Filename: T:\Projects\PDX\104000s\104961 - St Helens\Geologic Map.mxd Date: 6/30/2021 Login: DSJ



LEGEND

Liquefaction Hazard

- Low
- Moderate
- High

- Sewer Pipelines
- Stormwater Conduits

0 800 1,600 3,200

Scale in Feet

NOTES

1. Liquefaction hazard developed from data provided with OGDC-6, the Youd and Perkins, 1978 metodology, and knowledge of regional liquefaction hazards.
2. Stormwater and sewer assets provided by Keller Associates on June 14, 2021.

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LIQUEFACTION HAZARD

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FIG. 5

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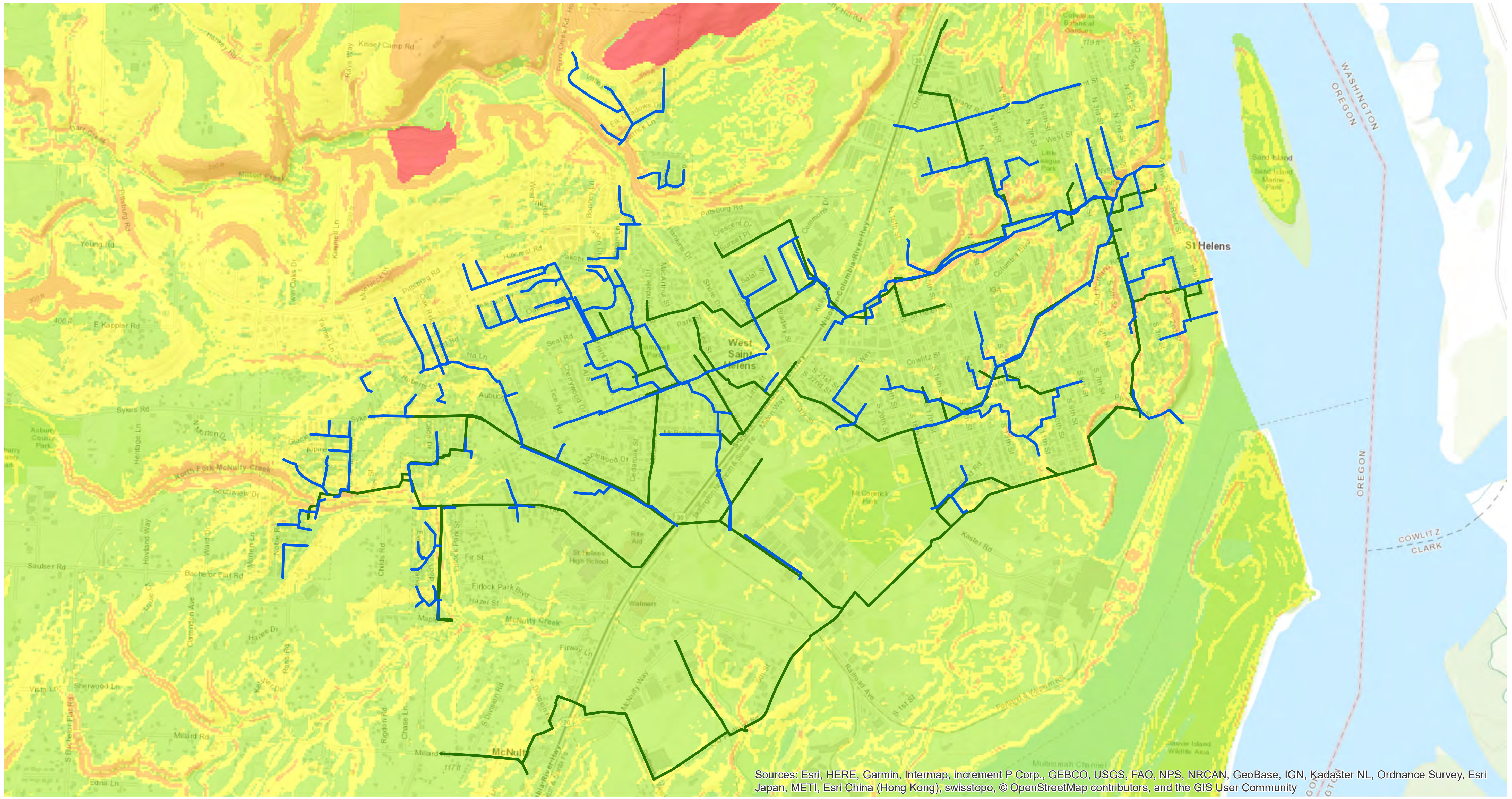

LEGEND

Landslide Susceptibility

- Low
- Moderate
- High
- Very High

- Stormwater Conduits
- Sewer Pipelines

0 800 1,600 3,200

Scale in Feet

NOTES

1. Stormwater and sewer assets provided by Keller Associates on June 14, 2021.
2. Landslide susceptibility from DOGAMI Open-File Report O-16-02.

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LANDSLIDE SUSCEPTIBILITY

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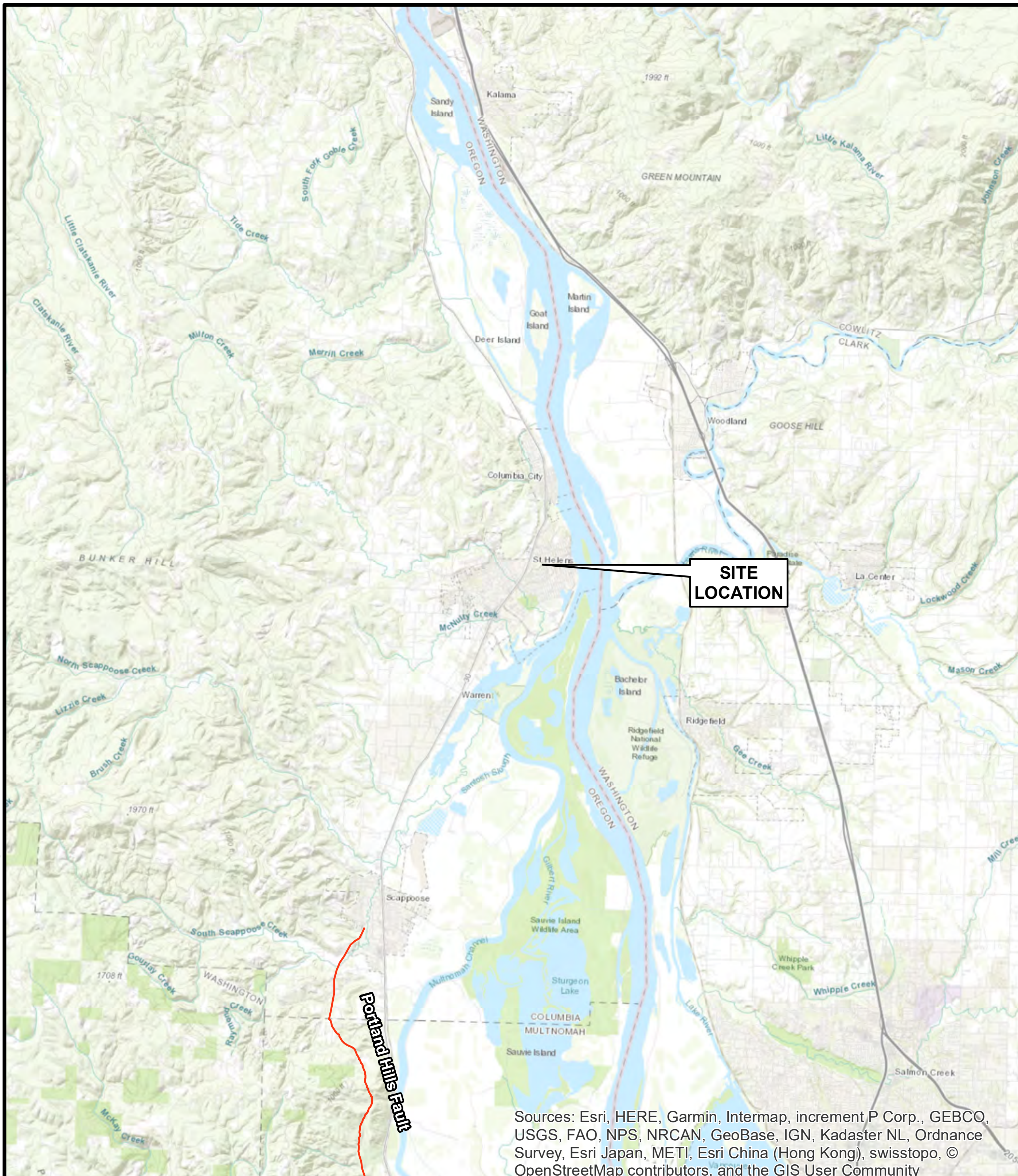
FIG. 6

Filename: T:\Projects\PDX\104000s\104961 - St Helens\Landslide Susceptibility.mxd Date: 6/30/2021 Login: DSJ



0 1.5 3 6

Scale in Miles

N

St. Helens Wastewater and Stormwater Master Plan Update
St. Helens, Oregon

FAULT MAP

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FIG. 7

Filename: T:\Projects\PDX\104000s\104961 - St Helens\Fault Map.mxd Date: 6/30/2021 Login: DSJ

ATTACHMENT A

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL/ENVIRONMENTAL REPORT

SHANNON & WILSON
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Attachment to and part of Report: 104961
Date: November 2021
To: Peter Olsen
Keller Associates

Important Information About Your Geotechnical/Environmental Report

CONSULTING SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND FOR SPECIFIC CLIENTS.

Consultants prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your consultant prepared your report expressly for you and expressly for the purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the consultant. No party should apply this report for any purpose other than that originally contemplated without first conferring with the consultant.

THE CONSULTANT'S REPORT IS BASED ON PROJECT-SPECIFIC FACTORS.

A geotechnical/environmental report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. Depending on the project, these may include the general nature of the structure and property involved; its size and configuration; its historical use and practice; the location of the structure on the site and its orientation; other improvements such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask the consultant to evaluate how any factors that change subsequent to the date of the report may affect the recommendations. Unless your consultant indicates otherwise, your report should not be used (1) when the nature of the proposed project is changed (for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one, or chemicals are discovered on or near the site); (2) when the size, elevation, or configuration of the proposed project is altered; (3) when the location or orientation of the proposed project is modified; (4) when there is a change of ownership; or (5) for application to an adjacent site. Consultants cannot accept responsibility for problems that may occur if they are not consulted after factors that were considered in the development of the report have changed.

SUBSURFACE CONDITIONS CAN CHANGE.

Subsurface conditions may be affected as a result of natural processes or human activity. Because a geotechnical/environmental report is based on conditions that existed at the time of subsurface exploration, construction decisions should not be based on a report whose adequacy may have been affected by time. Ask the consultant to advise if additional tests are desirable before construction starts; for example, groundwater conditions commonly vary seasonally.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes, or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical/environmental report. The consultant should be kept apprised of any such events and should be consulted to determine if additional tests are necessary.

MOST RECOMMENDATIONS ARE PROFESSIONAL JUDGMENTS.

Site exploration and testing identifies actual surface and subsurface conditions only at those points where samples are taken. The data were extrapolated by your consultant, who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your consultant can work together to help reduce their impacts. Retaining your consultant to observe subsurface construction operations can be particularly beneficial in this respect.

A REPORT'S CONCLUSIONS ARE PRELIMINARY.

The conclusions contained in your consultant's report are preliminary, because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Actual subsurface conditions can be discerned only during earthwork; therefore, you should retain your consultant to observe actual conditions and to provide conclusions. Only the consultant who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations based on those conclusions are valid and whether or not the contractor is abiding by applicable recommendations. The consultant who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

THE CONSULTANT'S REPORT IS SUBJECT TO MISINTERPRETATION.

Costly problems can occur when other design professionals develop their plans based on misinterpretation of a geotechnical/environmental report. To help avoid these problems, the consultant should be retained to work with other project design professionals to explain relevant geotechnical, geological, hydrogeological, and environmental findings, and to review the adequacy of their plans and specifications relative to these issues.

BORING LOGS AND/OR MONITORING WELL DATA SHOULD NOT BE SEPARATED FROM THE REPORT.

Final boring logs developed by the consultant are based upon interpretation of field logs (assembled by site personnel), field test results, and laboratory and/or office evaluation of field samples and data. Only final boring logs and data are customarily included in geotechnical/environmental reports. These final logs should not, under any circumstances, be redrawn for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process.

To reduce the likelihood of boring log or monitoring well misinterpretation, contractors should be given ready access to the complete geotechnical engineering/environmental report prepared or authorized for their use. If access is provided only to the report prepared for you, you should advise contractors of the report's limitations, assuming that a contractor was not one of the specific persons for whom the report was prepared, and that developing construction cost estimates was not one of the specific purposes for which it was prepared. While a contractor may gain important knowledge from a report prepared for another party, the contractor should discuss the report with your consultant and perform the additional or alternative work believed necessary to obtain the data specifically appropriate for construction cost estimating purposes. Some clients hold the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes that aggravate them to a disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY.

Because geotechnical/environmental engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against consultants. To help prevent this problem, consultants have developed a number of clauses for use in their contracts, reports, and other documents. These responsibility clauses are not exculpatory clauses designed to transfer the consultant's liabilities to other parties; rather, they are definitive clauses that identify where the consultant's responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your report, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to your questions.

The preceding paragraphs are based on information provided by the GBA, Silver Spring, Maryland

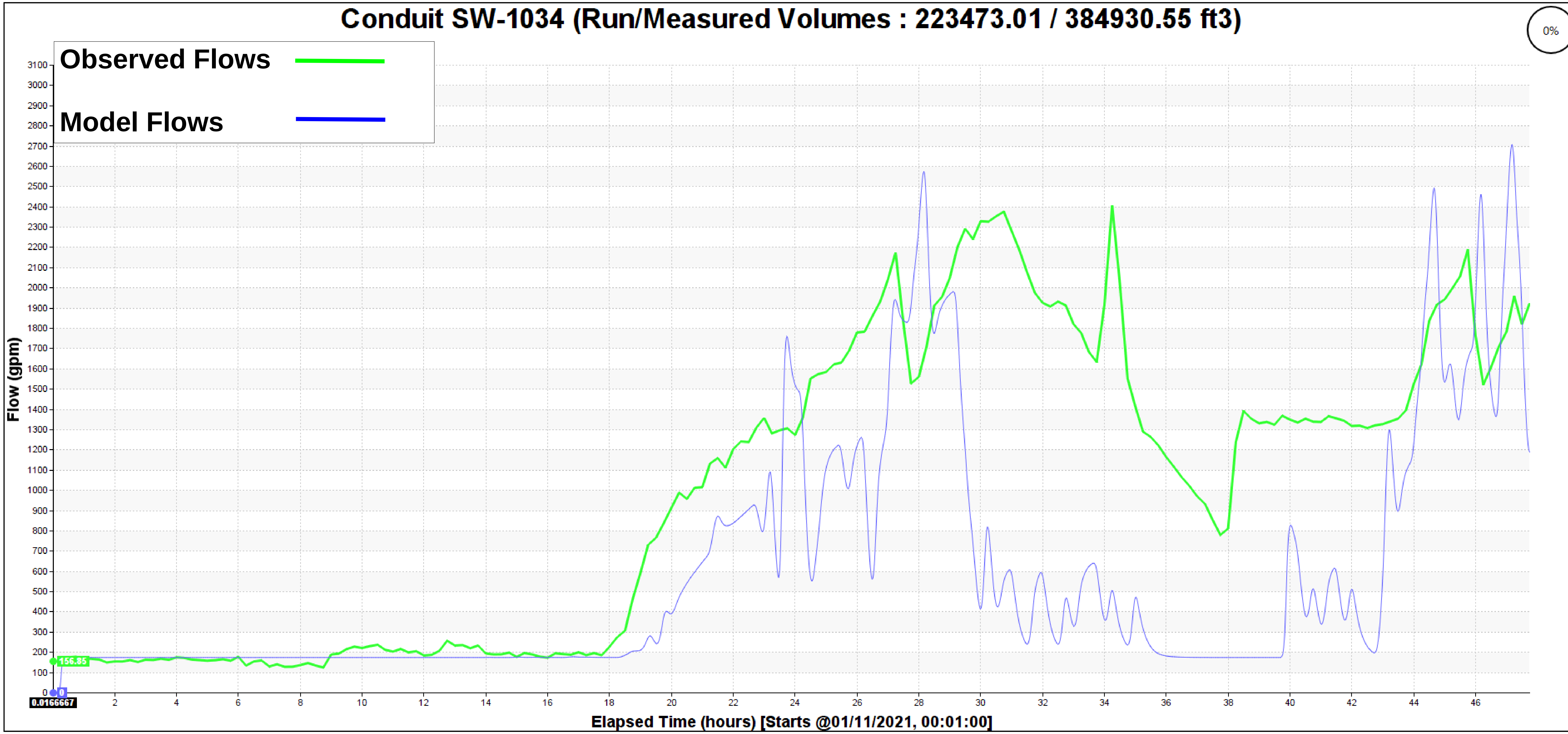
APPENDIX D

Calibration Summary

KELLER ASSOCIATES

Storm Event: January 11th - 12th.
Site 1 - SW-1034

Reduction of CN's by 7.5%
The storage nodes invert is set to the contour elevation
The connecting pipe has 0% slope and inverts equal to the rim elevation of the manholes.
Baseflow of 175 gpm upstream of ravine

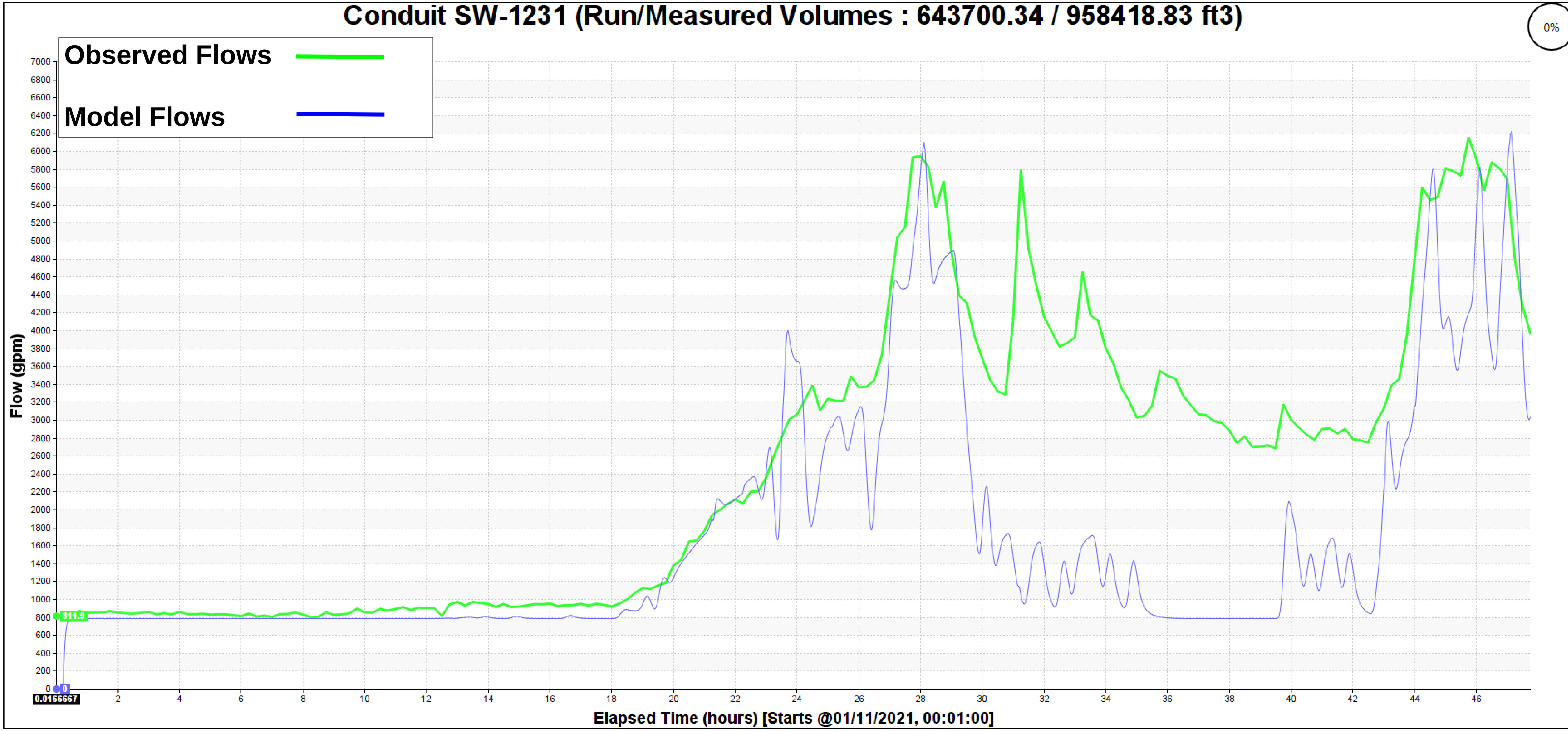


Flow Monitor Site	CN Adjustment	Baseflow for Event 1 (gpm)	Percent difference between model and recorded flows	
			Event 1: Jan 11th - 12th	Event 2: Jan 2nd - 4th
Site 1 (Middle Trunk)	Reduce 7.5%	175	7%	33%
Site 2 (Sykes Road)	Reduce 5%	800	3%	16%
Site 3 (Harris Street)	Reduce 5%	200	7%	2%
Site 4 (Columbia Boulevard)	Reduce 5%	0	5%	-2%

1) Positive value indicated model flows are higher than observed flows

Storm Event: January 11th - 12th.
Site 2 - SW-1231

Reduction of CN's by 5%
Base flow of 800 gpm

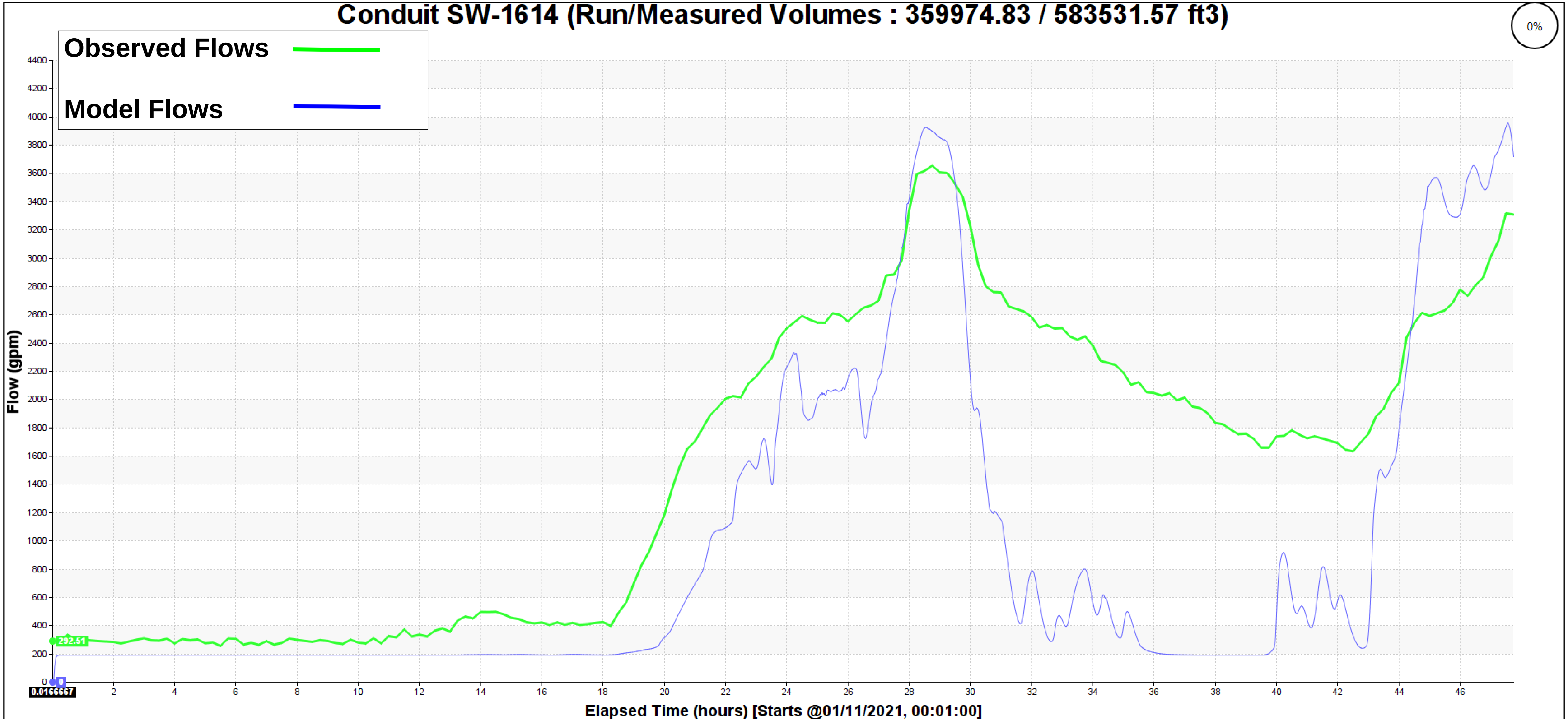


Flow Monitor Site	CN Adjustment	Baseflow for Event 1 (gpm)	Percent difference between model and recorded flows	
			Event 1: Jan 11th – 12th	Event 2: Jan 2nd – 4th
Site 1 (Middle Trunk)	Reduce 7.5%	175	7%	33%
Site 2 (Sykes Road)	Reduce 5%	800	3%	16%
Site 3 (Harris Street)	Reduce 5%	200	7%	2%
Site 4 (Columbia Boulevard)	Reduce 5%	0	5%	-2%

1) Positive value indicated model flows are higher than observed flows

Storm Event: January 11th - 12th.
Site 3 - SW-1614

Reduction of CN's by 7.5%
Base flow of 200 gpm downstream of flow split

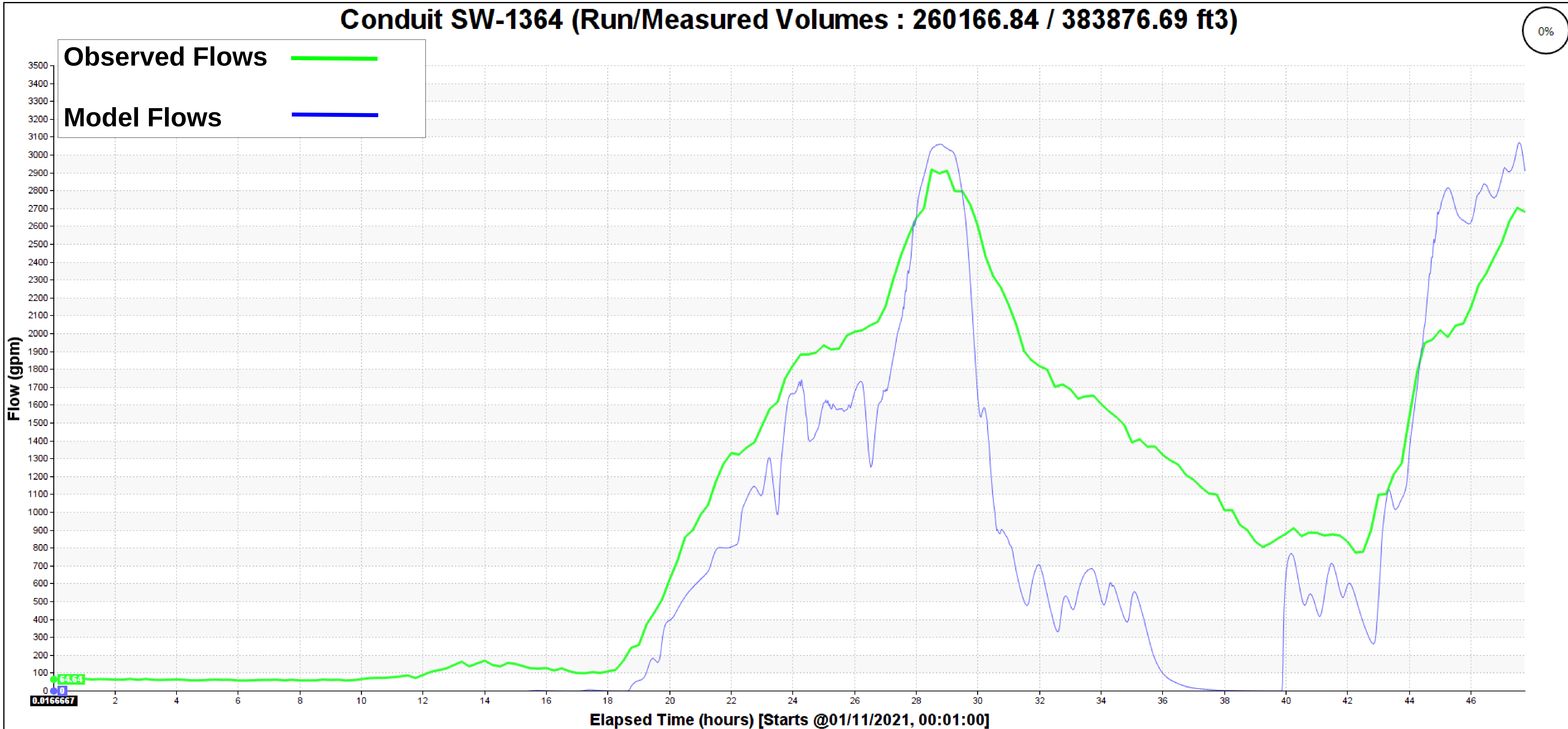


Flow Monitor Site	CN Adjustment	Baseflow for Event 1 (gpm)	Percent difference between model and recorded flows	
			Event 1: Jan 11th - 12th	Event 2: Jan 2nd - 4th
Site 1 (Middle Trunk)	Reduce 7.5%	175	7%	33%
Site 2 (Sykes Road)	Reduce 5%	800	3%	16%
Site 3 (Harris Street)	Reduce 5%	200	7%	2%
Site 4 (Columbia Boulevard)	Reduce 5%	0	5%	-2%

1) Positive value indicated model flows are higher than observed flows

Storm Event: January 11th - 12th.
Site 4 - SW-1364

Reduction in CN's by 7.5%
No base flow

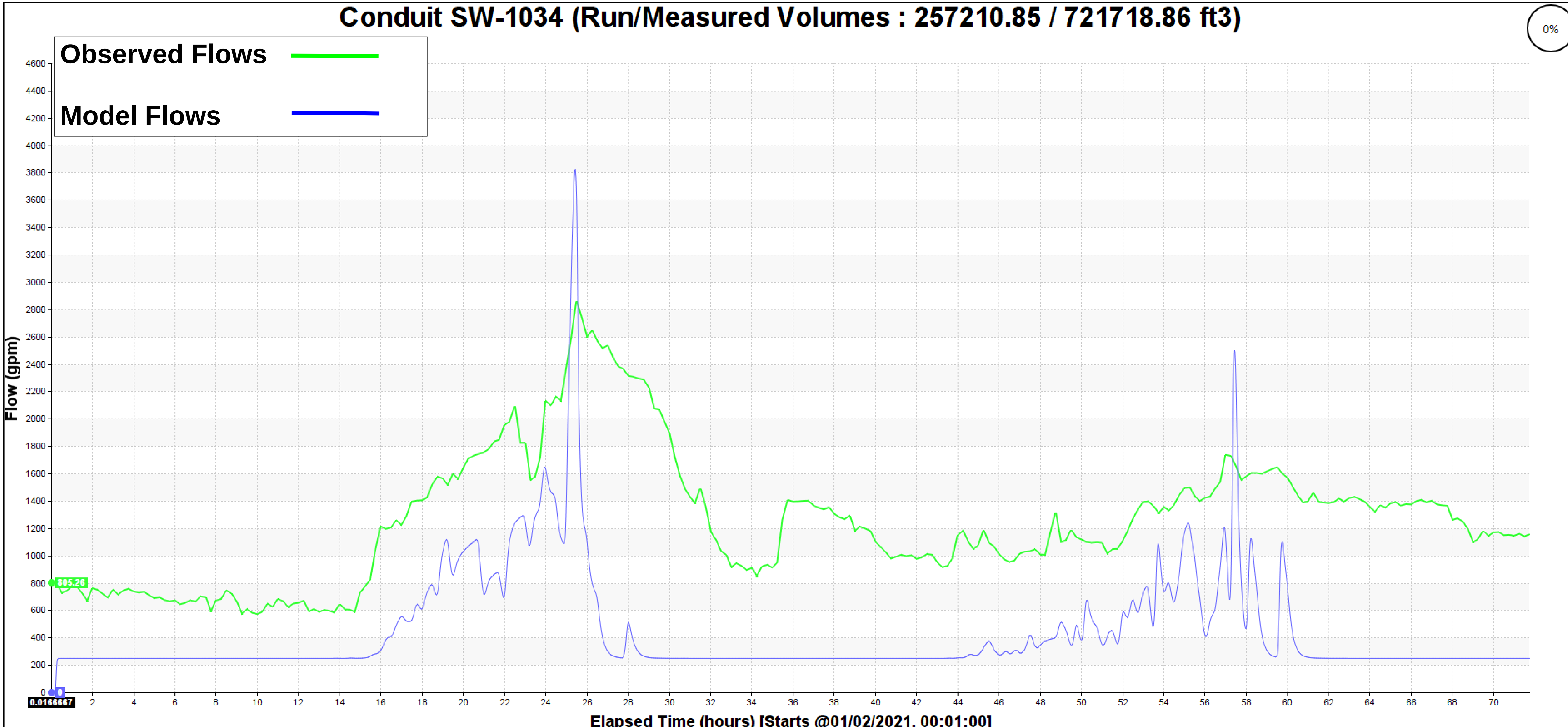


Flow Monitor Site	CN Adjustment	Baseflow for Event 1 (gpm)	Percent difference between model and recorded flows	
			Event 1: Jan 11th - 12th	Event 2: Jan 2nd - 4th
Site 1 (Middle Trunk)	Reduce 7.5%	175	7%	33%
Site 2 (Sykes Road)	Reduce 5%	800	3%	16%
Site 3 (Harris Street)	Reduce 5%	200	7%	2%
Site 4 (Columbia Boulevard)	Reduce 5%	0	5%	-2%

1) Positive value indicated model flows are higher than observed flows

Storm Event: January 2nd - 4th.
Site 1 - SW-1034

Reduction of CN's by 7.5%
The storage nodes invert is set to the contour elevation
The connecting pipe has 0% slope and inverts equal to the rim elevation of the manholes.

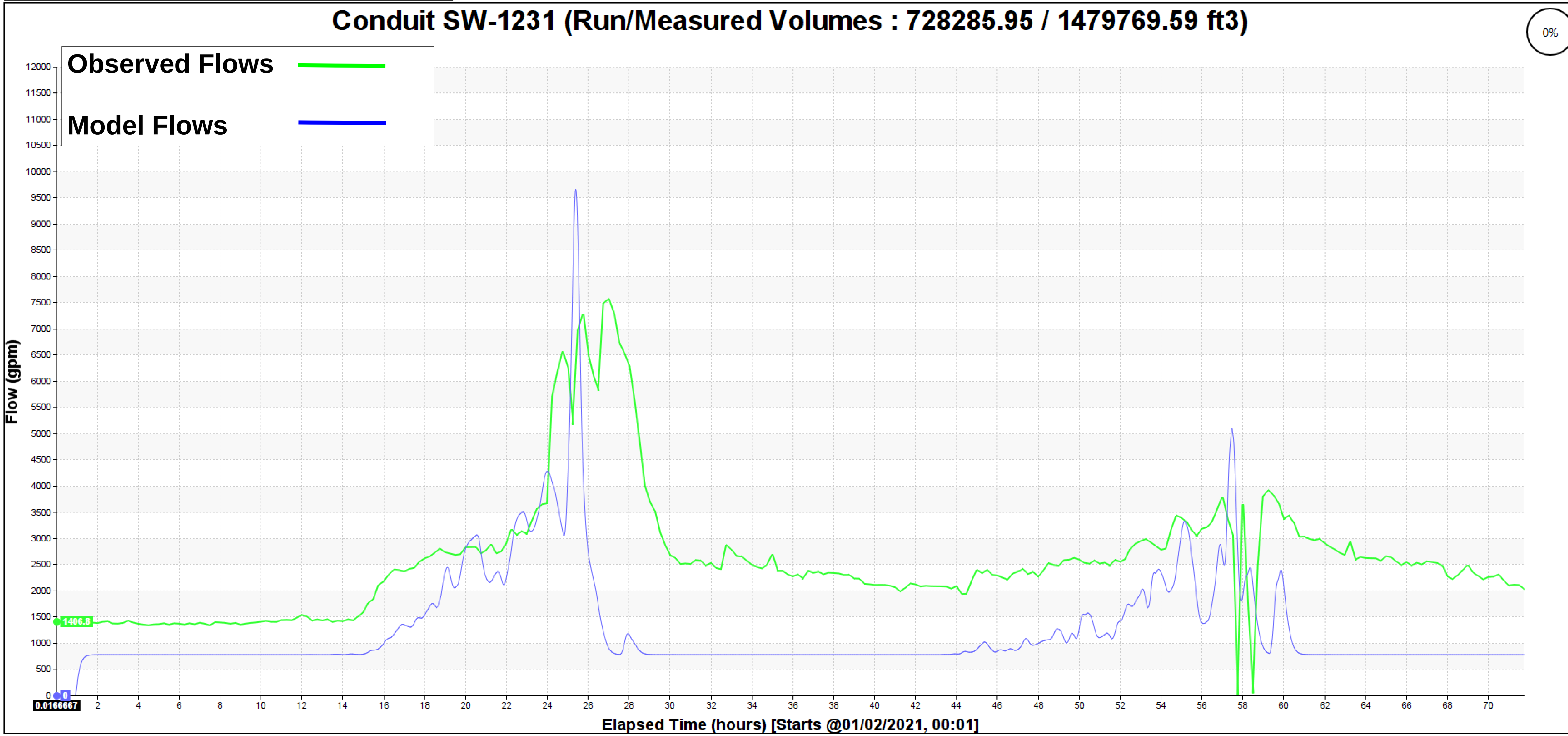


Flow Monitor Site	CN Adjustment	Baseflow for Event 1 (gpm)	Percent difference between model and recorded flows	
			Event 1: Jan 11th - 12th	Event 2: Jan 2nd - 4th
Site 1 (Middle Trunk)	Reduce 7.5%	175	7%	33%
Site 2 (Sykes Road)	Reduce 5%	800	3%	16%
Site 3 (Harris Street)	Reduce 5%	200	7%	2%
Site 4 (Columbia Boulevard)	Reduce 5%	0	5%	-2%

1) Positive value indicated model flows are higher than observed flows

Storm Event: January 2nd - 4th.
Site 2 - SW-1231

Reduction in CN's by 5%
Base flow of 800 gpm

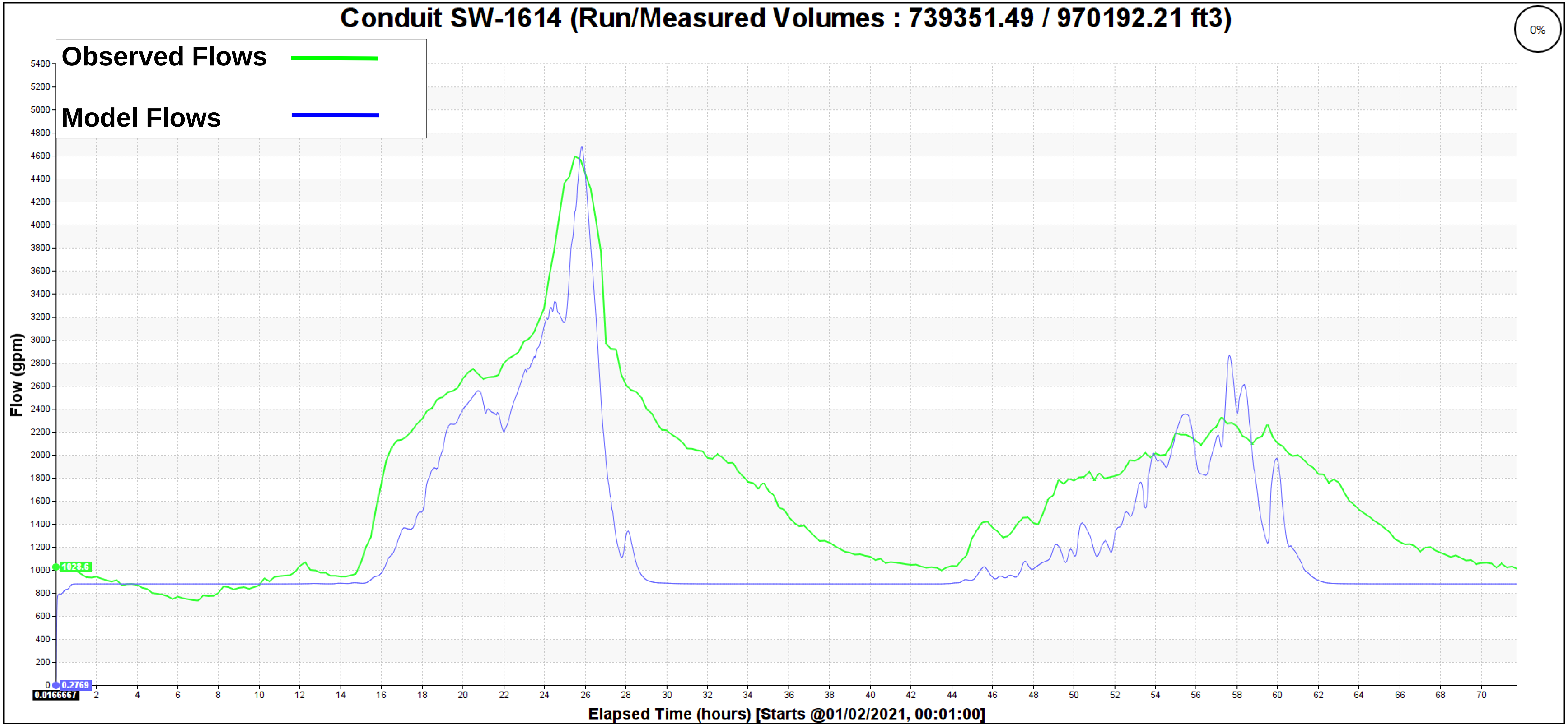


Flow Monitor Site	CN Adjustment	Baseflow for Event 1 (gpm)	Percent difference between model and recorded flows	
			Event 1: Jan 11th - 12th	Event 2: Jan 2nd - 4th
Site 1 (Middle Trunk)	Reduce 7.5%	175	7%	33%
Site 2 (Sykes Road)	Reduce 5%	800	3%	16%
Site 3 (Harris Street)	Reduce 5%	200	7%	2%
Site 4 (Columbia Boulevard)	Reduce 5%	0	5%	-2%

