CITY OF SILVERTON
· EST 1854 ·
OREGON'S GARDEN CITY

Stormwater Master Plan

June 2022

Adopted June 20, 2022
City Ordinance Number 22-03

KELLER ASSOCIATES

CITY OF SILVERTON, OR STORMWATER MASTER PLAN

DocuSigned by:
C7B8BE0F62374A5...

REGISTERED PROFESSIONAL ENGINEER
87384PE
Digitally Signed
OREGON
NOV. 31, 2018
EMILY C. FLOCK
6/21/2022
EXPIRES: 12-31-2023

JUNE 2022
KA PROJECT NO. 215004-025

PREPARED BY:

KELLER ASSOCIATES

245 Commercial St. SE, Suite 210
Salem, OR 97301
(503) 364-2002

PREPARED FOR:

CITY OF SILVERTON
EST 1854
OREGON'S GARDEN CITY

306 South Water Street
Silverton, OR 97381
(503) 873-5321

TABLE OF CONTENTS

FIGURES

TABLES

APPENDICES

ACRONYMS AND ABBREVIATIONS

AACE	Associate for the Advancement of Cost Engineering
AC	Acres
BFE	Base Flood Elevation
BMP	Best Management Practice
CCTV	Closed-Circuit-Television
CFS	Cubic Feet per Second
CIP	Capital Improvement Plan
CMP	Corrugated Metal Pipe
CN	Curve Number
CREP	Conservation Reserve Enhancement Program
CRP	Conservation Reserve Program
CSP	Conservation Stewardship Program
CWSRF	Clean Water State Revolving Fund
DEQ	Department of Environmental Quality
DI	Ductile Iron
DMA	Dedicated Management Agency
DSL	Department of State Lands
d/D	Maximum depth divided by full depth
EFRP	Emergency Forest Restoration Project
EQIP	Environmental Quality Incentives
EPA	Environmental Protection Agency
ESU	Equivalent Service Unit
EWP	Emergency Watershed Protection
FEMA	Federal Emergency Management Agency
FILOC	Fee in Lieu of Construction
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FRPP	Farm and Ranchland Protection Program
FTE	Full Time Equivalent/Employee
GIS	Geographical Information System
GPM	Gallons per Minute
GRP	Grassland Reserve Program
HDPE	High-Density Polyethylene
HGL	Hydraulic Grade Line
HOA	Homeowners Association
IDF	Intensity-Duration-Frequency
IDR	Intensity-Duration-recurrence interval

LF	Linear Feet
LID	Low Impact Development
LIDA	Low Impact Development Approach
LIP	Landowner Incentive Program
LOS	Level of Service
LWI	Local Wetlands Inventory
MS4	Municipal Separate Storm Sewer System
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
ODOT	Oregon Department of Transportation
ODF	Oregon Department of Forestry
ODFW	Oregon Department of Fish and Wildlife
OHW	Ordinary High-Water
O&M	Operations and Maintenance
ORS	Oregon Revised Statute
OWEB	Oregon Watershed Enhancement Board
PVC	Polyvinyl Chloride
PW	Public Works
PWDS	Public Works Design Standards
RC&D	Resource Conservation & Development
ROW	Right-of-Way
SBUH	Santa Barbara Unit Hydrograph Method
SCS	Soil Conservation Service
SDC	System Development Charge
SIP	Stewardship Incentive Program
SWCD	Soil and Water Conservation District
SWMM	Stormwater Management Model
SWMP	Stormwater Master Plan
TMDL	Total Maximum Daily Load
UGB	Urban Growth Boundary
USACE	United States Army Corp of Engineers
USGS	United States Geological Survey
WQMP	Water Quality Management Plan
WRP	Wetlands Reserve Program
WSE	Water Surface Elevation
WTP	Water Treatment Plan
WWTP	Wastewater Treatment Plant

SECTION 1 - EXECUTIVE SUMMARY

The City of Silverton contracted with Keller Associates, Inc. to complete a Stormwater Master Plan Update (SWMP) for the City's municipal stormwater system. The previous Stormwater Master Plan was completed in 2012. This report was commissioned by the City in an effort to assess the current state of the stormwater system and plan for future needs. The following section includes a summary of the stormwater planning criteria, existing system capacities, recommended improvements, and a capital improvement plan (CIP).

1.1 STUDY AREA

The study area is comprised of the areas within the City limits, the Urban Growth Boundary (UGB), and additional area outside of the two boundaries where stormwater runoff collects before it drains into the City's stormwater system. The City limits are comprised of approximately 2,300 acres and the City's UGB is approximately 2,700 additional acres. Note, there is about 200 acres which are currently within the City limits but not within the UGB. Additionally, there is an area of approximately 400 acres toward the southern City limit boundary which is not encompassed by the UGB. Including the City limits, UGB, and additional area draining to the City's stormwater system, there is approximately 3,300 acres included in the study area.

Stormwater from the study area generally drains into three different receiving streams: Silver Creek, Abiqua Creek, and Brush Creek. The majority, approximately 60% of the stormwater drainage area, drains to Silver Creek and approximately 30% of the area drains into Abiqua Creek, leaving the remaining 10% of the drainage area draining to Brush Creek. For this evaluation, Silver Creek was broken up into three major basins: Northeast Silver Creek, Southeast Silver Creek, and West Silver Creek. Abiqua Creek was broken into two major basins: Webb Lake and North Central Basin. Stormwater draining to Brush Creek does not drain through any of the modeled City stormwater components, therefore a major drainage basin was not delineated, and the area is not reflected in the table or figure below. This results in five major drainage basins to be evaluated in this study. The major drainage basin areas are summarized below in Table 1-1 and illustrated in Figure 1-1.

TABLE 1-1: PERCENT OF TOTAL DRAINAGE AREA FOR EACH MAJOR BASIN

	Northeast Silver Creek	Southeast Silver Creek	West Silver Creek	Webb Lake	North Central
Area (ac)	540	670	315	650	220
Percent of Total Drainage Area	23%	28%	13%	27%	9%

The City's zoning areas include residential, commercial, industrial, public right-of-way (ROW) (i.e., roadways), and open space. Existing zoning for the study area is shown in Figure 1-2 on page 1-3. It is anticipated that future development will not substantially increase stormwater peak runoff rates since the recommended policy within this study requires post-development peak runoff rates to be limited to pre-existing conditions runoff rates. However, there may be recommended improvements to future development areas where there is no existing stormwater infrastructure.