1) Positive value indicated model flows are higher than observed flows

Storm Event: January 2nd - 4th.
Site 3 - SW-1614

Reduction of CN's by 7.5%
Base flow of 800 gpm downstream of flow split

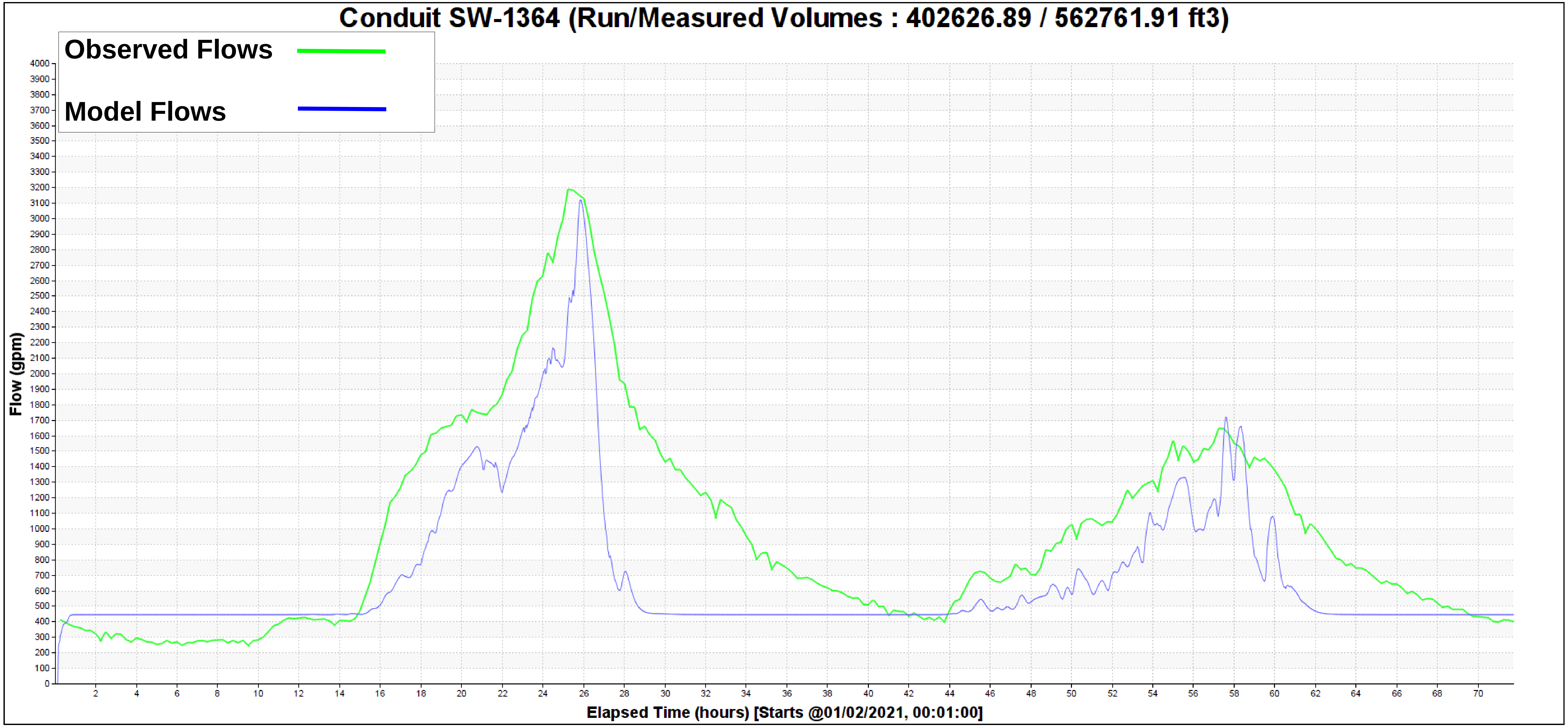


Flow Monitor Site	CN Adjustment	Baseflow for Event 1 (gpm)	Percent difference between model and recorded flows	
			Event 1: Jan 11th - 12th	Event 2: Jan 2nd - 4th
Site 1 (Middle Trunk)	Reduce 7.5%	175	7%	33%
Site 2 (Sykes Road)	Reduce 5%	800	3%	16%
Site 3 (Harris Street)	Reduce 5%	200	7%	2%
Site 4 (Columbia Boulevard)	Reduce 5%	0	5%	-2%

1) Positive value indicated model flows are higher than observed flows

Storm Event: January 2nd - 4th.
Site 4 - SW-1364

Reduction of CN's by 7.5%
Base flow of 450 gpm upstream of split



Flow Monitor Site	CN Adjustment	Baseflow for Event 1 (gpm)	Percent difference between model and recorded flows	
			Event 1: Jan 11th - 12th	Event 2: Jan 2nd - 4th
Site 1 (Middle Trunk)	Reduce 7.5%	175	7%	33%
Site 2 (Sykes Road)	Reduce 5%	800	3%	16%
Site 3 (Harris Street)	Reduce 5%	200	7%	2%
Site 4 (Columbia Boulevard)	Reduce 5%	0	5%	-2%

1) Positive value indicated model flows are higher than observed flows

APPENDIX E

Alternative Cost Estimates

KELLER ASSOCIATES

St. Helens Stormwater Master Plan
Alternative Cost Estimates

North Trunk Alternative 1				
Item	**Unit**	**Unit Price**	**Est. Qty**	**Cost (2021)**
30-inch Pipe - Excavation, Backfill	LF	$230	420	$96,600
36-inch Culvert - Excavation, Backfill (>10' Depth)	LF	$384	160	$61,440
36-inch Culvert - Excavation, Backfill	LF	$202	220	$44,352
72-Inch, Standard Manhole	EA	$16,500	3	$49,500
Pond Clearing, Grubbing, and Earthwork as Necessary	LS	$15,000	1	$15,000
Berm Construction	LF	$30	470	$14,100
Concrete Outlet Flow Control Structure, 72-inch	EA	$15,000	1	$15,000
Flow Control Manhole	EA	$15,000	1	$15,000
Soil Surface Repair, Seeding, and Stabilization	LF	$5	420	$2,100
Rock Excavation	CY	$300	210	$63,000
Roadway Restoration (Full Lane)	LF	$75	220	$16,500
Traffic Control With Flagging	LS	$14,000	1	$14,000
Existing Utility Protection	LF	$4	800	$3,200
ADA Ramp Reconstruction (Compliance)	EA	$4,600	2	$9,200
			Subtotal (Rounded)	**$419,000**
Mobilization	LS	5%	1	$20,950
Contingency	LS	30%	1	$125,700
			Construction Subtotal (Rounded)	**$566,000**
Property Acquisition	SF	$10	43,560	$435,600
Permitting (Field work, JPA, and application. Assumes SLOPES V)	LS	$50,000	1	$50,000
Geotechnical (assume 8% of total)	LS	$45,000	1	$45,000
Surveying	LS	$8,000	1	$8,000
Engineering and CMS	LS	20%	1	$113,200
Legal and Admin	LS	$5,000	1	$5,000
			Total Project Cost (Rounded)	**$1,223,000**

North Trunk Alternative 2				
Item	**Unit**	**Unit Price**	**Est. Qty**	**Cost (2021)**
36-inch Pipe - Excavation, Backfill	LF	$245	3,400	$833,000
72-Inch, Standard Manhole	EA	$16,500	16	$264,000
Soil Surface Repair	LF	$5	2,750	$13,750
Rock Excavation	CY	$300	1,322	$396,667
Local Road Full Lane Asphalt Repair	LF	$75	640	$48,000
Traffic Control - Without Flagging	LS	$40,000	1	$40,000
			Subtotal (Rounded)	**$1,595,000**
Mobilization	LS	5%	1	$79,750
Contingency	LS	30%	1	$478,500
			Construction Subtotal (Rounded)	**$2,153,000**
Permitting (Field work, JPA, and application. Assumes SLOPES V)	LS	$50,000	1	$50,000
Geotechnical (assume 8% of total)	LS	$172,000	1	$172,000
Surveying	LS	$8,000	1	$8,000
Engineering and CMS	LS	20%	1	$430,600
Legal and Admin	LS	$5,000	1	$5,000
			Total Project Cost (Rounded)	**$2,819,000**

Middle Trunk Alternative 1				
Item	Unit	Unit Price	Est. Qty	Cost (2021)
24-inch Pipe - Excavation, Backfill	LF	$205	430	$88,150
36-inch Pipe - Excavation, Backfill	LF	$245	300	$73,500
60-Inch, Standard Manhole	EA	$14,000	1	$14,000
72-Inch, Standard Manhole	EA	$16,500	1	$16,500
Abandonment of existing pipeline	LF	$25	800	$20,000
Pond Clearing, Grubbing, and Earthwork as Necessary	LS	$24,000	1	$24,000
Concrete Outlet Flow Control Structure, Grated Inlet	EA	$15,000	3	$45,000
Berm Construction	LF	$30	490	$14,700
Rock Excavation	CY	$300	541	$162,300
Roadway Restoration (Full Lane)	LF	$75	50	$3,750
Traffic Control With Flagging	LS	$1,000	1	$1,000
Soil Surface Repair, Seeding, and Stabilization	LF	$5	680	$3,400
Existing Utility Protection	LF	$4	730	$2,920
			Subtotal (Rounded)	**$469,200**
Mobilization	LS	5%	1	$23,460
Contingency	LS	30%	1	$140,760
			Construction Subtotal (Rounded)	**$633,400**
Property Acquisition	SF	$10	106,000	$1,060,000
Permitting (Field work, JPA, and application. Assumes SLOPES V)	LS	$30,000	1	$30,000
Geotechnical (Assume 4% of total)	LS	$25,000	1	$25,000
Surveying	LS	$50,000	1	$50,000
Engineering and CMS	LS	20%	1	$126,680
Wetland Hydroperiod and Ecological Assessment	LS	$20,000	1	$20,000
Legal and Admin	LS	$15,000	1	$15,000
			Total Project Cost (Rounded)	**$1,960,000**

Middle Trunk Alternative 2				
Item	Unit	Unit Price	Est. Qty	Cost (2021)
36-inch Pipe - Excavation, Backfill	LF	$245	2,800	$686,000
72-Inch, Standard Manhole	EA	$16,500	12	$198,000
Soil Surface Repair	LF	$5	2,300	$11,500
Rock Excavation	CY	$300	3,267	$980,000
Local Road Full Lane Asphalt Repair	LF	$75	440	$33,000
Traffic Control - Without Flagging	LS	$30,000	1	$30,000
			Subtotal (Rounded)	**$1,938,500**
Mobilization	LS	5%	1	$96,925
Contingency	LS	30%	1	$581,550
			Construction Subtotal (Rounded)	**$2,617,000**
Permitting (Field work, JPA, and application. Assumes SLOPES V)	LS	$30,000	1	$30,000
Geotechnical (Assume 4% of total)	LS	$105,000	1	$105,000
Surveying	LS	$50,000	1	$50,000
Engineering and CMS	LS	20%	1	$523,400
Wetland Hydroperiod and Ecological Assessment	LS	$20,000	1	$20,000
Legal and Admin	LS	$15,000	1	$15,000
			Total Project Cost (Rounded)	**$3,360,000**

St. Helens Stormwater Master Plan
Alternative Cost Estimates

Downtown Alternative 1				
Item	Unit	Unit Price	Est. Qty	Cost (2021)
18-inch Pipe - Excavation, Backfill	LF	$185	150	$27,750
21-inch Pipe - Excavation, Backfill	LF	$195	720	$140,400
30-inch Pipe - Excavation, Backfill	LF	$230	2,020	$464,600
48-Inch, Standard Manhole	EA	$8,000	1	$8,000
60-Inch, Standard Manhole	EA	$14,000	11	$154,000
ODOT Type G-2, Catch Basin with Connector Pipe	EA	$3,500	28	$98,000
Outfall Restoration	EA	$6,000	1	$6,000
Rock Excavation	CY	$300	572	$171,600
Roadway Restoration (Half Lane)	LF	$45	2,890	$130,050
Traffic Control With Flagging	LS	$82,000	1	$82,000
Existing Utility Protection	LF	$4	1	$4
ADA Ramp Reconstruction (Compliance)	EA	$4,600	26	$119,600
			Subtotal (Rounded)	**$1,402,000**
Mobilization	LS	5%	1	$70,100
Contingency	LS	30%	1	$420,600
			Construction Subtotal (Rounded)	**$1,893,000**
Permitting	LS	$45,000	1	$45,000
Geotechnical (Assume 2% of total)	LS	$38,000	1	$38,000
Surveying	LS	$29,000	1	$29,000
Engineering and CMS	LS	20%	1	$378,600
Legal and Admin	LS	$15,000	1	$15,000
			Total Project Cost (Rounded)	**$2,399,000**

Downtown Alternative 2				
Item	Unit	Unit Price	Est. Qty	Cost (2021)
24-inch, CIP Pipeline Repair	LF	$160	1,600	$256,000
18-inch Pipe - Excavation, Backfill	LF	$185	720	$133,200
21-inch Pipe - Excavation, Backfill	LF	$195	720	$140,400
Rock Excavation	CY	$300	240	$72,000
Local Road Full Lane Asphalt Repair	LF	$75	630	$47,250
Soil Surface Repair	LF	$5	90	$450
Traffic Control - Without Flagging	LF	$4	1,140	$4,560
Traffic Control - With Flagging	LF	$8	190	$1,520
			Subtotal (Rounded)	**$655,000**
Mobilization	LS	5%	1	$32,750
Contingency	LS	30%	1	$196,500
			Construction Subtotal (Rounded)	**$884,000**
Permitting	LS	$45,000	1	$45,000
Geotechnical (Assume 2% of total)	LS	$18,000	1	$18,000
Surveying	LS	$29,000	1	$29,000
Engineering and CMS	LS	20%	1	$176,800
Legal and Admin	LS	$15,000	1	$15,000
			Total Project Cost (Rounded)	**$1,168,000**

Greenway Alternative 1				
Item	Unit	Unit Price	Est. Qty	Cost (2021)
Pond Clearing, Grubbing, and Earthwork as Necessary	LS	$20,000	1	$20,000
Concrete Outlet Flow Control Structure, 60-inch	EA	$15,000	1	$15,000
Berm Construction	LF	$30	500	$15,000
Sediment Forebay	EA	$20,000	1	$20,000
15-inch Pipe - Rock Excavation, Backfill	LF	$340	960	$326,400
Abandonment of existing pipeline	LF	$25	400	$10,000
Traffic Control - With Flagging	LF	$20,000	550	$20,000
48-Inch, Standard Manhole	EA	$8,000	2	$16,000
Rock Excavation	CY	$300	267	$80,000
Local Road Full Lane Asphalt Repair	LF	$75	960	$72,000
			Subtotal (Rounded)	**$594,400**
Mobilization	LS	5%	1	$29,720
Contingency	LS	30%	1	$178,320
			Construction Subtotal (Rounded)	**$802,000**
Permitting	LS	$10,000	1	$10,000
Geotechnical (Assume 8% of total)	LS	$64,000	1	$64,000
Surveying	LS	$15,000	1	$15,000
Engineering and CMS	LS	40%	1	$320,800
Legal and Admin	LS	$8,000	1	$8,000
			Total Project Cost (Rounded)	**$1,220,000**

Greenway Alternative 2				
Item	Unit	Unit Price	Est. Qty	Cost (2021)
30-inch Pipe - Excavation, Backfill	LF	$230	1,330	$305,900
18-inch Pipe - Excavation, Backfill	LF	$185	927	$171,495
60-Inch, Standard Manhole	EA	$14,000	9	$126,000
48-Inch, Standard Manhole	EA	$8,000	7	$56,000
Soil Surface Repair	LF	$5	1,468	$7,340
Rock Excavation	CY	$300	752	$225,700
Local Road Full Lane Asphalt Repair	LF	$75	800	$60,000
Traffic Control - With Flagging	LF	$8	137	$1,096
Traffic Control - Without Flagging	LF	$4	436	$1,744
			Subtotal (Rounded)	**$955,000**
Mobilization	LS	5%	1	$47,750
Contingency	LS	30%	1	$286,500
			Construction Subtotal (Rounded)	**$1,289,000**
Permitting	LS	$10,000	1	$10,000
Geotechnical (Assume 8% of total)	LS	$103,000	1	$103,000
Surveying	LS	$15,000	1	$15,000
Engineering and CMS	LS	40%	1	$515,600
Legal and Admin	LS	$8,000	1	$8,000
			Total Project Cost (Rounded)	**$1,941,000**

Milton Creek Alternative 1				
Item	Unit	Unit Price	Est. Qty	Cost (2021)
24-inch Pipe - Excavation, Backfill	LF	$205	40	$8,200
Concrete Outlet Flow Control Structure, 60-inch	EA	$15,000	1	$15,000
Hydroseeding, Planting, and Other Restoration Features	AC	$5,000	0.7	$3,500
Berm Construction	LF	$30	1,030	$30,900
Detention Pond Excavation, removal, and grading	CY	$31	3,200	$99,200
21-inch Pipe - Excavation, Backfill	LF	$195	1,020	$198,900
30-inch Pipe - Excavation, Backfill	LF	$230	1,800	$414,000
60-Inch, Standard Manhole	EA	$14,000	3	$42,000
72-Inch, Standard Manhole	EA	$16,500	5	$82,500
ODOT Type G-2, Catch Basin with Connector Pipe	EA	$3,500	16	$56,000
Outfall Restoration	EA	$6,000	1	$6,000
Rock Excavation	CY	$300	1,717	$515,178
Roadway Restoration (Half Lane)	LF	$45	2,820	$126,900
Traffic Control - With Flagging	LF	$70,000	1	$70,000
18-inch Pipe - Excavation, Backfill	LF	$185	710	$131,350
48-Inch, Standard Manhole	EA	$8,000	3	$24,000
ODOT Type G-2, Catch Basin with Connector Pipe	EA	$3,500	4	$14,000
Pond Clearing, Grubbing, and Earthwork as Necessary	LS	$10,000	1	$10,000
Concrete Outlet Flow Control Structure, Ditch Inlet	EA	$15,000	1	$15,000
Berm Construction	LF	$30	400	$12,000
Rock Excavation	CY	$300	216	$64,804
Roadway Restoration (Half Lane)	LF	$45	710	$31,950
Traffic Control With Flagging	LS	$20,000	1	$20,000
Existing Utility Protection	LF	$4	710	$2,840
ADA Ramp Reconstruction (Compliance)	EA	$4,600	5	$23,000
			Subtotal (Rounded)	$2,017,000
Mobilization	LS	5%	1	$100,850
Contingency	LS	30%	1	$605,100
			Construction Subtotal (Rounded)	$2,723,000
Permitting	LS	$5,000	1	$5,000
Geotechnical (Assumes 8% of total)	LS	$218,000	1	$218,000
Surveying	LS	$10,000	1	$10,000
Engineering and CMS	LS	20%	1	$544,600
Legal and Admin	LS	$8,000	1	$8,000
			Total Project Cost (Rounded)	$3,509,000

Milton Creek Alternative 2				
Item	Unit	Unit Price	Est. Qty	Cost (2021)
24-inch Pipe - Excavation, Backfill	LF	$205	1,022	$209,510
36-inch Pipe - Excavation, Backfill	LF	$245	1,821	$446,145
Rock Excavation	CY	$300	3,317	$995,050
Local Road Full Lane Asphalt Repair	LF	$75	2,843	$213,225
72-Inch, Standard Manhole	EA	$16,500	6	$99,000
ADA Ramp Reconstruction (Compliance)	EA	$4,600	20	$92,000
			Subtotal (Rounded)	$2,055,000
Mobilization	LS	5%	1	$102,750
Contingency	LS	30%	1	$616,500
			Construction Subtotal (Rounded)	$2,774,000
Permitting	LS	$5,000	1	$5,000
Geotechnical (Assumes 8% of total)	LS	$222,000	1	$222,000
Surveying	LS	$20,000	1	$20,000
Engineering and CMS	LS	20%	1	$554,800
Legal and Admin	LS	$8,000	1	$8,000
			Total Project Cost (Rounded)	$3,584,000

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APPENDIX F

Engineering Standards and Comp Plan Review

TECHNICAL MEMORANDUM

TO: City of St. Helens

FROM: Peter Olsen, PE
Emily Flock, PE

DATE: 09/13/2021

SUBJECT: **ST. HELENS MUNICIPAL DEVELOPMENT CODE, ENGINEERING STANDARDS MANUAL, AND COMPREHENSIVE PLAN REVIEW – STORMWATER**

1. GENERAL

The City of St. Helens' existing engineering design standards (Title 18), development code (Title 17), and comprehensive plan (Title 19) were reviewed for new development as they pertain to stormwater conveyance and treatment to identify potential deficiencies and provide recommendations for updates. This effort was part of the Stormwater Master Plan (SWMP) process. Stormwater system design criteria developed for the SWMP encompass the fundamental principles applied in evaluating the existing system and planning for future expansion of the system. The criteria applied in the SWMP come from sources such as neighboring communities, industry standards, and state and federal stormwater regulations and are detailed in Section 3 of the SWMP. The aim of the criteria is to accurately assess the system demands to mitigate existing deficiencies and prevent future problems. Design criteria address design storm events, hydrologic methods, hydraulic calculation methods, and stormwater quality and quantity.

The following documents were examined during this review effort.

- St. Helens Municipal Code (SHMC) Title 17 Community Development Code
- St. Helens Municipal Code (SHMC) Title 18 Engineering Standards Manual
- St. Helens Municipal Code (SHMC) Title 19 Comprehensive Plan

Note that the recommendations below do not include legal services. Developing draft language and development details for revisions to the Municipal comprehensive plan, development code, and City standards is not included in the scope of this review. Any language provided in this section is intended to assist the City in revising standards and is not intended to be directly incorporated into any City Municipal Code.

2. COMMUNITY DEVELOPMENT CODE

This section discusses the results of reviewing SHMC Title 17 Community Development Code.

2.1 GENERAL AND LAND USE DEFINITIONS (17.16.010)

Title 17 of the SHMC defines specific infrastructure as "Public Facility, Minor" with all undefined infrastructure being a "Public Facility, Major." Keller Associates recommends that energy dissipaters and water flow measurement/monitoring/telemetry devices be excluded from the list of minor public facilities. These facilities should require special review and approval.

2.2 STORM DRAINAGE (17.152.100)

In numerous sections throughout Title 17 of the SHMC, the City's adopted master drainage plan is referenced. Following adoption of the updated 2021 Stormwater Master Plan, it is recommended that the City update each of these references.

Note 5 requires that any stormwater facility be designed by a registered professional engineer. It is recommended that the City revise this note to state that "the City Engineer shall approve all storm drainage plans and proposed systems prior to issuance of development permits. Such plans and systems shall be designed by a registered professional engineer." Additionally, a Drainage Report should be a requirement of proposed storm drainage plans and systems.

Note 6 discusses private storm water facility ownership. Where private stormwater facilities are approved, the developer shall be required to execute a maintenance agreement for private facilities that is satisfactory as determined by the City Engineer.

3. ENGINEERING STANDARDS MANUAL

This section discusses the results of reviewing St. Helens Municipal Code Title 18 Engineering Standards Manual.

3.1 GENERAL (18.16.005)

It is recommended that the City add a reference to Oregon Drainage Law: Oregon has adopted the civil law doctrine of drainage. Under this doctrine, adjoining landowners are entitled to have the normal course of natural drainage maintained. The landowner must accept water which naturally comes to their land from above, but they are entitled not to have the normal drainage changed or substantially increased. The lower landowner may not obstruct the run-off from the upper land if the upper landowner is properly discharging the water.

The St. Helens Engineering Standards Manual requires that roof and foundation drains for all multi-family, residential, commercial, or industrial developments be piped directly to the storm drain system. It is recommended the City revise this section to encourage best management practices (BMPs) of stormwater runoff. This can result in a lower runoff quantity and higher water quality. For example, runoff from the roof of industrial development may be reduce by having flows enter a swale with an overflow to the City's storm drain system.

An additional provision should be added stating that "stormwater; including street, parking lot, roof, or footing drainage; shall not be discharged into the sewer system. Stormwater shall be conveyed, treated, and controlled by a system of storm facilities separate from the sanitary sewer system in accordance with all applicable design standards."

In conformance with the City of St. Helens draft Mercury Total Maximum Daily Load (TMDL) tracking matrix, this section could also be used to prohibit any cross connections (the discharge of non-stormwater flows into the stormwater system). Title 17 of the SHMC states that "the stormwater drainage system or stormwater facilities shall be separate and independent of any sanitary sewerage systems", but the stormwater section should be used to explicitly prohibit any non-stormwater discharges to the system.

3.2 DRAINAGE REPORT (18.16.070)

Requirement number 9 listed under drainage report requires a hydrological analysis. It is recommended that the City modify this requirement to be more specific. Some general guidelines for a hydrological analysis are listed below:

- A stamped certificate of investigation stating that the developer has taken downstream impacts into consideration is required for each development constructing, collecting, or discharging more than 5,000 square feet of new impervious area.
- Projects that receive approval for a fee in lieu of construction and/or install partial or no stormwater quantity control facilities must extend the analysis downstream to a point in the storm system where the additional flow from the proposed development site constitutes 10 percent or less of the total tributary drainage flow.
- When the downstream analysis does not continue for at least one-quarter (1/4) mile, the design engineer shall provide a stamped certification of investigation that states the developer has visually investigated the downstream system for at least one-quarter (1/4) mile downstream and is aware of no downstream impacts to the conveyance system.
- For privately maintained water quantity or quality facilities or conveyance systems, a maintenance plan that clearly identifies maintenance activities and frequency is required in a form that can be easily understood by the person(s) responsible for maintenance.

3.3 DRAINAGE PLANS (18.16.080)

It is recommended that the City make the additional requirements mandatory on all Drainage Plans: The consulting firm’s name, address, and contact information; the project’s township, range, and section; and the vertical datum being referenced.

Additionally, the section may be used to demonstrate compliance with Item 5. a. of the draft St. Helens Mercury TMDL matrix, which states “for projects that disturb one or more acres, refer engineers/developers to the DEQ for 1200-C permit requirements.” This note in Title 18 of the SHMC could read, “when a proposed site disturbs one or more acres, it is the policy of the City of St. Helens to refer engineers and developers to the DEQ for 1200-C permit requirements.” This recommendation should be reviewed after DEQ approval of the Mercury TMDL matrix for any revisions from the draft matrix.

3.4 GENERAL (18.16.090)

City standards describe criteria that require on-site detention in multiple places. Section 18.16.090 states that “all development on sites within the McNulty Creek Drainage Basin that are one-half acre or greater in area shall be required to provide on-site detention. For sites smaller than one-half acre in area or where storm detention would have an adverse effect upon the receiving storm drainage system, as determined by the City Engineer, a system development charge will be assessed in lieu of a constructed facility. Detention for sites within the Milton Creek Drainage Basin or other basins shall be provided when proposed development will cause increased flows that could overwhelm downstream facilities in a large storm event.” Section 18.16.110 section 2 dictates that “Some criteria for requiring on-site detention facilities include, but are not limited to:

(a) There is an identified downstream deficiency, and detention rather than conveyance system enlargement is determined to be the more effective solution;

(b) There is an identified regional detention site within the boundary of the development;

(c) There is a site within the boundary of the development which would qualify as a regional detention site under criteria or capital plan adopted by the City;

(d) Water quantity facilities are required by City-adopted storm water management master plans."

It is recommended that the City reevaluate whether it is necessary to have differing requirements for different basins. The requirements for on-site detention should all be listed in one section. Additionally, it is not typical to require detention based on site size. Usually, this would be based on the proposed additional impervious area at the site. In conformance with the draft City of St. Helens Mercury TMDL tracking matrix, it is recommended that the City require the use of stormwater controls, site-specific stormwater management, and long-term O&M for projects that create or replace one quarter (1/4) acre of impervious area. The requirement details should be reviewed after DEQ approval of the Mercury TMDL matrix to incorporate any revisions from the draft matrix

This section also dictates that "Storm detention facilities shall be designed to provide storage using a 25-year event, with the safe overflow conveyance of the 100-year storm." It is recommended that the post-development peak release rates equal the pre-development release rates for their matching design storm event up to the 10-year design storm. The 25-year storm event peak release rate should not exceed the 10-year pre-development peak release rate.

3.5 HYDROLOGIC ANALYSIS (18.16.100)

Hydrologic methodology refers to the method applied to define how an area or "basin" will react to the design storm. Some items of particular concern are how much of the rainfall over the basin will be converted to runoff, where that runoff will go, and how quickly it will get there.

There are several acceptable hydrological methods for defining basin characteristics. In researching hydrological methodology, three design documents are widely used in the region. These documents are as follows:

- 2005 Oregon Department of Transportation (ODOT) Hydraulics Manual
- 2007 City of Portland Sewer and Drainage Facilities Design Manual
- 2007 Clean Water Services (CWS) Design and Construction Standards

The following is a list of acceptable hydrologic methods compiled from the above-mentioned design manuals:

- Natural Resources Conservation Service (NRCS) TR-20
- Hydrologic Modeling System (HEC-HMS)
- NRCS Urban Hydrograph Method (TR-55/SCS)
- Santa Barbara Urban Hydrograph (SBUH) Method
- Rational Method
- Environmental Protection Agency (EPA) Stormwater Management Model (SWMM)
- Flood Insurance Studies (FIS)
- Statistical Analysis of Stream Gage Data and USGS Regression Equations

Each of these methods have varying applications. The hydrological methodologies currently permitted by the City of St. Helens' are the Rational Method and the Unit Hydrograph Method. The rational method is only permitted for predicting a conservative peak flow rate to be used in determining the required capacity for conveyance elements. The unit hydrograph method is the primary permitted analysis method. A summary of restrictions with each method are summarized in Table 3-1.

TABLE 3-1: PERMITTED HYDROLOGICAL METHODOLOGIES

Rational Method	
Maximum Drainage Subbasin Area	25 Acres
Minimum Time of Concentration (TC)	5 Minutes
Rainfall Intensity	ODOT IDR Curves, Zone 8
Unit Hydrograph Methods	
Preferred Methodology	SBUH
Curve Number (CN)	NRCS
Maximum Sheet Flow Length	300 feet

ODOT: Oregon Department of Transportation
IDR: Intensity-Duration-Curve(s)
NRCS: National Resource Conservation Services
SBUH: Santa Barbara Urban Hydrograph

It is recommended that several modifications be made to section 18.16.100 Hydrological Analysis. The following list summarizes the recommendations.

- Reduce the maximum sheet flow distance from 300 feet to 100 feet.
- Establish acceptable Manning's "n" values for calculations. Acceptable Manning's "n" values for sheet flow can be found in the Oregon Department of Transportation (ODOT) Hydraulics Manual Chapter 7, Appendix F, page 5 (7-F-5). Additionally, acceptable Manning's "n" values for channel flow can be found in the ODOT Hydraulics Manual Chapter 8 (8-A-1). It is recommended that the City either provide their own table of Manning's "n" values or reference the ODOT Hydraulics Manual.
- Add a discussion of the design storm to be used in calculations. Some municipalities reference the current SWMP and the design storms outlined in the planning criteria. Selection of a design storm is a matter that balances level of service with economic feasibility. It is recommended that storm drainage conveyance system be capable of passing runoff from the 25-yr storm event without flooding as presented in the current SWMP. For detention facilities, the post-development maximum runoff rate from the 25-yr storm event should not exceed the pre-development runoff from the 10-yr storm event. In addition to the 25-yr storm, the detention facility should serve the same function for smaller storm events such as the 2-, 5-, and 10-yr events. In short, this means that when development occurs, the peak runoff rate must be less than or equal to the pre-existing conditions through the 25-year storm event. Detention facilities must have a means to safely bypass the 100-yr storm event without damage to property, endangering human life, or public health.

3.6 WATER QUANTITY FACILITY DESIGN (18.16.110)

The City's current design standards dictate that each new development is responsible for mitigating its impacts on the public stormwater system. This may be done by construction of permanent on-site stormwater quantity detention facilities or enlargement or improvement of the downstream conveyance system. It is recommended that the City refine the list to include implementing best management practices (BMPs) to reduce the proposed impervious area.

HydroCAD should be added to the list of approved software programs for calculating storm conditions.

It is recommended that flows be pretreated be a water quality manhole before entering a stormwater detention facility.

It is recommended that the post-development peak release rates be clarified to not exceed the 10-year pre-development peak release rate for the 25-year design storm event. It should also be added that the post-development peak release rates for the 2-, 5, and 10-year storms must be equal to or less than the pre-development peak release rates for their corresponding storm event.

City standards should dictate that storm detention facilities are not allowed to be constructed within any floodplain unless otherwise approved.

City standards refer to King County, Washington, “Surface Water Design Manual” for more complete guidelines to design criteria regarding stormwater detention facilities. It is recommended that the City consider adding a reference to the Portland Stormwater Management Manual (SWMM) and Clean Water Services (CWS) Design and Construction Standards.

Where orifice plates are to be used, a minimum size of ½ inch shall be used. Current City standards do not dictate a minimum size.

3.7 GENERAL CONCEPTS AND PRINCIPALS (18.16.120)

City standards do not currently dictate any trigger for when stormwater pollution reduction facilities are required. One possibility is to require stormwater quality design standards whenever stormwater quantity controls are triggered.

3.8 STORM MANHOLE AND PIPE DESIGN STANDARDS (18.16.200)

It is recommended that a Manning’s “n” value of 0.013 shall be used for PVC pipe calculations.

Current City standards dictate that a manhole shall be provided at least every 500 feet. It is recommended that this distance be reduced to 300 feet.

3.9 CULVERT DESIGN STANDARDS (18.16.230)

It is recommended that the City require structural calculations be provided for the design of all box culverts, pipe arch culverts, structural plate culverts, culverts that are not standard, and culverts that require special design.

3.10 ADDITIONAL RECOMMENDATIONS

The current SHMC does little to promote the implementation of Low Impact Development (LID) and Best Management Practices (BMP). LID and BMPs are measures or controls that reduce pollutants and runoff volume at the source. It is recommended that the City move stormwater design towards encouraging LID and the implementation of BMPs. Oregon Department of Environmental Quality (DEQ) has published a resource on BMPs titled “Construction Stormwater Best Management Practices Manual.” Additionally, many of the surrounding municipalities and service districts have Stormwater Management Manuals with varying levels of discussions of BMPs. It is recommended the City either 1) adopt one of these (or similar) documents or 2) draw inspiration from these documents to revise their Engineering Standards Manual.

Generally, it is recommended that the City move toward encouraging Green Stormwater Infrastructure (GSI) to the Maximum Extent Feasible (MEF).

- Green Storm Water Infrastructure (GSI) means a stormwater facility that mimics natural surface hydrologic functions through infiltration or evapotranspiration, or that involves stormwater reuse.
- Maximum Extent Feasible (MEF) means the extent to which a requirement or standard must be compiled with as constrained by the physical limitations of the site, practical considerations of engineering design, and reasonable considerations of financial costs and environmental impacts.

4. COMPREHENSIVE PLAN

There are no recommendations for storm sewer provisions in the SHMC Title 19 Comprehensive Plan.

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APPENDIX G

Model Parameters

Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060-001

Subcatchment Parameters and 25-Year Storm Event Results

Sub-Basin ID	Load Placement (ID)	Area (acres)	Average Slope (%)	Characteristic Length (ft)	NRCS Composite CN	Depression Storage (in)	25-Year Storm Event			
							Total Precipitation (in)	Total Runoff Depth (in)	Peak Runoff (gpm)	Time of Concentration (minutes)
DL-2	I9-37	8.1	1.3	1,059	76.3	0.08	3.5	1.8	1,369	32
DL-3	H9-1	21.8	1.1	1,644	90.8	0.04	3.5	2.6	6,160	31
DL-5	J9-14	1.8	6.6	301	86.5	0.06	3.5	2.3	819	4
DL-7	KJ-290	34.0	2.4	1,648	91.3	0.03	3.5	2.7	11,428	20
DT-1	J11-5	14.7	13.2	410	89.4	0.05	3.5	2.5	7,450	3
DT-2	I10-114	3.7	0.6	66	89.3	0.05	3.5	2.5	1,857	3
DT-2A	I10-98	2.8	4.3	419	85.0	0.05	3.5	2.5	1,238	6
DT-3	I11-71	4.1	5.8	451	86.3	0.06	3.5	2.3	1,721	6
DT-3A	J11-21	10.1	5.4	407	86.3	0.06	3.5	2.3	4,303	5
DT-4	J10-33	4.1	13.2	500	90.4	0.04	3.5	2.6	2,102	3
GW-1	J11-22	6.5	8.4	670	88.2	0.05	3.5	2.5	2,884	6
GW-10	H11-181	3.7	2.1	571	89.3	0.08	3.5	2.5	1,467	10
GW-11	I12-30	14.1	2.6	816	88.5	0.05	3.5	2.5	5,090	13
GW-12	I12-5	5.2	3.1	962	88.2	0.06	3.5	2.5	1,839	13
GW-1A	J11-29	5.6	8.5	869	88.2	0.05	3.5	2.5	2,359	7
GW-2	J11-63	9.1	2.2	819	84.7	0.36	3.5	2.0	2,378	16
GW-2A	J12-8	7.8	4.4	1,091	84.7	0.36	3.5	2.0	2,109	14
GW-2B	J12-3	5.3	4.3	836	84.7	0.36	3.5	2.0	1,554	11
GW-3	I11-89	5.0	2.9	558	88.7	0.07	3.5	2.5	2,030	9
GW-3A	I11-93	7.1	3.5	808	88.7	0.05	3.5	2.5	2,749	11
GW-3B	I12-93	7.2	2.0	707	88.7	0.08	3.5	2.5	2,604	13
GW-4	I12-4	12.8	4.9	487	87.2	0.03	3.5	2.4	5,420	6
GW-5	H11-124	11.9	3.6	412	89.9	0.05	3.5	2.6	5,645	6
GW-6	H12-65	7.5	1.3	1,510	80.0	0.13	3.5	1.9	1,312	38
GW-7	H11-103	9.7	3.2	497	88.3	0.05	3.5	2.5	4,092	8
GW-8	H12-10	4.1	2.0	489	84.7	0.09	3.5	2.2	1,357	11
GW-9	H11-107	9.9	3.1	828	91.7	0.09	3.5	2.7	4,227	10
MI-1	G9-19	3.9	11.7	1,178	83.4	0.09	3.5	2.1	1,274	9
MI-10	F11-234	3.9	8.8	820	82.9	0.07	3.5	2.1	1,320	8
MI-10A	F10-21	8.2	6.5	1,269	82.9	0.07	3.5	2.1	2,376	14
MI-11	H11-164	8.9	1.7	715	80.0	0.07	3.5	2.0	2,094	19
MI-12	G11-91	4.5	0.9	447	88.2	0.09	3.5	2.4	1,578	13
MI-13	KJ-699	1.7	1.0	360	92.2	0.05	3.5	2.8	783	9
MI-15	H10-13	3.2	0.6	320	89.5	0.10	3.5	2.5	1,232	12
MI-15A	H10-16	3.3	0.6	320	89.5	0.10	3.5	2.5	1,267	12
MI-16	G10-105	9.5	5.2	675	87.9	0.07	3.5	2.4	3,882	8
MI-16A	G10-66	4.6	5.2	675	87.9	0.07	3.5	2.4	1,895	8
MI-17	F11-207	4.0	3.5	406	87.4	0.06	3.5	2.4	1,665	6
MI-17A	F11-211	3.0	3.5	406	87.4	0.06	3.5	2.4	1,248	6
MI-17B	G11-143	1.4	3.5	406	87.4	0.06	3.5	2.4	588	6
MI-18	F11-1	6.2	4.6	476	84.0	0.12	3.5	2.1	2,259	7
MI-19	F11-25	2.5	5.5	362	83.4	0.03	3.5	2.2	962	5
MI-20	F11-37	4.4	6.3	347	82.9	0.03	3.5	2.2	1,727	5
MI-21	F11-50	2.7	4.1	339	83.9	0.04	3.5	2.2	1,058	6
MI-22	G10-92	2.4	3.9	311	84.6	0.05	3.5	2.3	975	5
MI-23	G11-160	8.6	1.6	882	78.4	0.06	3.5	1.9	1,767	24
MI-24	G11-70	22.8	2.9	2,306	76.6	0.07	3.5	1.8	3,612	40
MI-25	G11-132	9.1	1.1	923	83.0	0.07	3.5	2.1	2,094	26
MI-26	G11-9	9.7	1.2	1,330	79.9	0.08	3.5	1.9	1,770	36
MI-27	G11-9	12.1	2.1	1,691	80.0	0.08	3.5	1.9	2,292	34
MI-28	G10-89	2.9	4.1	563	81.9	0.08	3.5	2.1	911	9
MI-29	G10-118	31.3	9.1	1,634	81.3	0.06	3.5	2.0	8,380	15
MI-3	G9-46	25.2	10.6	1,718	78.8	0.08	3.5	1.9	6,084	16
MI-30	G11-159	6.3	1.5	593	81.9	0.08	3.5	2.1	1,671	16
MI-31	H11-62	8.8	2.1	745	90.0	0.12	3.5	2.5	3,342	12
MI-32	G10-57	11.7	0.5	600	87.2	0.12	3.5	2.3	3,199	23
MI-33	KJ-131	18.1	1.4	1,332	77.9	0.07	3.5	1.8	3,098	37
MI-34	G11-109	5.2	1.6	637	81.4	0.09	3.5	2.0	1,314	17
MI-35	G12-75	9.2	0.7	730	78.9	0.04	3.5	1.9	1,761	31

Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060-001

Subcatchment Parameters and 25-Year Storm Event Results

Sub-Basin ID	Load Placement (ID)	Area (acres)	Average Slope (%)	Characteristic Length (ft)	NRCS Composite CN	Depression Storage (in)	25-Year Storm Event: Total Precipitation (in)	Total Runoff Depth (in)	Peak Runoff (gpm)	Time of Concentration (minutes)
MI-35A	F12-170	6.2	0.1	732	78.9	0.12	3.5	1.8	827	69
MI-36	KJ-255	11.7	8.3	1,862	76.4	0.07	3.5	1.8	2,392	20
MI-37	KJ-268	10.0	15.5	761	83.9	0.09	3.5	2.2	3,861	6
MI-38	H12-21	3.3	1.2	489	87.2	0.05	3.5	2.4	1,137	13
MI-39	H12-62	3.2	1.8	454	89.5	0.05	3.5	2.6	1,321	9
MI-4	G9-13	11.2	10.1	594	78.1	0.03	3.5	1.9	3,475	7
MI-40	H11-183	5.1	0.8	651	89.2	0.06	3.5	2.5	1,641	19
MI-41	G11-42	2.5	2.4	496	89.1	0.04	3.5	2.5	1,025	8
MI-42	F10-31	2.6	6.2	453	82.9	0.05	3.5	2.1	945	6
MI-43	F10-34	4.0	6.8	515	81.0	0.06	3.5	2.0	1,345	7
MI-44	F11-223	0.4	2.4	411	98.0	0.05	3.5	3.2	246	5
MI-45	KJ-120	1.4	2.6	511	82.2	0.05	3.5	2.1	427	11
MI-45A	X-809	0.8	2.6	245	86.6	0.05	3.5	2.1	300	5
MI-46	G10-88	2.8	5.9	320	81.9	0.06	3.5	2.1	1,039	5
MI-5	G12-113	8.5	1.5	1,416	80.5	0.09	3.5	2.0	1,628	34
MI-6	F12-182	24.9	2.5	1,593	78.7	0.10	3.5	1.9	4,659	30
MI-7	I12-30	4.7	0.5	400	90.0	0.06	3.5	2.6	1,690	15
MI-8	G10-29	3.2	6.3	301	79.1	0.08	3.5	1.9	1,098	5
MI-9	G10-47	4.0	12.3	506	85.4	0.08	3.5	2.3	1,685	4
MN-1	F11-58	11.3	5.5	877	82.9	0.06	3.5	2.1	3,530	11
MN-11	F13-30	1.4	2.5	202	88.3	0.04	3.5	2.5	646	4
MN-12	F13-37	0.9	1.5	260	89.5	0.06	3.5	2.5	429	6
MN-13	F13-25	11.6	4.6	747	80.7	0.09	3.5	2.0	3,288	12
MN-14	F13-17	2.0	5.3	263	86.6	0.07	3.5	2.3	886	4
MN-15	F13-9	9.6	2.2	781	84.8	0.09	3.5	2.2	2,856	15
MN-16	F13-1	5.5	2.1	559	82.0	0.14	3.5	2.0	1,548	13
MN-17	F12-44	8.5	5.0	1,087	76.7	0.08	3.5	1.8	1,870	17
MN-17A	F12-48	7.6	5.0	1,087	76.7	0.08	3.5	1.8	1,663	17
MN-18	E12-30	0.8	4.8	415	90.5	0.06	3.5	2.6	372	5
MN-19	E12-19	6.1	4.4	735	84.7	0.04	3.5	2.3	2,081	10
MN-2	STOR-27	16.1	0.7	591	82.6	0.05	3.5	2.1	3,846	23
MN-20	E12-32	2.6	2.3	345	87.7	0.05	3.5	2.4	1,100	7
MN-21	E12-52	4.8	4.0	352	87.3	0.06	3.5	2.4	2,097	5
MN-22	E12-84	6.4	4.5	838	84.5	0.07	3.5	2.2	2,109	11
MN-23	E12-113	3.0	4.9	573	88.0	0.03	3.5	2.5	1,288	7
MN-24	E12-46	6.7	4.2	575	87.5	0.06	3.5	2.4	2,713	8
MN-25	E12-137	0.7	3.0	336	85.8	0.06	3.5	2.3	268	6
MN-26	E13-24	2.6	5.7	211	89.9	0.09	3.5	2.6	1,331	3
MN-27	E13-15	3.6	4.1	266	89.7	0.08	3.5	2.5	1,792	4
MN-28	E13-26	5.3	1.5	796	87.3	0.07	3.5	2.4	1,652	17
MN-3	F12-190	5.0	0.9	217	88.4	0.05	3.5	2.5	2,157	7
MN-30	E11-3	1.4	5.8	274	89.0	0.07	3.5	2.5	701	3
MN-31	F12-59	6.0	2.3	774	88.8	0.07	3.5	2.5	2,195	13
MN-32	F12-17	11.1	3.9	1,014	82.9	0.08	3.5	2.1	3,121	15
MN-33	KJ-134	22.0	0.4	1,542	87.7	0.06	3.5	2.4	4,399	55
MN-36	KJ-847	6.9	1.9	482	87.0	0.03	3.5	2.4	2,572	10
MN-37	G12-48	17.6	0.4	941	86.1	0.05	3.5	2.3	3,913	38
MN-39	F12-111	1.0	1.6	256	86.5	0.10	3.5	2.3	395	7
MN-4	G11-83	19.3	0.6	1,690	81.7	0.06	3.5	2.0	3,074	60
MN-40	F12-112	2.3	2.7	1,528	90.4	0.08	3.5	2.6	782	19
MN-41	G13-26	8.8	1.4	1,150	91.4	0.09	3.5	2.7	2,954	20
MN-42	F12-71	4.1	0.5	589	83.8	0.04	3.5	2.2	998	26
MN-43	F12-118	5.2	0.4	269	82.7	0.08	3.5	2.1	1,387	17
MN-44	G12-34	9.2	1.3	480	83.8	0.06	3.5	2.2	2,758	14
MN-45	F12-186	3.0	1.2	260	90.0	0.06	3.5	2.6	1,341	7
MN-46	F13-22	2.4	2.5	358	89.8	0.08	3.5	2.5	1,115	6
MN-47	F12-104	0.5	0.5	364	93.3	0.05	3.5	2.8	197	12
MN-48	KJ-277	1.6	2.3	432	86.1	0.06	3.5	2.3	588	9
MN-49	F11-187	5.6	5.6	518	81.0	0.07	3.5	2.0	1,825	8

Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060-001

Subcatchment Parameters and 25-Year Storm Event Results

Sub-Basin ID	Load Placement (ID)	Area (acres)	Average Slope (%)	Characteristic Length (ft)	NRCS Composite CN	Depression Storage (in)	25-Year Storm Event			
							Total Precipitation (in)	Total Runoff Depth (in)	Peak Runoff (gpm)	Time of Concentration (minutes)
MN-5	F11-80	4.9	2.9	345	82.9	0.04	3.5	2.2	1,774	7
MN-50	F11-94	3.4	5.5	506	80.4	0.04	3.5	2.0	1,115	8
MN-51	F11-186	2.1	9.1	265	80.3	0.06	3.5	2.0	761	4
MN-52	F13-5	0.8	2.8	390	85.2	0.08	3.5	2.3	317	8
MN-53	KJ-117	1.3	0.5	851	85.9	0.05	3.5	2.3	305	33
MN-54	F12-35	9.3	4.7	1,269	74.5	0.05	3.5	1.7	1,786	21
MN-55	E13-11	1.7	1.8	221	88.6	0.07	3.5	2.5	765	5
MN-56	E12-6	3.7	4.4	544	81.6	0.06	3.5	2.1	1,183	9
MN-57	F12-8	3.4	2.9	415	81.1	0.04	3.5	2.1	1,071	9
MN-59	F12-11	2.1	4.6	415	87.5	0.06	3.5	2.4	918	6
MN-6	F11-105	3.1	7.4	680	81.3	0.07	3.5	2.0	999	8
MN-61	KJ-100	24.9	2.3	2,659	82.0	0.04	3.5	2.1	4,603	43
MN-7	F11-163	3.9	7.0	1,062	84.9	0.06	3.5	2.3	1,315	11
MN-8	F11-186	11.4	15.6	1,676	81.7	0.04	3.5	2.1	3,400	12
MT-1	MT-8	3.5	8.0	611	86.7	0.08	3.5	2.3	1,447	6
MT-10	DT-3	5.2	8.3	432	83.8	0.07	3.5	2.2	2,057	5
MT-11	I11-40	20.8	4.4	1,002	83.7	0.10	3.5	2.1	6,195	13
MT-11A	MT-9	9.7	3.5	908	83.7	0.10	3.5	2.1	2,853	14
MT-12	I11-16	6.4	5.6	628	83.3	0.10	3.5	2.1	2,175	8
MT-2	I11-108	7.8	1.7	475	86.5	0.08	3.5	2.3	2,756	11
MT-3	I11-55	3.8	1.5	527	86.5	0.08	3.5	2.3	1,264	12
MT-4	I11-23	7.9	1.9	647	86.0	0.08	3.5	2.3	2,553	13
MT-5	H12-26	8.0	1.0	836	83.9	0.10	3.5	2.1	1,917	25
MT-6	I10-73	8.2	5.6	860	87.1	0.05	3.5	2.4	3,130	9
MT-7	I11-21	3.8	2.1	756	81.6	0.11	3.5	2.0	970	17
MT-8	I11-36	31.1	4.0	1,365	85.9	0.08	3.5	2.3	9,275	17
MT-9	NT-22	3.6	8.8	588	84.0	0.05	3.5	2.2	1,362	6
NT-1	I9-52	6.4	2.8	632	88.3	0.05	3.5	2.5	2,495	10
NT-10	H11-211	8.0	2.6	303	89.2	0.07	3.5	2.5	3,713	5
NT-11	H11-43	4.0	1.3	309	93.0	0.07	3.5	2.8	2,004	7
NT-11A	H11-231	1.2	1.3	309	93.0	0.07	3.5	2.8	603	7
NT-12	KJ-221	11.6	6.9	777	83.9	0.05	3.5	2.2	4,054	9
NT-13	I10-57	8.7	6.7	599	88.1	0.02	3.5	2.5	3,822	6
NT-14	X-804	13.6	1.0	1,346	86.8	0.08	3.5	2.3	3,305	31
NT-15	H10-24	13.6	0.8	1,018	87.1	0.05	3.5	2.4	3,494	29
NT-16	H11-58	20.8	7.2	692	88.1	0.06	3.5	2.4	8,915	7
NT-17	H11-23	8.2	0.7	1,069	88.0	0.06	3.5	2.4	2,143	29
NT-19	X-711	9.5	3.3	680	86.7	0.05	3.5	2.4	3,456	10
NT-2	I10-153	1.2	4.3	421	89.1	0.06	3.5	2.5	546	6
NT-20	X-800	5.0	0.9	325	87.1	0.06	3.5	2.4	1,816	11
NT-21	I10-14	8.5	3.2	378	86.1	0.06	3.5	2.3	3,412	7
NT-22	I10-94	11.4	3.3	908	86.8	0.07	3.5	2.4	3,846	13
NT-23	X-773	3.9	2.8	566	86.9	0.06	3.5	2.4	1,471	9
NT-24	I10-33	2.9	5.6	567	85.5	0.06	3.5	2.3	1,125	7
NT-25	H11-34	1.9	5.4	443	86.8	0.07	3.5	2.4	824	6
NT-26	H11-27	6.1	3.4	816	86.2	0.06	3.5	2.3	2,065	12
NT-27	H11-23	4.5	0.5	2,008	94.2	0.07	3.5	2.9	1,189	46
NT-28	X-804	9.1	1.7	326	83.4	0.02	3.5	2.2	3,164	9
NT-29	X-807	2.9	13.6	470	87.7	0.08	3.5	2.4	1,376	4
NT-3	I10-91	4.5	4.8	372	89.1	0.06	3.5	2.5	2,148	5
NT-30	H10-24	4.3	3.1	653	88.9	0.05	3.5	2.5	1,742	9
NT-4	I10-31	8.8	5.2	498	87.2	0.06	3.5	2.4	3,704	6
NT-4A	I10-28	4.8	5.7	560	87.2	0.06	3.5	2.4	2,001	7
NT-5	I10-64	8.6	1.3	700	86.7	0.06	3.5	2.4	2,644	17
NT-6	H10-1	3.1	3.3	735	87.9	0.05	3.5	2.5	1,175	10
NT-6A	H10-2	17.1	1.4	677	87.9	0.05	3.5	2.4	5,748	15
NT-7	KJ-114	9.0	12.7	668	88.0	0.05	3.5	2.5	4,137	5
NT-8	KJ-270	10.2	5.9	641	84.8	0.08	3.5	2.2	3,747	8
NT-9	KJ-240	5.6	9.1	394	84.8	0.08	3.5	2.2	2,332	4

Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060-001

Subcatchment Parameters and 25-Year Storm Event Results

							25-Year Storm Event			
Sub-Basin ID	Load Placement (ID)	Area (acres)	Average Slope (%)	Characteristic Length (ft)	NRCS Composite CN	Depression Storage (in)	Total Precipitation (in)	Total Runoff Depth (in)	Peak Runoff (gpm)	Time of Concentration (minutes)
NT-9A	STOR-30	10.6	7.1	617	84.8	0.08	3.5	2.2	4,011	7

Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060-001

Junction Parameters and 25-Year Storm Event Results

			25-Year Storm Event			
Junction ID (Char)	Rim Elevation (ft)	Invert Elevation (ft)	Maximum Depth (ft)	Freeboard (ft)	Total Flood Volume (MG)	Total Flood Time (hrs)
E11-2	215.67	209.37	0.30	6.00	0.000	0.00
E11-3	212.87	210.17	0.66	2.04	0.000	0.00
E11-6	202.08	197.98	0.35	3.75	0.000	0.00
E12-101	175.94	171.48	0.56	3.90	0.000	0.00
E12-104	174.34	169.94	0.70	3.70	0.000	0.00
E12-105	177.84	173.74	0.39	3.71	0.000	0.00
E12-108	192.04	186.84	0.43	4.77	0.000	0.00
E12-112	192.23	189.73	0.51	1.99	0.000	0.00
E12-113	193.74	190.72	0.94	2.08	0.000	0.00
E12-131	177.74	168.80	0.99	7.95	0.000	0.00
E12-132	182.04	173.48	0.57	7.99	0.000	0.00
E12-135	176.84	168.03	1.12	7.69	0.000	0.00
E12-136	170.44	165.97	0.64	3.83	0.000	0.00
E12-137	166.56	161.60	0.38	4.58	0.000	0.00
E12-19	213.14	208.52	0.55	4.07	0.000	0.00
E12-21	206.64	201.44	0.64	4.56	0.000	0.00
E12-24	202.64	197.97	0.63	4.04	0.000	0.00
E12-27	203.14	196.65	0.68	5.81	0.000	0.00
E12-30	212.04	209.14	0.23	2.67	0.000	0.00
E12-32	199.14	193.75	0.75	4.64	0.000	0.00
E12-36	193.64	187.54	0.94	5.16	0.000	0.00
E12-37	193.34	188.52	0.00	4.82	0.000	0.00
E12-40	203.44	198.34	0.00	5.10	0.000	0.00
E12-42	192.74	186.90	0.76	5.08	0.000	0.00
E12-44	190.24	184.78	0.75	4.71	0.000	0.00
E12-46	186.54	182.10	1.21	3.23	0.000	0.00
E12-49	185.74	182.83	1.52	1.39	0.000	0.00
E12-52	195.24	188.94	0.75	5.55	0.000	0.00
E12-6	191.59	187.49	4.12	-0.02	0.013	2.64
E12-64	183.34	178.67	1.22	3.45	0.000	0.00
E12-66	179.94	175.24	1.10	3.60	0.000	0.00
E12-71	176.24	170.53	1.02	4.69	0.000	0.00
E12-72	167.54	160.06	1.34	6.14	0.000	0.00
E12-75	168.04	159.56	1.25	7.23	0.000	0.00

Client: City of St. Helens
Project: Stormwater Master Plan
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Junction Parameters and 25-Year Storm Event Results

			25-Year Storm Event			
Junction ID (Char)	Rim Elevation (ft)	Invert Elevation (ft)	Maximum Depth (ft)	Freeboard (ft)	Total Flood Volume (MG)	Total Flood Time (hrs)
E12-79	174.37	158.08	1.28	15.01	0.000	0.00
E12-82	161.34	156.68	1.24	3.42	0.000	0.00
E12-84	214.14	209.65	0.48	4.01	0.000	0.00
E12-87	200.24	196.64	1.61	1.99	0.000	0.00
E12-88	199.64	196.28	0.58	2.78	0.000	0.00
E12-94	195.14	192.14	0.57	2.43	0.000	0.00
E12-95	190.54	187.44	0.57	2.53	0.000	0.00
E12-96	189.24	185.83	0.53	2.88	0.000	0.00
E12-99	179.44	174.76	0.63	4.05	0.000	0.00
E13-10	179.94	174.93	2.89	2.12	0.000	0.00
E13-11	183.34	176.16	0.82	6.36	0.000	0.00
E13-15	181.34	173.95	4.05	3.34	0.000	0.00
E13-16	178.14	173.75	2.66	1.73	0.000	0.00
E13-17	178.04	172.60	1.39	4.05	0.000	0.00
E13-23	179.84	172.08	1.44	6.32	0.000	0.00
E13-24	183.93	178.28	0.69	4.96	0.000	0.00
E13-25	177.34	172.90	1.36	3.08	0.000	0.00
E13-26	179.44	171.53	1.94	5.97	0.000	0.00
E13-3	177.14	171.17	0.00	5.97	0.000	0.00
E13-30	177.54	169.91	3.56	4.07	0.000	0.00
E13-7	179.74	174.09	2.22	3.43	0.000	0.00
E13-8	179.54	174.52	2.96	2.06	0.000	0.00
F10-1	173.87	169.17	3.84	0.86	0.000	0.00
F10-21	179.72	173.14	6.58	0.00	0.000	0.00
F10-23	182.02	174.84	5.61	1.57	0.000	0.00
F10-26	182.98	174.84	0.00	8.14	0.000	0.00
F10-27	182.86	176.55	2.43	3.88	0.000	0.00
F10-31	253.31	249.04	0.32	3.95	0.000	0.00
F10-34	250.82	246.14	0.36	4.32	0.000	0.00
F11-1	177.13	171.41	5.43	0.29	0.000	0.00
F11-105	212.00	208.90	0.34	2.76	0.000	0.00
F11-110	201.00	198.22	0.34	2.44	0.000	0.00
F11-111	194.40	190.95	0.34	3.11	0.000	0.00
F11-112	189.35	183.79	0.37	5.19	0.000	0.00

Client: City of St. Helens
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Junction Parameters and 25-Year Storm Event Results

			25-Year Storm Event			
Junction ID (Char)	Rim Elevation (ft)	Invert Elevation (ft)	Maximum Depth (ft)	Freeboard (ft)	Total Flood Volume (MG)	Total Flood Time (hrs)
F11-113	180.50	177.29	0.36	2.85	0.000	0.00
F11-114	175.50	171.20	0.31	3.99	0.000	0.00
F11-115	174.00	168.50	0.88	4.62	0.000	0.00
F11-117	173.88	170.54	0.00	3.34	0.000	0.00
F11-118	179.34	171.04	0.00	8.30	0.000	0.00
F11-12	171.06	163.06	5.05	2.95	0.000	0.00
F11-15	167.59	157.69	6.61	3.29	0.000	0.00
F11-15_DUMMY	170.93	161.52	2.35	7.06	0.000	0.00
F11-163	211.39	205.19	0.40	5.80	0.000	0.00
F11-164	191.39	184.25	0.42	6.72	0.000	0.00
F11-165	176.14	168.44	0.91	6.79	0.000	0.00
F11-17	167.08	159.78	5.17	2.13	0.000	0.00
F11-185	149.00	145.00	0.87	3.13	0.000	0.00
F11-186	149.00	145.70	1.22	2.29	0.000	0.00
F11-187	172.85	165.00	1.32	6.53	0.000	0.00
F11-188	169.50	165.50	0.94	3.11	0.000	0.00
F11-2	174.44	169.69	4.75	0.00	0.000	0.00
F11-20	161.05	154.75	0.85	5.45	0.000	0.00
F11-207	165.68	160.74	0.68	4.26	0.000	0.00
F11-21	152.99	148.74	4.25	0.00	0.000	0.00
F11-211	159.97	154.84	0.62	4.51	0.000	0.00
F11-214	158.45	148.84	1.83	7.78	0.000	0.00
F11-217	154.07	148.95	1.69	3.43	0.000	0.00
F11-219	151.29	146.74	3.76	0.79	0.000	0.00
F11-220	150.59	145.10	5.49	0.00	0.000	0.00
F11-221	150.10	144.34	5.79	-0.03	0.022	0.86
F11-223	155.31	152.60	0.18	2.53	0.000	0.00
F11-230	150.80	148.04	2.76	0.00	0.001	0.02
F11-233	180.04	174.34	0.00	5.70	0.000	0.00
F11-234	188.99	184.44	0.72	3.83	0.000	0.00
F11-237	196.90	192.33	0.77	3.80	0.000	0.00
F11-239	212.20	206.34	0.59	5.27	0.000	0.00
F11-242	221.76	215.78	0.39	5.59	0.000	0.00
F11-243	236.40	230.71	0.32	5.37	0.000	0.00

Client: City of St. Helens
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Junction Parameters and 25-Year Storm Event Results

			25-Year Storm Event			
Junction ID (Char)	Rim Elevation (ft)	Invert Elevation (ft)	Maximum Depth (ft)	Freeboard (ft)	Total Flood Volume (MG)	Total Flood Time (hrs)
F11-247	229.05	224.64	0.36	4.05	0.000	0.00
F11-25	195.57	185.62	0.61	9.34	0.000	0.00
F11-29	175.75	169.18	0.54	6.03	0.000	0.00
F11-34	175.88	166.81	0.90	8.17	0.000	0.00
F11-37	187.68	180.33	0.54	6.81	0.000	0.00
F11-42	170.32	164.62	0.78	4.92	0.000	0.00
F11-43	170.10	163.22	0.82	6.06	0.000	0.00
F11-5	174.57	167.79	3.07	3.71	0.000	0.00
F11-50	184.46	174.21	0.43	9.82	0.000	0.00
F11-58	265.74	256.92	0.80	8.02	0.000	0.00
F11-6	173.44	164.59	5.15	3.70	0.000	0.00
F11-61	246.35	242.17	0.63	3.55	0.000	0.00
F11-64	222.22	215.24	0.69	6.29	0.000	0.00
F11-75	205.53	197.80	0.58	7.15	0.000	0.00
F11-76	194.09	183.34	8.13	2.62	0.000	0.00
F11-80	187.50	174.36	0.65	12.49	0.000	0.00
F11-94	136.04	133.80	0.91	1.33	0.000	0.00
F11-98	165.75	161.65	0.00	4.10	0.000	0.00
F11-99	173.70	168.90	0.00	4.80	0.000	0.00
F12-104	122.66	119.50	3.11	0.05	0.000	0.00
F12-105	123.59	119.20	1.36	3.03	0.000	0.00
F12-11	162.05	156.10	0.44	5.51	0.000	0.00
F12-110	118.00	115.80	0.20	2.00	0.000	0.00
F12-111	121.80	118.30	0.33	3.17	0.000	0.00
F12-112	137.79	134.79	0.30	2.70	0.000	0.00
F12-113	131.51	122.66	0.54	8.31	0.000	0.00
F12-114	125.95	121.35	0.48	4.12	0.000	0.00
F12-118	113.84	110.75	0.94	2.15	0.000	0.00
F12-133	126.38	123.20	0.44	4.16	0.000	0.00
F12-134	129.20	124.80	1.11	3.29	0.000	0.00
F12-14	161.60	157.50	0.00	4.10	0.000	0.00
F12-15	138.94	132.46	1.64	4.84	0.000	0.00
F12-16	137.29	132.29	1.23	3.77	0.000	0.00
F12-17	136.84	131.84	1.13	3.87	0.000	0.00

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Junction Parameters and 25-Year Storm Event Results

			25-Year Storm Event			
Junction ID (Char)	Rim Elevation (ft)	Invert Elevation (ft)	Maximum Depth (ft)	Freeboard (ft)	Total Flood Volume (MG)	Total Flood Time (hrs)
F12-170	122.35	119.10	0.86	2.39	0.000	0.00
F12-171	122.48	119.40	0.97	2.11	0.000	0.00
F12-182	123.09	120.20	3.03	-0.14	0.101	4.89
F12-186	123.34	118.24	2.55	2.55	0.000	0.00
F12-188	124.10	117.99	2.79	3.32	0.000	0.00
F12-189	124.30	118.08	2.66	3.56	0.000	0.00
F12-190	125.38	117.77	2.76	4.85	0.000	0.00
F12-2	171.26	166.75	0.91	3.60	0.000	0.00
F12-23	131.28	125.50	2.06	3.72	0.000	0.00
F12-25	133.24	126.45	0.70	6.09	0.000	0.00
F12-26	138.84	130.14	0.82	7.88	0.000	0.00
F12-30	140.54	130.85	1.99	7.70	0.000	0.00
F12-34	146.64	135.51	4.48	6.65	0.000	0.00
F12-35	147.34	136.04	5.85	5.45	0.000	0.00
F12-38	144.24	137.67	5.61	0.96	0.000	0.00
F12-4	171.09	167.09	0.52	3.48	0.000	0.00
F12-41	143.54	138.43	5.11	0.00	0.000	0.00
F12-44	144.24	140.64	3.66	-0.06	0.044	1.80
F12-45	145.74	141.98	3.76	0.00	0.000	0.11
F12-48	150.09	147.21	2.88	0.00	0.000	0.01
F12-53	136.96	132.99	1.18	2.79	0.000	0.00
F12-56	137.90	133.64	1.10	3.16	0.000	0.00
F12-59	138.84	134.66	1.23	2.95	0.000	0.00
F12-6	175.76	172.25	0.41	3.10	0.000	0.00
F12-67	119.53	114.33	5.20	0.00	0.000	0.00
F12-68	119.95	114.75	5.20	0.00	0.000	0.00
F12-69	121.89	116.59	4.03	1.27	0.000	0.00
F12-7	177.39	173.89	0.53	2.97	0.000	0.00
F12-71	121.90	116.90	3.83	1.17	0.000	0.00
F12-8	179.10	175.66	0.61	2.83	0.000	0.00
F12-91	123.94	117.36	3.00	3.58	0.000	0.00
F12-95	125.05	117.50	2.85	4.70	0.000	0.00
F13-1	128.50	125.57	0.47	2.46	0.000	0.00
F13-11	118.88	114.28	0.76	3.84	0.000	0.00

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Junction Parameters and 25-Year Storm Event Results

Junction ID (Char)	Rim Elevation (ft)	Invert Elevation (ft)	25-Year Storm Event Maximum Depth (ft)	25-Year Storm Event Freeboard (ft)	25-Year Storm Event Total Flood Volume (MG)	25-Year Storm Event Total Flood Time (hrs)
F13-13	119.37	108.67	0.93	9.77	0.000	0.00
F13-15	125.81	122.39	0.35	3.07	0.000	0.00
F13-17	134.08	130.33	0.38	3.37	0.000	0.00
F13-2	128.25	123.95	0.48	3.82	0.000	0.00
F13-22	123.19	119.59	1.03	2.57	0.000	0.00
F13-25	103.89	100.71	1.00	2.18	0.000	0.00
F13-26	108.25	99.40	0.81	8.04	0.000	0.00
F13-27	106.11	98.85	1.11	6.15	0.000	0.00
F13-28	112.92	109.62	0.23	3.07	0.000	0.00
F13-3	127.09	122.97	0.42	3.70	0.000	0.00
F13-30	125.11	121.84	0.27	3.00	0.000	0.00
F13-32	102.19	97.55	0.94	3.70	0.000	0.00
F13-34	102.04	97.03	1.12	3.89	0.000	0.00
F13-35	100.92	95.72	0.71	4.49	0.000	0.00
F13-36	114.89	111.99	0.19	2.71	0.000	0.00
F13-37	122.75	119.70	0.21	2.84	0.000	0.00
F13-4	123.90	119.87	0.39	3.64	0.000	0.00
F13-40	98.45	93.87	1.58	3.00	0.000	0.00
F13-43	96.84	94.44	1.02	1.38	0.000	0.00
F13-44	103.34	99.84	0.19	3.31	0.000	0.00
F13-5	122.15	117.70	0.79	3.66	0.000	0.00
F13-6	122.45	118.68	2.19	1.58	0.000	0.00
F13-7	123.00	118.56	3.29	1.15	0.000	0.00
F13-8	125.50	122.19	3.31	0.00	0.000	0.12
F13-9	130.61	126.91	3.70	0.00	0.000	0.07
G10-10	223.74	217.74	0.32	5.68	0.000	0.00
G10-105	159.24	154.40	0.95	3.89	0.000	0.00
G10-11	222.14	218.03	0.06	4.05	0.000	0.00
G10-114	148.56	142.70	4.08	1.78	0.000	0.00
G10-115	149.50	142.30	4.50	2.70	0.000	0.00
G10-116	145.99	141.50	4.49	0.00	0.000	0.00
G10-117	148.42	138.90	2.16	7.36	0.000	0.00
G10-118	155.14	149.64	0.71	4.79	0.000	0.00
G10-119	149.25	142.30	4.49	2.46	0.000	0.00

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Junction Parameters and 25-Year Storm Event Results

			25-Year Storm Event			
Junction ID (Char)	Rim Elevation (ft)	Invert Elevation (ft)	Maximum Depth (ft)	Freeboard (ft)	Total Flood Volume (MG)	Total Flood Time (hrs)
G10-14	222.14	218.53	0.00	3.61	0.000	0.00
G10-15	223.84	219.14	0.00	4.70	0.000	0.00
G10-18	227.34	223.14	0.00	4.20	0.000	0.00
G10-22	195.24	189.53	0.40	5.31	0.000	0.00
G10-25	217.54	213.04	0.28	4.22	0.000	0.00
G10-28	227.14	216.09	0.42	10.63	0.000	0.00
G10-29	223.34	217.29	0.78	5.27	0.000	0.00
G10-3	236.24	232.24	0.00	4.00	0.000	0.00
G10-31	221.34	217.64	0.43	3.27	0.000	0.00
G10-35	142.42	137.84	1.26	3.32	0.000	0.00
G10-36	142.21	138.44	0.86	2.91	0.000	0.00
G10-37	142.18	138.64	0.54	3.00	0.000	0.00
G10-38	143.55	140.36	0.74	2.45	0.000	0.00
G10-4	233.84	230.21	0.00	3.63	0.000	0.00
G10-41	145.64	141.24	0.76	3.64	0.000	0.00
G10-42	153.01	148.09	0.46	4.46	0.000	0.00
G10-43	157.33	152.94	0.40	3.99	0.000	0.00
G10-45	171.96	167.44	0.48	4.04	0.000	0.00
G10-47	172.24	168.19	2.41	1.64	0.000	0.00
G10-5	232.24	227.64	0.00	4.60	0.000	0.00
G10-57	126.14	123.14	3.04	-0.04	0.029	1.54
G10-64	146.96	143.20	3.77	-0.01	0.006	0.23
G10-66	156.00	149.56	1.16	5.28	0.000	0.00
G10-67	158.00	151.27	0.88	5.85	0.000	0.00
G10-8	230.14	225.34	0.00	4.80	0.000	0.00
G10-88	141.57	133.80	0.44	7.33	0.000	0.00
G10-89	160.00	155.75	0.33	3.92	0.000	0.00
G10-9	224.24	217.57	0.51	6.16	0.000	0.00
G10-92	157.00	153.00	0.36	3.64	0.000	0.00
G11-102	112.90	107.80	0.91	4.19	0.000	0.00
G11-109	121.64	118.68	0.72	2.24	0.000	0.00
G11-11	127.34	120.82	3.11	3.41	0.000	0.00
G11-113	119.84	116.34	1.61	1.89	0.000	0.00
G11-115	118.04	115.64	0.84	1.56	0.000	0.00

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Junction Parameters and 25-Year Storm Event Results

			25-Year Storm Event			
Junction ID (Char)	Rim Elevation (ft)	Invert Elevation (ft)	Maximum Depth (ft)	Freeboard (ft)	Total Flood Volume (MG)	Total Flood Time (hrs)
G11-116	119.24	116.97	1.38	0.89	0.000	0.00
G11-119	117.24	114.61	1.38	1.25	0.000	0.00
G11-12	126.84	121.12	3.36	2.36	0.000	0.00
G11-122	138.19	135.26	2.93	0.00	0.000	0.00
G11-128	115.34	112.84	2.98	1.60	0.000	0.00
G11-132	113.98	109.68	1.28	3.02	0.000	0.00
G11-136	111.46	106.30	1.01	4.15	0.000	0.00
G11-138	151.44	147.44	0.43	3.57	0.000	0.00
G11-139	149.27	145.27	0.26	3.74	0.000	0.00
G11-14	130.49	122.20	2.19	6.10	0.000	0.00
G11-143	147.56	145.70	3.64	0.70	0.000	0.00
G11-144	145.00	140.00	0.28	4.72	0.000	0.00
G11-145	137.04	134.10	0.50	2.50	0.000	0.00
G11-146	145.90	139.43	0.41	6.06	0.000	0.00
G11-147	140.14	137.57	0.34	2.23	0.000	0.00
G11-159	138.71	136.07	2.64	0.00	0.000	0.16
G11-160	140.52	135.90	4.49	0.13	0.000	0.00
G11-17	132.93	130.60	0.68	1.65	0.000	0.00
G11-18	134.52	131.54	0.67	2.31	0.000	0.00
G11-19	137.14	132.34	0.76	4.04	0.000	0.00
G11-2	129.93	127.70	2.23	0.00	0.000	0.00
G11-21	123.74	120.44	3.30	0.00	0.000	0.01
G11-26	120.84	118.34	2.50	0.00	0.000	0.20
G11-28	120.89	117.84	2.63	0.42	0.000	0.00
G11-3	130.04	126.60	3.44	0.00	0.000	0.00
G11-41	115.15	112.95	0.98	1.22	0.000	0.00
G11-42	119.24	115.34	1.10	2.80	0.000	0.00
G11-6	125.80	123.50	0.41	1.89	0.000	0.00
G11-7	126.07	120.45	2.86	2.76	0.000	0.00
G11-70	128.38	125.10	3.31	-0.03	0.025	1.39
G11-71	124.70	123.20	0.46	11.54	0.000	0.00
G11-72	122.82	122.82	0.20	11.80	0.000	0.00
G11-73	127.24	123.19	0.00	4.05	0.000	0.00
G11-78	115.54	111.67	1.51	2.36	0.000	0.00

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			25-Year Storm Event			
Junction ID (Char)	Rim Elevation (ft)	Invert Elevation (ft)	Maximum Depth (ft)	Freeboard (ft)	Total Flood Volume (MG)	Total Flood Time (hrs)
G11-79	115.51	111.60	1.11	2.80	0.000	0.00
G11-8	125.58	120.34	2.63	2.61	0.000	0.00
G11-80	114.13	110.21	1.50	2.42	0.000	0.00
G11-81	113.77	110.10	1.16	2.51	0.000	0.00
G11-83	113.60	108.90	1.34	3.36	0.000	0.00
G11-84	113.31	108.36	1.07	3.88	0.000	0.00
G11-85	131.94	129.76	3.05	-0.05	0.038	2.49
G11-9	122.84	119.92	1.12	1.80	0.000	0.00
G11-91	114.48	108.88	1.87	3.73	0.000	0.00
G11-98	113.59	108.48	1.72	3.39	0.000	0.00
G12-1	117.33	114.39	2.75	0.19	0.000	0.00
G12-111	118.15	115.40	1.84	0.91	0.000	0.00
G12-113	120.15	117.20	2.41	0.54	0.000	0.00
G12-122	116.50	109.90	6.60	0.00	0.000	0.00
G12-123	109.34	106.43	2.61	0.30	0.000	0.00
G12-124	109.82	106.57	3.26	-0.01	0.004	0.33
G12-125	111.40	106.50	4.11	0.79	0.000	0.00
G12-129	112.12	105.55	4.99	1.58	0.000	0.00
G12-14	104.53	101.90	0.48	2.15	0.000	0.00
G12-17	104.93	98.69	1.04	5.20	0.000	0.00
G12-19	104.77	98.27	1.89	4.61	0.000	0.00
G12-2	119.59	113.80	1.93	3.86	0.000	0.00
G12-23	101.37	97.42	1.72	2.23	0.000	0.00
G12-25	99.20	93.88	5.32	0.00	0.000	0.00
G12-26	99.34	93.87	4.29	1.18	0.000	0.00
G12-27	99.34	92.34	3.92	3.08	0.000	0.00
G12-3	117.53	113.34	1.25	2.95	0.000	0.00
G12-34	115.49	109.00	6.49	0.00	0.000	0.00
G12-39	112.84	105.34	5.67	1.83	0.000	0.00
G12-43	106.84	101.84	3.41	1.59	0.000	0.00
G12-46	112.87	104.70	5.59	2.58	0.000	0.00
G12-48	105.52	93.34	7.29	4.89	0.000	0.00
G12-49	100.84	92.94	6.74	1.16	0.000	0.00
G12-51	96.74	91.30	1.00	4.44	0.000	0.00

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			25-Year Storm Event			
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G12-52	92.52	87.00	0.91	4.61	0.000	0.00
G12-53	96.75	91.00	1.05	4.70	0.000	0.00
G12-54	92.56	87.30	0.92	4.34	0.000	0.00
G12-55	113.00	106.38	4.45	2.17	0.000	0.00
G12-7	106.75	101.46	1.43	3.86	0.000	0.00
G12-75	116.34	114.80	2.34	-0.80	0.602	17.15
G12-79	111.34	107.01	4.07	0.26	0.000	0.00
G12-80	113.34	108.49	2.92	1.93	0.000	0.00
G12-9	106.09	101.29	1.08	3.72	0.000	0.00
G13-1	95.34	91.46	4.04	-0.16	0.120	1.89
G13-26	80.00	77.33	2.69	-0.02	0.012	0.69
G13-27	78.00	75.00	3.00	0.00	0.000	0.00
G13-3	88.76	83.00	1.14	4.62	0.000	0.00
G13-4	88.58	82.50	1.43	4.65	0.000	0.00
G9-13	212.34	205.34	0.79	6.21	0.000	0.00
G9-14	240.57	234.23	0.56	5.78	0.000	0.00
G9-15	241.61	235.51	1.12	4.98	0.000	0.00
G9-16	253.34	246.89	0.63	5.82	0.000	0.00
G9-18	195.34	193.34	1.63	1.37	0.000	0.00
G9-19	269.31	262.76	0.47	6.08	0.000	0.00
G9-2	193.45	164.29	1.03	28.13	0.000	0.00
G9-20	270.13	264.01	0.76	5.36	0.000	0.00
G9-26	235.34	229.14	0.90	5.30	0.000	0.00
G9-28	233.23	227.03	1.13	5.07	0.000	0.00
G9-29	235.10	225.56	0.72	8.82	0.000	0.00
G9-4	171.34	168.34	0.85	2.15	0.000	0.00
G9-42	241.38	232.18	0.83	8.37	0.000	0.00
G9-44	257.35	250.95	0.73	5.67	0.000	0.00
G9-45	261.67	255.47	0.75	5.45	0.000	0.00
G9-46	286.68	280.48	0.68	5.52	0.000	0.00
G9-5	198.25	190.89	0.00	7.36	0.000	0.00
G9-9	201.14	198.34	0.00	2.80	0.000	0.00
H10-1	97.04	94.82	2.25	-0.03	0.024	0.76
H10-10	113.62	105.59	0.71	7.32	0.000	0.00

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Junction ID (Char)	Rim Elevation (ft)	Invert Elevation (ft)	25-Year Storm Event Maximum Depth (ft)	25-Year Storm Event Freeboard (ft)	25-Year Storm Event Total Flood Volume (MG)	25-Year Storm Event Total Flood Time (hrs)
H10-11	102.64	97.74	0.92	3.98	0.000	0.00
H10-12	99.35	94.70	0.99	3.66	0.000	0.00
H10-13	129.24	125.29	3.96	-0.01	0.007	0.51
H10-16	130.64	124.66	5.25	0.73	0.000	0.00
H10-19	69.23	63.33	5.90	0.00	0.000	0.01
H10-2	97.34	93.90	3.44	0.00	0.001	0.17
H10-24	113.34	108.82	0.85	3.67	0.000	0.00
H11-103	87.66	84.69	2.98	-0.01	0.007	0.34
H11-104	87.52	84.33	3.21	-0.02	0.014	0.61
H11-105	87.66	84.06	3.15	0.45	0.000	0.00
H11-106	88.89	83.81	3.24	1.84	0.000	0.00
H11-107	85.67	82.73	3.03	-0.09	0.064	2.57
H11-108	85.71	82.70	2.94	0.07	0.000	0.00
H11-124	81.30	78.75	2.75	-0.20	0.151	4.57
H11-13	124.74	121.58	3.16	0.00	0.000	0.00
H11-145	85.54	81.60	3.25	0.69	0.000	0.00
H11-16	127.64	123.64	4.00	0.00	0.000	0.00
H11-162	106.80	103.60	1.30	1.90	0.000	0.00
H11-163	94.62	91.87	2.75	0.00	0.002	0.21
H11-164	98.83	93.38	5.45	0.00	0.000	0.00
H11-165	94.15	90.94	3.21	0.00	0.000	0.02
H11-168	86.21	83.33	2.94	-0.06	0.042	1.71
H11-181	88.91	85.84	3.00	0.07	0.000	0.00
H11-183	94.98	89.63	4.51	0.84	0.000	0.00
H11-185	94.76	90.10	4.13	0.53	0.000	0.00
H11-187	94.86	91.63	3.23	0.00	0.000	0.00
H11-2	72.00	67.30	2.13	2.57	0.000	0.00
H11-211	107.14	102.14	0.82	4.18	0.000	0.00
H11-22	103.31	94.65	0.75	7.91	0.000	0.00
H11-224	106.20	101.11	0.00	5.09	0.000	0.00
H11-23	111.68	97.20	0.78	13.70	0.000	0.00
H11-231	109.50	100.90	3.33	5.27	0.000	0.00
H11-232	108.71	100.50	1.86	6.35	0.000	0.00
H11-233	107.24	98.80	1.27	7.17	0.000	0.00

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Junction Parameters and 25-Year Storm Event Results

			25-Year Storm Event			
Junction ID (Char)	Rim Elevation (ft)	Invert Elevation (ft)	Maximum Depth (ft)	Freeboard (ft)	Total Flood Volume (MG)	Total Flood Time (hrs)
H11-24	106.64	91.63	1.46	13.55	0.000	0.00
H11-25	106.34	91.47	1.42	13.45	0.000	0.00
H11-26	100.44	90.89	1.36	8.19	0.000	0.00
H11-27	103.64	90.36	1.60	11.68	0.000	0.00
H11-29	92.94	86.71	1.36	4.87	0.000	0.00
H11-30	90.34	86.34	1.64	2.36	0.000	0.00
H11-33	91.34	86.00	1.29	4.05	0.000	0.00
H11-34	94.64	88.68	1.61	4.35	0.000	0.00
H11-37	94.34	89.86	1.52	2.96	0.000	0.00
H11-38	95.54	90.29	1.37	3.88	0.000	0.00
H11-40	95.84	90.91	1.35	3.58	0.000	0.00
H11-41	102.93	92.04	1.05	9.84	0.000	0.00
H11-43	107.13	102.50	4.63	0.00	0.002	0.20
H11-55	90.67	82.76	1.39	6.52	0.000	0.00
H11-58	83.50	80.50	2.68	0.32	0.000	0.00
H11-6	103.34	98.71	0.00	4.63	0.000	0.00
H11-60	109.92	107.40	0.72	1.80	0.000	0.00
H11-61	109.80	107.40	2.13	0.27	0.000	0.00
H11-62	111.86	106.40	5.47	-0.01	0.007	0.36
H12-10	79.19	74.60	1.53	3.06	0.000	0.00
H12-11	78.98	75.08	1.49	2.41	0.000	0.00
H12-17	88.93	85.34	1.42	2.17	0.000	0.00
H12-18	90.15	85.61	1.30	3.24	0.000	0.00
H12-21	91.59	87.50	0.97	3.12	0.000	0.00
H12-26	84.41	80.41	1.63	2.37	0.000	0.00
H12-27	83.95	76.15	5.19	2.61	0.000	0.00
H12-28	78.65	72.19	6.47	-0.01	0.008	0.78
H12-30	79.41	71.68	6.68	1.05	0.000	0.00
H12-48	64.84	62.92	1.13	0.79	0.000	0.00
H12-49	64.69	61.99	1.61	1.09	0.000	0.00
H12-51	88.02	84.56	1.51	1.95	0.000	0.00
H12-55	91.95	85.08	1.48	5.39	0.000	0.00
H12-56	88.07	84.50	1.45	2.12	0.000	0.00
H12-57	88.87	83.95	1.19	3.73	0.000	0.00