FIGURE 1-1: STUDY AREA AND MAJOR DRAINAGE BASINS

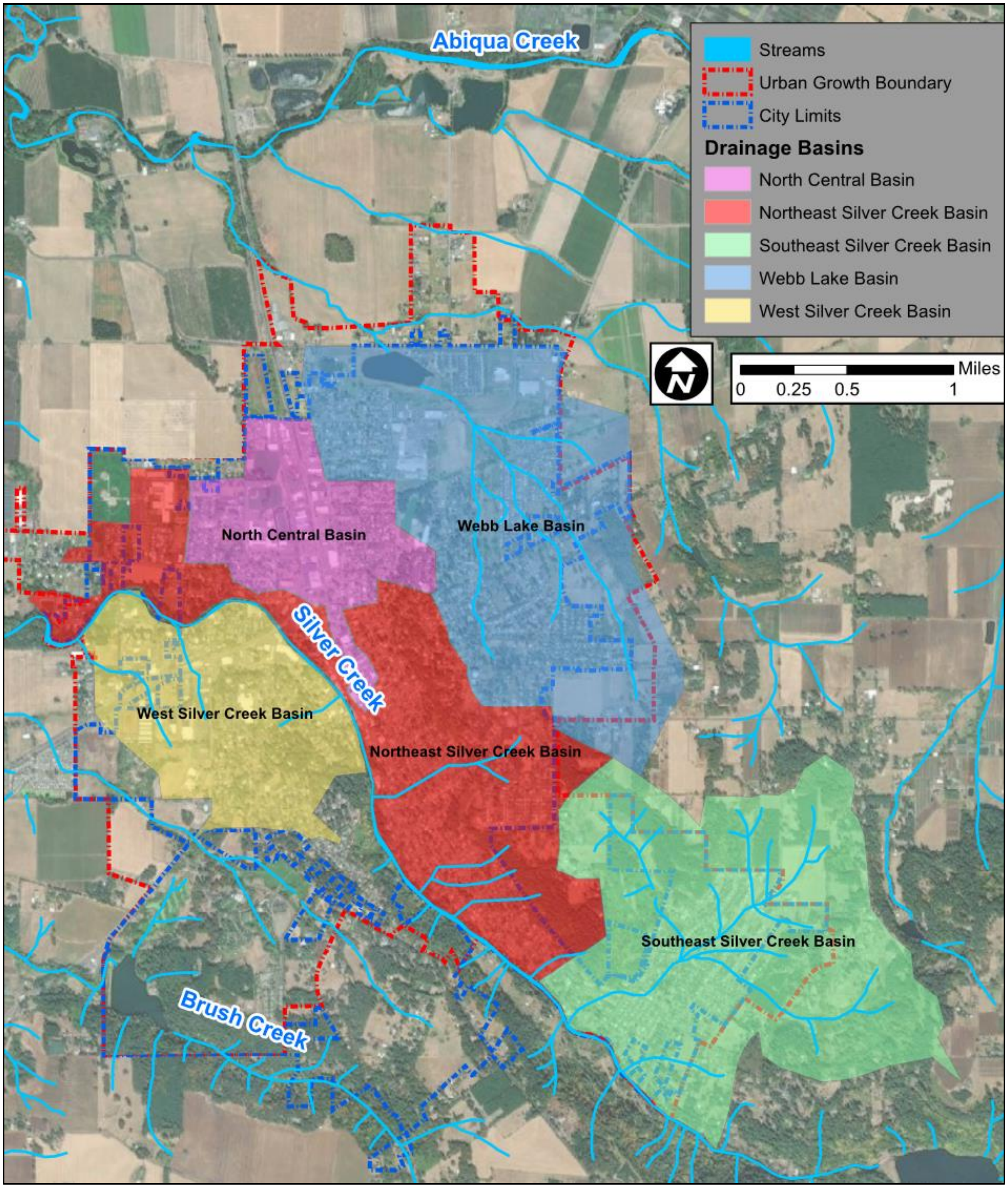
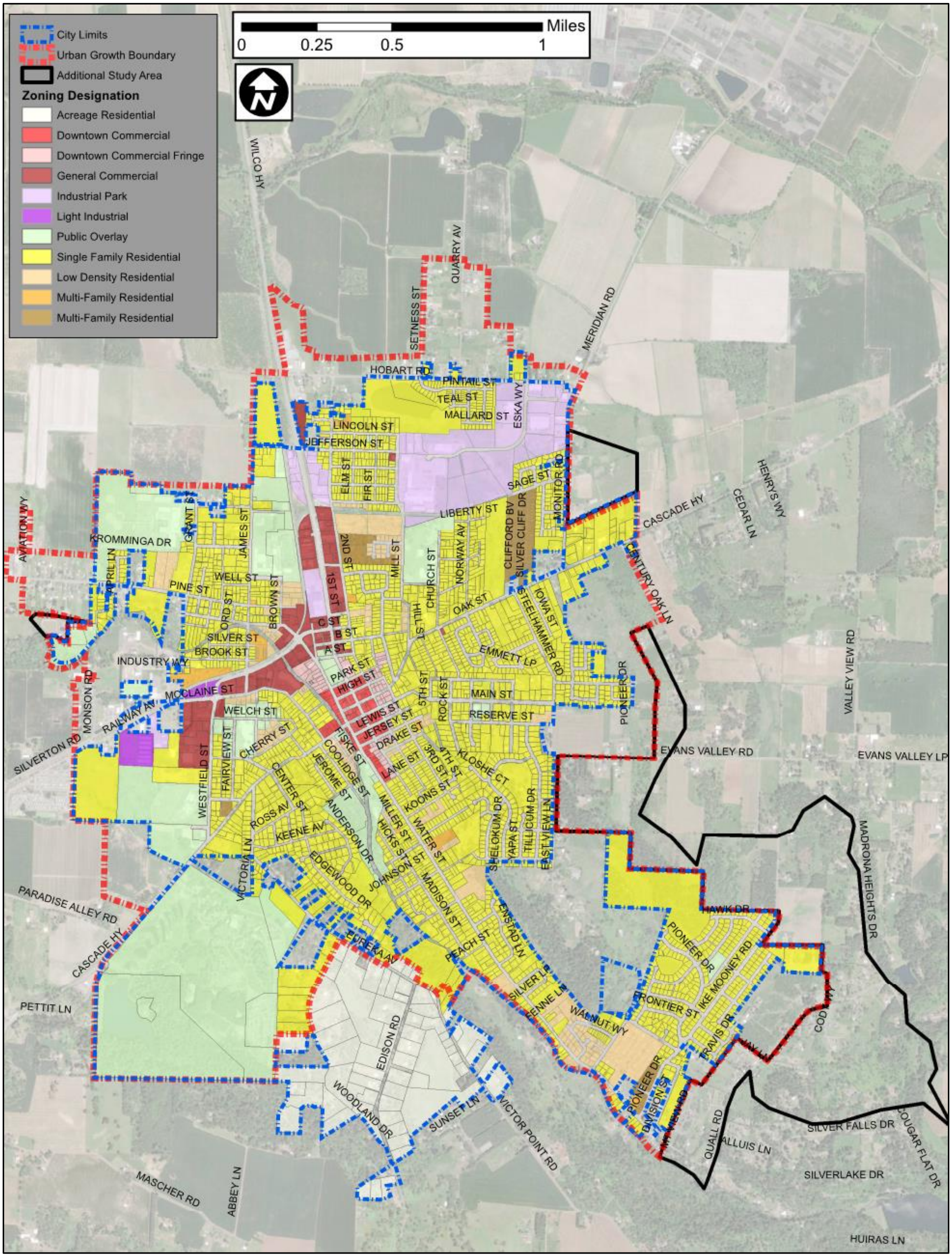


FIGURE 1-2: EXISTING CITY ZONING



1.2 PLANNING CRITERIA

The planning criteria was established with input from City staff and the City Council. Silverton's existing design standards require stormwater conveyance components to be capable of passing runoff from the 25-year storm event (equal to 4.0 inches within 24-hours). In this SWMP, deficiencies in the existing stormwater system and capital improvement projects were developed based on the existing conveyance design standards of passing the 25-year storm event. Conveyance system components were deemed capable of passing the design storm event if there was no flooding or surcharging to within 0.5 feet of the rim elevation of any structure. While this SWMP was developed based on existing design standards, the City would like to consider modifying the design standards for stormwater conveyance systems to be capable of passing runoff from the 50-year storm event (equal to 4.5 inches within 24-hours). For this reason, the planning criteria in Table 1-2 recommends stormwater conveyance components be capable of passing the 50-year storm. The City can consider updating the design standards and future SWMP updates could evaluate the system and recommend improvements based on the 50-year storm event rather than the 25-year 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. They should also be designed so that post-development maximum runoff from the design storm event does not exceed the pre-development runoff for the 5-year storm event. Additionally, the 2-year post-development peak discharge should equal the 2-year pre-development peak discharge. Design standards for detention facilities should be evaluated if the City changes the design storm for conveyance facilities. Further evaluation of the planning criteria is discussed in the following sections.

Stormwater quality treatment is recommended as part of each phase of development. Catch basins and detention pipes do not provide significant water quality treatment. Additional treatment devices are recommended to be included in each development and may include vegetated swales, extended dry basins, in-line filter systems, or other low impact development (LID) approaches. LID is an approach to land development (or re-development) that works with nature to manage stormwater as close to its source as possible. Currently, the City does not have stormwater quality management design standards. It is recommended the City evaluate and develop stormwater quality design standards. Typically, this will include the development or adoption of a stormwater management manual (SWMM) in addition to stormwater quality design standards. A summary of the recommended planning criteria is included in Table 1-2.

TABLE 1-2: PLANNING CRITERIA SUMMARY

Planning Criteria						
Planning Criteria	**Silverton Recommended**	**Silverton (Existing)**	**ODOT**	**Salem**	**Newberg**	**Stayton**
Runoff Model Approach	NRCS TR-55 & Rational Method	Rational Method	NRCS TR-55	Rational Method, SBUH, SWMM, or NRCS TR-55	Rational Method, SBUH, SWMM, or NRCS TR-55	Multiple
Storm Distribution	24-HOUR, NRCS 1A	ODOT Zone 8 IDF	24-HOUR, NRCS 1A	24-HOUR, NRCS 1A	24-HOUR, NRCS 1A	Multiple
Min. Tc	5 Minutes	10 minutes	NS	5 minutes	5 minutes	Multiple
24 hr Storm Precipitation	NOAA	NOAA	NOAA	NOAA	NOAA	Multiple
PVC "n" Value	0.013	0.013	NS	Varies	0.013	0.013
Min. Pipe Diameter	12"	12"	12"	12"	NS	12"
Minimum Freeboard in Open Channels (ft)	1	NS	NS	1	1	1
Minimum Freeboard in Detention Facility (ft)	1	NS	1	1	1	1
Surcharging Allowed	To within 0.5 feet of the rim elevation	NS	To within 0.5 feet of the rim elevation	NS	To within 2 feet of the rim elevation	To rim elevation
Design Storm for Conveyance	50-Year	25-Year	10-Year	50-years	50-Year	25
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	100-year	25-Year	50-year
Detention Facility Peak Discharge	Meet the existing 5-year pre-development criteria as well as 2-year post development should equal the 2-year pre-development storm runoff	Limit post-development to the more stringent of the 5-year pre-development or the remaining downstream capacity.	NS	Limit post-development flows to be equal to or less than the pre-development flows during 10-year event	Limit backwater in downstream systems during 25-year event	Equal to pre-development for 2-,5-,10-, and 50-year storm. 25-year post-development equal to 10-year pre-development
Stormwater Quality Requirements	Develop stormwater quality standards and stormwater management manual fitting Silverton soil types	None	Follow ODOT Hydraulics Manual - Section 14	Stormwater Source Controls (Administrative Rule Ch. 109 Division 012)	Follow PW Design Standards	Portland SWMM and PW Design Standards
1) NS = none specified , SBUH = Santa Barbara Unit Hydrograph, ODOT = Oregon Department of Transportation, SWMM = Stormwater Management Model, IDF = Intensity-Duration-Frequency						