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			25-Year Storm Event			
Junction ID (Char)	Rim Elevation (ft)	Invert Elevation (ft)	Maximum Depth (ft)	Freeboard (ft)	Total Flood Volume (MG)	Total Flood Time (hrs)
H12-62	95.44	88.73	3.66	3.05	0.000	0.00
H12-64	95.74	88.93	4.00	2.81	0.000	0.00
H12-65	66.00	63.60	0.74	1.66	0.000	0.00
H12-7	89.45	86.18	1.77	1.50	0.000	0.00
H12-74	79.19	71.14	7.08	0.97	0.000	0.00
H12-8	90.15	86.24	0.81	3.10	0.000	0.00
H12-9	81.03	77.73	1.35	1.95	0.000	0.00
H13-70	67.00	63.10	3.91	-0.01	0.007	0.92
H13-72	66.00	62.00	1.31	2.69	0.000	0.00
H9-1	106.00	99.00	1.75	6.19	0.000	0.00
H9-2	111.29	106.39	0.00	4.90	0.000	0.00
I10-1	95.14	91.96	2.90	0.28	0.000	0.00
I10-114	54.74	48.54	5.88	0.32	0.000	0.00
I10-115	56.65	48.82	3.75	4.08	0.000	0.00
I10-116	51.35	49.10	2.27	-0.02	0.015	0.60
I10-119	64.40	61.40	1.51	1.76	0.000	0.00
I10-126	62.30	59.30	0.94	2.06	0.000	0.00
I10-132	73.09	69.70	0.56	2.83	0.000	0.00
I10-136	73.97	69.20	1.11	3.66	0.000	0.00
I10-138	62.52	49.00	0.99	12.53	0.000	0.00
I10-139	64.72	54.30	5.05	5.37	0.000	0.00
I10-14	91.93	87.40	0.92	3.61	0.000	0.00
I10-141	89.90	85.76	0.18	3.96	0.000	0.00
I10-142	86.10	79.64	0.23	6.23	0.000	0.00
I10-143	67.60	64.54	0.66	2.40	0.000	0.00
I10-153	92.90	86.48	0.69	5.73	0.000	0.00
I10-154	28.96	23.46	4.47	7.53	0.000	0.00
I10-17	84.00	80.70	1.64	1.66	0.000	0.00
I10-2	94.64	91.55	2.79	0.30	0.000	0.00
I10-20	83.87	77.43	1.03	5.41	0.000	0.00
I10-21	84.34	81.74	1.90	0.70	0.000	0.00
I10-22	85.24	82.44	2.10	0.70	0.000	0.00
I10-24	87.84	84.71	1.00	2.13	0.000	0.00
I10-26	88.24	85.53	2.71	0.00	0.000	0.01

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Junction Parameters and 25-Year Storm Event Results

			25-Year Storm Event			
Junction ID (Char)	Rim Elevation (ft)	Invert Elevation (ft)	Maximum Depth (ft)	Freeboard (ft)	Total Flood Volume (MG)	Total Flood Time (hrs)
I10-28	90.34	86.43	3.92	-0.01	0.005	0.43
I10-30	94.34	90.55	2.88	0.91	0.000	0.00
I10-31	93.84	91.39	2.47	-0.02	0.018	0.78
I10-33	65.17	57.26	2.39	5.52	0.000	0.00
I10-34	54.93	52.43	0.41	2.09	0.000	0.00
I10-42	88.78	83.48	5.30	0.00	0.000	0.00
I10-44	96.78	82.91	0.36	13.51	0.000	0.00
I10-45	68.38	61.48	2.64	4.26	0.000	0.00
I10-46	61.38	61.38	0.15	1.10	0.000	0.00
I10-47	71.28	62.74	5.46	3.08	0.000	0.00
I10-48	70.09	62.40	4.78	2.91	0.000	0.00
I10-5	93.54	90.98	2.58	-0.02	0.013	0.69
I10-51	65.19	60.93	4.75	-0.49	0.370	3.79
I10-52	66.40	60.40	5.35	0.65	0.000	0.00
I10-53	66.37	60.30	5.35	0.72	0.000	0.00
I10-54	65.61	59.50	5.90	0.21	0.000	0.00
I10-55	65.25	59.00	6.32	-0.07	0.049	1.79
I10-56	67.80	57.90	6.25	3.65	0.000	0.00
I10-57	64.49	60.80	2.15	1.54	0.000	0.00
I10-58	66.43	53.70	4.61	8.12	0.000	0.00
I10-59	70.63	52.50	4.70	13.43	0.000	0.00
I10-6	92.78	89.87	2.57	0.34	0.000	0.00
I10-60	70.66	52.30	4.68	13.68	0.000	0.00
I10-61	68.68	50.70	3.92	14.06	0.000	0.00
I10-62	69.39	61.40	1.88	6.11	0.000	0.00
I10-63	85.61	74.97	1.52	9.12	0.000	0.00
I10-64	90.09	76.21	8.69	5.19	0.000	0.00
I10-66	63.44	50.00	2.45	10.99	0.000	0.00
I10-67	42.31	37.31	2.90	2.10	0.000	0.00
I10-72	56.71	44.49	0.95	11.27	0.000	0.00
I10-73	56.21	45.70	2.41	8.10	0.000	0.00
I10-74	66.80	60.61	1.97	4.22	0.000	0.00
I10-8	91.89	87.90	4.10	-0.11	0.082	1.65
I10-83	55.60	46.90	2.96	5.74	0.000	0.00

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			25-Year Storm Event			
Junction ID (Char)	Rim Elevation (ft)	Invert Elevation (ft)	Maximum Depth (ft)	Freeboard (ft)	Total Flood Volume (MG)	Total Flood Time (hrs)
I10-84	56.19	47.70	3.55	4.94	0.000	0.00
I10-85	57.69	48.34	3.97	5.38	0.000	0.00
I10-91	61.80	55.37	2.20	4.23	0.000	0.00
I10-93	73.45	70.17	2.08	1.20	0.000	0.00
I10-94	73.06	71.10	1.99	-0.03	0.019	0.85
I10-98	54.27	48.35	5.92	0.00	0.000	0.00
I11-10	54.84	46.14	8.70	0.00	0.000	0.00
I11-104	74.44	70.84	0.39	3.21	0.000	0.00
I11-104A	68.24	65.43	2.81	0.00	0.000	0.00
I11-105	95.24	90.17	0.40	4.67	0.000	0.00
I11-108	93.32	89.65	3.69	-0.02	0.013	0.82
I11-115	103.58	100.26	0.44	2.88	0.000	0.00
I11-116	85.27	81.55	0.33	3.39	0.000	0.00
I11-117	93.31	88.70	1.66	2.95	0.000	0.00
I11-118	92.58	88.91	2.79	0.88	0.000	0.00
I11-119	92.37	89.27	2.93	0.17	0.000	0.00
I11-127	73.86	67.14	4.23	2.49	0.000	0.00
I11-129	91.70	88.47	0.37	2.86	0.000	0.00
I11-16	70.36	63.64	6.78	-0.06	0.042	2.01
I11-17	67.34	62.06	5.64	-0.36	0.266	15.11
I11-18	68.10	61.03	6.39	0.68	0.000	0.00
I11-19	73.19	66.96	0.96	5.27	0.000	0.00
I11-20	74.19	67.28	0.96	5.95	0.000	0.00
I11-21	75.69	67.73	1.13	6.83	0.000	0.00
I11-23	75.26	64.00	2.24	9.02	0.000	0.00
I11-33	65.58	63.60	2.64	-0.64	0.476	16.72
I11-34	72.19	59.41	6.97	5.81	0.000	0.00
I11-35	66.00	58.56	7.53	-0.09	0.074	12.82
I11-36	66.19	58.02	8.25	-0.08	0.063	1.20
I11-37	66.19	56.33	8.19	2.17	0.000	0.00
I11-39	66.19	55.07	7.62	4.00	0.000	0.00
I11-40	59.69	52.75	7.18	-0.24	0.181	15.21
I11-41	56.19	51.35	5.77	-0.43	0.318	16.85
I11-42	56.69	50.28	6.47	-0.06	0.048	8.82

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			25-Year Storm Event			
Junction ID (Char)	Rim Elevation (ft)	Invert Elevation (ft)	Maximum Depth (ft)	Freeboard (ft)	Total Flood Volume (MG)	Total Flood Time (hrs)
I11-55	111.44	106.74	3.05	1.65	0.000	0.00
I11-56	108.54	106.10	0.57	1.87	0.000	0.00
I11-58	104.49	102.85	1.03	0.61	0.000	0.00
I11-59	104.23	102.28	0.53	1.42	0.000	0.00
I11-6	58.34	46.11	8.63	3.60	0.000	0.00
I11-69	56.43	50.34	6.09	0.00	0.001	0.11
I11-70	71.16	58.70	7.54	4.92	0.000	0.00
I11-71	56.43	53.82	2.62	-0.01	0.010	0.32
I11-81	95.16	91.41	0.50	3.25	0.000	0.00
I11-89	77.62	68.88	5.23	3.51	0.000	0.00
I11-91	78.51	68.69	4.99	4.84	0.000	0.00
I11-92	73.82	69.53	4.34	-0.05	0.034	1.50
I11-93	85.82	69.90	6.39	9.53	0.000	0.00
I12-10	69.50	63.44	0.98	5.08	0.000	0.00
I12-11	73.30	67.42	0.73	5.15	0.000	0.00
I12-12	69.00	66.98	0.73	1.29	0.000	0.00
I12-13	68.40	64.42	0.74	3.24	0.000	0.00
I12-15	67.70	59.39	0.66	7.65	0.000	0.00
I12-16	70.60	63.09	0.96	6.55	0.000	0.00
I12-18	64.40	57.90	1.09	5.41	0.000	0.00
I12-2	77.26	74.54	0.84	1.88	0.000	0.00
I12-21	58.50	57.50	1.29	1.71	0.000	0.00
I12-3	74.42	72.76	2.05	0.31	0.000	0.00
I12-30	69.15	63.70	5.55	-0.10	0.072	2.19
I12-34	65.87	60.95	3.70	1.22	0.000	0.00
I12-35	63.78	59.90	2.99	0.89	0.000	0.00
I12-36	63.30	58.80	0.72	3.78	0.000	0.00
I12-37	76.34	70.73	5.35	0.26	0.000	0.00
I12-38	75.34	66.97	7.14	1.23	0.000	0.00
I12-39	73.98	66.55	6.49	0.94	0.000	0.00
I12-4	73.99	72.55	2.25	-0.06	0.047	11.17
I12-40	71.83	65.72	6.13	-0.02	0.016	1.62
I12-49	68.04	58.77	0.94	8.33	0.000	0.00
I12-5	72.80	70.90	3.89	-1.70	1.282	19.28

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			25-Year Storm Event			
Junction ID (Char)	**Rim Elevation (ft)**	**Invert Elevation (ft)**	**Maximum Depth (ft)**	**Freeboard (ft)**	**Total Flood Volume (MG)**	**Total Flood Time (hrs)**
I12-5_DUMMY	72.80	70.90	0.83	1.07	0.000	0.00
I12-50	68.04	55.47	0.97	11.60	0.000	0.00
I12-53	64.78	54.00	2.07	8.71	0.000	0.00
I12-54	58.00	55.50	0.50	2.50	0.000	0.00
I12-58	59.03	54.30	0.94	3.79	0.000	0.00
I12-6	73.95	70.25	0.68	3.02	0.000	0.00
I12-7	72.21	69.91	1.15	1.15	0.000	0.00
I12-74	72.70	69.43	0.84	2.43	0.000	0.00
I12-76	63.81	61.60	0.57	1.64	0.000	0.00
I12-77	63.18	60.30	0.50	2.38	0.000	0.00
I12-78	62.78	59.40	1.38	2.00	0.000	0.00
I12-8	72.52	69.61	0.76	2.15	0.000	0.00
I12-88	78.40	68.33	4.95	5.12	0.000	0.00
I12-89	74.60	68.02	5.13	1.45	0.000	0.00
I12-9	72.40	68.68	0.84	2.88	0.000	0.00
I12-92	82.59	65.82	10.47	6.30	0.000	0.00
I12-93	73.89	63.89	1.15	8.85	0.000	0.00
I12-97	74.92	67.85	5.72	1.35	0.000	0.00
I9-27	90.20	87.60	0.00	2.60	0.000	0.00
I9-32	102.39	94.70	0.89	6.80	0.000	0.00
I9-34	104.00	95.05	1.02	7.93	0.000	0.00
I9-35	102.00	96.25	0.89	4.86	0.000	0.00
I9-36	100.10	97.15	0.84	2.11	0.000	0.00
I9-37	106.00	102.23	0.42	3.35	0.000	0.00
I9-52	104.18	93.68	0.61	9.89	0.000	0.00
I9-54	91.48	84.48	6.77	0.23	0.000	0.00
I9-65	89.60	87.21	0.00	2.39	0.000	0.00
I9-83	102.81	98.67	1.23	2.91	0.000	0.00
I9-84	101.95	96.99	1.43	3.53	0.000	0.00
J10-11	62.43	53.60	1.01	7.82	0.000	0.00
J10-12	62.58	54.24	1.28	7.06	0.000	0.00
J10-15	64.75	54.73	1.26	8.76	0.000	0.00
J10-22	60.84	45.24	7.04	8.56	0.000	0.00
J10-24	50.00	44.46	5.03	0.51	0.000	0.00

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			25-Year Storm Event			
Junction ID (Char)	Rim Elevation (ft)	Invert Elevation (ft)	Maximum Depth (ft)	Freeboard (ft)	Total Flood Volume (MG)	Total Flood Time (hrs)
J10-27	50.84	44.21	4.24	2.39	0.000	0.00
J10-29	50.34	43.92	4.35	2.07	0.000	0.00
J10-30	49.84	43.24	1.14	5.46	0.000	0.00
J10-33	45.34	38.06	1.27	6.01	0.000	0.00
J10-57	25.86	14.56	2.83	8.47	0.000	0.00
J10-58	21.70	7.84	2.66	11.20	0.000	0.00
J11-10	35.76	23.34	7.38	5.04	0.000	0.00
J11-15	26.34	21.24	4.31	0.79	0.000	0.00
J11-19	54.75	48.48	6.27	0.00	0.001	0.09
J11-2	59.04	45.39	7.63	6.02	0.000	0.00
J11-21	56.86	50.32	6.54	0.00	0.000	0.00
J11-22	81.34	74.04	5.30	2.00	0.000	0.00
J11-27	84.84	73.39	0.36	11.09	0.000	0.00
J11-28	38.84	30.34	1.41	7.09	0.000	0.00
J11-29	36.14	28.94	0.78	6.42	0.000	0.00
J11-30	32.60	21.84	8.19	2.57	0.000	0.00
J11-5	56.34	45.65	8.44	2.25	0.000	0.00
J11-63	50.64	42.25	4.27	4.12	0.000	0.00
J11-8	37.34	29.54	1.37	6.43	0.000	0.00
J12-10	34.62	16.33	0.66	17.63	0.000	0.00
J12-11	22.92	12.40	0.60	9.92	0.000	0.00
J12-2	49.14	40.67	3.36	5.11	0.000	0.00
J12-3	45.18	38.18	1.38	5.62	0.000	0.00
J12-8	42.89	37.80	0.57	4.52	0.000	0.00
J12-9	38.60	18.90	1.06	18.64	0.000	0.00
J9-14	89.94	87.69	0.69	1.56	0.000	0.00
J9-17	88.74	86.32	0.29	2.13	0.000	0.00
J9-18	83.38	81.05	0.19	2.14	0.000	0.00
KJ-100	194.10	193.10	1.09	-0.09	0.063	2.37
KJ-101	98.84	95.10	3.74	0.00	0.001	0.00
KJ-107	101.56	96.81	1.65	3.10	0.000	0.00
KJ-113	104.94	100.29	1.67	2.98	0.000	0.00
KJ-114	22.12	16.62	1.90	3.65	0.000	0.00
KJ-115	18.64	13.14	1.55	3.95	0.000	0.00

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Junction Parameters and 25-Year Storm Event Results

			25-Year Storm Event			
Junction ID (Char)	Rim Elevation (ft)	Invert Elevation (ft)	Maximum Depth (ft)	Freeboard (ft)	Total Flood Volume (MG)	Total Flood Time (hrs)
KJ-116	94.52	90.22	3.99	0.31	0.000	0.00
KJ-117	105.34	103.34	0.26	1.74	0.000	0.00
KJ-118	174.98	168.39	0.56	6.03	0.000	0.00
KJ-119	179.34	173.85	0.00	5.49	0.000	0.00
KJ-120	139.76	136.97	0.83	1.96	0.000	0.00
KJ-122	132.83	131.57	1.26	0.00	0.000	0.11
KJ-125	91.00	89.46	0.30	1.45	0.000	0.00
KJ-127	83.66	80.66	2.54	0.46	0.000	0.00
KJ-131	115.40	114.36	1.46	-0.24	0.189	16.17
KJ-133	103.03	98.82	2.62	1.59	0.000	0.00
KJ-134	101.83	98.18	1.69	1.96	0.000	0.00
KJ-135	167.95	166.95	2.08	0.92	0.000	0.00
KJ-136	185.78	184.78	0.66	2.34	0.000	0.00
KJ-137	61.74	56.07	2.24	3.43	0.000	0.00
KJ-138	137.23	134.42	0.89	1.92	0.000	0.00
KJ-139	135.49	133.05	1.24	1.20	0.000	0.00
KJ-141	132.87	131.40	1.19	0.31	0.000	0.00
KJ-143	132.18	130.22	1.40	0.56	0.000	0.00
KJ-144	131.09	129.42	1.53	0.14	0.000	0.00
KJ-145	130.53	128.86	1.75	-0.08	0.062	3.29
KJ-146	129.98	126.70	2.93	0.35	0.000	0.00
KJ-147	130.65	126.40	2.76	1.49	0.000	0.00
KJ-152	116.96	114.71	1.11	1.33	0.000	0.00
KJ-153	116.60	115.02	0.80	1.64	0.000	0.00
KJ-154	115.91	114.89	0.93	0.19	0.000	0.00
KJ-155	115.82	114.97	0.85	0.27	0.000	0.00
KJ-156	115.58	114.60	1.22	-0.10	0.076	12.47
KJ-157	115.43	114.52	1.30	-0.18	0.138	15.32
KJ-158	115.24	114.54	1.28	-0.06	0.046	9.38
KJ-159	115.58	114.48	1.34	-0.12	0.092	13.24
KJ-160	115.28	114.16	1.54	1.14	0.000	0.00
KJ-161	114.89	113.73	1.87	0.81	0.000	0.00
KJ-162	115.28	113.90	1.64	0.28	0.000	0.00
KJ-163	114.95	113.68	1.80	0.32	0.000	0.00

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Junction Parameters and 25-Year Storm Event Results

			25-Year Storm Event			
Junction ID (Char)	Rim Elevation (ft)	Invert Elevation (ft)	Maximum Depth (ft)	Freeboard (ft)	Total Flood Volume (MG)	Total Flood Time (hrs)
KJ-164	115.11	113.75	1.55	0.57	0.000	0.00
KJ-165	115.00	113.45	1.65	0.47	0.000	0.00
KJ-166	115.29	113.38	1.49	0.63	0.000	0.00
KJ-167	114.93	112.99	1.69	0.43	0.000	0.00
KJ-168	115.00	112.97	1.52	0.60	0.000	0.00
KJ-169	114.61	112.80	1.40	0.72	0.000	0.00
KJ-170	116.55	114.50	1.32	1.12	0.000	0.00
KJ-175	143.39	138.53	0.76	4.34	0.000	0.00
KJ-182	119.01	117.21	2.02	-0.02	0.011	0.54
KJ-187	116.40	116.01	0.88	1.12	0.000	0.00
KJ-188	115.93	115.33	1.01	-0.13	0.098	14.85
KJ-189	115.57	114.74	1.55	-0.65	0.490	17.94
KJ-189_DUMMY	115.57	114.74	0.71	1.29	0.000	0.00
KJ-190	117.22	114.55	0.65	2.02	0.000	0.00
KJ-191	116.62	114.24	0.61	1.79	0.000	0.00
KJ-192	116.20	113.85	0.53	1.87	0.000	0.00
KJ-193	115.27	113.47	0.52	1.88	0.000	0.00
KJ-194	115.58	113.38	0.44	1.96	0.000	0.00
KJ-209	69.21	65.55	1.27	2.39	0.000	0.00
KJ-213	66.99	64.38	1.67	0.94	0.000	0.00
KJ-219	65.48	63.72	1.91	0.27	0.000	0.00
KJ-220	66.84	63.84	1.59	1.41	0.000	0.00
KJ-221	66.59	63.59	1.77	1.23	0.000	0.00
KJ-225	65.56	62.56	2.44	0.56	0.000	0.00
KJ-226	65.52	62.52	2.08	0.92	0.000	0.00
KJ-240	69.48	67.38	2.36	-0.03	0.020	0.40
KJ-254	286.45	275.25	0.53	10.67	0.000	0.00
KJ-255	292.53	287.13	0.49	4.91	0.000	0.00
KJ-258	253.83	248.03	0.85	4.95	0.000	0.00
KJ-259	264.88	249.54	1.07	14.27	0.000	0.00
KJ-260	262.23	250.93	1.03	10.27	0.000	0.00
KJ-261	256.19	252.99	1.02	2.18	0.000	0.00
KJ-262	256.96	254.06	2.38	0.52	0.000	0.00
KJ-263	259.38	254.98	3.88	0.52	0.000	0.00

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			25-Year Storm Event			
Junction ID (Char)	Rim Elevation (ft)	Invert Elevation (ft)	Maximum Depth (ft)	Freeboard (ft)	Total Flood Volume (MG)	Total Flood Time (hrs)
KJ-264	262.21	256.11	5.16	0.94	0.000	0.00
KJ-265	274.77	268.27	0.49	6.01	0.000	0.00
KJ-266	285.24	277.74	0.53	6.97	0.000	0.00
KJ-267	291.62	281.02	4.22	6.38	0.000	0.00
KJ-268	286.27	282.65	3.63	-0.01	0.006	0.28
KJ-269	112.00	110.04	1.39	1.61	0.000	0.00
KJ-270	39.30	32.27	3.40	11.63	0.000	0.00
KJ-271	37.52	30.97	2.96	11.59	0.000	0.00
KJ-272	35.79	29.42	2.75	11.62	0.000	0.00
KJ-273	34.85	28.17	3.06	11.62	0.000	0.00
KJ-274	33.71	27.31	2.77	11.63	0.000	0.00
KJ-275	32.34	26.21	2.54	11.59	0.000	0.00
KJ-276	25.59	24.58	3.39	11.56	0.000	0.00
KJ-277	179.17	175.67	0.24	3.26	0.000	0.00
KJ-278	103.13	99.01	2.54	1.58	0.000	0.00
KJ-284	104.81	100.56	2.04	2.21	0.000	0.00
KJ-285	105.66	100.96	2.04	2.66	0.000	0.00
KJ-286	105.79	101.09	1.95	2.75	0.000	0.00
KJ-287	106.95	103.60	0.70	2.65	0.000	0.00
KJ-290	107.21	104.21	2.57	0.43	0.000	0.00
KJ-300	176.00	171.58	0.75	3.67	0.000	0.00
KJ-301	176.00	170.92	0.81	4.27	0.000	0.00
KJ-302	165.32	157.97	2.95	4.40	0.000	0.00
KJ-303	106.70	102.70	2.61	1.39	0.000	0.00
KJ-304	106.20	102.20	3.06	0.94	0.000	0.00
KJ-305	116.00	115.00	1.48	-0.45	0.349	9.87
KJ-306	95.25	92.25	2.02	0.98	0.000	0.00
KJ-307	95.54	92.54	2.01	0.99	0.000	0.00
KJ-308	112.90	99.75	0.00	13.15	0.000	0.00
KJ-308_DUMMY	112.90	99.75	0.00	13.15	0.000	0.00
KJ-309	118.10	104.04	0.00	14.06	0.000	0.00
KJ-310	112.50	102.42	0.00	10.08	0.000	0.00
KJ-311	115.41	102.42	0.00	12.99	0.000	0.00
KJ-312	116.30	103.00	0.00	13.30	0.000	0.00

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Junction Parameters and 25-Year Storm Event Results

			25-Year Storm Event			
Junction ID (Char)	Rim Elevation (ft)	Invert Elevation (ft)	Maximum Depth (ft)	Freeboard (ft)	Total Flood Volume (MG)	Total Flood Time (hrs)
KJ-313	118.63	107.62	0.00	11.01	0.000	0.00
KJ-314	118.39	111.89	0.00	6.50	0.000	0.00
KJ-315	120.27	113.32	0.00	6.95	0.000	0.00
KJ-316	123.95	115.23	0.00	8.72	0.000	0.00
KJ-317	122.57	116.01	0.00	6.56	0.000	0.00
KJ-318	123.88	116.90	0.00	6.98	0.000	0.00
KJ-319	121.81	118.37	0.00	3.44	0.000	0.00
KJ-320	116.42	108.38	0.00	8.04	0.000	0.00
KJ-321	116.03	111.59	0.00	4.44	0.000	0.00
KJ-322	121.01	114.52	0.00	6.49	0.000	0.00
KJ-323	123.13	118.98	0.00	4.15	0.000	0.00
KJ-324	126.46	122.79	0.00	3.67	0.000	0.00
KJ-325	131.18	127.97	0.00	3.21	0.000	0.00
KJ-326	131.34	127.91	0.00	3.43	0.000	0.00
KJ-327	127.64	124.40	0.00	3.24	0.000	0.00
KJ-328	127.74	123.48	0.00	4.26	0.000	0.00
KJ-329	118.26	116.21	0.00	2.05	0.000	0.00
KJ-330	119.79	114.32	0.00	5.47	0.000	0.00
KJ-331	118.28	113.62	0.00	4.66	0.000	0.00
KJ-628	108.02	103.40	1.00	3.62	0.000	0.00
KJ-699	101.58	99.94	1.10	0.54	0.000	0.00
KJ-700	100.50	99.51	0.99	0.00	0.001	0.27
KJ-701	100.50	99.41	0.54	0.55	0.000	0.00
KJ-702	100.00	98.67	0.51	0.82	0.000	0.00
KJ-720	108.60	106.09	2.10	0.41	0.000	0.00
KJ-786	195.00	188.80	0.44	5.76	0.000	0.00
KJ-844	130.22	127.50	2.72	0.00	0.000	0.00
KJ-845	109.25	101.66	2.07	5.52	0.000	0.00
KJ-846	109.59	105.49	2.27	1.83	0.000	0.00
KJ-847	111.40	106.50	4.30	0.60	0.000	0.00
X-696	100.20	97.69	0.00	2.51	0.000	0.00
X-711	98.66	96.40	2.27	-0.01	0.010	0.47
X-773	63.65	60.65	1.60	1.40	0.000	0.00
X-781	69.45	67.50	3.04	-0.04	0.027	0.35

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			25-Year Storm Event			
Junction ID (Char)	Rim Elevation (ft)	Invert Elevation (ft)	Maximum Depth (ft)	Freeboard (ft)	Total Flood Volume (MG)	Total Flood Time (hrs)
X-799	98.00	96.20	1.80	0.00	0.000	0.00
X-800	92.00	87.50	2.72	1.78	0.000	0.00
X-804	68.19	66.52	0.88	1.05	0.000	0.00
X-805	68.37	66.70	1.96	0.19	0.000	0.00
X-806	64.07	62.41	1.97	0.03	0.000	0.00
X-807	64.18	62.51	1.65	1.62	0.000	0.00
X-808	38.40	34.40	1.25	10.75	0.000	0.00
X-809	144.00	141.27	2.87	-0.14	0.105	2.72
X-810	135.50	134.50	0.78	2.22	0.000	0.00
X-811	115.66	113.00	0.65	2.01	0.000	0.00
X-812	113.61	110.80	0.72	2.09	0.000	0.00
X-835	121.41	119.41	2.30	9.70	0.000	0.00
X-836	121.28	119.28	0.80	1.20	0.000	0.00
X-837	115.14	112.40	1.55	1.19	0.000	0.00
X-838	108.00	105.10	1.09	1.81	0.000	0.00
X-839	107.57	104.64	1.25	1.68	0.000	0.00

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Conduit Parameters and 25-Year Storm Event Results

Conduit ID	LENGTH (ft)	Manning's N	Upstream Invert (ft)	Upstream Node ID	Downstream Invert (ft)	Downstream Node ID	Max Depth (ft)	25-Year Storm Event Full Flow (gpm)	Maximum Flow	Percent Slope (%)	Max.Flow/ Full Flow	Max.Depth/ Full Depth
SW-1004	244	0.013	117.50	F12-95	117.39	F12-91	30	3908.9	3641.1	0.0	0.9	1.00
SW-1005	36	0.013	117.36	F12-91	117.35	F12-90	12	266.5	3634.7	0.0	13.6	1.00
SW-1006	335	0.013	122.40	G11-14	121.12	G11-12	18	2915.9	2390.6	0.4	0.8	1.00
SW-1007	106	0.013	121.12	G11-12	120.82	G11-11	18	2511.3	2350.1	0.3	0.9	1.00
SW-1008	185	0.013	120.82	G11-11	120.45	G11-7	18	2124.4	2349.2	0.2	1.1	1.00
SW-1009	142	0.013	48.34	I10-85	47.70	I10-84	18	3165.2	4313.8	0.5	1.4	1.00
SW-1010	114	0.013	182.10	E12-46	178.77	E12-64	18	8059.5	7967.3	2.9	1.0	0.81
SW-1011	116	0.013	178.67	E12-64	175.34	E12-66	18	7989.9	7959.8	2.9	1.0	0.82
SW-1012	42	0.013	160.06	E12-72	159.64	E12-75	24	10154.1	7962.9	1.0	0.8	0.67
SW-1013	123	0.013	159.56	E12-75	158.08	E12-79	24	11138.3	7962.0	1.2	0.7	0.63
SW-1014	196	0.013	213.04	G10-25	189.73	G10-22	12	5536.3	963.3	12.0	0.2	0.28
SW-1015	126	0.013	170.14	E12-104	159.42	O-10	18	13750.9	3287.0	8.5	0.2	0.33
SW-1016	119	0.013	158.08	E12-79	156.68	E12-82	24	11013.6	7972.2	1.2	0.7	0.63
SW-1017	93	0.013	156.68	E12-82	155.54	E12-83	24	11242.2	7967.6	1.2	0.7	0.62
SW-1018	96	0.013	161.60	E12-137	144.34	E12-142	12	6836.4	2095.1	18.3	0.3	0.38
SW-1019	97	0.013	190.72	E12-113	190.23	E12-112	12	1135.2	1278.6	0.5	1.1	0.83
SW-1020	57	0.013	189.73	E12-112	188.34	E12-108	12	2494.9	1278.2	2.4	0.5	0.51
SW-1021	110	0.013	171.17	E13-3	166.17	E12-136	12	3412.0	0.0	4.6	0.0	0.22
SW-1022	172	0.013	165.97	E12-136	161.60	E12-137	15	4623.4	1838.1	2.5	0.4	0.41
SW-1027	158	0.013	66.55	I12-39	65.76	I12-40	12	1132.5	1361.9	0.5	1.2	1.00
SW-1028	295	0.013	71.14	H12-74	70.73	I12-37	12	596.5	1361.5	0.1	2.3	1.00
SW-1029	122	0.013	62.06	I11-17	61.18	I11-18	15	2466.0	1569.9	0.7	0.6	1.00
SW-1030	168	0.013	63.60	I11-33	60.90	I11-70	24	12877.9	3236.3	1.6	0.3	1.00
SW-1031	296	0.013	75.84	I10-63	61.74	I10-62	12	3491.6	2641.9	4.8	0.8	0.83
SW-1032	52	0.013	61.54	I10-62	60.90	I10-61	12	1780.1	2642.8	1.2	1.5	0.97
SW-1033	57	0.013	48.55	I10-114	48.35	I10-98	12	943.2	1387.3	0.3	1.5	1.00
SW-1034	185	0.013	47.70	I10-84	47.00	I10-83	18	2900.0	4313.8	0.4	1.5	1.00
SW-1035	235	0.013	46.90	I10-83	45.70	I10-73	18	3366.4	4313.8	0.5	1.3	1.00
SW-1036	295	0.013	44.49	I10-72	37.31	I10-67	24	15831.7	7193.9	2.4	0.5	0.74
SW-1037	181	0.013	122.39	F13-15	114.47	F13-13	12	3346.6	877.0	4.4	0.3	0.35
SW-1038	83	0.013	114.48	F13-11	108.67	F13-13	24	26897.2	4590.5	7.0	0.2	0.37
SW-1039	169	0.013	117.70	F13-5	114.28	F13-11	24	14445.6	4591.0	2.0	0.3	0.39
SW-1040	67	0.013	119.87	F13-4	117.70	F13-5	24	18277.9	1546.8	3.2	0.1	0.29
SW-1041	247	0.013	130.33	F13-17	122.41	F13-15	12	2864.2	878.4	3.2	0.3	0.38
SW-1042	98	0.013	108.67	F13-13	107.38	F13-14	24	11649.9	5123.4	1.3	0.4	0.46
SW-1043	29	0.013	93.87	F13-40	93.90	F13-42	18	1520.0	4247.5	0.1	2.8	0.90
SW-1044	116	0.013	122.97	F13-3	119.87	F13-4	24	16601.6	1547.2	2.7	0.1	0.20
SW-1045	57	0.013	123.95	F13-2	123.09	F13-3	24	12472.7	1547.2	1.5	0.1	0.24
SW-1046	97	0.013	125.57	F13-1	124.04	F13-2	24	12752.9	1547.6	1.6	0.1	0.24
SW-1047	40	0.013	130.85	F12-30	130.34	F12-26	12	1815.2	2905.7	1.3	1.6	1.00

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Conduit Parameters and 25-Year Storm Event Results

Conduit ID	LENGTH (ft)	Manning's N	Upstream Invert (ft)	Upstream Node ID	Downstream Invert (ft)	Downstream Node ID	Max Depth (ft)	25-Year Storm Event				
								Full Flow (gpm)	Maximum Flow	Percent Slope (%)	Max.Flow/ Full Flow	Max.Depth/ Full Depth
SW-1048	116	0.013	130.14	F12-26	126.65	F12-25	12	2772.3	3158.0	3.0	1.1	0.91
SW-1049	62	0.013	126.45	F12-25	123.34	F12-24	12	3595.6	3014.5	5.1	0.8	0.70
SW-1050	287	0.013	256.92	F11-58	242.37	F11-61	12	3602.9	3526.3	5.1	1.0	0.80
SW-1051	188	0.013	197.80	F11-75	183.44	F11-76	15	8024.8	3520.6	7.7	0.4	0.73
SW-1052	293	0.013	242.17	F11-61	215.47	F11-64	12	4838.7	3523.6	9.2	0.7	0.63
SW-1053	240	0.013	215.24	F11-64	198.00	F11-75	12	4291.4	3520.8	7.2	0.8	0.69
SW-1054	212	0.013	106.40	H11-62	107.40	H11-61	18	3235.1	4971.5	0.5	1.5	1.00
SW-1055	26	0.013	107.40	H11-61	107.40	H11-60	18	293.3	4973.3	0.0	17.0	0.74
SW-1056	71	0.013	107.40	H11-60	103.70	H11-59	18	10790.4	4971.5	5.2	0.5	0.48
SW-1059	59	0.013	82.91	I10-44	64.98	I10-45	15	16374.9	2877.9	31.9	0.2	0.29
SW-1060	296	0.013	76.48	I10-64	76.04	I10-63	12	616.3	2643.7	0.1	4.3	0.97
SW-1061	115	0.013	175.24	E12-66	170.53	E12-71	18	9535.1	7963.7	4.1	0.8	0.71
SW-1062	240	0.013	170.53	E12-71	160.06	E12-72	18	9857.1	7960.5	4.4	0.8	0.79
SW-1063	157	0.013	78.75	H11-124	77.83	H12-9	15	2220.6	3757.9	0.6	1.7	1.00
SW-1064	43	0.013	59.41	I11-34	58.70	I11-70	15	3737.9	1801.8	1.7	0.5	1.00
SW-1065	78	0.013	62.41	X-806	62.51	X-807	20	4567.0	13527.3	0.1	1.5	1.00
SW-1067	48	0.013	71.10	I10-94	70.19	I10-93	12	2211.8	2159.9	1.9	1.0	1.00
SW-1068	402	0.013	57.26	I10-33	56.07	KJ-137	42	24569.0	19808.2	0.3	0.8	0.66
SW-1069	174	0.013	91.63	H11-187	91.06	H11-165	16	1972.8	2248.7	0.3	1.1	1.00
SW-1070	431	0.013	88.73	H12-62	86.18	H12-7	18	3628.4	4512.3	0.6	1.2	1.00
SW-1071	205	0.013	89.86	H11-37	88.83	H11-34	18	3340.5	3585.4	0.5	1.1	0.99
SW-1072	56	0.013	90.29	H11-38	90.01	H11-37	18	3327.3	3657.8	0.5	1.1	0.91
SW-1073	105	0.013	90.91	H11-40	90.39	H11-38	18	3324.7	3673.0	0.5	1.1	0.86
SW-1074	107	0.013	92.04	H11-41	91.11	H11-40	18	4405.0	3685.7	0.9	0.8	0.73
SW-1075	95	0.013	102.14	H11-211	97.84	H11-41	12	3402.4	3947.4	4.5	1.2	0.91
SW-1076	115	0.013	88.68	H11-34	88.00	H11-33	18	3629.6	4357.5	0.6	1.2	0.90
SW-1077	35	0.013	86.34	H11-30	86.02	H11-33	30	17621.6	58327.2	0.9	3.3	0.56
SW-1078	47	0.013	86.71	H11-29	86.54	H11-30	30	11063.8	6407.9	0.4	0.6	0.53
SW-1079	194	0.013	90.36	H11-27	89.54	H11-29	24	6606.2	6407.9	0.4	1.0	0.74
SW-1080	105	0.013	59.39	I12-15	58.40	I12-18	24	9846.4	2301.9	0.9	0.2	0.33
SW-1081	104	0.013	63.09	I12-16	62.86	I12-15	24	4771.0	2301.9	0.2	0.5	0.44
SW-1082	92	0.013	90.89	H11-26	90.56	H11-27	24	6081.1	4810.9	0.4	0.8	0.69
SW-1083	158	0.013	91.47	H11-25	90.99	H11-26	24	5596.4	4811.5	0.3	0.9	0.67
SW-1084	38	0.013	91.63	H11-24	91.58	H11-25	24	3683.2	4820.8	0.1	1.3	0.69
SW-1085	117	0.013	94.65	H11-22	91.63	H11-24	24	16312.4	4829.0	2.6	0.3	0.55
SW-1086	170	0.013	94.82	H10-1	94.45	H10-2	12	746.0	1667.4	0.2	2.2	1.00
SW-1087	174	0.013	108.82	H10-24	105.84	H10-10	21	9310.9	4440.6	1.7	0.5	0.49
SW-1088	238	0.013	105.59	H10-10	97.89	H10-11	21	12799.2	4440.5	3.2	0.3	0.42
SW-1089	220	0.013	97.74	H10-11	94.85	H10-12	21	8148.4	4439.1	1.3	0.5	0.53
SW-1090	125	0.013	94.70	H10-12	89.46	KJ-125	21	14591.1	4439.1	4.2	0.3	0.37

Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060-001

Conduit Parameters and 25-Year Storm Event Results

Conduit ID	LENGTH (ft)	Manning's N	Upstream Invert (ft)	Upstream Node ID	Downstream Invert (ft)	Downstream Node ID	Max Depth (ft)	25-Year Storm Event				
								Full Flow (gpm)	Maximum Flow	Percent Slope (%)	Max.Flow/ Full Flow	Max.Depth/ Full Depth
SW-1091	221	0.013	67.80	H11-2	63.48	H10-19	21	9941.7	5582.7	2.0	0.6	0.97
SW-1092	275	0.013	63.33	H10-19	62.78	I10-47	21	3182.3	5583.1	0.2	1.8	1.00
SW-1093	281	0.013	60.93	I10-51	60.50	I10-52	24	3971.1	5849.8	0.2	1.5	1.00
SW-1094	141	0.013	108.88	G11-91	108.48	G11-98	21	3783.4	4561.0	0.3	1.2	0.99
SW-1096	233	0.013	97.20	H11-23	94.65	H11-22	24	10614.5	3229.8	1.1	0.3	0.37
SW-1097	144	0.013	60.40	I10-52	60.30	I10-53	24	2674.7	5834.3	0.1	2.2	1.00
SW-1098	545	0.013	87.40	I10-14	80.90	I10-17	26	25389.3	9165.2	1.2	0.4	0.54
SW-1100	242	0.013	80.70	I10-17	77.52	I10-20	24	11634.3	12578.3	1.3	1.1	0.86
SW-1101	383	0.013	107.80	G11-102	103.60	H11-162	24	10629.1	4555.8	1.1	0.4	0.55
SW-1102	83	0.013	103.60	H11-162	103.32	H11-144	24	5905.8	4552.7	0.3	0.8	0.61
SW-1103	386	0.013	108.48	G11-98	107.80	G11-102	24	4264.3	4558.4	0.2	1.1	0.66
SW-1104	140	0.013	62.74	I10-47	62.50	I10-48	24	4204.0	5584.1	0.2	1.3	1.00
SW-1105A	279	0.013	62.40	I10-48	61.13	I10-51	24	6851.9	5846.4	0.5	0.9	1.00
SW-1106	62	0.013	89.46	KJ-125	67.38	KJ-240	0	73616.0	4439.0	38.3	0.1	0.62
SW-1107	174	0.013	60.30	I10-53	59.70	I10-54	24	5962.5	5627.6	0.3	0.9	1.00
SW-1108	132	0.013	59.50	I10-54	59.00	I10-55	24	6244.2	5627.8	0.4	0.9	1.00
SW-1109	304	0.013	59.00	I10-55	58.10	I10-56	24	5527.3	9547.0	0.3	1.7	1.00
SW-1110	432	0.013	57.90	I10-56	54.40	I10-139	24	9138.6	9546.5	0.8	1.0	1.00
SW-1111	126	0.013	54.30	I10-139	53.70	I10-58	24	7007.8	9549.2	0.5	1.4	1.00
SW-1112	137	0.013	53.70	I10-58	52.50	I10-59	24	9497.8	9554.2	0.9	1.0	1.00
SW-1113	106	0.013	48.82	I10-115	48.54	I10-114	12	821.1	2052.7	0.3	2.5	1.00
SW-1114	41	0.013	49.10	I10-116	48.90	I10-115	12	1121.1	2053.7	0.5	1.8	1.00
SW-1115	29	0.013	52.50	I10-59	52.50	I10-60	24	592.3	9556.6	0.0	16.1	1.00
SW-1116	165	0.013	86.00	H11-33	82.84	H11-55	30	25461.3	18584.8	1.9	0.7	0.57
SW-1117	285	0.013	52.30	I10-60	50.80	I10-61	24	7369.1	9547.7	0.5	1.3	1.00
SW-1118	161	0.013	50.70	I10-61	50.00	I10-66	24	6692.0	11786.3	0.4	1.8	1.00
SW-1119	111	0.013	50.00	I10-66	49.10	I10-138	24	9135.7	11786.3	0.8	1.3	0.95
SW-1120	280	0.013	93.90	H10-2	92.04	I10-1	21	5796.4	6922.3	0.7	1.2	1.00
SW-1121	51	0.013	91.96	I10-1	91.87	I10-2	21	2991.4	6926.3	0.2	2.3	1.00
SW-1122	158	0.013	90.98	I10-5	89.99	I10-6	21	5632.7	6198.4	0.6	1.1	1.00
SW-1123	70	0.013	91.55	I10-2	90.98	I10-5	21	6417.4	6924.2	0.8	1.1	1.00
SW-1124	258	0.013	111.60	G11-79	110.60	G11-80	18	2933.4	5247.3	0.4	0.9	0.74
SW-1125	238	0.013	85.53	I10-26	84.81	I10-24	15	1594.7	2853.7	0.3	1.8	0.91
SW-1126	145	0.013	91.39	I10-31	90.65	I10-30	12	1140.6	1978.3	0.5	1.7	1.00
SW-1127	199	0.013	90.65	I10-30	86.73	I10-28	12	2244.6	2047.3	2.0	0.9	1.00
SW-1128	162	0.013	84.71	I10-24	82.54	I10-22	15	3355.8	2861.8	1.3	0.9	0.90
SW-1129	112	0.013	82.44	I10-22	81.84	I10-21	15	2122.1	2860.9	0.5	1.3	1.00
SW-1130	111	0.013	81.74	I10-21	81.04	I10-17	15	2306.2	2860.8	0.6	1.2	1.00
SW-1131	235	0.013	94.70	I9-32	94.21	I9-31	18	2153.0	1361.0	0.2	0.6	0.52
SW-1132	234	0.013	95.05	I9-34	94.80	I9-32	18	1542.2	1363.4	0.1	0.9	0.61

Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060-001

Conduit Parameters and 25-Year Storm Event Results

Conduit ID	LENGTH (ft)	Manning's N	Upstream Invert (ft)	Upstream Node ID	Downstream Invert (ft)	Downstream Node ID	Max Depth (ft)	25-Year Storm Event Full Flow (gpm)	Maximum Flow	Percent Slope (%)	Max.Flow/ Full Flow	Max.Depth/ Full Depth
SW-1133	141	0.013	102.23	I9-37	97.15	I9-36	15	5501.8	1368.9	3.6	0.2	0.51
SW-1134	255	0.013	97.15	I9-36	96.25	I9-35	15	1723.2	1367.1	0.4	0.8	0.69
SW-1135	267	0.013	96.25	I9-35	95.35	I9-34	15	1684.3	1365.9	0.3	0.8	0.64
SW-1136	67	0.013	89.87	I10-6	88.70	I10-8	18	6235.8	3840.6	1.7	0.6	1.00
SW-1137	237	0.013	87.90	I10-8	87.50	X-800	18	1938.2	4441.3	0.2	2.3	1.00
SW-1138	59	0.013	87.50	X-800	87.40	I10-14	18	1936.3	5840.8	0.2	3.0	0.81
SW-1139	69	0.013	60.95	I12-34	59.90	I12-35	12	1967.8	2591.0	1.5	1.3	1.00
SW-1140	181	0.013	63.70	I12-30	60.95	I12-34	12	1972.4	2590.2	1.5	1.3	1.00
SW-1141	288	0.011	29.54	J11-8	23.54	J11-10	24	17312.3	14085.8	2.1	0.8	0.84
SW-1142	209	0.011	23.34	J11-10	21.34	J11-15	24	11747.8	14086.5	1.0	1.2	1.00
SW-1143	24	0.011	21.24	J11-15	20.64	J11-16	24	18976.2	14087.2	2.5	0.7	0.82
SW-1144	318	0.011	38.06	J10-33	29.74	J11-8	24	19403.2	14091.0	2.6	0.7	0.63
SW-1145	197	0.011	43.24	J10-30	38.06	J10-33	24	19466.3	12043.6	2.6	0.6	0.60
SW-1146	156	0.011	43.92	J10-29	43.44	J10-30	24	6660.1	12051.6	0.3	1.8	0.95
SW-1147	63	0.011	44.21	J10-27	44.02	J10-29	24	6590.0	12051.4	0.3	1.8	1.00
SW-1148	128	0.011	44.46	J10-24	44.21	J10-27	24	5303.2	12048.0	0.2	2.3	1.00
SW-1149	222	0.011	45.24	J10-22	44.56	J10-24	24	6635.6	12046.2	0.3	1.8	1.00
SW-1151	247	0.013	50.32	J11-21	49.38	J11-19	18	2910.4	4471.2	0.4	1.5	1.00
SW-1152	151	0.013	50.34	I11-69	50.38	J11-21	12	260.3	1952.6	0.0	7.5	1.00
SW-1153	149	0.013	53.82	I11-71	52.18	I11-69	12	1675.1	1952.2	1.1	1.2	1.00
SW-1154	291	0.013	124.80	F12-134	119.65	STOR-27	36	39809.0	11610.3	1.8	0.3	0.68
SW-1155	129	0.013	123.20	F12-133	119.65	STOR-27	36	49717.7	2316.9	2.8	0.0	0.57
SW-1156	244	0.013	48.35	I10-98	46.21	I11-6	12	1496.2	1886.7	0.9	1.3	1.00
SW-1157	216	0.013	82.76	H11-55	80.66	KJ-127	30	18155.1	10238.6	1.0	0.6	0.77
SW-1158	30	0.013	80.66	KJ-127	80.50	H11-58	36	21861.0	10325.0	0.5	0.5	0.87
SW-1162	277	0.011	46.14	I11-10	45.75	J11-5	24	4499.1	5711.5	0.1	1.3	1.00
SW-1163	110	0.011	45.65	J11-5	45.49	J11-2	24	4572.9	12047.5	0.1	2.6	1.00
SW-1164	30	0.011	45.39	J11-2	45.24	J10-22	24	8473.0	12045.4	0.5	1.4	1.00
SW-1165	298	0.013	74.04	J11-22	73.59	J11-27	15	1126.7	2884.0	0.2	2.6	0.91
SW-1166	124	0.013	73.39	J11-27	34.34	J11-28	15	16700.9	2879.9	33.2	0.2	0.28
SW-1167	162	0.013	30.34	J11-28	29.14	J11-29	15	2495.4	2828.1	0.7	1.1	0.90
SW-1168	110	0.013	28.94	J11-29	22.04	J11-30	15	7268.8	5172.5	6.3	0.7	0.81
SW-1169	452	0.013	21.84	J11-30	21.17	J11-32	20	2404.0	5172.5	0.1	2.2	0.88
SW-1171	66	0.013	136.04	F12-35	135.71	F12-34	12	1129.9	2905.9	0.5	2.6	1.00
SW-1172	287	0.013	137.67	F12-38	136.24	F12-35	12	1129.0	1784.4	0.5	1.6	1.00
SW-1173	213	0.013	135.51	F12-34	131.05	F12-30	12	2316.0	2905.5	2.1	1.3	1.00
SW-1174	262	0.013	183.34	F11-76	180.49	F11-80	15	3023.0	3526.3	1.1	1.2	0.94
SW-1176	162	0.013	209.65	E12-84	196.84	E12-87	12	4501.8	2108.5	7.9	0.5	0.74
SW-1177	52	0.013	196.64	E12-87	196.38	E12-88	12	1126.6	2110.4	0.5	1.9	0.95
SW-1178	303	0.013	186.84	E12-108	173.84	E12-105	12	3312.3	1272.1	4.3	0.4	0.43

Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060-001

Conduit Parameters and 25-Year Storm Event Results

Conduit ID	LENGTH (ft)	Manning's N	Upstream Invert (ft)	Upstream Node ID	Downstream Invert (ft)	Downstream Node ID	Max Depth (ft)	25-Year Storm Event Full Flow (gpm)	Maximum Flow	Percent Slope (%)	Max.Flow/ Full Flow	Max.Depth/ Full Depth
SW-1179	55	0.013	173.74	E12-105	170.34	E12-104	12	3978.6	1271.9	6.2	0.3	0.39
SW-1180	43	0.013	171.48	E12-101	170.14	E12-104	15	5117.4	2107.8	3.1	0.4	0.45
SW-1181	151	0.013	174.76	E12-99	171.68	E12-101	15	4136.0	2107.8	2.0	0.5	0.51
SW-1182	191	0.013	185.83	E12-96	174.96	E12-99	12	3816.5	2109.0	5.7	0.6	0.53
SW-1183	30	0.013	187.44	E12-95	186.03	E12-96	12	3492.0	2109.4	4.8	0.6	0.56
SW-1184	158	0.013	77.73	H12-9	75.48	H12-11	15	3455.0	3700.3	1.4	1.1	0.95
SW-1185	100	0.013	192.14	E12-94	187.64	E12-95	12	3400.8	2108.5	4.5	0.6	0.57
SW-1186	94	0.013	196.28	E12-88	192.34	E12-94	12	3282.6	2109.2	4.2	0.6	0.58
SW-1187	312	0.013	92.94	G12-49	91.46	G13-1	27	9571.1	15720.2	0.5	1.6	1.00
SW-1188	71	0.013	93.34	G12-48	92.94	G12-49	27	10456.1	15725.6	0.6	1.5	1.00
SW-1189	109	0.013	216.09	G10-28	213.24	G10-25	12	2590.2	964.1	2.6	0.4	0.42
SW-1190	60	0.013	189.53	G10-22	187.56	G10-21	12	2898.3	963.2	3.3	0.3	0.40
SW-1191	245	0.013	217.29	G10-29	216.19	G10-28	12	1070.9	964.9	0.4	0.9	0.70
SW-1192	205	0.013	91.46	G13-1	90.49	G13-2	24	6984.5	12705.8	0.5	1.8	0.96
SW-1193	572	0.013	119.14	STOR-27	114.34	F12-67	24	9298.4	9444.7	0.8	1.0	1.00
SW-1194	276	0.013	93.68	I9-52	84.68	I9-54	15	5237.0	2493.6	3.3	0.5	0.74
SW-1195	276	0.013	84.48	I9-54	83.68	I10-42	15	1561.0	2494.2	0.3	1.6	1.00
SW-1196	250	0.013	83.48	I10-42	83.11	I10-44	15	1115.4	3388.7	0.1	3.0	0.94
SW-1197	63	0.013	61.48	I10-45	61.38	I10-46	15	1155.2	2487.9	0.2	2.2	0.56
SW-1198	199	0.013	54.74	J10-15	54.44	J10-12	18	1831.2	2120.7	0.2	1.2	0.77
SW-1199	309	0.013	54.24	J10-12	53.80	J10-11	18	1779.1	1982.3	0.1	1.1	0.70
SW-1200	43	0.013	53.60	J10-11	53.54	J10-10	18	1761.1	1970.5	0.1	1.1	0.60
SW-1201	42	0.013	51.35	I11-41	50.28	I11-42	18	7526.3	4432.6	2.5	0.6	1.00
SW-1202	109	0.013	97.03	F13-34	95.72	F13-35	18	5168.7	3696.8	1.2	0.7	0.61
SW-1203	273	0.013	58.02	I11-36	56.33	I11-37	18	3709.5	3880.9	0.6	1.0	1.00
SW-1204	287	0.013	56.33	I11-37	55.07	I11-39	18	3123.9	3802.8	0.4	1.2	1.00
SW-1205	51	0.013	95.72	F13-35	93.87	F13-40	18	8970.3	4049.1	3.6	0.5	0.74
SW-1210	304	0.013	87.30	G12-54	83.20	G13-3	36	34785.8	7173.4	1.4	0.2	0.31
SW-1211	427	0.013	91.00	G12-53	87.50	G12-54	36	27089.3	7174.9	0.8	0.3	0.35
SW-1212	112	0.013	92.25	KJ-306	91.40	G12-53	36	26038.3	7213.5	0.8	0.3	0.52
SW-1213	104	0.013	82.50	G13-4	82.36	X-660	36	10954.8	5990.1	0.1	0.5	0.43
SW-1214	113	0.013	92.54	KJ-307	91.40	G12-51	30	18493.7	6047.1	1.0	0.3	0.60
SW-1215	441	0.013	55.07	I11-39	52.75	I11-40	18	3419.6	3776.4	0.5	1.1	1.00
SW-1216	290	0.013	52.75	I11-40	51.35	I11-41	18	3275.8	4889.5	0.5	1.5	1.00
SW-1217	72	0.013	132.29	F12-16	131.84	F12-17	60	92176.6	10906.3	0.6	0.1	0.24
SW-1218	121	0.013	63.44	I12-10	63.19	I12-16	24	4618.4	2301.9	0.2	0.5	0.46
SW-1219	168	0.013	66.98	I12-12	65.92	I12-13	24	8065.7	2301.9	0.6	0.3	0.37
SW-1220	558	0.013	50.28	I11-42	48.34	I10-85	18	2779.9	4313.8	0.3	1.6	1.00
SW-1221	284	0.013	58.56	I11-35	58.02	I11-36	18	2055.7	2447.8	0.2	1.2	1.00
SW-1222	86	0.013	58.70	I11-70	58.56	I11-35	18	1897.6	2372.7	0.2	1.3	1.00

Client: City of St. Helens
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Conduit Parameters and 25-Year Storm Event Results

Conduit ID	LENGTH (ft)	Manning's N	Upstream Invert (ft)	Upstream Node ID	Downstream Invert (ft)	Downstream Node ID	Max Depth (ft)	25-Year Storm Event Full Flow (gpm)	Maximum Flow	Percent Slope (%)	Max.Flow/ Full Flow	Max.Depth/ Full Depth
SW-1223	51	0.013	102.85	I11-58	102.74	I11-59	12	740.3	1256.9	0.2	1.7	0.86
SW-1224	190	0.013	106.10	I11-56	103.11	I11-58	12	2005.2	1260.2	1.6	0.6	0.67
SW-1225	226	0.013	107.09	I11-55	106.10	I11-56	12	1057.7	1264.0	0.4	1.2	0.79
SW-1226	315	0.013	61.03	I11-18	59.41	I11-34	15	2078.1	1800.2	0.5	0.9	1.00
SW-1227	325	0.013	63.64	I11-16	62.06	I11-17	15	2020.1	2775.5	0.5	1.4	1.00
SW-1228	334	0.013	65.72	I12-40	64.14	I11-16	12	1099.1	1058.3	0.5	1.0	1.00
SW-1229	150	0.013	66.97	I12-38	66.61	I12-39	12	783.4	1362.0	0.2	1.7	1.00
SW-1230	273	0.013	70.73	I12-37	66.97	I12-38	12	1875.1	1361.5	1.4	0.7	1.00
SW-1231	398	0.013	104.70	G12-46	101.94	G12-43	24	8456.4	12431.1	0.7	1.5	1.00
SW-1232	285	0.013	101.84	G12-43	96.84	G12-48	24	13438.2	12373.6	1.8	0.9	1.00
SW-1233	394	0.013	109.00	G12-34	105.44	G12-39	24	9657.3	11452.8	0.9	1.2	1.00
SW-1234	125	0.013	90.27	I11-105	70.84	I11-104	12	6343.2	1255.0	15.7	0.2	0.35
SW-1235	90	0.013	70.84	I11-104	65.43	I11-104A	12	3924.1	1254.8	6.0	0.3	0.69
SW-1236	233	0.013	86.43	I10-28	85.73	I10-26	15	1589.2	2834.6	0.3	1.8	1.00
SW-1237	296	0.013	147.21	F12-48	142.18	F12-45	12	2084.0	1929.7	1.7	0.9	1.00
SW-1238	136	0.013	141.98	F12-45	140.84	F12-44	12	1464.0	1667.0	0.8	1.1	1.00
SW-1239	23	0.013	138.43	F12-41	138.24	F12-38	10	900.7	1785.0	0.8	2.0	1.00
SW-1240	156	0.013	140.64	F12-44	138.43	F12-41	12	1901.4	1784.2	1.4	0.9	1.00
SW-1241	110	0.013	131.54	G11-18	130.80	G11-17	12	1311.5	1019.7	0.7	0.8	0.66
SW-1242	120	0.013	132.34	G11-19	131.74	G11-18	12	1130.7	1023.9	0.5	0.9	0.70
SW-1243	63	0.013	130.60	G11-17	128.20	G11-14	12	3112.1	2496.0	3.8	0.8	0.68
SW-1244	103	0.013	140.36	G10-38	138.94	G10-37	12	1876.5	1673.7	1.4	0.9	0.74
SW-1245	54	0.013	141.14	G10-41	140.56	G10-38	12	1801.7	1677.0	1.3	0.9	0.76
SW-1246	116	0.013	148.09	G10-42	141.44	G10-41	12	3835.9	1680.7	5.8	0.4	0.51
SW-1247	6	0.013	138.44	G10-36	138.33	G10-35	12	2150.9	1700.8	1.8	0.8	0.77
SW-1248	6	0.013	138.64	G10-37	138.44	G10-36	12	2922.5	1673.7	3.3	0.6	0.70
SW-1249	46	0.013	152.94	G10-43	148.29	G10-42	12	5091.2	1681.0	10.1	0.3	0.40
SW-1250	272	0.013	167.44	G10-45	153.14	G10-43	12	3666.2	1681.4	5.3	0.5	0.48
SW-1251	127	0.013	168.19	G10-47	167.64	G10-45	12	1053.0	1685.3	0.4	1.6	0.91
SW-1252	40	0.013	142.70	G10-114	142.50	G10-115	18	3322.4	4959.6	0.5	1.5	1.00
SW-1253	115	0.013	142.30	G10-119	141.70	G10-116	18	3405.6	4934.9	0.5	1.4	1.00
SW-1254	396	0.013	141.50	G10-116	139.30	G10-117	18	3514.3	4638.4	0.6	1.3	1.00
SW-1255	92	0.013	149.64	G10-118	143.50	G10-117	30	47492.4	8377.4	6.7	0.2	0.28
SW-1256	142	0.013	138.90	G10-117	138.33	G10-35	30	11647.5	12733.1	0.4	1.1	0.80
SW-1257	87	0.013	137.84	G10-35	135.96	X-813	30	27062.4	13767.4	2.2	0.5	0.51
SW-1258	207	0.013	57.90	I12-18	57.50	I12-21	24	4468.7	2301.9	0.2	0.5	0.60
SW-1259	69	0.013	67.42	I12-11	66.98	I12-12	24	8103.0	2301.9	0.6	0.3	0.37
SW-1260	101	0.013	69.91	I12-7	69.70	I12-8	18	2150.4	2301.9	0.2	1.1	0.67
SW-1261	18	0.013	70.25	I12-6	70.01	I12-7	18	5497.3	2301.9	1.4	0.4	0.58
SW-1263	92	0.013	102.28	I11-59	100.41	I11-115	12	2281.8	1256.5	2.0	0.6	0.53

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Conduit Parameters and 25-Year Storm Event Results

Conduit ID	LENGTH (ft)	Manning's N	Upstream Invert (ft)	Upstream Node ID	Downstream Invert (ft)	Downstream Node ID	Max Depth (ft)	25-Year Storm Event Full Flow (gpm)	Maximum Flow	Percent Slope (%)	Max.Flow/ Full Flow	Max.Depth/ Full Depth
SW-1264	220	0.013	100.26	I11-115	91.49	I11-81	12	3190.6	1255.1	4.0	0.4	0.44
SW-1265	30	0.013	91.41	I11-81	90.12	I11-105	12	3270.7	1255.1	4.2	0.4	0.45
SW-1266	108	0.013	67.14	I11-127	66.98	I11-16	12	616.6	1485.5	0.1	2.4	1.00
SW-1267	99	0.013	88.70	I11-117	88.61	I11-129	12	481.6	1485.6	0.1	3.1	0.89
SW-1268	155	0.013	88.91	I11-118	88.64	I11-117	12	588.6	1485.7	0.1	2.5	1.00
SW-1269	58	0.013	89.27	I11-119	89.11	I11-118	12	841.0	1486.1	0.3	1.8	1.00
SW-1271	236	0.013	60.80	I10-57	60.61	I10-74	36	8489.2	18100.9	0.1	1.1	0.69
SW-1273	97	0.013	61.40	I10-119	60.80	I10-57	36	23560.7	14154.5	0.6	0.3	0.61
SW-1275	80	0.013	60.61	I10-74	60.65	X-773	36	6699.2	18064.8	0.1	1.3	0.59
SW-1276	54	0.013	88.93	H12-64	88.73	H12-62	16	2089.0	3527.2	0.4	1.7	1.00
SW-1277	140	0.013	89.63	H11-183	88.93	H12-64	16	2433.1	3527.0	0.5	1.4	1.00
SW-1278	50	0.013	90.10	H11-185	89.67	H11-183	16	3204.4	2247.4	0.9	0.7	1.00
SW-1279	80	0.013	90.94	H11-165	90.22	KJ-116	16	3259.3	2244.6	0.9	0.7	1.00
SW-1280	107	0.013	93.38	H11-164	91.89	H11-163	12	1890.0	2094.0	1.4	1.1	1.00
SW-1281	51	0.013	86.18	H12-7	86.07	H12-18	18	2183.7	4512.5	0.2	2.1	0.91
SW-1282	35	0.013	86.24	H12-8	86.20	H12-18	16	1166.1	1146.6	0.1	1.0	0.56
SW-1283	43	0.013	85.61	H12-18	85.37	H12-17	24	7574.6	5647.7	0.6	0.7	0.67
SW-1284	226	0.013	87.50	H12-21	86.57	H12-8	12	1025.2	1120.1	0.4	1.1	0.82
SW-1285	60	0.013	85.34	H12-17	85.08	H12-55	24	6711.8	5647.7	0.4	0.8	0.72
SW-1286	136	0.013	85.08	H12-55	84.56	H12-51	24	6283.1	5616.1	0.4	0.9	0.75
SW-1287	135	0.013	84.50	H12-56	83.95	H12-57	24	6480.5	5593.2	0.4	0.9	0.66
SW-1288	44	0.013	83.96	H12-57	83.65	H12-58	24	8566.9	5576.5	0.7	0.7	0.59
SW-1289	42	0.013	114.80	G12-75	114.58	G12-1	16	2503.5	2369.8	0.5	0.9	1.00
SW-1290	22	0.013	59.30	I10-126	57.26	I10-33	36	90529.1	19092.2	9.1	0.2	0.55
SW-1293	121	0.013	143.20	G10-64	142.70	G10-114	18	3037.0	4978.2	0.4	1.6	1.00
SW-1294	278	0.013	149.56	G10-66	143.40	G10-64	18	7015.3	5752.5	2.2	0.8	0.89
SW-1295	67	0.013	151.27	G10-67	149.56	G10-66	15	4626.1	3877.6	2.5	0.8	0.81
SW-1296	138	0.013	154.40	G10-105	151.27	G10-67	15	4365.9	3881.3	2.3	0.9	0.73
SW-1297	171	0.013	208.90	F11-105	198.42	F11-110	12	3965.6	997.7	6.1	0.3	0.34
SW-1298	114	0.013	198.22	F11-110	191.05	F11-111	12	4015.0	997.2	6.3	0.2	0.34
SW-1299	114	0.013	190.95	F11-111	183.89	F11-112	12	3984.1	996.7	6.2	0.3	0.34
SW-1300	147	0.013	183.79	F11-112	177.39	F11-113	12	3335.1	995.8	4.3	0.3	0.37
SW-1301	123	0.013	177.29	F11-113	171.30	F11-114	12	3538.1	995.2	4.9	0.3	0.36
SW-1302	32	0.013	171.20	F11-114	168.50	F11-115	12	4638.8	995.1	8.4	0.2	0.59
SW-1309	42	0.013	168.44	F11-165	168.24	STOR-24	12	1102.0	1310.0	0.5	1.2	0.82
SW-1310	303	0.013	184.25	F11-164	168.64	F11-165	12	3630.0	1310.4	5.2	0.4	0.56
SW-1311	269	0.013	205.19	F11-163	189.00	KJ-786	12	3928.2	1311.1	6.0	0.3	0.40
SW-1315	165	0.013	124.80	F12-133	123.30	F12-134	36	737.9	2317.2	0.0	3.1	0.30
SW-1316	409	0.013	114.24	F12-67	110.00	G12-122	24	10451.4	9622.5	1.1	0.9	1.00
SW-1317	309	0.013	131.84	F12-17	125.60	F12-23	40	56372.2	13999.8	2.0	0.2	0.46

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Conduit Parameters and 25-Year Storm Event Results

Conduit ID	LENGTH (ft)	Manning's N	Upstream Invert (ft)	Upstream Node ID	Downstream Invert (ft)	Downstream Node ID	Max Depth (ft)	25-Year Storm Event Full Flow (gpm)	Maximum Flow	Percent Slope (%)	Max.Flow/ Full Flow	Max.Depth/ Full Depth
SW-1318	187	0.013	125.50	F12-23	124.80	F12-134	40	24265.1	13953.7	0.4	0.6	0.47
SW-1319	150	0.013	77.43	I10-20	69.40	I10-136	24	23517.8	12246.8	5.4	0.5	0.51
SW-1320	238	0.013	69.20	I10-136	59.60	I10-55	24	20396.9	12189.3	4.0	0.6	0.78
SW-1322	252	0.013	55.47	I12-50	54.30	I12-53	36	20400.5	4649.7	0.5	0.2	0.46
SW-1323	192	0.013	54.00	I12-53	54.30	I12-58	36	11821.2	6474.2	0.2	0.5	0.50
SW-1324	191	0.013	54.50	I12-58	49.40	I12-60	36	48953.4	6471.9	2.7	0.1	0.25
SW-1325	144	0.013	64.42	I12-13	63.54	I12-10	24	7935.7	2301.9	0.6	0.3	0.41
SW-1326	119	0.013	46.11	I11-6	46.14	I11-10	24	1611.2	1990.8	0.0	1.2	1.00
SW-1329	146	0.013	198.34	G9-9	194.34	G9-5	12	2651.7	0.0	2.7	0.0	0.00
SW-1330	276	0.013	190.89	G9-5	182.87	G9-2	12	2726.2	0.0	2.9	0.0	0.00
SW-1331	67	0.013	205.34	G9-13	193.34	G9-18	24	43317.8	14377.4	18.2	0.3	0.60
SW-1332	152	0.013	234.23	G9-14	205.84	G9-13	18	20531.4	5993.4	19.0	0.3	0.37
SW-1333	55	0.013	235.51	G9-15	234.43	G9-14	18	6596.3	5993.5	2.0	0.9	0.75
SW-1334	93	0.013	246.89	G9-16	235.71	G9-15	18	16449.0	5994.0	12.2	0.4	0.52
SW-1335	57	0.013	264.01	G9-20	263.46	G9-19	18	4644.2	2390.9	1.0	0.5	0.51
SW-1336	145	0.013	262.76	G9-19	247.09	G9-16	18	15535.0	3319.6	10.9	0.2	0.31
SW-1337	131	0.013	227.03	G9-28	225.76	G9-29	24	9988.5	6079.6	1.0	0.6	0.56
SW-1338	415	0.013	225.56	G9-29	205.84	G9-13	24	22140.7	6074.7	4.8	0.3	0.36
SW-1339	91	0.013	229.14	G9-26	227.23	G9-28	24	14694.7	6082.1	2.1	0.4	0.46
SW-1343	101	0.013	232.18	G9-42	229.34	G9-26	24	17011.1	6082.2	2.8	0.4	0.41
SW-1344	193	0.013	250.95	G9-44	236.79	G9-42	18	12783.1	6082.4	7.4	0.5	0.49
SW-1345	57	0.013	255.47	G9-45	251.56	G9-44	18	12346.3	6082.9	6.9	0.5	0.50
SW-1346	249	0.013	280.48	G9-46	256.67	G9-45	18	14623.9	6082.8	9.6	0.4	0.45
SW-1350	98	0.013	69.43	I12-74	68.78	I12-9	18	3833.8	2301.9	0.7	0.6	0.56
SW-1351	115	0.013	68.68	I12-9	67.92	I12-11	18	3828.7	2301.9	0.7	0.6	0.56
SW-1352	71	0.013	110.21	G11-80	110.37	G11-81	18	2252.1	5247.3	0.2	1.2	0.81
SW-1354	28	0.013	111.67	G11-78	112.00	G11-79	18	5158.3	5247.3	1.2	0.5	0.75
SW-1357	367	0.013	113.34	G12-3	112.84	G11-78	18	1740.2	1814.9	0.1	1.0	0.67
SW-1358	294	0.013	113.80	G12-2	113.34	G12-3	15	1146.2	1814.9	0.2	1.6	1.00
SW-1359	360	0.013	114.39	G12-1	113.90	G12-2	15	1069.8	1814.9	0.1	1.7	1.00
SW-1360	207	0.013	49.00	I10-138	37.66	I10-67	24	23778.5	11786.3	5.5	0.5	0.75
SW-1361	58	0.013	88.47	I11-129	82.40	I11-116	12	5181.0	1484.9	10.5	0.3	0.37
SW-1362	90	0.013	81.55	I11-116	67.44	I11-127	12	6382.2	1484.7	15.9	0.2	0.66
SW-1363	48	0.013	91.87	H11-163	91.69	H11-187	16	2105.0	2246.0	0.4	1.1	1.00
SW-1364	193	0.013	110.15	G11-81	109.77	G11-132	24	4501.4	2706.4	0.2	0.6	0.52
SW-1365	99	0.013	69.70	I10-132	64.79	I10-143	12	3555.3	2159.0	4.9	0.6	0.56
SW-1366	85	0.013	70.17	I10-93	69.78	I10-132	12	1085.6	2159.5	0.5	2.0	0.95
SW-1367	75	0.013	64.54	I10-143	62.27	I10-57	12	2784.0	2158.8	3.0	0.8	0.67
SW-1368	437	0.013	91.30	G12-51	87.20	G12-52	30	17842.4	6000.0	0.9	0.3	0.40
SW-1369	307	0.013	87.00	G12-52	83.00	G13-4	30	21021.4	5998.0	1.3	0.3	0.37

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Conduit Parameters and 25-Year Storm Event Results

Conduit ID	LENGTH (ft)	Manning's N	Upstream Invert (ft)	Upstream Node ID	Downstream Invert (ft)	Downstream Node ID	Max Depth (ft)	25-Year Storm Event				
								Full Flow (gpm)	Maximum Flow	Percent Slope (%)	Max.Flow/ Full Flow	Max.Depth/ Full Depth
SW-1370	105	0.013	83.00	G13-3	82.36	X-659	36	23380.2	7169.7	0.6	0.3	0.38
SW-1371	110	0.013	64.00	I11-23	63.60	I11-33	24	6118.7	2552.8	0.4	0.4	1.00
SW-1373	321	0.013	48.48	J11-19	46.64	I11-10	18	3567.4	4669.5	0.6	1.3	1.00
SW-1374	333	0.013	79.64	I10-142	56.07	KJ-137	12	4257.7	509.6	7.1	0.1	0.62
SW-1375	31	0.013	85.76	I10-141	79.64	I10-142	12	7173.8	511.1	20.1	0.1	0.21
SW-1376	64	0.013	86.32	J9-17	81.25	J9-18	12	4506.4	797.4	7.9	0.2	0.28
SW-1377	221	0.013	87.69	J9-14	86.78	J9-17	12	1026.1	797.7	0.4	0.8	0.63
SW-1378	79	0.013	81.05	J9-18	49.64	O-14	12	10488.1	797.2	43.0	0.1	0.19
SW-1382	337	0.013	86.48	I10-153	85.76	I10-141	12	739.7	511.8	0.2	0.7	0.43
SW-1383	83	0.013	87.60	I9-27	87.41	I9-65	12	764.7	0.0	0.2	0.0	0.00
SW-1387	244	0.013	87.21	I9-65	86.48	I10-153	12	875.0	0.0	0.3	0.0	0.34
SW-1388	120	0.013	109.90	G12-122	109.10	G12-34	24	8301.6	9624.2	0.7	1.2	1.00
SW-1390	46	0.013	37.31	I10-67	34.40	X-808	24	25479.1	18720.4	6.3	0.7	0.81
SW-1391	178	0.013	23.90	I10-154	16.67	KJ-114	66	303879.9	42822.1	4.1	0.1	0.53
SW-1392	173	0.013	13.14	KJ-115	7.97	J10-58	66	260596.7	44954.5	3.0	0.2	0.37
SW-1393	62	0.013	7.84	J10-58	7.35	J9-58O	66	134466.7	44917.3	0.8	0.3	0.44
SW-1394	141	0.013	16.67	KJ-114	14.56	J10-57	66	184386.7	45061.2	1.5	0.2	0.43
SW-1395	105	0.013	14.46	J10-57	13.14	KJ-115	66	175298.6	44984.9	1.4	0.3	0.40
SW-1396	64	0.013	55.50	I12-54	54.20	I12-53	30	26189.1	2301.9	2.0	0.1	0.46
SW-1397	268	0.013	59.90	I12-35	59.50	I12-78	15	1120.4	2590.4	0.1	2.3	1.00
SW-1398	138	0.013	89.65	I11-108	89.27	I11-119	12	839.7	1485.4	0.3	1.8	1.00
SW-1400	112	0.013	99.00	H9-1	98.67	I9-83	30	10014.4	17309.7	0.3	0.9	0.60
SW-1401	25	0.013	106.39	H9-2	106.11	H9-1	10	1041.4	0.0	1.1	0.0	0.00
SW-1405	264	0.013	109.68	G11-132	108.93	G11-91	24	5413.7	3431.4	0.3	0.6	0.77
SW-1406	80	0.013	65.43	I11-104A	63.79	I11-17	12	2292.8	1255.7	2.1	0.5	1.00
SW-1407	140	0.013	98.67	KJ-702	97.90	X-802	12	1185.9	606.4	0.6	0.5	0.50
SW-1408	151	0.013	99.41	KJ-701	98.70	KJ-702	12	1096.5	606.4	0.5	0.6	0.52
SW-1409	40	0.013	99.51	KJ-700	99.41	KJ-701	8	271.1	606.4	0.2	2.2	0.91
SW-1410	21	0.013	99.94	KJ-699	99.51	KJ-700	8	774.1	783.8	2.0	1.0	1.00
SW-1411	35	0.011	68.02	I12-89	67.91	I12-97	12	1072.3	2062.0	0.3	1.9	1.00
SW-1412	263	0.011	67.85	I12-97	66.02	I12-92	12	1578.3	2062.1	0.7	1.3	1.00
SW-1413	231	0.011	65.82	I12-92	64.13	I12-93	12	1616.5	2062.2	0.7	1.3	0.95
SW-1414	105	0.011	63.89	I12-93	63.05	I12-49	18	4987.9	4653.4	0.8	0.9	0.77
SW-1415	51	0.011	58.77	I12-49	57.64	I12-50	18	8277.3	4651.6	2.2	0.6	0.58
SW-1418	110	0.013	98.67	I9-83	97.73	I9-84	38	59263.1	17311.6	0.9	0.3	0.39
SW-1421	42	0.013	115.40	G12-111	114.53	G12-1	18	6746.9	4085.9	2.0	0.6	1.00
SW-1423	59	0.013	98.27	G12-19	98.18	KJ-134	30	7194.0	10418.7	0.2	1.4	0.71
SW-1426	101	0.013	115.64	G11-115	114.66	G11-119	12	1575.3	1297.3	1.0	0.8	0.92
SW-1428	191	0.013	116.34	G11-113	115.74	G11-115	12	896.9	1320.3	0.3	1.5	0.87
SW-1429	189	0.013	118.68	G11-109	116.97	G11-116	12	1519.3	1314.0	0.9	0.9	0.86

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Conduit Parameters and 25-Year Storm Event Results

Conduit ID	LENGTH (ft)	Manning's N	Upstream Invert (ft)	Upstream Node ID	Downstream Invert (ft)	Downstream Node ID	Max Depth (ft)	25-Year Storm Event Full Flow (gpm)	Maximum Flow	Percent Slope (%)	Max.Flow/ Full Flow	Max.Depth/ Full Depth
SW-1430	53	0.013	117.09	G11-116	116.54	G11-113	12	1626.8	1320.0	1.0	0.8	1.00
SW-1431	26	0.013	114.61	G11-119	114.64	KJ-170	12	544.0	1298.2	0.1	2.4	1.00
SW-1432	124	0.013	123.19	G11-73	122.82	G11-72	12	873.5	0.0	0.3	0.0	0.10
SW-1434	53	0.013	182.83	E12-49	182.30	E12-46	12	1599.1	2087.0	1.0	1.3	1.00
SW-1435	289	0.013	188.94	E12-52	182.93	E12-49	12	2306.3	2086.9	2.1	0.9	0.87
SW-1436	124	0.013	184.78	E12-44	182.20	E12-46	18	6801.4	3389.7	2.1	0.5	0.62
SW-1437	98	0.013	186.90	E12-42	184.98	E12-44	18	6599.9	3390.0	2.0	0.5	0.51
SW-1438	135	0.013	196.65	E12-27	193.95	E12-32	15	4100.7	2368.4	2.0	0.6	0.55
SW-1439	24	0.013	187.54	E12-36	187.10	E12-42	18	6384.1	3391.0	1.8	0.5	0.57
SW-1440	201	0.013	193.75	E12-32	187.74	E12-36	15	5018.8	3393.5	3.0	0.7	0.60
SW-1441	30	0.013	188.52	E12-37	187.94	E12-36	12	2223.7	0.0	1.9	0.0	0.27
SW-1442	214	0.013	198.34	E12-40	188.72	E12-37	12	3392.2	0.0	4.5	0.0	0.00
SW-1443	115	0.013	173.48	E12-132	169.00	E12-131	12	3161.2	1958.0	3.9	0.6	0.68
SW-1444	170	0.013	67.73	I11-21	67.48	I11-20	12	612.7	970.2	0.1	1.6	0.88
SW-1445	56	0.013	118.68	F13-6	117.70	F13-5	12	2115.6	2788.8	1.8	1.3	0.89
SW-1446	34	0.013	118.56	F13-7	119.12	F13-6	12	2052.4	2789.9	1.6	1.4	1.00
SW-1447	126	0.013	122.19	F13-8	119.52	F13-7	12	2328.1	2788.9	2.1	1.2	1.00
SW-1448	164	0.013	126.91	F13-9	122.20	F13-8	12	2710.5	2822.7	2.9	1.0	1.00
SW-1449	179	0.013	121.84	F13-30	109.67	F13-28	12	4174.4	644.8	6.8	0.2	0.27
SW-1450	84	0.013	109.62	F13-28	99.07	F13-27	12	5689.7	644.8	12.7	0.1	0.54
SW-1451	106	0.013	99.04	F13-27	97.69	F13-32	18	5320.9	3699.4	1.3	0.7	0.61
SW-1452	34	0.013	97.55	F13-32	97.14	F13-34	18	5164.5	3699.3	1.2	0.7	0.65
SW-1453	37	0.013	99.40	F13-26	98.85	F13-27	18	5748.6	3283.6	1.5	0.6	0.64
SW-1454	137	0.013	100.71	F13-25	99.40	F13-26	18	4608.2	3285.3	1.0	0.7	0.61
SW-1455	193	0.013	133.80	F11-94	133.00	F12-16	12	1029.8	1092.9	0.4	1.1	0.79
SW-1457	66	0.013	125.10	G11-70	123.20	G11-71	18	8000.7	6323.4	2.9	0.8	0.65
SW-1459	174	0.013	76.15	H12-27	72.63	H12-28	12	2273.8	1917.2	2.0	0.8	1.00
SW-1460	173	0.013	210.17	E11-3	209.57	E11-2	12	940.7	685.8	0.3	0.7	0.59
SW-1461	227	0.013	209.37	E11-2	198.58	E11-6	12	3492.0	683.9	4.8	0.2	0.30
SW-1462	68	0.013	197.98	E11-6	197.00	E11-9	18	5676.5	683.7	1.4	0.1	0.23
SW-1463	238	0.013	209.14	E12-30	199.14	E12-27	12	3279.3	369.1	4.2	0.1	0.23
SW-1464	57	0.013	197.97	E12-24	196.85	E12-27	15	4064.7	2076.3	2.0	0.5	0.51
SW-1465	104	0.013	201.44	E12-21	198.17	E12-24	12	2836.2	2076.9	3.1	0.7	0.64
SW-1466	208	0.013	134.66	F12-59	133.74	F12-56	15	1928.3	2188.5	0.4	1.1	0.89
SW-1467	110	0.013	133.64	F12-56	133.09	F12-53	15	2050.2	2180.3	0.5	1.1	0.87
SW-1468	104	0.013	132.99	F12-53	132.57	F12-52	15	1846.6	2178.0	0.4	1.2	0.83
SW-1469	317	0.013	121.58	H11-13	118.34	G11-28	12	1616.4	1943.5	1.0	1.2	1.00
SW-1470	251	0.013	123.64	H11-16	121.78	H11-13	12	1376.4	1789.6	0.7	1.3	1.00
SW-1471	274	0.013	124.66	H10-16	123.84	H11-16	12	874.3	1854.3	0.3	2.1	1.00
SW-1472	39	0.013	118.34	G11-26	117.94	G11-28	12	1623.1	1903.2	1.0	1.2	1.00

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Conduit Parameters and 25-Year Storm Event Results