1.3 MODEL DEVELOPMENT

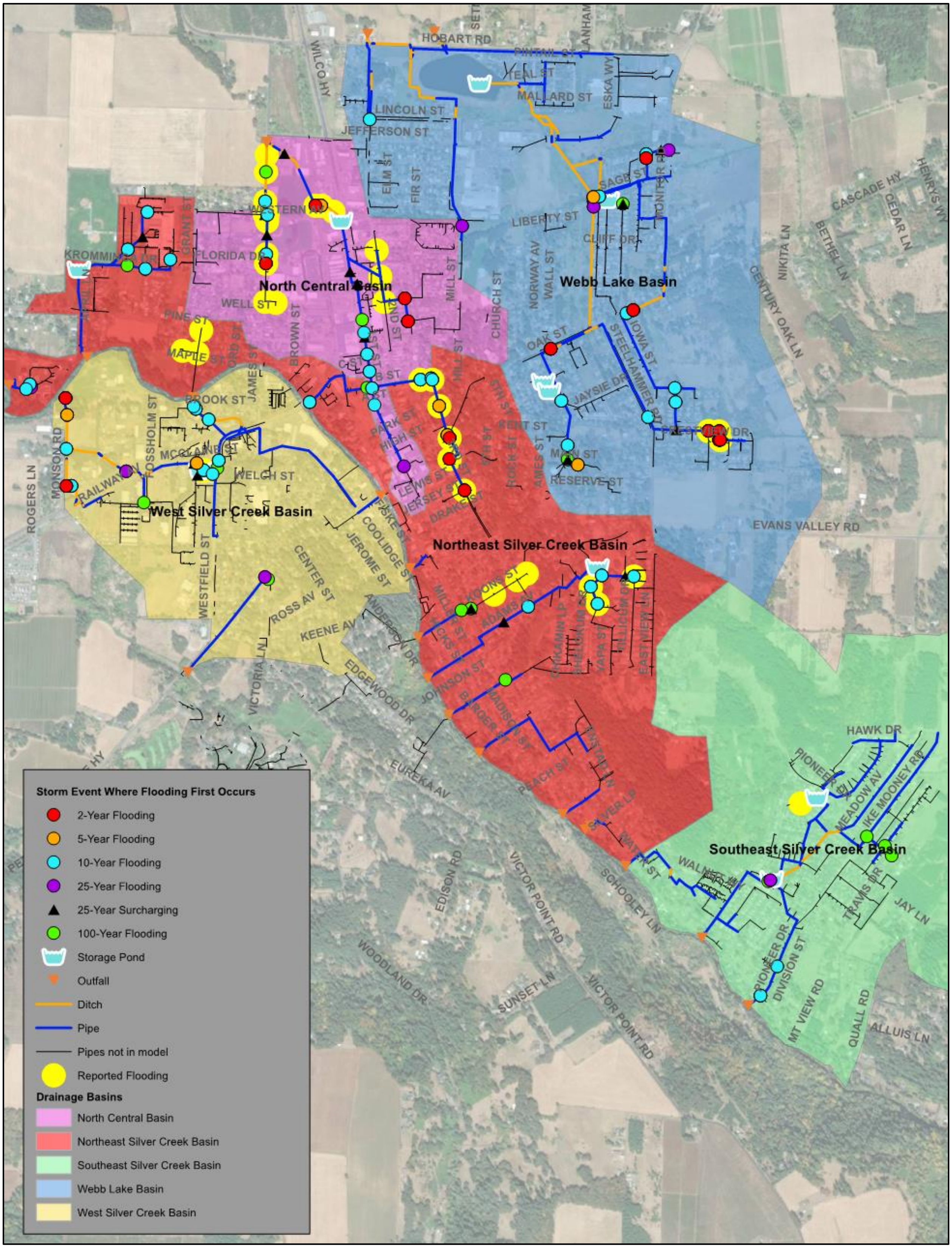
The stormwater modeling software InfoSWMM (Suite 14.7, Update #2) was used to assess stormwater runoff from the study area using the Natural Resources Conservation Service (NRCS) Unitless Hydrograph Method. Additionally, InfoSWMM was used to dynamically route the hydrologic model runoff through a hydraulic 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 computer model was calibrated using flow monitor data collected in February and March of 2021.

1.4 EXISTING SYSTEM EVALUATION

Silverton's existing stormwater system includes approximately 43 miles of closed-conduit pipe ranging in diameter from 3-inches to 72-inches, 15 miles of which is modeled and generally greater than 15-inches in diameter. The system is also comprised of about 25 miles of open channel with approximately 3 miles included in the stormwater model. The system also includes about 600 manholes, and 1,300 catch basins. The pipelines were evaluated based on both the existing conditions and capacities to convey the design storm event.

Capacity related deficiencies were identified both by the City staff's historical observations and by the stormwater model. Deficiencies in the model were identified for the 2-, 5-, 10-, 25-, 50-, and 100-year storm events. Flooding and surcharging were identified in each of the major drainage basins. Some of the flooding can be attributed backwater from the receiving water's surface level. Where the outfall elevations were below the storm event's water surface level, flooding was projected. A summary of City reported problem areas and modeled flooding and surcharging within 0.5 feet of the rim elevation locations for each storm event is shown in Figure 1-3.

FIGURE 1-3: EXISTING SYSTEM EVALUATION



1.5 ALTERNATIVES ANALYSIS

The SWMP evaluates the conveyance system (e.g., closed-conduit pipes and open channels) to be capable of passing up to the 25-year storm event. 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. Pipes were recommended to be upsized where detention storage was not a viable option. New pipelines were sized to convey the peak flow during a 25-year storm event with a d/D of less than 1 (e.g., no surcharging in the new pipes), unless otherwise noted. 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.

1.6 DESIGN STANDARDS AND LOW IMPACT DESIGN (LID)

The City of Silverton's existing public works design standards (PWDS) were reviewed for new development as they pertain to stormwater conveyance and water quality to identify potential deficiencies and provide recommendations for updates. The following documents were examined during this review effort:

- Silverton Public Works Design Standards | Division 1 – General Requirements
- Silverton Public Works Design Standards | Division 3 – Stormwater Management
- Appendix A, Standard Details | Division 3 – Stormwater Management

A number of recommendations are included in the report regarding the documents listed above. More significant recommendations pertain to updating water quality requirements, adding additional approved design calculation methods, and updating out-of-date references.