Conduit ID	LENGTH (ft)	Manning's N	Upstream Invert (ft)	Upstream Node ID	Downstream Invert (ft)	Downstream Node ID	Max Depth (ft)	25-Year Storm Event Full Flow (gpm)	Maximum Flow	Percent Slope (%)	Max.Flow/ Full Flow	Max.Depth/ Full Depth
SW-1473	241	0.013	120.44	G11-21	118.44	G11-26	12	1456.8	1903.9	0.8	1.3	1.00
SW-1474	59	0.013	117.84	G11-28	117.80	STOR-28	15	754.6	3707.9	0.1	4.9	1.00
SW-1475	232	0.013	123.14	G10-57	121.14	G11-21	12	1484.5	1906.4	0.9	1.3	1.00
SW-1476	145	0.013	125.29	H10-13	124.66	H10-16	12	1054.6	1104.8	0.4	1.0	1.00
SW-1477	95	0.013	108.90	G11-83	108.41	G11-84	30	13206.1	7402.9	0.5	0.6	0.54
SW-1478	21	0.013	110.45	G11-81	109.40	G11-83	24	22595.8	5126.5	5.0	0.2	0.36
SW-1479	169	0.013	108.36	G11-84	106.30	G11-136	30	20314.7	7402.9	1.2	0.4	0.42
SW-1480	57	0.013	110.80	X-812	110.37	G11-81	18	4095.7	1921.9	0.8	0.5	0.53
SW-1483	150	0.013	67.50	X-781	67.38	KJ-240	28	5510.2	14372.7	0.1	2.6	1.00
SW-1485	56	0.013	96.20	X-799	95.28	H10-2	12	2041.4	3026.0	1.6	0.7	1.00
SW-1490	207	0.013	101.90	G12-14	101.29	G12-9	12	867.1	42.8	0.3	0.0	0.74
SW-1491	316	0.013	101.29	G12-9	98.69	G12-17	36	27166.2	7391.4	0.8	0.3	0.35
SW-1492	34	0.013	98.69	G12-17	98.37	G12-19	36	28907.8	7420.3	0.9	0.3	0.47
SW-1493	56	0.013	101.46	G12-7	101.29	G12-9	36	16565.1	7388.9	0.3	0.4	0.42
SW-1494	83	0.013	67.28	I11-20	67.16	I11-19	12	608.6	964.4	0.1	1.6	0.86
SW-1495	186	0.013	66.96	I11-19	61.23	I11-18	12	2804.5	954.8	3.1	0.3	0.98
SW-1496	59	0.013	74.60	H12-10	74.54	I12-2	24	3226.3	4982.9	0.1	1.5	0.59
SW-1497	87	0.013	106.30	G11-136	105.09	X-838	30	21646.1	7402.9	1.4	0.3	0.42
SW-1498	83	0.013	93.88	G12-25	93.87	G12-26	30	2020.8	20913.1	0.0	10.3	1.00
SW-1499	198	0.013	93.87	G12-26	92.34	G12-27	30	16183.3	15213.1	0.8	0.9	1.00
SW-1500	300	0.011	69.53	I11-92	69.08	I11-89	12	732.0	1429.2	0.2	2.0	1.00
SW-1501	70	0.011	68.88	I11-89	68.77	I11-91	12	751.8	2062.3	0.2	2.7	1.00
SW-1502	120	0.013	40.67	J12-2	40.48	J12-3	12	636.4	2377.8	0.2	3.7	0.96
SW-1503	115	0.013	166.75	F12-2	163.91	F12-3	15	4548.9	3989.4	2.5	0.9	0.73
SW-1504	138	0.013	208.52	E12-19	201.64	E12-21	12	3572.7	2078.2	5.0	0.6	0.55
SW-1505	115	0.013	168.79	E12-131	168.23	E12-135	15	2042.3	1941.0	0.5	1.0	0.74
SW-1506	219	0.013	55.28	I10-91	54.94	J10-15	15	1283.5	2148.8	0.2	1.7	0.92
SW-1507	133	0.013	111.99	F13-36	95.93	F13-35	12	5577.6	429.1	12.2	0.1	0.34
SW-1508	103	0.013	119.70	F13-37	112.05	F13-36	12	4364.0	429.1	7.4	0.1	0.21
SW-1509	220	0.013	119.89	F13-22	119.20	F12-105	24	5686.4	1118.3	0.3	0.2	0.51
SW-1510	37	0.013	119.20	F12-105	118.86	F12-190	15	2762.9	1270.1	0.9	0.5	1.00
SW-1511	124	0.013	119.50	F12-104	119.20	F12-105	12	786.5	376.7	0.2	0.5	1.00
SW-1512	163	0.013	103.34	KJ-117	99.84	F13-44	12	2340.3	305.1	2.1	0.1	0.22
SW-1513	87	0.013	99.84	F13-44	94.44	F13-43	12	3982.0	305.1	6.2	0.1	0.58
SW-1514	48	0.013	94.44	F13-43	93.87	F13-40	12	1735.0	315.7	1.2	0.2	1.00
SW-1527	101	0.013	98.71	H11-6	97.69	X-696	15	2919.7	0.0	1.0	0.0	0.00
SW-1528	137	0.013	101.11	H11-224	98.79	H11-6	15	3779.7	0.0	1.7	0.0	0.00
SW-1529	27	0.013	132.46	F12-15	132.29	F12-16	60	92753.9	9984.2	0.6	0.1	0.29
SW-1531	128	0.013	92.34	G12-27	92.24	STOR-29	36	8149.9	15418.7	0.1	1.9	1.00
SW-1532	84	0.013	97.42	G12-23	95.20	KJ-101	30	29882.6	43336.7	2.6	1.5	0.84

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Conduit Parameters and 25-Year Storm Event Results

Conduit ID	LENGTH (ft)	Manning's N	Upstream Invert (ft)	Upstream Node ID	Downstream Invert (ft)	Downstream Node ID	Max Depth (ft)	25-Year Storm Event: Full Flow (gpm)	Maximum Flow	Percent Slope (%)	Max.Flow/ Full Flow	Max.Depth/ Full Depth
SW-1534	83	0.013	174.09	E13-7	173.68	E12-132	12	1126.2	1959.0	0.5	1.7	0.94
SW-1535	48	0.013	174.52	E13-8	174.29	E13-7	12	1106.9	1959.1	0.5	1.8	1.00
SW-1536	218	0.013	110.75	F12-118	110.04	KJ-269	15	1655.8	1389.4	0.3	0.8	0.87
SW-1539	119	0.013	171.41	F11-1	169.74	F11-2	12	1893.6	2259.2	1.4	1.2	1.00
SW-1540	182	0.013	169.69	F11-2	167.99	F11-5	12	1544.4	2259.2	0.9	1.5	1.00
SW-1541	61	0.013	167.79	F11-5	165.64	F11-6	12	3005.8	2259.2	3.5	0.8	1.00
SW-1542	71	0.013	164.59	F11-6	163.21	F11-12	12	2224.9	2259.6	1.9	1.0	1.00
SW-1543	186	0.013	163.06	F11-12	161.62	F11-15	12	1407.9	2260.2	0.8	1.6	1.00
SW-1544	112	0.013	161.52	11-15_DUMM	160.98	F11-17	12	1111.9	931.6	0.5	0.8	1.00
SW-1545	372	0.013	185.87	F11-25	169.33	F11-29	12	3374.9	956.2	4.5	0.3	0.38
SW-1546	56	0.013	169.18	F11-29	168.59	KJ-118	12	1646.6	946.4	1.1	0.6	0.54
SW-1547	218	0.013	168.39	KJ-118	167.06	F11-34	15	2263.0	943.6	0.6	0.4	0.49
SW-1548	190	0.013	166.81	F11-34	164.82	F11-42	15	2963.5	2574.6	1.0	0.9	0.72
SW-1549	76	0.013	164.62	F11-42	163.42	F11-43	15	3639.6	2573.4	1.6	0.7	0.62
SW-1550	375	0.013	180.33	F11-37	167.06	F11-34	12	3008.4	1719.7	3.5	0.6	0.59
SW-1551	363	0.013	173.21	F11-50	163.32	F11-43	12	2770.5	1052.2	3.0	0.4	0.57
SW-1552	160	0.013	169.17	F10-1	160.98	F11-17	12	3619.9	3889.3	5.1	1.1	1.00
SW-1553	133	0.013	159.78	F11-17	154.95	F11-20	12	3045.6	3890.8	3.6	1.3	1.00
SW-1554	47	0.013	72.19	H12-28	71.96	H12-30	12	1118.4	1362.9	0.5	1.2	1.00
SW-1557	215	0.013	85.84	H11-181	83.81	H11-106	12	1553.1	1467.1	0.9	0.9	1.00
SW-1558	129	0.013	83.33	H11-168	82.82	H11-107	12	1007.1	2067.6	0.4	1.0	1.00
SW-1559	17	0.013	82.73	H11-107	82.70	H11-108	12	679.4	3083.5	0.2	2.3	1.00
SW-1560	157	0.013	153.00	G10-92	147.44	G11-138	15	5454.4	972.6	3.5	0.2	0.32
SW-1561	61	0.013	147.44	G11-138	145.27	G11-139	15	5481.9	969.5	3.6	0.2	0.28
SW-1562	44	0.013	145.27	G11-139	139.68	G11-146	15	10383.8	968.6	12.8	0.1	0.21
SW-1563	103	0.013	137.57	G11-147	134.10	G11-145	18	8639.9	968.1	3.4	0.1	0.28
SW-1564	174	0.013	134.10	G11-145	129.76	G11-85	18	7439.9	1788.8	2.5	0.2	0.67
SW-1565	336	0.013	178.28	E13-24	174.92	E13-8	12	1598.7	1324.3	1.0	0.8	0.85
SW-1566	171	0.013	173.75	E13-16	172.90	E13-25	12	1126.5	1793.6	0.5	1.6	1.00
SW-1567	63	0.013	172.60	E13-17	172.28	E13-23	12	1135.4	1795.1	0.5	1.6	0.99
SW-1568	41	0.013	174.93	E13-10	174.92	E13-8	12	250.8	848.9	0.0	3.4	1.00
SW-1569	203	0.013	176.16	E13-11	175.13	E13-10	12	1138.0	842.6	0.5	0.7	0.91
SW-1570	126	0.013	173.95	E13-15	173.75	E13-16	12	637.9	1792.6	0.2	2.8	1.00
SW-1571	20	0.013	172.90	E13-25	172.80	E13-17	12	1133.5	1794.9	0.5	1.6	1.00
SW-1572	30	0.013	172.08	E13-23	171.93	E13-26	12	1130.7	1792.8	0.5	1.6	1.00
SW-1573	286	0.013	171.53	E13-26	170.11	E13-30	48	45442.8	3159.9	0.5	0.1	0.65
SW-1575	216	0.013	169.91	E13-30	169.34	O-13	12	821.5	1986.0	0.3	2.4	0.94
SW-1576	68	0.013	61.60	I12-76	60.40	I12-77	12	2119.8	1311.3	1.8	0.6	0.57
SW-1588	281	0.013	117.20	G12-113	115.50	G12-111	18	3665.6	4079.3	0.6	1.1	1.00
SW-1589	301	0.013	81.60	H11-145	78.80	H11-124	15	2794.2	3078.1	0.9	1.1	1.00

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Conduit Parameters and 25-Year Storm Event Results

Conduit ID	LENGTH (ft)	Manning's N	Upstream Invert (ft)	Upstream Node ID	Downstream Invert (ft)	Downstream Node ID	Max Depth (ft)	25-Year Storm Event Full Flow (gpm)	Maximum Flow	Percent Slope (%)	Max.Flow/ Full Flow	Max.Depth/ Full Depth
SW-1590	72	0.013	82.70	H11-108	81.70	H11-145	15	3422.7	3080.0	1.4	0.9	1.00
SW-1591	71	0.013	62.92	H12-48	62.09	H12-49	12	1723.2	1312.0	1.2	0.8	1.00
SW-1592	155	0.013	61.99	H12-49	61.70	I12-76	12	691.0	1311.8	0.2	1.9	0.87
SW-1593	79	0.013	100.50	H11-232	99.50	H11-233	12	1802.8	2147.7	1.3	1.2	0.95
SW-1594	115	0.013	100.90	H11-231	100.60	H11-232	12	815.1	2147.9	0.3	2.6	1.00
SW-1595	346	0.013	102.50	H11-43	101.00	H11-231	12	1052.9	1666.1	0.4	1.6	1.00
SW-1599	193	0.013	96.40	X-711	96.20	X-799	15	934.4	2601.2	0.1	2.8	1.00
SW-1601	45	0.013	45.70	I10-73	45.60	I10-72	18	2229.2	7200.5	0.2	3.2	0.97
SW-1602	47	0.013	80.41	H12-26	78.75	H12-27	12	3017.8	1918.3	3.6	0.6	1.00
SW-1603	39	0.013	96.99	I9-84	96.81	KJ-107	36	37389.2	17311.5	0.5	0.5	0.51
SW-1604	49	0.013	60.30	I12-77	59.00	I12-36	12	2609.4	1311.2	2.7	0.5	0.51
SW-1605	64	0.013	63.60	H12-65	62.94	H12-48	12	1626.3	1311.4	1.0	0.8	0.87
SW-1607	154	0.013	168.03	E12-135	166.27	E12-136	12	1711.4	1842.2	1.1	1.1	0.93
SW-1608	82	0.013	165.55	F11-188	165.00	F11-187	48	97795.1	4319.5	0.7	0.0	0.28
SW-1609	78	0.013	145.71	F11-186	145.04	F11-185	42	101079.2	10332.3	0.9	0.1	0.29
SW-1610	72	0.013	163.22	F11-43	161.34	STOR-22	15	4673.1	3604.8	2.6	0.8	0.73
SW-1611	53	0.013	112.71	X-837	112.59	G11-78	15	1385.7	1570.5	0.2	1.1	0.80
SW-1612	49	0.013	112.71	X-837	112.69	G11-78	18	947.8	1862.0	0.0	2.0	0.67
SW-1614	179	0.013	104.64	X-839	103.50	KJ-628	30	14677.1	7388.6	0.6	0.5	0.50
SW-1615	137	0.013	103.40	KJ-628	101.46	G12-7	30	21938.5	7388.6	1.4	0.3	0.49
SW-1616	75	0.013	118.24	F12-186	117.99	F12-188	24	5862.2	1473.1	0.3	0.3	1.00
SW-1617	17	0.013	117.99	F12-188	118.08	F12-189	24	7387.9	1493.9	0.5	0.2	1.00
SW-1618	200	0.013	118.08	F12-189	117.77	F12-190	24	3995.9	1539.8	0.2	0.4	1.00
SW-1621	160	0.013	152.60	F11-223	147.10	F11-220	15	5377.1	245.5	3.4	0.0	0.57
SW-1622	163	0.013	154.84	F11-20	149.44	F11-21	16	6261.2	3890.7	3.3	0.6	0.79
SW-1623	30	0.013	148.74	F11-21	148.08	F11-230	16	5108.7	5836.1	2.2	1.1	1.00
SW-1624	32	0.013	148.04	F11-230	146.31	F11-221	16	7964.3	4904.4	5.3	0.6	1.00
SW-1625	81	0.013	106.43	G12-123	106.19	KJ-720	12	870.4	1649.9	0.3	1.9	1.00
SW-1626	78	0.013	106.57	G12-124	106.43	G12-123	12	677.5	1649.5	0.2	2.4	1.00
SW-1627	100	0.013	106.50	G12-125	106.57	G12-124	30	4870.8	2720.9	0.1	0.6	1.00
SW-1628	100	0.013	106.50	G12-125	106.50	KJ-847	36	946.7	2633.7	0.0	2.8	1.00
SW-1632	74	0.013	105.55	G12-129	105.10	G12-46	12	1246.0	1214.0	0.6	1.0	1.00
SW-1633	63	0.013	105.40	G12-39	104.70	G12-46	24	10729.9	11454.0	1.1	1.1	1.00
SW-1634	90	0.013	106.38	G12-55	105.55	G12-129	12	1535.7	1214.3	0.9	0.8	1.00
SW-1635	84	0.013	107.01	G12-79	106.58	G12-55	12	1144.1	1214.6	0.5	1.1	1.00
SW-1636	100	0.013	108.49	G12-80	107.21	G12-79	12	1811.8	1215.3	1.3	0.7	1.00
SW-1638	134	0.013	174.84	F10-23	173.34	F10-21	12	1692.0	2212.4	1.1	1.3	1.00
SW-1639	63	0.013	174.84	F10-26	174.34	F11-233	12	1429.8	0.0	0.8	0.0	0.00
SW-1640	103	0.013	173.14	F10-21	169.54	F10-1	12	2987.8	4348.2	3.5	1.5	1.00
SW-1642	57	0.013	176.55	F10-27	176.34	STOR-10	18	2867.5	3546.4	0.4	1.2	1.00

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Conduit Parameters and 25-Year Storm Event Results

Conduit ID	LENGTH (ft)	Manning's N	Upstream Invert (ft)	Upstream Node ID	Downstream Invert (ft)	Downstream Node ID	Max Depth (ft)	25-Year Storm Event Full Flow (gpm)	Maximum Flow	Percent Slope (%)	Max.Flow/ Full Flow	Max.Depth/ Full Depth
SW-1643	346	0.013	192.33	F11-237	184.64	F11-234	12	2385.8	2241.0	2.2	0.9	0.77
SW-1644	251	0.013	249.04	F10-31	230.91	F11-243	12	4305.5	943.5	7.2	0.2	0.32
SW-1645	67	0.013	177.34	STOR-10	174.84	F10-23	12	3092.1	2212.5	3.7	0.7	1.00
SW-1646	300	0.013	184.44	F11-234	176.74	F10-27	18	7549.8	3548.2	2.6	0.5	0.74
SW-1647	225	0.013	246.14	F10-34	224.84	F11-247	12	4928.4	1340.7	9.5	0.3	0.36
SW-1648	266	0.013	215.78	F11-242	206.54	F11-239	12	2981.1	941.8	3.5	0.3	0.39
SW-1649	181	0.013	230.71	F11-243	218.62	F11-242	12	4135.1	942.9	6.7	0.2	0.32
SW-1652	193	0.013	224.64	F11-247	207.34	F11-239	12	4799.7	1338.5	9.0	0.3	0.36
SW-1654	307	0.013	12.40	J12-11	1.00	X-803	48	124335.5	5952.8	3.7	0.0	0.15
SW-1655	206	0.013	18.90	J12-9	16.53	J12-10	24	10891.4	5955.6	1.2	0.5	0.53
SW-1656	154	0.013	37.80	J12-8	20.80	J12-9	24	33867.4	5958.7	11.1	0.2	0.28
SW-1657	160	0.013	38.18	J12-3	37.90	J12-8	24	4247.7	3852.0	0.2	0.9	0.61
SW-1658	92	0.011	68.33	I12-88	68.05	I12-89	12	1033.2	2062.4	0.3	2.0	1.00
SW-1659	59	0.011	68.69	I11-91	68.40	I12-88	12	1326.8	2062.3	0.5	1.6	1.00
SW-1660	154	0.013	16.33	J12-10	12.60	J12-11	48	100223.1	5954.4	2.4	0.1	0.17
SW-1663	77	0.013	75.08	H12-11	74.80	H12-10	18	2836.4	3700.3	0.4	1.3	0.94
SW-1667	68	0.013	83.92	H11-106	83.60	H11-168	12	1100.7	3451.4	0.5	1.6	1.00
SW-1668	254	0.013	116.59	F12-69	114.85	F12-68	12	1324.5	1013.7	0.7	0.8	1.00
SW-1669	288	0.013	63.10	H13-70	62.00	H13-72	12	988.3	1921.4	0.4	1.9	1.00
SW-1670	189	0.013	77.33	G13-26	75.00	G13-27	12	1775.1	2373.1	1.2	1.3	1.00
SW-1671	68	0.013	230.21	G10-4	227.84	G10-5	12	2995.5	0.0	3.5	0.0	0.00
SW-1672	80	0.013	227.64	G10-5	225.54	G10-8	12	2593.2	0.0	2.6	0.0	0.00
SW-1673	25	0.013	217.86	G10-9	217.74	G10-10	12	1107.9	60.2	0.5	0.1	0.27
SW-1674	136	0.013	225.34	G10-8	218.06	G10-9	12	3698.0	0.0	5.3	0.0	0.01
SW-1675	113	0.013	218.03	G10-11	217.57	G10-9	12	1022.4	19.2	0.4	0.0	0.28
SW-1676	75	0.013	218.53	G10-14	218.23	G10-11	12	1014.5	0.0	0.4	0.0	0.00
SW-1677	102	0.013	219.14	G10-15	218.73	G10-14	12	1011.6	0.0	0.4	0.0	0.00
SW-1678	211	0.013	223.14	G10-18	219.34	G10-15	12	2147.9	0.0	1.8	0.0	0.00
SW-1679	97	0.013	232.24	G10-3	230.41	G10-4	12	2200.6	0.0	1.9	0.0	0.00
SW-1680	168	0.013	175.66	F12-8	173.89	F12-7	12	1641.4	1069.0	1.1	0.7	0.57
SW-1681	84	0.013	173.89	F12-7	172.25	F12-6	12	2234.6	1067.8	2.0	0.5	0.47
SW-1682	150	0.013	172.25	F12-6	167.09	F12-4	12	2969.5	1067.0	3.4	0.4	0.47
SW-1685	132	0.013	156.10	F12-11	153.50	F12-13	12	2244.5	913.7	2.0	0.4	0.44
SW-1686	127	0.013	157.50	F12-14	156.20	F12-11	12	1617.9	0.0	1.0	0.0	0.17
SW-1687	81	0.013	161.65	F11-98	157.60	F12-14	12	3578.0	0.0	5.0	0.0	0.00
SW-1688	106	0.013	168.90	F11-99	161.75	F11-98	12	4157.8	0.0	6.8	0.0	0.00
SW-1689	105	0.013	171.04	F11-118	170.54	F11-117	12	1104.2	0.0	0.5	0.0	0.00
SW-1691	138	0.013	187.49	E12-6	184.78	KJ-136	12	2241.4	2964.2	2.0	1.3	0.83
SW-1692	167	0.013	134.79	F12-112	125.01	F12-113	12	3873.1	781.6	5.9	0.2	0.30
SW-1693	133	0.013	122.66	F12-113	121.70	F12-114	12	1358.6	781.2	0.7	0.6	0.54

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Conduit Parameters and 25-Year Storm Event Results

Conduit ID	LENGTH (ft)	Manning's N	Upstream Invert (ft)	Upstream Node ID	Downstream Invert (ft)	Downstream Node ID	Max Depth (ft)	25-Year Storm Event Full Flow (gpm)	Maximum Flow	Percent Slope (%)	Max.Flow/ Full Flow	Max.Depth/ Full Depth
SW-1694	69	0.013	121.35	F12-114	120.60	F12-115	12	1667.2	781.1	1.1	0.5	0.48
SW-1695	141	0.013	118.30	F12-111	115.80	F12-110	12	2129.5	394.4	1.8	0.2	0.26
SW-1696	35	0.013	115.80	F12-110	113.00	X-840	12	4553.1	393.7	8.1	0.1	0.20
SW-1697	212	0.013	119.10	F12-170	117.40	G12-113	18	4222.8	2639.7	0.8	0.6	0.78
SW-1698	87	0.013	119.40	F12-171	119.20	F12-170	18	2264.3	1818.6	0.2	0.8	0.58
SW-1699	229	0.013	120.20	F12-182	119.50	F12-171	12	883.7	1818.6	0.3	2.1	0.93
SW-1700	221	0.013	135.26	G11-122	134.50	X-810	12	937.7	1779.0	0.3	1.9	0.89
SW-1701	179	0.013	135.90	G11-160	135.26	G11-122	12	956.2	1767.5	0.4	1.8	1.00
SW-1702	378	0.013	149.04	G11-143	136.07	G11-159	12	2961.5	586.2	3.4	0.2	0.65
SW-1704	385	0.013	136.07	G11-159	131.57	KJ-122	12	1727.8	2108.2	1.2	1.2	1.00
SW-1705	354	0.013	126.60	G11-3	123.60	G11-6	12	1471.7	1915.5	0.8	1.3	0.93
SW-1706	34	0.013	127.70	G11-2	127.00	G11-3	12	2285.6	1956.7	2.0	0.9	1.00
SW-1707	175	0.013	120.34	G11-8	119.92	G11-9	18	2312.5	4040.7	0.2	1.7	0.87
SW-1708	172	0.013	119.92	G11-9	117.21	KJ-182	24	12757.1	7672.6	1.6	0.6	0.78
SW-1712	105	0.013	66.70	X-805	66.52	X-804	20	2584.1	8045.2	0.2	1.6	0.77
SW-1714	19	0.013	84.56	H12-51	84.53	H12-56	24	4081.6	5600.1	0.2	1.4	0.73
SW-1715	20	0.013	71.68	H12-30	71.17	H12-74	12	2573.3	1362.6	2.6	0.5	1.00
SW-1716	5	0.013	69.61	I12-8	69.53	I12-74	18	6117.3	2301.9	1.7	0.4	0.48
SW-1718	40	0.013	84.10	H11-105	83.84	H11-106	12	1288.3	2357.4	0.6	0.9	1.00
SW-1719	17	0.013	84.69	H11-103	84.42	H11-104	12	1995.3	2872.6	1.6	0.7	1.00
SW-1723	57	0.013	133.80	G10-88	132.34	G11-19	12	2560.1	1038.0	2.6	0.4	0.60
SW-1724	24	0.013	117.10	F12-71	116.69	F12-69	12	2101.3	1007.2	1.7	0.5	1.00
SW-1725	35	0.013	114.75	F12-68	114.46	F12-67	12	1457.8	1017.3	0.8	0.7	1.00
SW-1726	164	0.013	117.77	F12-190	117.50	F12-95	24	4124.4	3815.3	0.2	0.9	1.00
SW-1727	63	0.013	164.29	G9-2	161.34	G9-3	36	65018.1	14342.1	4.7	0.2	0.33
SW-1728	29	0.013	90.24	KJ-116	90.20	H11-185	16	1286.7	2246.7	0.1	1.7	1.00
SW-1729	114	0.011	69.90	I11-93	69.73	I11-92	12	729.8	2749.8	0.1	3.8	1.00
SW-1731	107	0.013	174.36	F11-80	171.58	STOR-26	42	72680.7	5473.8	2.6	0.1	0.47
SW-1732	67	0.013	175.67	KJ-277	174.36	F11-80	42	63353.0	586.6	2.0	0.0	0.13
SW-1733	54	0.013	168.34	G9-4	164.29	G9-2	36	81848.5	14370.0	7.5	0.2	0.31
SW-1734	73	0.013	161.42	STOR-16	161.42	F11-15	12	59.3	1925.5	0.0	32.5	1.00
SW-1735	155	0.013	130.26	G11-85	130.60	G11-17	12	748.3	1477.6	0.2	2.0	0.84
SW-1737	16	0.013	142.30	G10-115	142.30	G10-119	18	367.2	4942.2	0.0	13.5	1.00
SW-1738	9	0.013	167.09	F12-4	166.95	F12-2	12	1997.7	1066.0	1.6	0.5	0.61
SW-1739	35	0.013	217.64	G10-31	217.49	G10-29	12	1046.9	102.9	0.4	0.1	0.50
SW-1744	311	0.013	113.00	X-811	110.90	X-812	24	8348.6	1921.9	0.7	0.2	0.33
SW-1745	85	0.013	119.54	STOR-28	115.64	G11-42	15	6225.9	544.4	4.6	0.1	0.42
SW-1747	246	0.013	115.34	G11-42	112.95	G11-41	15	2858.5	2866.1	1.0	1.0	0.79
SW-1748	286	0.013	112.95	G11-41	108.90	H11-62	15	3449.2	2865.5	1.4	0.8	0.89
SW-1750	79	0.013	188.80	KJ-786	185.39	F11-164	12	3332.2	1311.0	4.3	0.4	0.44

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SW-1751	300	0.013	206.34	F11-239	192.53	F11-237	12	3432.3	2263.9	4.6	0.7	0.59
SW-1752	33	0.013	180.04	STOR-10	174.84	F10-26	12	6366.9	0.0	15.9	0.0	0.00
SW-1753	210	0.013	160.74	F11-207	154.94	F11-211	10	1633.7	1731.2	2.8	1.1	0.89
SW-1754	60	0.013	154.84	F11-211	150.74	F11-214	12	4177.0	2944.0	6.8	0.7	0.62
SW-1755	128	0.013	148.95	F11-214	148.95	F11-217	38	1790.3	2996.4	0.0	1.7	0.53
SW-1756	92	0.013	148.95	F11-217	146.84	F11-219	16	5209.9	2903.1	2.3	0.6	1.00
SW-1757	40	0.013	146.74	F11-219	146.60	F11-220	16	2031.2	2904.4	0.3	1.4	1.00
SW-1758	108	0.013	145.10	F11-220	144.81	F11-221	36	15512.7	4615.0	0.3	0.3	1.00
SW-1759	141	0.013	144.34	F11-221	141.27	X-809	15	4285.6	6037.8	2.2	1.4	1.00
SW-1760	62	0.013	119.41	X-835	119.28	X-836	24	4688.4	6163.8	0.2	1.3	0.70
SW-1761	120	0.013	98.20	X-696	97.20	H11-23	24	9278.5	0.0	0.8	0.0	0.20
SW-1763	40	0.013	106.09	KJ-720	105.59	KJ-846	12	1781.2	1649.8	1.2	0.9	1.00
SW-1764	183	0.013	105.49	KJ-846	104.94	KJ-845	12	876.8	1648.8	0.3	1.9	0.91
SW-1765	91	0.013	193.10	KJ-100	188.59	E12-6	12	3552.9	2890.9	4.9	0.8	1.00
SW-1766	92	0.013	139.43	G11-146	137.57	G11-147	18	6692.5	968.9	2.0	0.1	0.25
SW-1767	64	0.013	95.10	KJ-101	93.98	G12-25	30	24412.6	18795.8	1.8	0.8	1.00
SW-1769	891	0.013	96.81	KJ-107	91.72	X-797	48	48720.0	17277.2	0.6	0.4	0.41
SW-1776	208	0.013	100.29	KJ-113	99.00	H9-1	30	14504.2	11404.2	0.6	0.8	0.68
SW-1777	62	0.030	61.38	I10-46	23.46	KJ-276	0	0.0	2487.9	73.9	-1.0	-1.00
SW-1778	21	0.013	72.76	I12-3	72.55	I12-4	24	10195.3	4968.5	1.0	0.5	1.00
SW-1779	76	0.030	217.74	G10-10	217.64	G10-31	0	4994.1	72.6	0.1	0.0	0.12
SW-1781	115	0.013	174.34	F11-233	173.85	KJ-119	12	1043.4	0.0	0.4	0.0	0.00
SW-1782	518	0.013	173.85	KJ-119	173.84	O-11	8	23.8	0.0	0.0	0.0	0.00
SW-1783	222	0.013	141.27	X-809	136.97	KJ-120	15	4033.8	4308.8	1.9	1.1	0.83
SW-1786	422	0.030	134.50	X-810	128.60	G11-85	0	14546.6	1762.0	1.1	0.1	0.63
SW-1787	216	0.013	131.51	KJ-122	127.70	G11-2	12	2138.6	2013.4	1.8	0.9	1.00
SW-1788	54	0.013	120.45	G11-7	120.34	G11-8	18	2081.3	4037.9	0.2	1.9	1.00
SW-1789	26	0.013	123.50	G11-6	120.46	G11-7	12	5497.8	1915.4	11.8	0.3	0.70
SW-1793	85	0.013	59.40	I12-78	58.80	I12-36	15	2432.0	2589.8	0.7	1.1	0.79
SW-1794	392	0.013	58.80	I12-36	51.20	I12-86	24	14130.6	3900.8	1.9	0.3	0.36
SW-2000	94	0.013	84.33	H11-104	84.06	H11-105	12	856.9	2354.0	0.3	1.4	1.00
SW-2001	10	0.013	99.01	KJ-278	98.99	KJ-133	12	729.6	1653.3	0.2	2.3	1.00
SW-2002	120	0.013	104.21	KJ-290	102.70	KJ-303	36	33548.6	11427.2	1.3	0.3	0.86
SW-2003	72	0.013	102.70	KJ-303	102.20	KJ-304	36	25016.6	11430.9	0.7	0.5	0.94
SW-2004	81	0.013	102.20	KJ-304	103.70	KJ-287	30	46309.9	11431.2	1.8	0.2	0.68
SW-2005	75	0.013	103.60	KJ-287	101.09	KJ-286	30	33645.9	11431.0	3.3	0.2	0.53
SW-2006	50	0.013	101.09	KJ-286	100.96	KJ-285	30	9412.6	11411.4	0.3	0.6	0.80
SW-2007	103	0.013	100.96	KJ-285	100.56	KJ-284	30	11463.3	11408.0	0.4	1.0	0.82
SW-2008	88	0.013	100.56	KJ-284	100.29	KJ-113	30	10172.2	11407.3	0.3	1.1	0.74
SW-2009	67	0.013		I10-6	88.90	I10-8	15	3489.4	2361.0	1.4	0.7	1.00

Client: City of St. Helens
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Conduit Parameters and 25-Year Storm Event Results

Conduit ID	LENGTH (ft)	Manning's N	Upstream Invert (ft)	Upstream Node ID	Downstream Invert (ft)	Downstream Node ID	Max Depth (ft)	25-Year Storm Event: Full Flow (gpm)	Maximum Flow	Percent Slope (%)	Max.Flow/ Full Flow	Max.Depth/ Full Depth
SW-2012	64	0.013	98.80	H11-233	98.00	H11-22	12	1789.2	2146.9	1.3	1.2	0.95
SW-2013	34	0.030	52.43	I10-34	34.40	X-808	0	0.0	20218.0	63.1	-1.0	-1.00
SW-2014	69	0.013	56.19	I11-40S	56.19	I11-41	6	9.6	0.0	0.0	0.0	0.50
SW-2015	18	0.013	66.19	I11-39S	66.19	I11-39	6	19.0	0.0	0.0	0.0	0.00
SW-2017	22	0.013	66.19	I11-37ST	66.19	I11-37	6	17.0	0.0	0.0	0.0	0.00
SW-2019	113	0.013	42.25	J11-63	40.87	J12-2	12	1768.6	2378.1	1.2	1.3	1.00
SW-2021	35	0.013	114.74	(J-189_DUMM	114.55	KJ-190	24	7515.7	1931.3	0.5	0.3	0.34
SW-2022	279	0.013	117.21	KJ-182	116.01	KJ-187	24	6655.8	6938.7	0.4	1.0	0.72
SW-2025	22	0.013	167.09	STOR-24	165.50	F11-188	48	36784.4	1168.7	7.2	0.0	0.21
SW-2026	34	0.030	171.58	KJ-300	170.92	KJ-301	42	27199.6	2712.6	1.9	0.1	0.22
SW-2028	101	0.030	170.92	KJ-301	168.50	F11-115	0	21298.5	2709.8	2.4	0.1	0.28
SW-2029	977	0.013	160.43	KJ-302	145.10	F11-220	24	12722.4	1707.7	1.6	0.1	0.62
SW-2030	44	0.013	163.85	STOR-22	160.43	KJ-302	15	8073.4	0.0	7.8	0.0	0.20
SW-2032	370	0.030	115.00	KJ-305	114.36	KJ-131	12	4296.0	4460.3	0.2	1.0	1.00
SW-2034	72	0.013	101.86	(J-308_DUMM	101.11	H11-224	15	2957.1	0.0	1.0	0.0	0.00
SW-2035	16	0.013	102.42	KJ-310	102.34	KJ-308	18	3359.5	0.0	0.5	0.0	0.00
SW-2036	171	0.013	104.04	KJ-309	102.42	KJ-310	96	398438.5	0.0	0.9	0.0	0.00
SW-2037	21	0.013	102.42	KJ-311	102.42	KJ-310	96	28376.9	0.0	0.0	0.0	0.00
SW-2038	66	0.013	103.00	KJ-312	102.42	KJ-311	96	384306.9	0.0	0.9	0.0	0.00
SW-2039	19	0.013	107.62	KJ-313	107.45	KJ-309	18	4409.7	0.0	0.9	0.0	0.00
SW-2040	106	0.013	118.37	KJ-319	117.67	KJ-318	12	1299.6	0.0	0.7	0.0	0.00
SW-2041	154	0.013	116.90	KJ-318	116.14	KJ-317	15	2038.1	0.0	0.5	0.0	0.00
SW-2042	96	0.013	116.01	KJ-317	115.39	KJ-316	15	2324.2	0.0	0.6	0.0	0.00
SW-2043	338	0.013	115.23	KJ-316	113.43	KJ-315	15	2114.8	0.0	0.5	0.0	0.00
SW-2044	90	0.013	113.32	KJ-315	112.11	KJ-314	15	3361.1	0.0	1.3	0.0	0.00
SW-2045	126	0.013	111.89	KJ-314	110.36	KJ-313	15	3190.3	0.0	1.2	0.0	0.00
SW-2046	203	0.013	127.97	KJ-325	123.05	KJ-324	12	2487.8	0.0	2.4	0.0	0.00
SW-2047	160	0.013	122.79	KJ-324	119.78	KJ-323	12	2196.6	0.0	1.9	0.0	0.00
SW-2048	60	0.013	118.98	KJ-323	118.24	KJ-322	12	1772.2	0.0	1.2	0.0	0.00
SW-2049	55	0.013	114.52	KJ-322	112.89	KJ-321	12	2748.0	0.0	3.0	0.0	0.00
SW-2050	283	0.013	111.59	KJ-321	110.20	KJ-320	12	1120.6	0.0	0.5	0.0	0.00
SW-2051	107	0.013	108.38	KJ-320	107.82	KJ-313	12	1157.1	0.0	0.5	0.0	0.00
SW-2052	277	0.013	127.91	KJ-326	124.62	KJ-327	12	1744.3	0.0	1.2	0.0	0.00
SW-2053	26	0.013	124.40	KJ-327	123.98	KJ-328	12	2026.6	0.0	1.6	0.0	0.00
SW-2054	224	0.013	123.48	KJ-328	120.71	KJ-318	12	1776.6	0.0	1.2	0.0	0.00
SW-2055	53	0.013	116.21	KJ-329	115.38	KJ-330	10	1226.8	0.0	1.6	0.0	0.00
SW-2056	106	0.013	114.32	KJ-330	113.77	KJ-331	14	1736.8	0.0	0.5	0.0	0.00
SW-2057	179	0.013	113.62	KJ-331	109.81	KJ-313	15	4230.4	0.0	2.1	0.0	0.00
SW-2058	63	0.013	71.00	I12-5_DUMMY	70.35	I12-6	18	4799.4	2301.9	1.0	0.5	0.49
SW-612	143	0.030	72.55	I12-4	70.90	I12-5	0	26337.8	10138.9	1.2	0.4	1.00

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Conduit Parameters and 25-Year Storm Event Results

Conduit ID	LENGTH (ft)	Manning's N	Upstream Invert (ft)	Upstream Node ID	Downstream Invert (ft)	Downstream Node ID	Max Depth (ft)	25-Year Storm Event: Full Flow (gpm)	Maximum Flow	Percent Slope (%)	Max.Flow/ Full Flow	Max.Depth/ Full Depth
SW-613	148	0.030	74.54	I12-2	72.76	I12-3	0	39371.1	4970.7	1.2	0.1	0.58
SW-626	488	0.030	80.48	H11-58	67.10	X-781	0	22401.3	18558.5	2.7	0.8	0.95
SW-635	120	0.030	110.04	KJ-269	108.49	G12-80	0	15580.6	1222.7	1.3	0.1	0.72
SW-638	786	0.030	165.00	F11-187	145.71	F11-186	0	21503.0	5589.7	2.5	0.3	0.42
SW-640	115	0.030	145.00	F11-185	138.53	KJ-175	0	162360.7	10133.9	5.6	0.1	0.28
SW-642	366	0.030	155.00	G10-89	140.00	G11-144	0	28469.9	899.3	4.3	0.0	0.10
SW-643	87	0.030	140.00	G11-144	134.10	G11-145	0	35709.2	892.5	6.8	0.0	0.13
SW-644	177	0.030	123.20	G11-71	122.82	G11-72	144	1545262.8	6248.4	0.2	0.0	0.03
SW-645	191	0.030	122.82	G11-72	119.41	X-835	144	4465355.0	6165.4	1.8	0.0	0.10
SW-646	51	0.030	114.50	KJ-170	114.71	KJ-152	0	68670.9	1313.8	0.4	0.0	0.50
SW-647	280	0.030	114.98	G11-128	114.89	KJ-154	0	2525.1	1055.7	0.0	0.4	0.79
SW-648	450	0.030	119.28	X-836	115.00	KJ-305	12	10072.0	6115.8	1.0	0.6	0.89
SW-649	396	0.030	114.36	KJ-131	114.16	KJ-160	0	5001.4	3908.4	0.1	0.8	1.00
SW-655	118	0.030	105.10	X-838	104.64	X-839	0	33832.5	7389.3	0.4	0.2	0.51
SW-718	252	0.030	57.50	I12-21	55.50	I12-54	0	12232.7	2301.9	0.8	0.2	0.30
SW-764	103	0.030	66.52	X-804	65.55	KJ-209	0	50788.3	11904.4	0.9	0.2	0.56
SW-811	78	0.030	34.40	X-808	32.27	KJ-270	144	5525780.0	39208.6	2.7	0.0	0.19
SW-814	342	0.030	67.30	H11-2	66.86	STOR-30	0	9279.3	13321.7	0.1	1.4	1.00
SW-818	116	0.030	168.50	F11-115	165.55	F11-188	24	21897.3	3155.0	2.5	0.1	0.29
SW-820	212	0.013	101.66	KJ-845	99.08	KJ-278	12	1764.4	1651.1	1.2	0.9	1.00
SW-821	69	0.013	98.18	KJ-134	97.47	G12-23	30	18704.8	69397.9	1.0	3.7	0.68
SW-822	165	0.013	98.92	KJ-133	98.63	KJ-134	12	671.2	1651.3	0.2	2.5	1.00
SW-823	342	0.030	184.78	KJ-136	166.95	KJ-135	0	31345.4	2954.1	5.2	0.1	0.46
SW-824	6	0.030	166.95	KJ-135	166.95	F12-2	12	90.1	2954.1	0.0	32.8	1.00
SW-826	47	0.030	170.54	F11-117	168.50	F11-115	0	28491.5	0.0	4.3	0.0	0.15
SW-829	621	0.013	75.00	G13-27	63.30	H13-70	12	2195.1	2123.7	1.9	1.0	1.00
SW-830	92	0.013	62.00	H13-72	61.00	O-12	12	1666.3	1875.2	1.1	1.1	0.93
SW-831	87	0.030	56.07	KJ-137	52.43	I10-34	30	30150.8	20218.1	4.2	0.7	0.53
SW-832	90	0.013	136.97	KJ-120	134.42	KJ-138	18	7932.6	4732.6	2.8	0.6	0.58
SW-833	60	0.013	134.42	KJ-138	133.05	KJ-139	18	7131.7	4732.5	2.3	0.7	0.69
SW-835	56	0.013	133.05	KJ-139	131.40	KJ-141	16	5889.8	5412.4	2.9	0.9	0.80
SW-836	40	0.013	131.40	KJ-141	130.68	KJ-143	18	6348.6	13643.0	1.8	2.1	0.72
SW-838	44	0.013	130.22	KJ-143	129.42	KJ-144	18	6393.0	7382.3	1.8	1.2	0.87
SW-839	39	0.013	129.42	KJ-144	128.86	KJ-145	18	5642.4	5583.4	1.4	1.0	1.00
SW-840	83	0.013	128.86	KJ-145	127.60	KJ-844	18	5822.3	4492.1	1.5	0.8	1.00
SW-841	105	0.013	127.50	KJ-844	126.70	KJ-146	18	4123.7	4471.4	0.8	1.1	1.00
SW-842	56	0.013	126.70	KJ-146	126.50	KJ-147	18	2807.7	4471.5	0.4	1.6	1.00
SW-843	94	0.013	126.40	KJ-147	125.10	G11-70	18	5535.1	4471.5	1.4	0.8	1.00
SW-847	151	0.030	114.71	KJ-152	115.02	KJ-153	0	48259.1	1191.8	0.2	0.0	0.39
SW-848	52	0.030	115.02	KJ-153	114.98	G11-128	0	29503.6	1128.5	0.1	0.0	0.34

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Conduit Parameters and 25-Year Storm Event Results

Conduit ID	LENGTH (ft)	Manning's N	Upstream Invert (ft)	Upstream Node ID	Downstream Invert (ft)	Downstream Node ID	Max Depth (ft)	25-Year Storm Event				
								Full Flow (gpm)	Maximum Flow	Percent Slope (%)	Max.Flow/ Full Flow	Max.Depth/ Full Depth
SW-849	280	0.030	114.89	KJ-154	114.97	KJ-155	0	2380.6	992.7	0.0	0.4	0.79
SW-850	280	0.030	114.97	KJ-155	114.60	KJ-156	0	5119.8	939.5	0.1	0.2	0.88
SW-851	280	0.030	114.60	KJ-156	114.52	KJ-157	0	2380.6	878.7	0.0	0.4	1.00
SW-852	280	0.030	114.52	KJ-157	114.54	KJ-158	0	873.2	815.0	0.0	0.9	1.00
SW-853	280	0.030	114.54	KJ-158	114.48	KJ-159	0	3257.5	883.1	0.0	0.3	1.00
SW-854	280	0.030	114.48	KJ-159	114.36	KJ-131	0	4606.8	1449.6	0.0	0.3	1.00
SW-855	396	0.030	114.16	KJ-160	113.73	KJ-161	0	20635.5	3853.9	0.1	0.2	0.64
SW-856	396	0.030	113.73	KJ-161	113.90	KJ-162	0	7885.4	3789.7	0.0	0.5	0.91
SW-857	396	0.030	113.90	KJ-162	113.68	KJ-163	0	8970.4	3726.2	0.1	0.4	0.89
SW-858	396	0.030	113.68	KJ-163	113.75	KJ-164	0	4045.9	3682.0	0.0	0.9	0.79
SW-859	396	0.030	113.75	KJ-164	113.45	KJ-165	0	8375.9	3639.4	0.1	0.4	0.75
SW-860	396	0.030	113.45	KJ-165	113.38	KJ-166	0	4045.9	3597.4	0.0	0.9	0.74
SW-861	396	0.030	113.38	KJ-166	112.99	KJ-167	0	9550.0	3555.0	0.1	0.4	0.75
SW-862	396	0.030	112.99	KJ-167	112.97	KJ-168	0	2162.6	3512.3	0.0	1.6	0.76
SW-863	396	0.030	112.97	KJ-168	112.80	KJ-169	0	6305.1	3472.5	0.0	0.6	0.69
SW-864	396	0.030	112.80	KJ-169	112.40	X-837	0	9671.6	3432.5	0.1	0.4	0.70
SW-869	170	0.030	138.53	KJ-175	132.46	F12-15	0	262207.8	10046.2	3.6	0.0	0.24
SW-881	72	0.030	116.01	KJ-187	115.33	KJ-188	0	7135.8	6919.1	0.9	1.0	1.00
SW-882	65	0.030	115.33	KJ-188	114.74	KJ-189	0	6992.7	5830.7	0.9	0.8	1.00
SW-884	56	0.030	114.55	KJ-190	114.24	KJ-191	0	32659.0	1927.6	0.6	0.1	0.26
SW-885	49	0.030	114.24	KJ-191	113.85	KJ-192	0	39169.0	1924.6	0.8	0.0	0.24
SW-886	27	0.030	113.85	KJ-192	113.47	KJ-193	0	51955.3	1923.0	1.4	0.0	0.22
SW-887	6	0.030	113.47	KJ-193	113.38	KJ-194	0	55070.4	1922.6	1.6	0.0	0.20
SW-888	12	0.030	113.38	KJ-194	113.00	X-811	0	78823.7	1921.9	3.3	0.0	0.23
SW-903	213	0.030	65.55	KJ-209	64.38	KJ-213	26	35684.2	11902.7	0.5	0.3	0.67
SW-908	317	0.030	64.38	KJ-213	63.72	KJ-219	0	22003.5	11900.4	0.2	0.5	0.82
SW-913	56	0.030	63.72	KJ-219	63.84	KJ-220	0	15849.9	11920.5	0.2	0.8	0.85
SW-914	21	0.030	63.84	KJ-220	63.59	KJ-221	36	24184.8	11929.4	1.2	0.5	0.56
SW-915	173	0.030	63.59	KJ-221	62.56	KJ-225	0	22884.0	13543.0	0.6	0.6	1.00
SW-919	20	0.030	62.56	KJ-225	62.52	KJ-226	36	5750.5	13534.2	0.2	2.4	0.75
SW-920	185	0.030	62.52	KJ-226	62.41	X-806	0	9678.7	13533.3	0.1	1.4	0.99
SW-926	213	0.030	62.51	X-807	61.40	I10-119	0	63654.2	13971.9	0.5	0.2	0.48
SW-931	216	0.030	60.65	X-773	59.30	I10-126	0	31823.1	19111.4	0.6	0.6	0.68
SW-934	63	0.030	67.38	KJ-240	67.30	H11-2	0	8818.6	19089.6	0.1	2.2	1.00
SW-946	336	0.030	66.22	STOR-30	66.70	X-805	0	16468.6	8070.8	0.1	0.5	0.96
SW-948	102	0.013	283.34	KJ-268	281.12	KJ-267	12	2364.9	2756.0	2.2	1.2	1.00
SW-949	163	0.013	281.02	KJ-267	278.04	KJ-266	12	2161.5	2676.0	1.8	1.2	0.98
SW-950	97	0.013	277.74	KJ-266	268.57	KJ-265	12	4921.9	2675.7	9.5	0.5	0.53
SW-951	97	0.013	268.27	KJ-265	256.71	KJ-264	12	5531.8	2675.8	12.0	0.5	0.75
SW-952	26	0.013	256.11	KJ-264	255.38	KJ-263	12	2677.8	2696.2	2.8	1.0	1.00

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Conduit Parameters and 25-Year Storm Event Results

Conduit ID	LENGTH (ft)	Manning's N	Upstream Invert (ft)	Upstream Node ID	Downstream Invert (ft)	Downstream Node ID	Max Depth (ft)	25-Year Storm Event				
								Full Flow (gpm)	Maximum Flow	Percent Slope (%)	Max.Flow/ Full Flow	Max.Depth/ Full Depth
SW-953	60	0.013	254.98	KJ-263	254.26	KJ-262	12	1757.2	2727.2	1.2	1.6	1.00
SW-954	57	0.013	254.06	KJ-262	253.29	KJ-261	12	1864.9	2754.2	1.4	1.5	0.98
SW-955	361	0.013	252.99	KJ-261	251.13	KJ-260	18	3383.4	2675.4	0.5	0.8	0.66
SW-956	244	0.013	250.93	KJ-260	249.69	KJ-259	18	3359.9	2675.3	0.5	0.8	0.66
SW-957	259	0.013	249.54	KJ-259	248.33	KJ-258	18	3222.7	2675.2	0.5	0.8	0.67
SW-958	112	0.013	248.03	KJ-258	247.09	G9-16	18	4328.0	2675.2	0.8	0.6	0.57
SW-961	120	0.013	287.13	KJ-255	275.45	KJ-254	12	5005.6	2391.8	9.8	0.5	0.49
SW-962	150	0.013	275.25	KJ-254	264.21	G9-20	12	4341.6	2391.7	7.4	0.6	0.55
SW-963	204	0.030	193.34	G9-18	168.34	G9-4	0	48271.0	14370.2	12.4	0.3	0.41
SW-964	41	0.030	35.30	KJ-270	30.97	KJ-271	0	#########	42190.8	10.7	0.0	0.14
SW-965	58	0.030	33.52	KJ-271	29.42	KJ-272	0	8911917.0	41957.5	7.1	0.0	0.13
SW-966	39	0.030	31.79	KJ-272	28.17	KJ-273	0	#########	41899.6	9.4	0.0	0.14
SW-967	39	0.030	30.85	KJ-273	27.31	KJ-274	0	#########	41847.0	9.2	0.0	0.13
SW-968	36	0.030	29.71	KJ-274	26.21	KJ-275	0	#########	41800.4	9.9	0.0	0.12
SW-969	53	0.030	28.34	KJ-275	24.58	KJ-276	0	8939560.0	41752.5	7.2	0.0	0.16
SW-970	62	0.030	27.53	KJ-276	23.46	I10-154	0	8550136.0	43854.0	6.6	0.0	0.20

Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060-001

Storage Parameters and 25-Year Storm Event Results

ID	Invert Elevation (ft)	25-Year Storm Event Maximum Depth (ft)	25-Year Storm Event Total Inflow Volume (MG)	25-Year Storm Event Average Percent Full (%)
I11-37ST	62	6	0.00	0
I11-39S	64	6	0.00	0
I11-40S	52	6	0.00	0
STOR-10	176	6	0.59	14
STOR-16	161	4	0.07	23
STOR-22	161	4	0.57	10
STOR-24	167	4	0.24	9
STOR-26	172	6	1.04	11
STOR-27	119	4	5.22	18
STOR-28	117	4	1.19	7
STOR-29	92	3	8.17	46
STOR-30	66	6	4.10	12

Appendix H

Capital Improvement Plan

Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060-001

CIP Summary Table

Priority	Project Description	Estimated Cost	SDC Eligibility	SDC Improvement Amount	City Amount
Priority 1 Improvements					
1A	Campbell Park Detention Pond (Milton Creek)	$300,000	0%	$0	$300,000
1B	Columbia Boulevard Detention Pond (Milton Creek)	$1,100,000	66%	$727,000	$373,000
1C	Columbia Boulevard Upsize (Milton Creek)	$2,800,000	14%	$392,000	$2,408,000
1D	Middle Trunk Detention Ponds and Piping	$2,000,000	5%	$103,000	$1,897,000
1E	Upsize and Realign Tualatin Street (Middle Trunk)	$5,000,000	14%	$677,000	$4,323,000
1F	Detention Pond and Piping Between N 12th and N 7th Street (North Trunk)	$1,600,000	17%	$269,000	$1,331,000
1G	Ridgeway Loop Pipe Installation	$60,000	0%	$0	$60,000
	Total Priority 1 Improvement Costs	$12,900,000	-	$2,200,000	$10,700,000
Priority 2 Improvements					
2A	Upsize Pipes along West Street and N 10th Street (North Trunk)	$1,400,000	0%	$0	$1,400,000
2B	S 4th Street to Outfall CCTV Inspection (Downtown)	$20,000	0%	$0	$20,000
2C	Heinie Huemann Park Detention Pond (Greenway)	$200,000	26%	$52,000	$148,000
2D	Upsize from S 20th Street to Heinie Huemann Park (Greenway)	$1,100,000	29%	$318,000	$782,000
2E	Nob Hill Park CIP lining (Greenway)	$400,000	0%	$0	$400,000
2F	Franz Street (Milton Creek)	$400,000	0%	$0	$400,000
2G	Mayfair Drive CIP lining and Upsize (Milton Creek)	$400,000	0%	$0	$400,000
2H	Riverfront Development Stormwater Infrastructure	$3,300,000	100%	$3,300,000	$0
2I	Industrial Business Park Stormwater Infrastructure	$8,600,000	100%	$8,600,000	$0
2J	S 16th Street to Old Portland Road Upsize (Greenway)	$500,000	0%	$0	$500,000
2K	Stormwater Master Plan Update	$200,000	0%	$0	$0
	Total Priority 2 Improvement Costs	$16,500,000	-	$12,300,000	$4,100,000
Priority 3 Improvements					
3A	Upsize N 13th Street to West Street (North Trunk)	$200,000	0%	$0	$200,000
3B	Upsize from 6th Street Ball Park to N 10th Street (North Trunk)	$900,000	0%	$0	$900,000
3C	Upsize Milton Way at Street Helens Street (North Trunk)	$600,000	75%	$450,000	$150,000
3D	Upsize N 7th Street from Columbia Boulevard to Trunkline (North Trunk)	$400,000	0%	$0	$400,000
3E	Upsize N 4th Street south of West Street (North Trunk)	$1,400,000	0%	$0	$1,400,000
3F	Upsize and Regrade along S 14th Street (Middle Trunk)	$600,000	50%	$298,000	$302,000
3G	Upsize existing pipes from Heinie Huemann to Tualatin Street (Middle Trunk)	$400,000	0%	$0	$400,000
3H	Street Helens Street to South 4th Street Upsizing (Downtown)	$500,000	0%	$0	$500,000
3I	S 4th Street to Outfall Pipe Upsizing (Downtown)	$2,400,000	0%	$0	$2,400,000
3J	Crouse Way Upsize (Milton Creek)	$1,000,000	14%	$137,000	$863,000
3K	Eilertson Street (Milton Creek)	$100,000	0%	$0	$100,000
3L	N Vernonia Road from Oakwood to Ava Court (Milton Creek)	$400,000	0%	$0	$400,000
3M	Ethan Lane Upsizing (Milton Creek)	$600,000	0%	$0	$600,000
3N	Sunset Boulevard to Outfall Upsize (Milton Creek)	$800,000	0%	$0	$800,000
3O	Sunset Boulevard, Trillium Street and Salmon Street upsize (Milton Creek)	$1,100,000	0%	$0	$1,100,000
3P	Sykes Road Upsize from Columbia Boulevard to Outfall (McNulty Creek)	$2,700,000	0%	$0	$2,700,000
3Q	McBride Street Upsize (McNulty Creek)	$600,000	0%	$0	$600,000
3R	Port Avenue Upsize (McNulty Creek)	$900,000	0%	$0	$900,000
3S	Whitetail Avenue Upsize (McNulty Creek)	$800,000	0%	$0	$800,000
3T	Sykes Road Cuvert near Mountain View Drive Upsize (McNulty Creek)	$80,000	0%	$0	$80,000
	Total Priority 3 Improvement Costs	$16,500,000	-	$900,000	$15,600,000
	Total Capital Improvement Costs	$45,900,000	-	$15,400,000	$30,400,000

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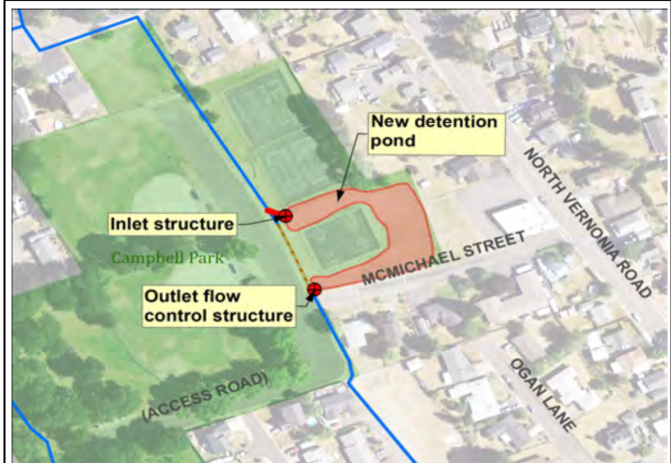
Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060

CIP Project Sheets

Project Title: Campbell Park Detention Pond (Milton Creek)

Location: Campbell Park



Project Identifier: 1A

Objective: Construct a new 2.0 acre-feet detention pond to reduce peak flows during the 25-year storm event and reduce required upsizing along Columbia Boulevard.

Design Considerations:

- Construct pond with appropriate freeboard (minimum one foot).

- Consider implementing water treatment features (not included in cost estimates). Adding water quality topsoil and plantings and sizing orificies to retain 1/2 the 2-year storm event could be an relatively easy addition to this facility.

SDC Eligibility: 0%

Item	Unit	Unit Price	Est. Qty	Cost (2021)
24-inch Pipe - Excavation, Backfill	LF	$205	40	$8,200
Concrete Outlet Flow Control Structure, 60-inch	EA	$15,000	1	$15,000
Hydroseeding, Planting, and Other Restoration Features	AC	$5,000	0.7	$3,500
Berm Construction	LF	$30	1,030	$30,900
Detention Pond Excavation, removal, and grading	CY	$31	3,200	$99,200
			Subtotal (Rounded)	**$157,000**
Mobilization	LS	5%	1	$7,850
Contingency	LS	30%	1	$47,100
			Construction Subtotal (Rounded)	**$212,000**
Permitting	LS	$5,000	1	$5,000
Geotechnical (Assumes 8% of total)	LS	$17,000	1	$17,000
Surveying	LS	$10,000	1	$10,000
Engineering and CMS	LS	20%	1	$42,400
Legal and Admin	LS	$8,000	1	$8,000
			Total Project Cost (Rounded)	**$300,000**

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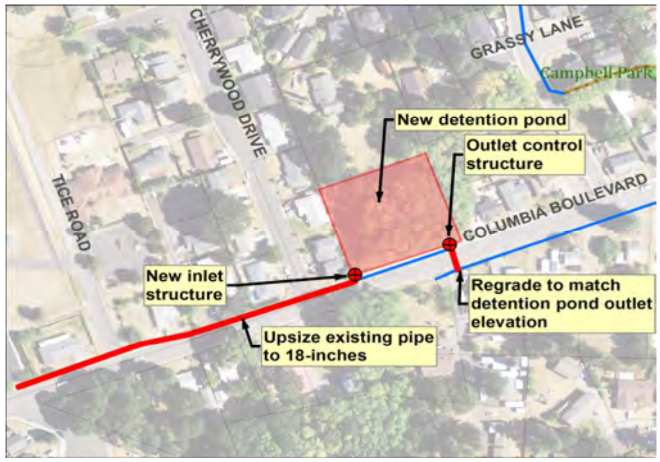
Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060

CIP Project Sheets

Project Title: Columbia Boulevard Detention Pond (Milton Creek)

Location: Columbia Boulevard and Cherrywood Drive



Project Identifier: 1B

Objective: Construct a new 2.0 acre-feet detention pond to reduce peak flows during the 25-year storm event and reduce required upsizing along Columbia Boulevard.

Design Considerations:

- Construct pond with appropriate freeboard (minimum one foot) during 25-year storm event and approximate storage volume of 2.0 acre-feet.
- Consider implementing water treatment features (not included in cost estimates).
- Must purchase private property north of Columbia Boulevard.

SDC Eligibility: 66%

Item	Unit	Unit Price	Est. Qty	Cost (2021)
18-inch Pipe - Excavation, Backfill	LF	$185	710	$131,350
48-Inch, Standard Manhole	EA	$8,000	3	$24,000
ODOT Type G-2, Catch Basin with Connector Pipe	EA	$3,500	4	$14,000
Pond Clearing, Grubbing, and Earthwork as Necessary	LS	$10,000	1	$10,000
Concrete Outlet Flow Control Structure, Ditch Inlet	EA	$15,000	1	$15,000
Berm Construction	LF	$30	400	$12,000
Rock Excavation	CY	$300	216	$64,804
Roadway Restoration (Half Lane)	LF	$45	710	$31,950
Traffic Control With Flagging	LS	$20,000	1	$20,000
Existing Utility Protection	LF	$4	710	$2,840
ADA Ramp Reconstruction (Compliance)	EA	$4,600	5	$23,000
			Subtotal (Rounded)	**$349,000**
Mobilization	LS	5%	1	$17,450
Contingency	LS	30%	1	$104,700
			Construction Subtotal (Rounded)	**$471,000**
Property Acquisition	SF	$10	43,000	$430,000
Permitting (Field work, JPA, and application. Assumes SLOPES V)	LS	$50,000	1	$50,000
Geotechnical (assume 8% of total)	LS	$38,000	1	$38,000
Surveying	LS	$10,000	1	$10,000
Engineering and CMS	LS	20%	1	$94,200
Legal and Admin	LS	$15,000	1	$15,000
			Total Project Cost (Rounded)	**$1,100,000**

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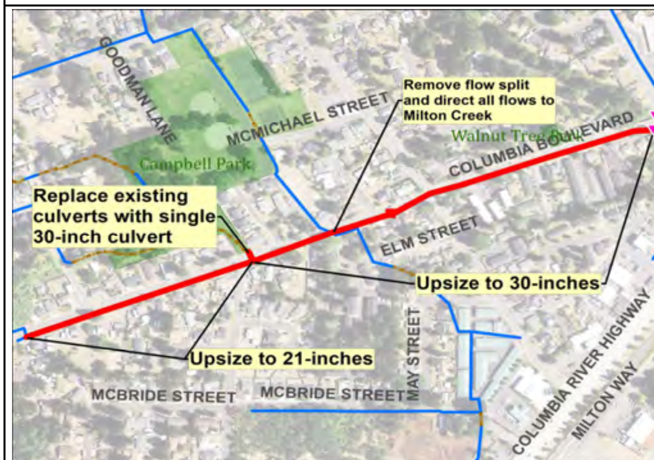
Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060

CIP Project Sheets

Project Title: Columbia Boulevard Upsize (Milton Creek)

Location: Columbia Boulevard from Alderwood Court to Milton Creek



Project Identifier: 1C

Objective: Upsize the existing pipes along Columbia Boulevard and eliminate flow split with McNulty Creek Basin

Design Considerations:

- Environmental permitting likely necessary because improvments are recommended at the outfall.

- Confirm adequate capacity in Milton Creek to eliminate the flow split with McNulty Creek Basin.

SDC Eligibility: 14%

Item	Unit	Unit Price	Est. Qty	Cost (2021)
21-inch Pipe - Excavation, Backfill	LF	$195	1,020	$198,900
30-inch Pipe - Excavation, Backfill	LF	$230	1,800	$414,000
60-Inch, Standard Manhole	EA	$14,000	3	$42,000
72-Inch, Standard Manhole	EA	$16,500	5	$82,500
ODOT Type G-2, Catch Basin with Connector Pipe	EA	$3,500	16	$56,000
Outfall Restoration	EA	$6,000	1	$6,000
Rock Excavation	CY	$300	1,717	$515,178
Roadway Restoration (Half Lane)	LF	$45	2,820	$126,900
Traffic Control - With Flagging	LF	$70,000	1	$70,000
Existing Utility Protection	LF	$4	2,820	$11,280
ADA Ramp Reconstruction (Compliance)	EA	$4,600	22	$101,200
			Subtotal (Rounded)	**$1,624,000**
Mobilization	LS	5%	1	$81,200
Contingency	LS	30%	1	$487,200
			Construction Subtotal (Rounded)	**$2,192,000**
Permitting (Field work, JPA, and application. Assumes SLOPES V)	LS	$50,000	1	$50,000
Geotechnical (Assume 4% of total)	LS	$88,000	1	$88,000
Surveying	LS	$30,000	1	$30,000
Engineering and CMS	LS	20%	1	$438,400
Legal and Admin	LS	$10,000	1	$10,000
			Total Project Cost (Rounded)	**$2,800,000**

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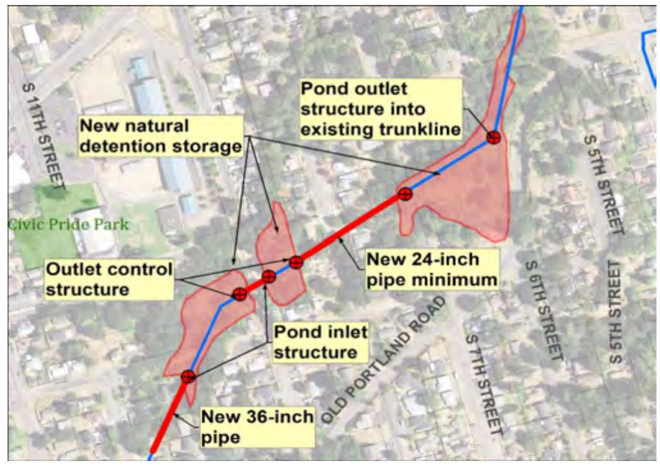
Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060

CIP Project Sheets

Project Title: Middle Trunk Detention Ponds and Piping

Location: Middle Trunk From Cowlitz Street to South 4th Street



Project Identifier: 1D

Objective: Improve natural detention within the Middle Trunk Basin to hold approximately 14 acre-feet of storage and reduce peak flows in the 25-year storm event

Design Considerations:

- Utilize natural detention within Middle Trunk Ravine. Purchase property as necessary.
- Abandon existing 18-inch pipes draining through each storage location
- Detailed analysis on any existing wetland impacts within proposed storage locations.

SDC Eligibility: 5%

Item	Unit	Unit Price	Est. Qty	Cost (2021)
24-inch Pipe - Excavation, Backfill	LF	$205	430	$88,150
36-inch Pipe - Excavation, Backfill	LF	$245	300	$73,500
60-Inch, Standard Manhole	EA	$14,000	1	$14,000
72-Inch, Standard Manhole	EA	$16,500	1	$16,500
Abandonment of existing pipeline	LF	$25	800	$20,000
Pond Clearing, Grubbing, and Earthwork as Necessary	LS	$24,000	1	$24,000
Concrete Outlet Flow Control Structure, Grated Inlet	EA	$15,000	3	$45,000
Berm Construction	LF	$30	490	$14,700
Rock Excavation	CY	$300	541	$162,333
Roadway Restoration (Full Lane)	LF	$75	50	$3,750
Traffic Control With Flagging	LS	$1,000	1	$1,000
Soil Surface Repair, Seeding, and Stabilization	LF	$5	680	$3,400
Existing Utility Protection	LF	$4	730	$2,920
			Subtotal (Rounded)	**$469,300**
Mobilization	LS	5%	1	$23,465
Contingency	LS	30%	1	$140,790
			Construction Subtotal (Rounded)	**$633,600**
Property Acquisition	SF	$10	106,000	$1,060,000
Permitting (Field work, JPA, and application. Assumes SLOPES V)	LS	$30,000	1	$30,000
Geotechnical (Assume 4% of total)	LS	$25,000	1	$25,000
Surveying	LS	$50,000	1	$50,000
Engineering and CMS	LS	20%	1	$126,720
Wetland Hydroperiod and Ecological Assessment	LS	$20,000	1	$20,000
Legal and Admin	LS	$15,000	1	$15,000
			Total Project Cost (Rounded)	**$2,000,000**

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Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060

CIP Project Sheets

Project Title: Upsize and Realign Tualatin Street (Middle Trunk)

Location: Tualatin Street to South 11th Street

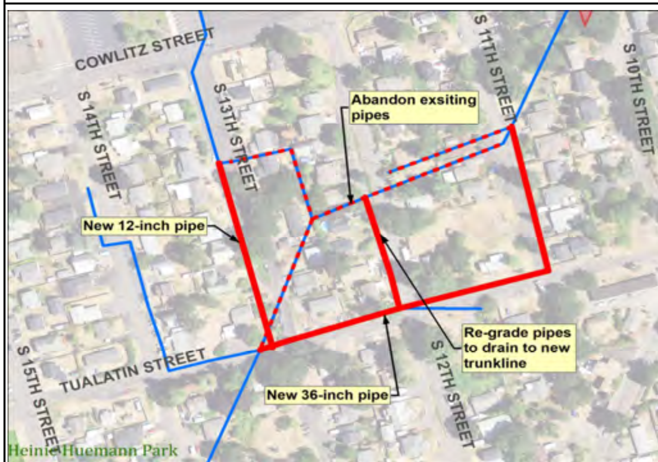
Project Identifier: 1E

Objective: Abandon existing pipes and install a new trunkline from Tualatin St. to new detention pond

Design Considerations:

-Existing pipelines to be abandoned may be underneath existing structures.

SDC Eligibility: 14%



Item	Unit	Unit Price	Est. Qty	Cost (2021)
12-inch Pipe - Excavation, Backfill	LF	$160	720	$115,200
36-inch Pipe - Excavation, Backfill	LF	$245	970	$237,650
48-Inch, Standard Manhole	EA	$8,000	2	$16,000
72-Inch, Standard Manhole	EA	$16,500	5	$82,500
ODOT Type G-2, Catch Basin with Connector Pipe	EA	$3,500	14	$49,000
Abandonment of existing manholes	EA	$4,000	8	$32,000
Abandonment of existing pipeline	LF	$25	1,420	$35,500
Filling Abandoned Structures	EA	$3,000	5	$15,000
Rock Excavation	CY	$300	1,574	$472,222
Roadway Restoration (Full Lane)	LF	$75	1,690	$126,750
Existing Utility Protection	LF	$4	1,690	$6,760
Traffic Control With Flagging	LS	$96,000	1	$96,000
			Subtotal (Rounded)	**$1,285,000**
Mobilization	LS	5%	1	$64,250
Contingency	LS	30%	1	$385,500
			Construction Subtotal (Rounded)	**$2,666,000**
Permitting	LS	$10,000	1	$10,000
Geotechnical (Assume 2% of total)	LS	$53,000	1	$53,000
Surveying	LS	$17,000	1	$17,000
Engineering and CMS	LS	20%	1	$533,200
Legal and Admin	LS	$10,000	1	$10,000
			Total Project Cost (Rounded)	**$5,000,000**

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Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060

CIP Project Sheets

Project Title: Detention Pond and Piping Between N 12th and N 7th Street (North Trunk)	**Location:** North 15th to North 10th Street

Project Identifier: 1F

Objective: Construct a 7 acre-feet detention pond to reduce peak flows during the 25-year storm event.

Design Considerations:

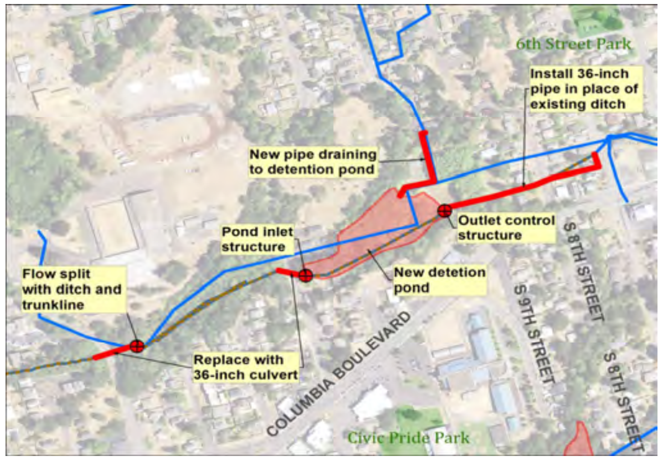
- Flow control structure near N. 15th Street is within designated wetlands. Removal and fill permit likely required.

- Berms should be constructed as needed to protect existing structures nearby the detention pond.

- A detailed survey should be completed to confirm the capacity of the proposed detention pond area.

- Consider phasing project as needed.

SDC Eligibility: 17%



Item	Unit	Unit Price	Est. Qty	Cost (2021)
30-inch Pipe - Excavation, Backfill	LF	$230	420	$96,600
36-inch Pipe - Excavation, Backfill	LF	$245	740	$181,300
36-inch Culvert - Excavation, Backfill (>10' Depth)	LF	$384	160	$61,440
72-Inch, Standard Manhole	EA	$16,500	7	$115,500
Pond Clearing, Grubbing, and Earthwork as Necessary	LS	$15,000	1	$15,000
Berm Construction	LF	$30	470	$14,100
Concrete Outlet Flow Control Structure, 72-inch	EA	$15,000	1	$15,000
Flow Control Manhole	EA	$15,000	1	$15,000
Soil Surface Repair, Seeding, and Stabilization	LF	$5	420	$2,100
Rock Excavation	CY	$300	210	$63,000
Roadway Restoration (Full Lane)	LF	$75	320	$24,000
Traffic Control With Flagging	LS	$25,000	1	$25,000
Existing Utility Protection	LF	$4	1,320	$5,280
ADA Ramp Reconstruction (Compliance)	EA	$4,600	2	$9,200
			Subtotal (Rounded)	**$643,000**
Mobilization	LS	5%	1	$32,150
Contingency	LS	30%	1	$192,900
			Construction Subtotal (Rounded)	**$868,000**
Property Acquisition	SF	$10	43,560	$435,600
Permitting (Field work, JPA, and application. Assumes SLOPES V)	LS	$50,000	1	$50,000
Geotechnical (assume 8% of total)	LS	$69,000	1	$69,000
Surveying	LS	$13,000	1	$13,000
Engineering and CMS	LS	20%	1	$173,600
Legal and Admin	LS	$5,000	1	$5,000
			Total Project Cost (Rounded)	**$1,600,000**

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Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060

CIP Project Sheets

Project Title: Ridgeway Loop Pipe Installation

Location: 59995 Ridgeway Loop

Project Identifier: 1G

Objective: Install a 12-inch pipe in place of an existing ditch/grassy swale to alleviate flooding of nearby properties.

Design Considerations:

- Replace existing inlet/outlets with manholes.
- Existing ditch/grassy swale will be filled in.

SDC Eligibility: 0%

Item	Unit	Unit Price	Est. Qty	Cost (2021)
12-inch Pipe - Excavation, Backfill	LF	$160	100	$16,000
48-Inch, Standard Manhole	EA	$8,000	2	$16,000
Soil Surface Repair, Seeding, and Stabilization	LF	$5	100	$500
Existing Utility Protection	LF	$4	100	$400
			Subtotal (Rounded)	**$33,000**
Mobilization	LS	5%	1	$1,650
Contingency	LS	30%	1	$9,900
			Construction Subtotal (Rounded)	**$45,000**
Permitting	LS	$0	1	$0
Geotechnical (Assume 2% of total)	LS	$0	1	$0
Surveying	LS	$1,000	1	$1,000
Engineering and CMS	LS	20%	1	$9,000
Legal and Admin	LS	$2,000	1	$2,000
			Total Project Cost (Rounded)	**$60,000**

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Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060

CIP Project Sheets

Project Title: Upsize Pipes along West Street and N 10th Street (North Trunk)

Project Identifier: 2A

Objective: Upsize existing pipes along West Street and North 10th Street

Design Considerations:

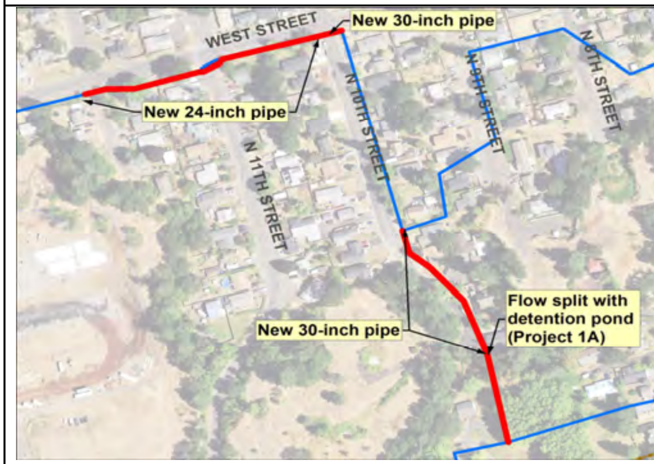
- Protect existing 26"x42" arch pipe along North 10th Street.

- Coordinate with CIP Project 1A to determine flow split south of 10th Street.

- Re-grade pipes along West Street to maintain mimimum cover with upsized pipes and use reinforced piping material.

SDC Eligibility: 0%

Location: West Street and North 10th Street



Item	Unit	Unit Price	Est. Qty	Cost (2021)
24-inch Pipe - Excavation, Backfill	LF	$205	600	$123,000
30-inch Pipe - Excavation, Backfill	LF	$230	420	$96,600
60-Inch, Standard Manhole	EA	$14,000	3	$42,000
72-Inch, Standard Manhole	EA	$16,500	3	$49,500
ODOT Type G-2, Catch Basin with Connector Pipe	EA	$3,500	12	$42,000
Flow Control Manhole	EA	$15,000	1	$15,000
Rock Excavation	CY	$300	581	$174,304
Roadway Restoration (Half Lane)	LF	$45	760	$34,200
Rock Excavation	CY	$300	581	$174,304
Soil Surface Repair, Seeding, and Stabilization	LF	$5	260	$1,300
Traffic Control With Flagging	LS	$36,000	1	$36,000
Existing Utility Protection	LF	$4	1,020	$4,080
ADA Ramp Reconstruction (Compliance)	EA	$4,600	10	$46,000
			Subtotal (Rounded)	**$838,000**
Mobilization	LS	5%	1	$41,900
Contingency	LS	30%	1	$251,400
			Construction Subtotal (Rounded)	**$1,131,000**
Permitting	LS	$5,000	1	$5,000
Geotechnical (Assume 4% of total)	LS	$45,000	1	$45,000
Surveying	LS	$10,000	1	$10,000
Engineering and CMS	LS	20%	1	$226,200
Legal and Admin	LS	$8,000	1	$8,000
			Total Project Cost (Rounded)	**$1,400,000**

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Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060

CIP Project Sheets

Project Title: S 4th Street to Outfall CCTV Inspection (Downtown)

Project Identifier: 2B

Objective: Determine condition of existing pipelines within the Downtown Basin

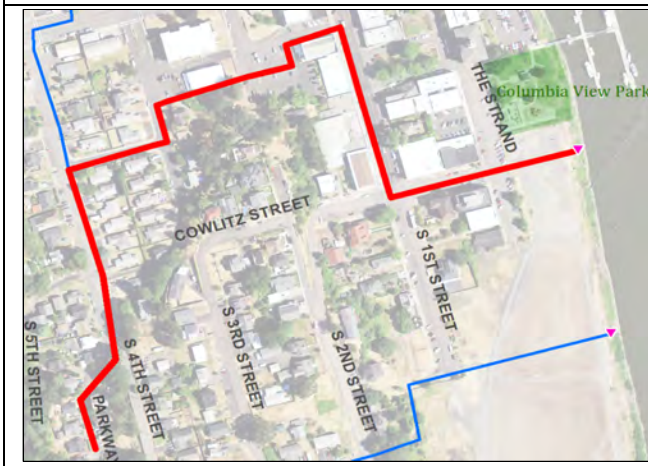
Design Considerations:

- Capacity of the trunkline should be evaluated futher if improvements are needed based on the inspection.

- SWMP CIP Project 3I should be considered if pipes are in poor condition and in need of replacement

SDC Eligibility: 0%

Location: South 4th Street to Cowlitz Street and Outfall



Item	Unit	Unit Price	Est. Qty	Cost (2021)
Cleaning and CCTV Pipelines	LF	$3	2,890	$8,670
			Subtotal (Rounded)	**$9,000**
Mobilization	LS	5%	1	$450
Contingency	LS	30%	1	$2,700
			Construction Subtotal (Rounded)	**$12,000**
Permitting	LS	$0	1	$0
Geotechnical (Assume 2% of total)	LS	$0	1	$0
Surveying	LS	$0	1	$0
Engineering and CMS	LS	20%	1	$2,400
Legal and Admin	LS	$5,000	1	$5,000
			Total Project Cost (Rounded)	**$20,000**

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Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060

CIP Project Sheets

Project Title: Heinie Huemann Park Detention Pond (Greenway)

Project Identifier: 2C

Objective: Improve detention at Heinie Huemann Park by restricting downstream flows to back up water during the 25-year storm event to hold about 1.7 acre-feet of storage.

Design Considerations:

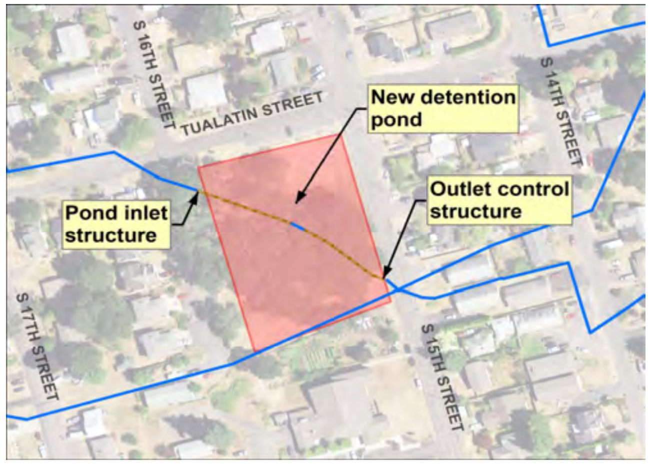
- Install sediment forebay to prevent clogging at the pond outlet and concentrate sediment build-up to assist with maintenance.

- Consider water quality features.

- Minimal improvements needed because the park currently acts as a detention pond, resulting in higher percentage of engineering and CMS costs.

SDC Eligibility: 26%

Location: Heinie Huemann Park



Item	Unit	Unit Price	Est. Qty	Cost (2021)
Pond Clearing, Grubbing, and Earthwork as Necessary	LS	$20,000	1	$20,000
Concrete Outlet Flow Control Structure, 60-inch	EA	$15,000	1	$15,000
Berm Construction	LF	$30	500	$15,000
Sediment Forebay	EA	$20,000	1	$20,000
			Subtotal (Rounded)	**$70,000**
Mobilization	LS	5%	1	$3,500
Contingency	LS	30%	1	$21,000
			Construction Subtotal (Rounded)	**$95,000**
Permitting	LS	$10,000	1	$10,000
Geotechnical (Assume 8% of total)	LS	$8,000	1	$8,000
Surveying	LS	$15,000	1	$15,000
Engineering and CMS	LS	40%	1	$38,000
Legal and Admin	LS	$8,000	1	$8,000
			Total Project Cost (Rounded)	**$200,000**

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Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060

CIP Project Sheets

Project Title: Upsize from S 20th Street to Heinie Huemann Park (Greenway)

Location: South 19th Street to Heinie Hueman Park

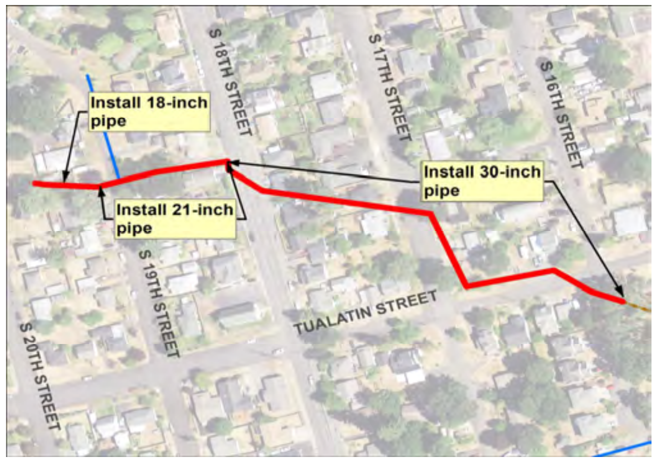
Project Identifier: 2D

Objective: Upsize existing trunkline from South 19th Street to Heinie Huemann Park

Design Considerations:

- Assumes existing pipes are not located beneath existing structures

SDC Eligibility: 29%



Item	Unit	Unit Price	Est. Qty	Cost (2021)
18-inch Pipe - Excavation, Backfill	LF	$185	120	$22,200
21-inch Pipe - Excavation, Backfill	LF	$195	230	$44,850
30-inch Pipe - Excavation, Backfill	LF	$230	840	$193,200
48-Inch, Standard Manhole	EA	$8,000	1	$8,000
60-Inch, Standard Manhole	EA	$14,000	6	$84,000
ODOT Type G-2, Catch Basin with Connector Pipe	EA	$3,500	8	$28,000
Rock Excavation	CY	$300	782	$234,672
Roadway Restoration (Full Lane)	LF	$75	280	$21,000
Soil Surface Repair, Seeding, and Stabilization	LF	$5	910	$4,550
Existing Utility Protection	LF	$4	1,190	$4,760
Traffic Control With Flagging	LS	$37,000	1	$37,000
			Subtotal (Rounded)	**$682,000**
Mobilization	LS	5%	1	$34,100
Contingency	LS	30%	1	$204,600
			Construction Subtotal (Rounded)	**$921,000**
Permitting	LS	$10,000	1	$10,000
Surveying	LS	$12,000	1	$12,000
Engineering and CMS	LS	20%	1	$184,200
Legal and Admin	LS	$5,000	1	$5,000
			Total Project Cost (Rounded)	**$1,100,000**

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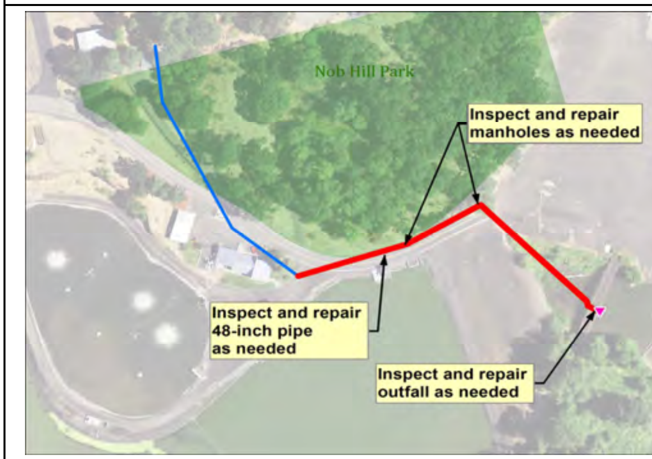
Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060

CIP Project Sheets

Project Title: Nob Hill Park CIP lining (Greenway)

Location: Near Nob Hill Park



Project Identifier: 2E

Objective: Repair the existing 48-inch pipes along Plymouth Street near Nob Hill Park

Design Considerations:

- Inspect pipes, manholes, and outfall before improvements are made.