City design standards for low impact development integrated management practices (PWDS Div 3.22) are currently under development. It is recommended the City continue to gather information and begin to educate City officials and the public on low impact development and its potential role in the City's future stormwater management strategy.

1.7 MAINTENANCE 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. Silverton's public works division has an annual budget of $5,000 for materials and equipment but does not have any designated full-time equivalent (FTE) budgeted for stormwater O&M.

Using similar expected labor hours for activities as reported by current staff, and using reference values from other staffing analyses, it is estimated that approximately 4.0 FTE are needed to meet the O&M described above to meet the desired LOS goals. It is recommended that the City start by budgeting 2.0 FTE for stormwater O&M. The City should reevaluate staffing requirements and needs every two to three years. In addition to the increased staffing level outlined in the preceding paragraph, the City could benefit from investing in back-up equipment such as mobile vactor equipment or closed-circuit television (CCTV) equipment for inspection of pipelines.

1.8 CAPITAL IMPROVEMENT PLAN

Improvements were recommended to alleviate the flooding and surcharging identified in the existing system evaluation. Improvements were designed to the existing City design standards. The CIP was categorized onto three priorities. The criteria for each priority are shown in Table 1-3.

TABLE 1-3: CAPITAL IMPROVEMENT PLAN PRIORITIZATION CRITERIA

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

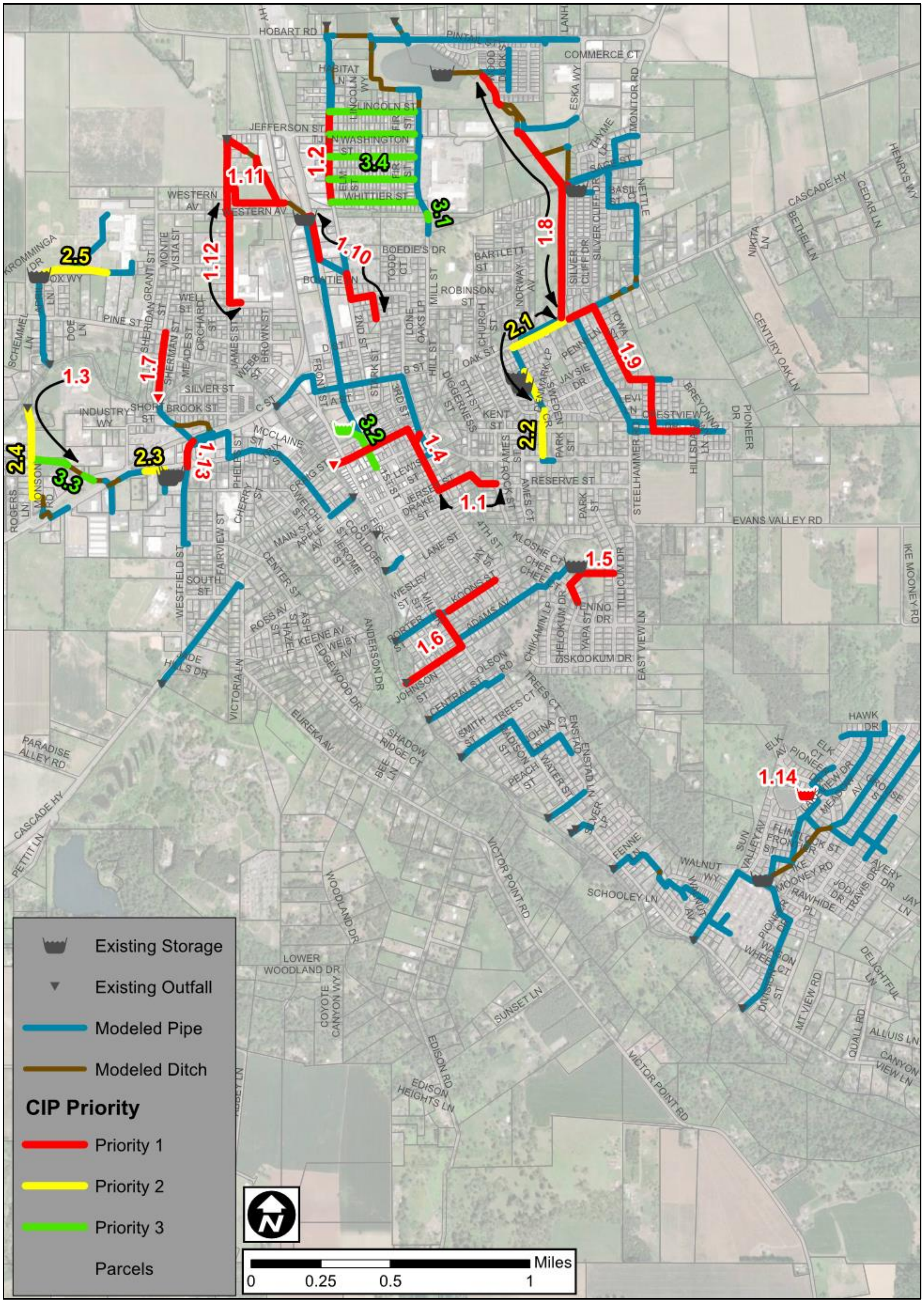
System development charge (SDC) eligibility was evaluated for each of the improvement projects recommended. The SDC improvement amount is based on the percentage of developable land within the capital improvement project's contributing drainage basin. The SDC eligibility for each project is summarized in Table 1-4 and the project extents are shown in Figure 1-4.

TABLE 1-4: CAPITAL IMPROVEMENT PLAN

Project ID	Project Name	Total Estimated Cost (2022 Dollars)	SDC Eligibility (%)	Cost Allocated to Growth	Cost Allocated to City
Priority 1 Improvements					
1.1	Rock Street Stormwater Improvements (Northeast Silver Creek)	$770,000	0%	$0	$770,000
1.2	2nd Street and Lincoln Street (Webb Lake)	$1,700,000	0%	$0	$1,700,000
1.3	Public Works Shop Decant Facility Roof Structure	$184,000	0%	$0	$184,000
1.4	3rd Street and Jersey Street to Mill and B Street (Northeast Silver Creek)	$3,600,000	0%	$0	$3,600,000
1.5	Abiqua Heights, upstream of storage pond (Northeast Silver Creek)	$900,000	11%	$100,000	$800,000
1.6	Koons Street and Adams Avenue to Silver Creek (Northeast Silver Creek)	$3,300,000	12%	$390,000	$2,910,000
1.7	Sheridan Street to Silver Creek (Northeast Silver Creek)	$710,000	0%	$0	$710,000
1.8	Olson's Ditch at Sage Street (Webb Lake)	$1,100,000	9%	$100,000	$1,000,000
1.9	Crestview Drive, Breyonna Way, Iowa Street, and Oak Street (Webb Lake)	$3,200,000	4%	$110,000	$3,090,000
1.10	Lone Oaks Loop and 2nd Street to Bowtie Lane (North Central)	$2,500,000	0%	$0	$2,500,000
1.11	Davisson Baseball Fields (North Central)	$2,700,000	3%	$90,000	$2,610,000
1.12	James Street and Schlador to Western Avenue (North Central)	$1,900,000	33%	$630,000	$1,270,000
1.13	Westfield Street and C Street (West Silver Creek)	$630,000	6%	$40,000	$590,000
1.14a	Pioneer Lake Geotechnical Investigation	$60,000	23%	$10,000	$50,000
1.14b	Pioneer Lake Improvements	$780,000	23%	$180,000	$600,000
	Total Priority 1 Improvement Costs (Rounded)	$24,000,000	-	$1,700,000	$22,400,000
Priority 2 Improvements					
2.1	Norway Street to Oak Street (Webb Lake)	$2,000,000	8%	$150,000	$1,850,000
2.2	Main Street by Water Treatment Plant (Webb Lake)	$490,000	9%	$40,000	$450,000
2.3	McClaine Street and Railway Street (West Silver Creek)	$460,000	0%	$0	$460,000
2.4	Monson Road (West Silver Creek)	$650,000	16%	$110,000	$540,000
2.5	Silverton High School, Kromminga Drive (Northeast Silver Creek)	$1,100,000	0%	$0	$1,100,000
2.6	Stormwater Master Plan Update	$200,000	100%	$200,000	$0
	Total Priority 2 Improvement Costs (Rounded)	$4,900,000	-	$500,000	$4,400,000
Priority 3 Improvements					
3.1	Mill Street (Webb Lake)	$350,000	0%	$0	$350,000
3.2	1st Street Detention Pond (North Central)	$1,500,000	0%	$0	$1,500,000
3.3	Between Silverton Road NE and Railway Street (West Silver Creek)	$790,000	16%	$130,000	$660,000
3.4	Webb Lake Local Street Improvements (Webb Lake)	$5,900,000	0%	$0	$5,900,000
3.5	Stormwater Master Plan Update #2	$330,000	100%	$330,000	$0
	Total Priority 3 Improvement Costs (Rounded)	$8,900,000	-	$460,000	$8,400,000
	Total Improvement Costs (Rounded)	**$37,800,000**	**-**	**$2,700,000**	**$35,200,000**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our opinion of probable 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 costs presented herein.

FIGURE 1-4: CAPITAL IMPROVEMENT PLAN



1.9 PLANNING RECOMMENDATIONS

It is recommended that the City update their planning documents every five to ten 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 and an update #2 as a Priority 3 improvement with an estimated cost of $330,000. Note the increased costs in the Priority 3 stormwater master plan update is to account for inflation (Table 1-4).

1.10 OTHER ANNUAL COSTS

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

An annual replacement program is based on the total amount of existing City stormwater infrastructure and its estimated useful life. The City facilities include approximately 15 miles of storm pipes (15-inches in diameter and larger), 600 manholes, and 1,300 catch basins. Assuming an average useful life of 75 years for pipes and 50 years for manholes and catch basins, the replacement program should target approximately 1,000 feet of pipe, 26 catch basins, and 12 manholes per year. Assuming an average pipe replacement cost of $200 per foot, a catch basin cost of $3,200 each, and a manhole cost of $13,000, the City would need an annual replacement budget of approximately $440,000. Table 1-5 summarizes the annual replacement program targets and associated costs.

TABLE 1-5: SUMMARY OF ANNUAL REPLACEMENT COSTS

Item	Lifespan	Unit Cost[1]	Annual Replacement Quantity	Annual Cost[1] (rounded)
Stormwater Pipelines (LF)	75 Years	$200	1,000	$200,000
Catch Basins	50 Years	$3,200	26	$80,000
Manholes	50 Years	$13,000	12	$160,000
			Total (Rounded)	$440,000

1) Storm pipes unit price is equal to average unit price of 12" to 36". Manhole unit price equal to average of 48", 60", and 72" manhole.

SECTION 2 - STUDY AREA

The following section discusses the general study area and its physical characteristics. The major drainage basins and the existing and future land use are also summarized.

2.1 STUDY AREA

The study area is comprised of the areas within the City limits, the Urban Growth Boundary (UGB), and additional area outside of the two boundaries where stormwater runoff collects before it drains into the City's stormwater system. The City limits are comprised of approximately 2,300 acres and the City's UGB is approximately 2,700 additional acres. Note, there is about 200 acres which are currently within the City limits but not within the UGB. Additionally, there is an area of approximately 400 acres toward the southern City limit boundary which is not encompassed by the UGB. Including the City limits, UGB, and additional area draining to the City's stormwater system, there is approximately 3,300 acres included in the study area.

2.2 PHYSICAL ENVIRONMENT

The section below provides a review of the physical environment of the study area including climate, soils, and topography.

2.2.1 CLIMATE

The City of Silverton lies within the Willamette Valley which has relatively mild climate throughout the year and is characterized by cool wet winters and warm dry summers. Table 2-1 summarizes the historical temperatures and total precipitation for each month.