- Outfall pipe was submerged during 2020 survey for this project.

SDC Eligibility: 0%

Item	Unit	Unit Price	Est. Qty	Cost (2021)
Cleaning and CCTV Pipelines	LF	$3	670	$2,010
Line existing manhole (discharge manhole)	EA	$5,000	2	$10,000
48-inch, CIP Pipeline Repair	LF	$320	670	$214,400
Outfall Restoration	EA	$6,000	1	$6,000
			Subtotal (Rounded)	**$232,000**
Mobilization	LS	5%	1	$11,600
Contingency	LS	30%	1	$69,600
			Construction Subtotal (Rounded)	**$313,000**
Permitting (Field work, JPA, and application. Assumes SLOPES V)	LS	$50,000	1	$50,000
Surveying	LS	$5,000	1	$5,000
Engineering and CMS	LS	20%	1	$62,600
Legal and Admin	LS	$5,000	1	$5,000
			Total Project Cost (Rounded)	**$400,000**

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Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060

CIP Project Sheets

Project Title: Franz Street (Milton Creek)

Location: Edie's Way and Alderwood Court

Project Identifier: 2F

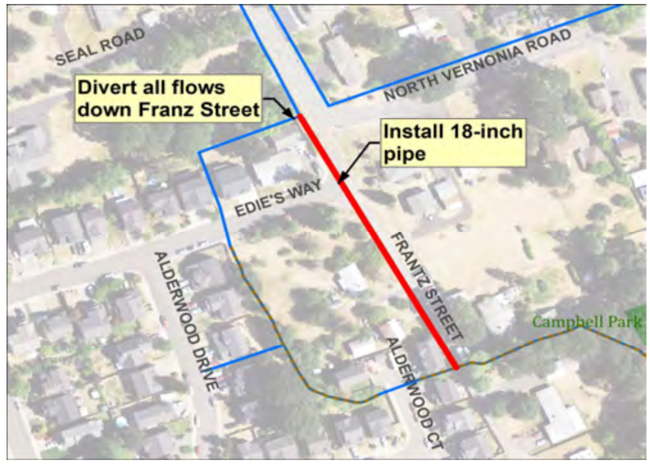
Objective: Upsize existing pipelines along Edie's Way and culvert under Alderwood Court

Design Considerations:

- Inspect open channel between Edie's Way and Alderwood Court and improve as needed.

- Consider arch culvert under Alderwood Court if not enough cover can be achieved.

SDC Eligibility: 0%



Item	Unit	Unit Price	Est. Qty	Cost (2021)
18-inch Pipe - Excavation, Backfill	LF	$185	470	$86,950
48-Inch, Standard Manhole	EA	$8,000	3	$24,000
ODOT Type G-2, Catch Basin with Connector Pipe	EA	$3,500	4	$14,000
Outfall Restoration	EA	$6,000	1	$6,000
Rock Excavation	CY	$300	152	$45,694
Roadway Restoration (Half Lane)	LF	$45	470	$21,150
Existing Utility Protection	LF	$4	470	$1,880
Traffic Control With Flagging	LS	$13,539	1	$13,539
Existing Utility Protection	LF	$4	470	$1,880
			Subtotal (Rounded)	**$215,000**
Mobilization	LS	5%	1	$10,750
Contingency	LS	30%	1	$64,500
			Construction Subtotal (Rounded)	**$290,000**
Permitting	LS	$5,000	1	$5,000
Geotechnical (Assume 4% of total)	LS	$12,000	1	$12,000
Surveying	LS	$4,700	1	$4,700
Engineering and CMS	LS	20%	1	$58,000
Legal and Admin	LS	$2,000	1	$2,000
			Total Project Cost (Rounded)	**$400,000**

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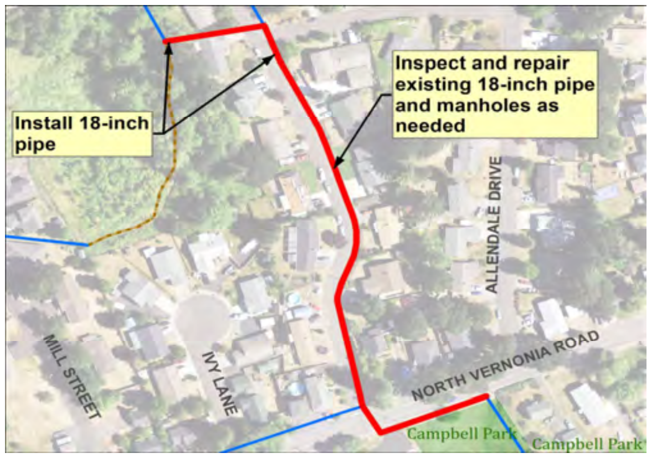
Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060

CIP Project Sheets

Project Title: Mayfair Drive CIP lining and Upsize (Milton Creek)	**Location:** Mayfair Drive
Project Identifier: 2G	
Objective: Upsize pipes draining to Mayfair Drive and CIP line the existing 18-inch pipes.	
Design Considerations:	
- Inspect pipes and manholes along Mayfair Drive before improvements are made	
SDC Eligibility: 0%	



Item	Unit	Unit Price	Est. Qty	Cost (2021)
18-inch Pipe - Excavation, Backfill	LF	$185	200	$37,000
48-Inch, Standard Manhole	EA	$8,000	2	$16,000
Concrete Inlet, Standard Side Inlet	EA	$2,100	1	$2,100
ODOT Type G-2, Catch Basin with Connector Pipe	EA	$3,500	2	$7,000
Rock Excavation	CY	$300	61	$18,255
Roadway Restoration (Full Lane)	LF	$75	120	$9,000
Existing Utility Protection	LF	$4	200	$800
Cleaning and CCTV Pipelines	LF	$3	860	$2,580
Line existing manhole (discharge manhole)	EA	$5,000	5	$25,000
18-inch, CIP Pipeline Repair	LF	$110	860	$94,600
Traffic Control With Flagging	LS	$8,000	1	$8,000
			Subtotal (Rounded)	**$220,000**
Mobilization	LS	5%	1	$11,000
Contingency	LS	30%	1	$66,000
			Construction Subtotal (Rounded)	**$297,000**
Permitting (Field work, JPA, and application. Assumes SLOPES V)	LS	$50,000	1	$50,000
Geotechnical (Assume 8% of total)	LS	$24,000	1	$24,000
Surveying	LS	$12,000	1	$12,000
Engineering and CMS	LS	20%	1	$59,400
Legal and Admin	LS	$5,000	1	$5,000
			Total Project Cost (Rounded)	**$400,000**

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Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060

CIP Project Sheets

Project Title: Riverfront Development Stormwater Infrastructure

Location: Riverfront Development

Project Identifier: 2H

Objective: Install stormwater infrastructure within the proposed riverfront development.

Design Considerations:

- Coordinate with WWMP CIP Project XX.
- Project is within 100-year and 500-year floodplain.
- Assumes existing outfall pipe to be replaced with 24-inch pipe.

SDC Eligibility: 100%

Item	Unit	Unit Price	Est. Qty	Cost (2021)
18-inch Pipe - Excavation, Backfill	LF	$185	1,250	$231,250
21-inch Pipe - Excavation, Backfill	LF	$195	840	$163,800
24-inch Pipe - Excavation, Backfill	LF	$205	940	$192,700
48-Inch, Standard Manhole	EA	$8,000	5	$40,000
60-Inch, Standard Manhole	EA	$14,000	6	$84,000
ODOT Type G-2, Catch Basin with Connector Pipe	EA	$3,500	36	$126,000
Outfall Restoration	EA	$6,000	2	$12,000
Roadway Restoration (Full Lane)	LF	$75	3,030	$227,250
Concrete Curbs, Curb and Gutter	LF	$50	6,060	$303,000
Rock Excavation	CY	$300	1,263	$378,750
ADA Ramp Reconstruction (Compliance)	EA	$4,600	23	$105,800
Existing Utility Protection	LF	$4	3,030	$12,120
Traffic Control With Flagging	LS	$82,000	1	$82,000
			Subtotal (Rounded)	**$1,959,000**
Mobilization	LS	5%	1	$97,950
Contingency	LS	30%	1	$587,700
			Construction Subtotal (Rounded)	**$2,645,000**
Permitting	LS	$50,000	1	$50,000
Geotechnical (Assume 4% of total)	LS	$106,000	1	$106,000
Surveying	LS	$10,000	1	$10,000
Engineering and CMS	LS	20%	1	$529,000
Legal and Admin	LS	$8,000	1	$8,000
			Total Project Cost (Rounded)	**$3,300,000**

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Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060

CIP Project Sheets

Project Title: Industrial Business Park Stormwater Infrastructure	**Location:** 1300 Kaster Road
Project Identifier: 2I **Objective:** Install stormwater infrastructure within the proposed industrial business park development. **Design Considerations:** - Project is within 100-year and 500-year floodplain. - Assumes existing stormwater infrastructure is not suitable and new infrastructure will be installed throughout the development **SDC Eligibility: 100%**	

Item	Unit	Unit Price	Est. Qty	Cost (2021)
12-inch Pipe - Excavation, Backfill	LF	$160	2,900	$464,000
15-inch Pipe - Excavation, Backfill	LF	$170	1,700	$289,000
18-inch Pipe - Excavation, Backfill	LF	$185	1,000	$185,000
24-inch Pipe - Excavation, Backfill	LF	$205	500	$102,500
30-inch Pipe - Excavation, Backfill	LF	$230	2,300	$529,000
36-inch Pipe - Excavation, Backfill	LF	$245	1,700	$416,500
48-inch Pipe - Excavation, Backfill	LF	$300	500	$150,000
48-Inch, Standard Manhole	EA	$8,000	14	$112,000
60-Inch, Standard Manhole	EA	$14,000	8	$112,000
72-Inch, Standard Manhole	EA	$16,500	4	$66,000
ODOT Type G-2, Catch Basin with Connector Pipe	EA	$3,500	84	$294,000
Outfall Restoration	EA	$6,000	3	$18,000
Roadway Restoration (Full Lane)	LF	$75	10,600	$795,000
Rock Excavation	CY	$300	4,700	$1,410,000
ADA Ramp Reconstruction (Compliance)	EA	$4,600	10	$46,000
Existing Utility Protection	LF	$4	10,600	$42,400
Traffic Control With Flagging	LS	$49,000	1	$49,000
			Subtotal (Rounded)	**$5,080,000**
Mobilization	LS	5%	1	$254,000
Contingency	LS	30%	1	$1,524,000
			Construction Subtotal (Rounded)	**$6,858,000**
Permitting	LS	$50,000	1	$50,000
Geotechnical (Assume 2% of total)	LS	$137,000	1	$137,000
Surveying	LS	$106,000	1	$106,000
Engineering and CMS	LS	20%	1	$1,371,600
Legal and Admin	LS	$50,000	1	$50,000
			Total Project Cost (Rounded)	**$8,600,000**

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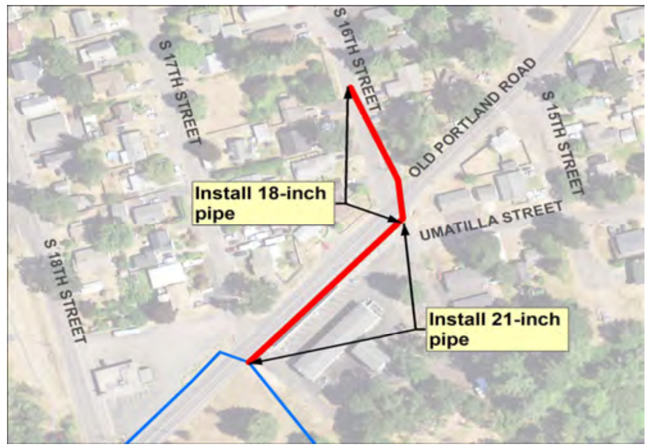
Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060

CIP Project Sheets

Project Title: S 16th Street to Old Portland Road Upsize (Greenway)

Location: South 16th Street to Old Portland Road



Project Identifier: 2J

Objective: Upsize existing trunkline from South 16th Street to Old Portland Road

Design Considerations:

- Trenchless pipe installation could be considered.

SDC Eligibility: 0%

Item	Unit	Unit Price	Est. Qty	Cost (2021)
18-inch Pipe - Excavation, Backfill	LF	$185	250	$46,250
21-inch Pipe - Excavation, Backfill	LF	$195	360	$70,200
48-Inch, Standard Manhole	EA	$8,000	2	$16,000
60-Inch, Standard Manhole	EA	$14,000	2	$28,000
ODOT Type G-2, Catch Basin with Connector Pipe	EA	$3,500	6	$21,000
Rock Excavation	CY	$300	210	$63,000
Roadway Restoration (Half Lane)	LF	$45	610	$27,450
Existing Utility Protection	LF	$4	610	$2,440
Traffic Control With Flagging	LS	$21,000	1	$21,000
			Subtotal (Rounded)	**$295,000**
Mobilization	LS	5%	1	$14,750
Contingency	LS	30%	1	$88,500
			Construction Subtotal (Rounded)	**$398,000**
Permitting	LS	$5,000	1	$5,000
Surveying	LS	$6,000	1	$6,000
Engineering and CMS	LS	20%	1	$79,600
Legal and Admin	LS	$3,000	1	$3,000
			Total Project Cost (Rounded)	**$500,000**

The cost estimate herin is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Keller Associates has no control over variances in the cost of labor, materials, equipment, services provided by others, contractor's methods of determining prices, competitive bidding or market conditions, practices, or bidding strategies. Keller Associates cannot and does not warrant or guarantee that proposals, bids, or actual construction costs will not vary from the cost presented herein.

Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060

CIP Project Sheets

Project Title: Stormwater Master Plan Update	**Location: Whole System**

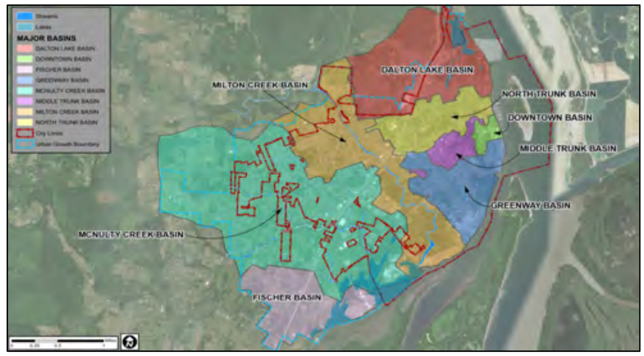
Project Identifier: 2K

Objective: Update the stormwater master plan

Design Considerations:

- New areas built-out since previous planning studies.

SDC Eligibility: 0%



Item	Unit	Unit Price	Est. Qty	Cost (2021)
Stormwater Master Plan Update	LS	$200,000	1	$200,000
			Total Project Cost (Rounded)	**$200,000**

The cost estimate herin is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Keller Associates has no control over variances in the cost of labor, materials, equipment, services provided by others, contractor's methods of determining prices, competitive bidding or market conditions, practices, or bidding strategies. Keller Associates cannot and does not warrant or guarantee that proposals, bids, or actual construction costs will not vary from the cost presented herein.

Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060

CIP Project Sheets

Project Identifier - 3A: Upsize N 13th Street to West Street (North Trunk)				
General Line Item	Unit	Unit Price	Estimated Quantity	Item Cost
21-inch Pipe - Excavation, Backfill	LF	$195	200	$39,000
48-Inch, Standard Manhole	EA	$8,000	2	$16,000
ODOT Type G-2, Catch Basin with Connector Pipe	EA	$3,500	4	$14,000
Rock Excavation	CY	$300	74	$22,200
Roadway Restoration (Half Lane)	LF	$45	200	$9,000
Existing Utility Protection	LF	$4	200	$800
Traffic Control With Flagging	LS	$9,000	1	$9,000
ADA Ramp Reconstruction (Compliance)	EA	$4,600	2	$9,200
			Subtotal (Rounded)	**$119,000**
Mobilization	LS	5%	1	$6,000
Contingency	LS	30%	1	$35,700
			Construction Subtotal (Rounded)	**$161,000**
Permitting	LS	$10,000	1	$10,000
Geotechnical (Assume 4% of total)	LS	$6,000	1	$6,000
Surveying	LS	$12,000	1	$12,000
Engineering and CMS	LS	20%	1	$32,200
Legal and Admin	LS	$5,000	1	$5,000
			Total Project Cost (Rounded)	**$200,000**

Project Identifier - 3B: Upsize from 6th Street Ball Park to N 10th Street (North Trunk)				
General Line Item	Unit	Unit Price	Estimated Quantity	Item Cost
18-inch Pipe - Excavation, Backfill	LF	$185	350	$64,800
21-inch Pipe - Excavation, Backfill	LF	$195	860	$167,700
48-Inch, Standard Manhole	EA	$8,000	2	$16,000
60-Inch, Standard Manhole	EA	$14,000	5	$70,000
Connect to Existing Manhole	EA	$1,750	1	$1,800
ODOT Type G-2, Catch Basin with Connector Pipe	EA	$3,500	8	$28,000
Rock Excavation	CY	$300	448	$134,400
Roadway Restoration (Full Lane)	LF	$75	390	$29,300
Soil Surface Repair, Seeding, and Stabilization	LF	$5	820	$4,100
Existing Utility Protection	LF	$4	1,210	$4,800
Traffic Control With Flagging	LS	$18,000	1	$18,000
			Construction Subtotal (Rounded)	**$539,000**
Mobilization	LS	5%	1	$27,000
Contingency	LS	30%	1	$161,700
			Construction Subtotal (Rounded)	**$728,000**
Permitting	LS	$10,000	1	$10,000
Geotechnical (Assume 4% of total)	LS	$29,000	1	$29,000
Surveying	LS	$12,000	1	$12,000
Engineering and CMS	LS	20%	1	$145,600
Legal and Admin	LS	$5,000	1	$5,000
			Total Project Cost (Rounded)	**$900,000**

Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060

CIP Project Sheets

Project Identifier - 3C: Upsize Milton Way at Street Helens Street (North Trunk)				
General Line Item	**Unit**	**Unit Price**	**Estimated Quantity**	**Item Cost**
18-inch Pipe - Excavation, Backfill	LF	$185	620	$114,700
48-Inch, Standard Manhole	EA	$8,000	4	$32,000
Connect to Existing Manhole	EA	$1,750	1	$1,800
ODOT Type G-2, Catch Basin with Connector Pipe	EA	$3,500	6	$21,000
Rock Excavation	CY	$300	230	$68,900
Roadway Restoration (Full Lane)	LF	$75	620	$46,500
Existing Utility Protection	LF	$4	620	$2,500
Traffic Control With Flagging	LS	$22,000	1	$22,000
ADA Ramp Reconstruction (Compliance)	EA	$4,600	3	$13,800
			Construction Subtotal (Rounded)	**$323,000**
Mobilization	LS	5%	1	$16,200
Contingency	LS	30%	1	$96,900
			Construction Subtotal (Rounded)	**$436,000**
Permitting	LS	$10,000	1	$10,000
Geotechnical (Assume 4% of total)	LS	$17,000	1	$17,000
Surveying	LS	$12,000	1	$12,000
Engineering and CMS	LS	20%	1	$87,200
Legal and Admin	LS	$5,000	1	$5,000
			Total Project Cost (Rounded)	**$600,000**

Project Identifier - 3D: Upsize N 7th Street from Columbia Boulevard to Trunkline (North Trunk)				
General Line Item	**Unit**	**Unit Price**	**Estimated Quantity**	**Item Cost**
21-inch Pipe - Excavation, Backfill	LF	$195	310	$60,500
60-Inch, Standard Manhole	EA	$14,000	3	$42,000
Connect to Existing Manhole	EA	$1,750	1	$1,800
ODOT Type G-2, Catch Basin with Connector Pipe	EA	$3,500	4	$14,000
Rock Excavation	CY	$300	115	$34,400
Roadway Restoration (Full Lane)	LF	$75	310	$23,300
Existing Utility Protection	LF	$4	310	$1,200
Traffic Control With Flagging	LS	$14,000	1	$14,000
ADA Ramp Reconstruction (Compliance)	EA	$4,600	3	$13,800
			Construction Subtotal (Rounded)	**$205,000**
Mobilization	LS	5%	1	$10,300
Contingency	LS	30%	1	$61,500
			Construction Subtotal (Rounded)	**$277,000**
Permitting	LS	$10,000	1	$10,000
Geotechnical (Assume 4% of total)	LS	$11,000	1	$11,000
Surveying	LS	$12,000	1	$12,000
Engineering and CMS	LS	20%	1	$55,400
Legal and Admin	LS	$5,000	1	$5,000
			Total Project Cost (Rounded)	**$400,000**

Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060

CIP Project Sheets

Project Identifier - 3E: Upsize N 4th Street south of West Street (North Trunk)

General Line Item	Unit	Unit Price	Estimated Quantity	Item Cost
15-inch Pipe - Excavation, Backfill	LF	$170	770	$130,900
18-inch Pipe - Excavation, Backfill	LF	$185	1,230	$227,600
48-Inch, Standard Manhole	EA	$8,000	8	$64,000
Connect to Existing Manhole	EA	$1,750	1	$1,800
ODOT Type G-2, Catch Basin with Connector Pipe	EA	$3,500	14	$49,000
Rock Excavation	CY	$300	741	$222,200
Roadway Restoration (Full Lane)	LF	$75	940	$70,500
Existing Utility Protection	LF	$4	940	$3,800
Traffic Control With Flagging	LS	$53,000	1	$53,000
ADA Ramp Reconstruction (Compliance)	EA	$4,600	3	$13,800
			Construction Subtotal (Rounded)	**$837,000**
Mobilization	LS	5%	1	$41,900
Contingency	LS	30%	1	$251,100
			Construction Subtotal (Rounded)	**$1,130,000**
Permitting	LS	$10,000	1	$10,000
Geotechnical (Assume 4% of total)	LS	$45,000	1	$45,000
Surveying	LS	$12,000	1	$12,000
Engineering and CMS	LS	20%	1	$226,000
Legal and Admin	LS	$5,000	1	$5,000
			Total Project Cost (Rounded)	**$1,400,000**

Project Identifier - 3F: Upsize and Regrade along S 14th Street (Middle Trunk)

General Line Item	Unit	Unit Price	Estimated Quantity	Item Cost
18-inch Pipe - Excavation, Backfill	LF	$185	700	$129,500
48-Inch, Standard Manhole	EA	$8,000	5	$40,000
Connect to Existing Manhole	EA	$1,750	1	$1,800
ODOT Type G-2, Catch Basin with Connector Pipe	EA	$3,500	6	$21,000
Rock Excavation	CY	$300	259	$77,800
Roadway Restoration (Full Lane)	LF	$75	700	$52,500
Existing Utility Protection	LF	$4	700	$2,800
Traffic Control With Flagging	LS	$26,000	1	$26,000
			Construction Subtotal (Rounded)	**$351,000**
Mobilization	LS	5%	1	$17,600
Contingency	LS	30%	1	$105,300
			Construction Subtotal (Rounded)	**$474,000**
Permitting	LS	$10,000	1	$10,000
Geotechnical (Assume 4% of total)	LS	$19,000	1	$19,000
Surveying	LS	$12,000	1	$12,000
Engineering and CMS	LS	20%	1	$94,800
Legal and Admin	LS	$5,000	1	$5,000
			Total Project Cost (Rounded)	**$600,000**

Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060

CIP Project Sheets

Project Identifier - 3G: Upsize existing pipes from Heinie Huemann to Tualatin Street (Middle Trunk)				
General Line Item	Unit	Unit Price	Estimated Quantity	Item Cost
15-inch Pipe - Excavation, Backfill	LF	$170	650	$110,500
48-Inch, Standard Manhole	EA	$8,000	3	$24,000
Connect to Existing Manhole	EA	$1,750	1	$1,800
ODOT Type G-2, Catch Basin with Connector Pipe	EA	$3,500	4	$14,000
Rock Excavation	CY	$300	241	$72,200
Roadway Restoration (Full Lane)	LF	$75	110	$8,300
Soil Surface Repair, Seeding, and Stabilization	LF	$5	540	$2,700
Existing Utility Protection	LF	$4	650	$2,600
Traffic Control With Flagging	LS	$10,000	1	$10,000
			Construction Subtotal (Rounded)	**$246,000**
Mobilization	LS	5%	1	$12,300
Contingency	LS	30%	1	$73,800
			Construction Subtotal (Rounded)	**$332,000**
Permitting	LS	$10,000	1	$10,000
Geotechnical (Assume 4% of total)	LS	$13,000	1	$13,000
Surveying	LS	$12,000	1	$12,000
Engineering and CMS	LS	20%	1	$66,400
Legal and Admin	LS	$5,000	1	$5,000
			Total Project Cost (Rounded)	**$400,000**

Project Identifier - 3H: Street Helens Street to South 4th Street Upsizing (Downtown)				
General Line Item	Unit	Unit Price	Estimated Quantity	Item Cost
18-inch Pipe - Excavation, Backfill	LF	$185	460	$85,100
48-Inch, Standard Manhole	EA	$8,000	3	$24,000
Concrete Inlet, Standard Side Inlet	EA	$2,100	1	$2,100
Connect to Existing Manhole	EA	$1,750	1	$1,800
ODOT Type G-2, Catch Basin with Connector Pipe	EA	$3,500	4	$14,000
Rock Excavation	CY	$300	170	$51,100
Roadway Restoration (Full Lane)	LF	$75	460	$34,500
Existing Utility Protection	LF	$4	460	$1,800
Traffic Control With Flagging	LS	$16,000	1	$16,000
ADA Ramp Reconstruction (Compliance)	EA	$4,600	8	$36,800
			Construction Subtotal (Rounded)	**$267,000**
Mobilization	LS	5%	1	$13,400
Contingency	LS	30%	1	$80,100
			Construction Subtotal (Rounded)	**$361,000**
Permitting	LS	$10,000	1	$10,000
Geotechnical (Assume 4% of total)	LS	$14,000	1	$14,000
Surveying	LS	$12,000	1	$12,000
Engineering and CMS	LS	20%	1	$72,200
Legal and Admin	LS	$5,000	1	$5,000
			Total Project Cost (Rounded)	**$500,000**

Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060

CIP Project Sheets

Project Identifier - 3I: S 4th Street to Outfall Pipe Upsizing (Downtown)

General Line Item	Unit	Unit Price	Estimated Quantity	Item Cost
18-inch Pipe - Excavation, Backfill	LF	$185	150	$27,800
21-inch Pipe - Excavation, Backfill	LF	$195	720	$140,400
30-inch Pipe - Excavation, Backfill	LF	$230	2,020	$464,600
48-Inch, Standard Manhole	EA	$8,000	1	$8,000
60-Inch, Standard Manhole	EA	$14,000	11	$154,000
ODOT Type G-2, Catch Basin with Connector Pipe	EA	$3,500	28	$98,000
Outfall Restoration	EA	$6,000	1	$6,000
Rock Excavation	CY	$300	572	$171,600
Roadway Restoration (Half Lane)	LF	$45	2,890	$130,100
Traffic Control With Flagging	LS	$82,000	1	$82,000
Existing Utility Protection	LF	$4	2,890	$11,600
ADA Ramp Reconstruction (Compliance)	EA	$4,600	26	$119,600
			Construction Subtotal (Rounded)	**$1,414,000**
Mobilization	LS	5%	1	$70,700
Contingency	LS	30%	1	$424,200
			Construction Subtotal (Rounded)	**$1,909,000**
Permitting	LS	$50,000	1	$50,000
Geotechnical (Assume 2% of total)	LS	$38,000	1	$38,000
Surveying	LS	$29,000	1	$29,000
Engineering and CMS	LS	20%	1	$381,800
Legal and Admin	LS	$15,000	1	$15,000
			Total Project Cost (Rounded)	**$2,400,000**

Project Identifier - 3J: Crouse Way Upsize (Milton Creek)

General Line Item	Unit	Unit Price	Estimated Quantity	Item Cost
18-inch Pipe - Excavation, Backfill	LF	$185	580	$107,300
21-inch Pipe - Excavation, Backfill	LF	$195	480	$93,600
48-Inch, Standard Manhole	EA	$8,000	5	$40,000
60-Inch, Standard Manhole	EA	$14,000	3	$42,000
ODOT Type G-2, Catch Basin with Connector Pipe	EA	$3,500	8	$28,000
Rock Excavation	CY	$300	393	$117,800
Roadway Restoration (Full Lane)	LF	$75	1,060	$79,500
Existing Utility Protection	LF	$4	1,060	$4,200
Traffic Control With Flagging	LS	$40,000	1	$40,000
ADA Ramp Reconstruction (Compliance)	EA	$4,600	11	$50,600
			Construction Subtotal (Rounded)	**$603,000**
Mobilization	LS	5%	1	$30,200
Contingency	LS	30%	1	$180,900
			Construction Subtotal (Rounded)	**$814,000**
Permitting	LS	$5,000	1	$5,000
Geotechnical (Assume 4% of total)	LS	$33,000	1	$33,000
Surveying	LS	$10,000	1	$10,000
Engineering and CMS	LS	20%	1	$162,800
Legal and Admin	LS	$5,000	1	$5,000
			Total Project Cost (Rounded)	**$1,000,000**

Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060

CIP Project Sheets

Project Identifier - 3K: Eilertson Street (Milton Creek)				
General Line Item	**Unit**	**Unit Price**	**Estimated Quantity**	**Item Cost**
12-inch Pipe - Excavation, Backfill	LF	$160	60	$9,600
48-Inch, Standard Manhole	EA	$8,000	3	$24,000
ODOT Type G-2, Catch Basin with Connector Pipe	EA	$3,500	4	$14,000
Rock Excavation	CY	$300	22	$6,700
Roadway Restoration (Half Lane)	LF	$45	60	$2,700
Existing Utility Protection	LF	$4	60	$200
Traffic Control With Flagging	LS	$9,000	1	$9,000
ADA Ramp Reconstruction (Compliance)	EA	$4,600	2	$9,200
			Construction Subtotal (Rounded)	**$75,000**
Mobilization	LS	5%	1	$3,800
Contingency	LS	30%	1	$22,500
			Construction Subtotal (Rounded)	**$101,000**
Permitting	LS	$1,000	1	$1,000
Geotechnical (Assume 4% of total)	LS	$4,000	1	$4,000
Surveying	LS	$2,000	1	$2,000
Engineering and CMS	LS	20%	1	$20,200
Legal and Admin	LS	$1,000	1	$1,000
			Total Project Cost (Rounded)	**$100,000**

Project Identifier - 3L: N Vernonia Road from Oakwood to Ava Court (Milton Creek)				
General Line Item	**Unit**	**Unit Price**	**Estimated Quantity**	**Item Cost**
18-inch Pipe - Excavation, Backfill	LF	$185	360	$66,600
48-Inch, Standard Manhole	EA	$8,000	3	$24,000
ODOT Type G-2, Catch Basin with Connector Pipe	EA	$3,500	4	$14,000
Rock Excavation	CY	$300	133	$40,000
Roadway Restoration (Half Lane)	LF	$45	360	$16,200
Existing Utility Protection	LF	$4	360	$1,400
Traffic Control With Flagging	LS	$14,000	1	$14,000
ADA Ramp Reconstruction (Compliance)	EA	$4,600	10	$46,000
			Construction Subtotal (Rounded)	**$222,000**
Mobilization	LS	5%	1	$11,100
Contingency	LS	30%	1	$66,600
			Construction Subtotal (Rounded)	**$300,000**
Permitting	LS	$2,000	1	$2,000
Geotechnical (Assume 4% of total)	LS	$12,000	1	$12,000
Surveying	LS	$3,000	1	$3,000
Engineering and CMS	LS	20%	1	$60,000
Legal and Admin	LS	$2,000	1	$2,000
			Total Project Cost (Rounded)	**$400,000**

Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060

CIP Project Sheets

Project Identifier - 3M: Ethan Lane Upsizing (Milton Creek)				
General Line Item	**Unit**	**Unit Price**	**Estimated Quantity**	**Item Cost**
21-inch Pipe - Excavation, Backfill	LF	$195	700	$136,500
60-Inch, Standard Manhole	EA	$14,000	4	$56,000
ODOT Type G-2, Catch Basin with Connector Pipe	EA	$3,500	6	$21,000
Rock Excavation	CY	$300	259	$77,800
Roadway Restoration (Half Lane)	LF	$45	220	$9,900
Soil Surface Repair, Seeding, and Stabilization	LF	$5	480	$2,400
Existing Utility Protection	LF	$4	700	$2,800
Traffic Control With Flagging	LS	$21,000	1	$21,000
			Construction Subtotal (Rounded)	**$327,000**
Mobilization	LS	5%	1	$16,400
Contingency	LS	30%	1	$98,100
			Construction Subtotal (Rounded)	**$442,000**
Permitting	LS	$2,000	1	$2,000
Geotechnical (Assume 4% of total)	LS	$18,000	1	$18,000
Surveying	LS	$3,000	1	$3,000
Engineering and CMS	LS	20%	1	$88,400
Legal and Admin	LS	$2,000	1	$2,000
			Total Project Cost (Rounded)	**$600,000**

Project Identifier - 3N: Sunset Boulevard to Outfall Upsize (Milton Creek)				
General Line Item	**Unit**	**Unit Price**	**Estimated Quantity**	**Item Cost**
21-inch Pipe - Excavation, Backfill	LF	$195	840	$163,800
60-Inch, Standard Manhole	EA	$14,000	4	$56,000
ODOT Type G-2, Catch Basin with Connector Pipe	EA	$3,500	6	$21,000
Rock Excavation	CY	$300	311	$93,300
Roadway Restoration (Half Lane)	LF	$45	840	$37,800
Outfall Restoration	EA	$6,000	1	$6,000
Existing Utility Protection	LF	$4	840	$3,400
Traffic Control With Flagging	LS	$25,000	1	$25,000
ADA Ramp Reconstruction (Compliance)	EA	$4,600	10	$46,000
			Construction Subtotal (Rounded)	**$452,000**
Mobilization	LS	5%	1	$22,600
Contingency	LS	30%	1	$135,600
			Construction Subtotal (Rounded)	**$610,000**
Permitting	LS	$2,000	1	$2,000
Geotechnical (Assume 4% of total)	LS	$24,000	1	$24,000
Surveying	LS	$3,000	1	$3,000
Engineering and CMS	LS	20%	1	$122,000
Legal and Admin	LS	$2,000	1	$2,000
			Total Project Cost (Rounded)	**$800,000**

Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060

CIP Project Sheets

Project Identifier - 3O: Sunset Boulevard, Trillium Street and Salmon Street upsize (Milton Creek)

General Line Item	Unit	Unit Price	Estimated Quantity	Item Cost
15-inch Pipe - Excavation, Backfill	LF	$170	1,580	$268,600
48-Inch, Standard Manhole	EA	$8,000	7	$56,000
ODOT Type G-2, Catch Basin with Connector Pipe	EA	$3,500	12	$42,000
Rock Excavation	CY	$300	585	$175,600
Roadway Restoration (Half Lane)	LF	$45	1,580	$71,100
Existing Utility Protection	LF	$4	1,580	$6,300
Traffic Control With Flagging	LS	$46,000	1	$46,000
ADA Ramp Reconstruction (Compliance)	EA	$4,600	6	$27,600
			Construction Subtotal (Rounded)	**$666,000**
Mobilization	LS	5%	1	$33,300
Contingency	LS	30%	1	$199,800
			Construction Subtotal (Rounded)	**$899,000**
Permitting	LS	$2,000	1	$2,000
Geotechnical (Assume 4% of total)	LS	$36,000	1	$36,000
Surveying	LS	$3,000	1	$3,000
Engineering and CMS	LS	20%	1	$179,800
Legal and Admin	LS	$2,000	1	$2,000
			Total Project Cost (Rounded)	**$1,100,000**

Project Identifier - 3P: Sykes Road Upsize from Columbia Boulevard to Outfall (McNulty Creek)

General Line Item	Unit	Unit Price	Estimated Quantity	Item Cost
30-inch Pipe - Excavation, Backfill	LF	$230	1,570	$361,100
36-inch Pipe - Excavation, Backfill	LF	$245	1,300	$318,500
72-Inch, Standard Manhole	EA	$16,500	5	$82,500
ODOT Type G-2, Catch Basin with Connector Pipe	EA	$3,500	12	$42,000
Concrete Headwall	EA	$10,000	1	$10,000
Rock Excavation	CY	$300	1,544	$463,300
Roadway Restoration (Full Lane)	LF	$75	2,870	$215,300
Existing Utility Protection	LF	$4	2,870	$11,500
Traffic Control With Flagging	LS	$63,000	1	$63,000
ADA Ramp Reconstruction (Compliance)	EA	$4,600	13	$59,800
			Construction Subtotal (Rounded)	**$1,627,000**
Mobilization	LS	5%	1	$81,400
Contingency	LS	30%	1	$488,100
			Construction Subtotal (Rounded)	**$2,197,000**
Permitting	LS	$2,000	1	$2,000
Geotechnical (Assume 4% of total)	LS	$88,000	1	$88,000
Surveying	LS	$3,000	1	$3,000
Engineering and CMS	LS	20%	1	$439,400
Legal and Admin	LS	$2,000	1	$2,000
			Total Project Cost (Rounded)	**$2,700,000**

Client: City of St. Helens
Project: Stormwater Master Plan
Project No.: 220060

CIP Project Sheets

Project Identifier - 3Q: McBride Street Upsize (McNulty Creek)				
General Line Item	**Unit**	**Unit Price**	**Estimated Quantity**	**Item Cost**
18-inch Pipe - Excavation, Backfill	LF	$185	770	$142,500
48-Inch, Standard Manhole	EA	$8,000	4	$32,000
Connect to Existing Manhole	EA	$1,750	1	$1,800
ODOT Type G-2, Catch Basin with Connector Pipe	EA	$3,500	6	$21,000
Rock Excavation	CY	$300	285	$85,600
Roadway Restoration (Half Lane)	LF	$45	770	$34,700
Existing Utility Protection	LF	$4	770	$3,100
Traffic Control With Flagging	LS	$24,000	1	$24,000
			Construction Subtotal (Rounded)	**$345,000**
Mobilization	LS	5%	1	$17,300
Contingency	LS	30%	1	$103,500
			Construction Subtotal (Rounded)	**$466,000**
Permitting	LS	$2,000	1	$2,000
Geotechnical (Assume 4% of total)	LS	$19,000	1	$19,000
Surveying	LS	$3,000	1	$3,000
Engineering and CMS	LS	20%	1	$93,200
Legal and Admin	LS	$2,000	1	$2,000
			Total Project Cost (Rounded)	**$600,000**

Project Identifier - 3R: Port Avenue Upsize (McNulty Creek)				
General Line Item	**Unit**	**Unit Price**	**Estimated Quantity**	**Item Cost**
15-inch Pipe - Excavation, Backfill	LF	$170	810	$137,700
18-inch Pipe - Excavation, Backfill	LF	$185	380	$70,300
Outfall Restoration	EA	$6,000	1	$6,000
48-Inch, Standard Manhole	EA	$8,000	4	$32,000
ODOT Type G-2, Catch Basin with Connector Pipe	EA	$3,500	6	$21,000
Rock Excavation	CY	$300	441	$132,200
Roadway Restoration (Half Lane)	LF	$45	1,190	$53,600
Existing Utility Protection	LF	$4	1,190	$4,800
Traffic Control With Flagging	LS	$31,000	1	$31,000
ADA Ramp Reconstruction (Compliance)	EA	$4,600	6	$27,600
			Construction Subtotal (Rounded)	**$516,000**
Mobilization	LS	5%	1	$25,800
Contingency	LS	30%	1	$154,800
			Construction Subtotal (Rounded)	**$697,000**
Permitting	LS	$2,000	1	$2,000
Geotechnical (Assume 4% of total)	LS	$28,000	1	$28,000
Surveying	LS	$3,000	1	$3,000
Engineering and CMS	LS	20%	1	$139,400
Legal and Admin	LS	$2,000	1	$2,000
			Total Project Cost (Rounded)	**$900,000**

Client: City of St. Helens
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Project Identifier - 3S: Whitetail Avenue Upsize (McNulty Creek)				
General Line Item	**Unit**	**Unit Price**	**Estimated Quantity**	**Item Cost**
18-inch Pipe - Excavation, Backfill	LF	$185	970	$179,500
48-Inch, Standard Manhole	EA	$8,000	6	$48,000
ODOT Type G-2, Catch Basin with Connector Pipe	EA	$3,500	10	$35,000
Outfall Restoration	EA	$6,000	1	$6,000
Rock Excavation	CY	$300	359	$107,800
Roadway Restoration (Half Lane)	LF	$45	970	$43,700
Existing Utility Protection	LF	$4	970	$3,900
Traffic Control With Flagging	LS	$33,000	1	$33,000
			Construction Subtotal (Rounded)	**$457,000**
Mobilization	LS	5%	1	$22,900
Contingency	LS	30%	1	$137,100
			Construction Subtotal (Rounded)	**$617,000**
Permitting	LS	$2,000	1	$2,000
Geotechnical (Assume 4% of total)	LS	$25,000	1	$25,000
Surveying	LS	$3,000	1	$3,000
Engineering and CMS	LS	20%	1	$123,400
Legal and Admin	LS	$2,000	1	$2,000
			Total Project Cost (Rounded)	**$800,000**

Project Identifier - 3T: Sykes Road Cuvert near Mountain View Drive Upsize (McNulty Creek)				
General Line Item	**Unit**	**Unit Price**	**Estimated Quantity**	**Item Cost**
15-inch Pipe - Excavation, Backfill	LF	$170	140	$23,800
48-Inch, Standard Manhole	EA	$8,000	1	$8,000
Concrete Headwall	EA	$10,000	1	$10,000
Soil Surface Repair, Seeding, and Stabilization	LF	$5	140	$700
Existing Utility Protection	LF	$4	140	$600
			Construction Subtotal (Rounded)	**$43,000**
Mobilization	LS	5%	1	$2,200
Contingency	LS	30%	1	$12,900
			Construction Subtotal (Rounded)	**$58,000**
Permitting	LS	$2,000	1	$2,000
Geotechnical (Assume 4% of total)	LS	$2,000	1	$2,000
Surveying	LS	$3,000	1	$3,000
Engineering and CMS	LS	20%	1	$11,600
Legal and Admin	LS	$2,000	1	$2,000
			Total Project Cost (Rounded)	**$80,000**

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