TABLE 2-1: CLIMATOLOGICAL DATA (1962-2016) FOR SILVERTON, OR

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Avg. Max Temperature (F)	46	50.6	54.7	59	65.8	71.5	78.7	79.2	74.1	62.9	52	45.6	61.7
Avg. Min Temperature (F)	33.8	35.4	38	40.6	45.5	50.6	54.2	54.5	50.6	44	38.6	33.9	43.3
Avg. Total Precipitation (in)	6.83	4.85	5.11	3.69	2.83	1.94	0.69	0.87	1.77	3.63	7.08	7.52	46.82

1) Data from Western Regional Climate Center Station 357823: https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?or7823

2.2.2 SOILS AND TOPOGRAPHY

Soil types in the study area consist mainly of silty clay loam or silt loam. The soils are characterized by National Resources Conservation Services (NRCS) hydrologic soil groups A-D which are representative of the amount of runoff they are likely to produce. Soils within the study area are generally Groups B through D indicating moderate to poorly draining soils. Majority of the study area is indicated to have poorly drained hydrologic soil types (Groups C and D) as shown in Figure 2 in Appendix A, which typically leads to moderate to high runoff potential.

Ground elevations in the study area range from 200 feet to 650 feet above mean sea level and slopes within the City vary from 0 to 50 percent. Shallow slopes are found toward the center of the City, parallel to Silver Creek, and toward the northern City limit boundary. Steeper slopes characterize the east and western boundaries and generally drain toward Silver Creek. Soils data was retrieved from the NRCS Soil Survey website. Figure 2 in Appendix A shows the soil hydrologic soil groups and topography within the study area.

2.2.3 FLOOD HAZARDS AND WETLANDS

Generally, the 100-year and 500-year floodplain for Silver Creek is directly adjacent to the creek and does not extend beyond 500 feet from the channel for majority of the creek section running through the City. North of C Street however, the flood risk increases and extends to up to 1,000 feet from the creek channel. The majority of the City is located outside of any flood hazards. Flood hazards were retrieved from the Federal Emergency Management Agency (FEMA) Flood Hazard mapping. Figure 3 in Appendix A shows the flood hazards within the City of Silverton. For specific projects in these areas, the individual FEMA Flood Insurance Rate Map (FIRM) Panels should be referenced.

A local wetlands inventory (LWI) was completed for the City in 1998 that was accepted by the Department of State Lands (DSL). The LWI identified multiple wetlands within the study area totaling approximately 54 acres. Furthermore, "Locally Significant Wetlands" that contribute to water quality, hydrologic control, educational opportunities, recreational opportunities, enhancement potential, aesthetic quality, and impact sensitivity identified and included approximately 36 of the 54 acres. These wetlands include Webb Lake and surrounding area, wetlands within and around Oregon Gardens, Gossack Property, and Pioneer Lake. Most of the wetlands are classified as palustrine emergent wetlands which are vegetated by grasses and other non-woody, low growing plants. Streams, ditches, and other drainage channels make up the remainder of identified wetlands. A few of the designated wetlands within the City limits act as stormwater storage ponds including Webb Lake and Pioneer Lake. Webb Lake and Pioneer lake are classified as freshwater ponds. There is a freshwater forested/shrub wetland located north of Crestview Drive and additional freshwater emergent wetlands are located within the study toward the southern City limit boundary. Wetland mapping was indicated by 1998 local wetland inventory and Figure 4 in Appendix A shows mapped wetlands.

2.3 MAJOR DRAINAGE BASINS

Stormwater from the study area generally drains into three different receiving streams: Silver Creek, Abiqua Creek, and Brush Creek. The majority (approximately 60%) of the stormwater drainage area drains to Silver Creek. Approximately 30% of the area drains into Abiqua Creek, leaving the remaining 10% of the drainage area draining to Brush Creek. For this evaluation, Silver Creek was broken up into three major basins: Northeast Silver Creek, Southeast Silver Creek, and West Silver Creek. Abiqua Creek was broken into two major basins: Webb Lake and North Central Basin. Stormwater draining to Brush Creek does not drain through any of the modeled City stormwater components, therefore a major drainage basin was not delineated, and the area is not reflected in the table or figure below. This results in five major drainage basins to be evaluated in this study. The major drainage basin areas are summarized below in Table 2-2 and illustrated in Figure 5 in Appendix A.

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

	Northeast Silver Creek	Southeast Silver Creek	West Silver Creek	Webb Lake	North Central
Area (ac)	540	670	315	650	220
Percent of Total Drainage Area	23%	28%	13%	27%	9%

2.4 LAND USE

Land used within the City of Silverton consists of residential, commercial, industrial, public right-of-way (i.e. transportation roadways), and open space. Existing zoning for the study area is shown in Figure 1 in Appendix A. It is anticipated that future development will not substantially increase stormwater peak runoff rates since the recommended policy within the study area requires post-development runoff rates to be limited to pre-existing conditions unless it can be satisfactorily demonstrated by the applicant that there is no adverse impact to downstream properties. However, there may be recommended improvements to areas of future development where there is no existing stormwater infrastructure.

SECTION 3 - PLANNING CRITERIA

3.1 GENERAL

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

3.2 DESIGN STORM

The design storms were established to evaluate the existing stormwater system performance, and to assist in design of future improvements. Recurrence intervals, the total depth of rainfall, and duration of the storm event are important characteristics which define a design storm. Recurrence intervals are the average interval between successive storm events and can be expressed in annual probability of occurrence. For example, a 50-year storm has a 2 percent 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	2.5
5-Year	3
10-Year	3.5
25-Year	4
50-Year	4.5
100-Year	4.5

1) From NOAA Atlas 2, Volume 10

The temporal distribution of the design storm is an additional characteristic of the design storm that was considered. The temporal distribution is how the given amount of precipitation is distributed over the duration of the storm. The Natural Resources 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 shown in Figure 3-2 is used to approximate storm events for the Silverton region. It should be noted that the hyetographs are appropriate for approximating the distribution of the design storm. However, because it is an approximation, a real storm may not have the same uniform distribution to the maximum intensity shown in Figure 3-2.

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

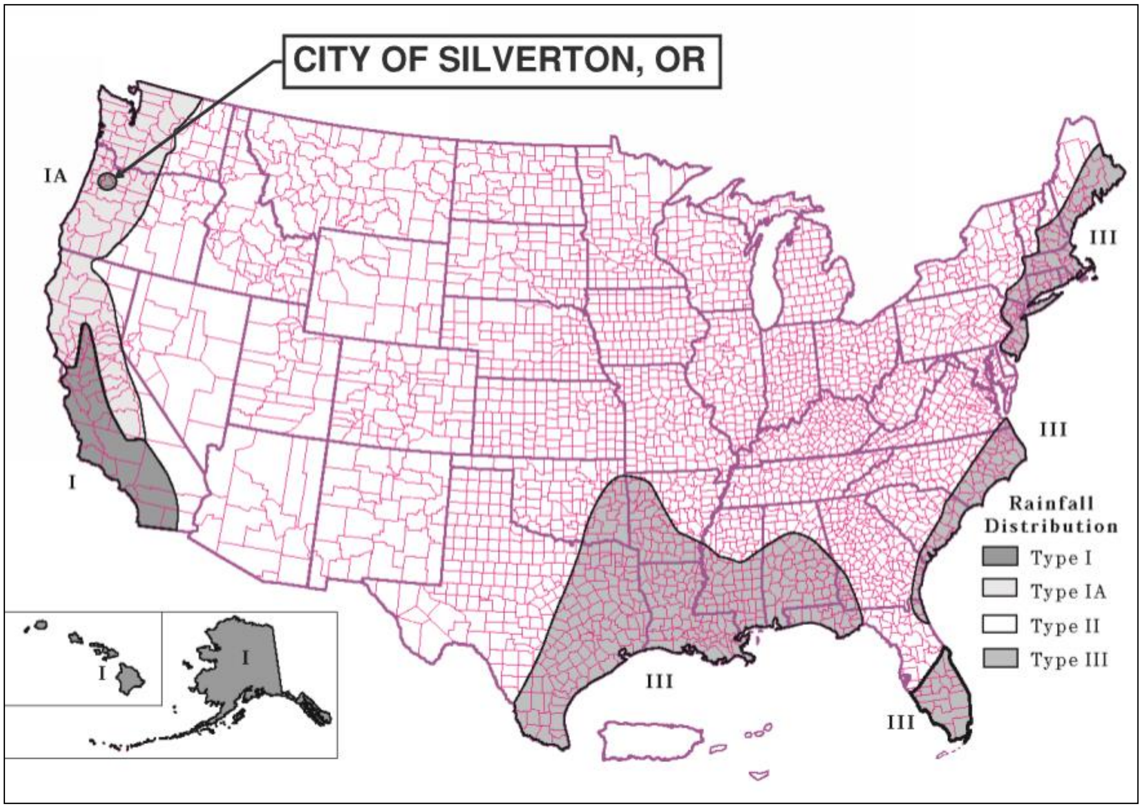
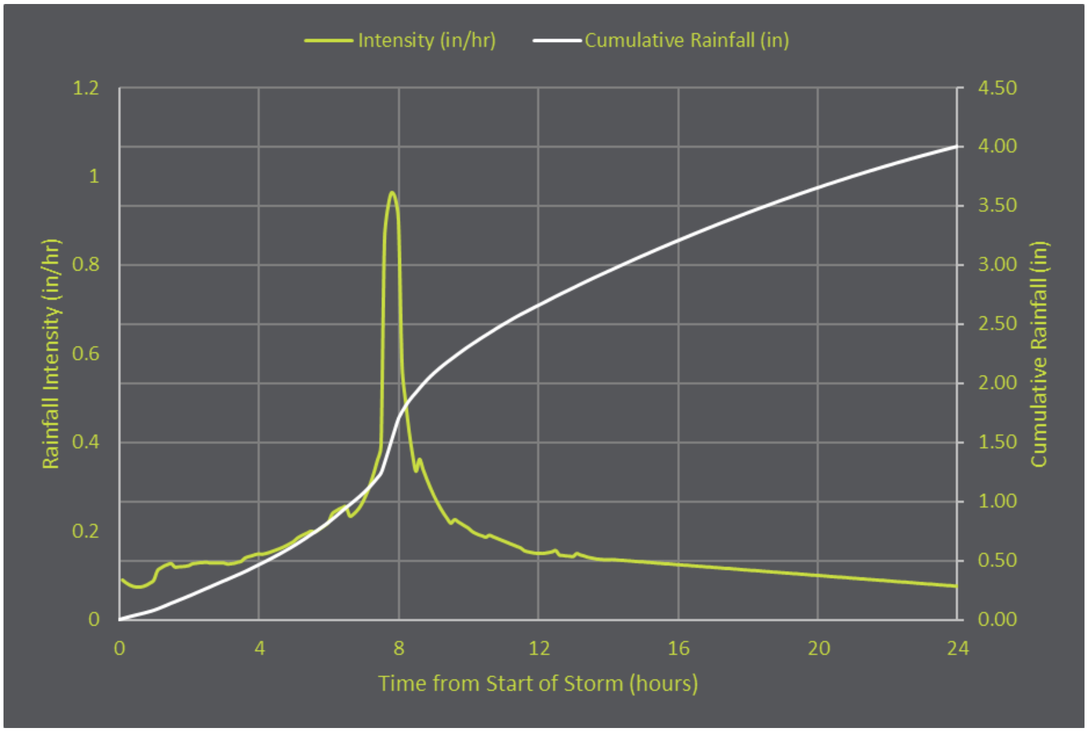


FIGURE 3-2: SILVERTON 25-YEAR STORM HYETOGRAPH



The NOAA isopluvial charts, NRCS hyetograph, and the basis of the SWMP do not assess impacts of potential changing climate for the planning period or beyond. In general, anticipated impacts to the designated storm events in the Pacific Northwest are increased frequency and intensity of storm events. Impacts to municipal stormwater infrastructure could be an increase in the frequency of storm events and potential increase to peak runoff during storm events. Estimating these potential changes is outside the scope of the study at this time. The City could include an exploration of updated and predictive storm event data as part of the next SWMP update process. Additionally, the City could review options to evaluate potential impacts during the predesign process of individual stormwater infrastructure projects.

3.3 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 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), the overall purpose of the evaluation. Some of the most common methods used in this region include the following:

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

These 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.

The NRCS TR-55 methodology is recommended to use in the characterization of the basins because this method is commonly used in the region and the characteristics of the study area fit within the methods limitations. The previous stormwater master plan from 2012 also used the NRCS TR-55 method and there has not been any changes to the system or parameters to warrant using a different method. 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 evaluate runoff or "loads" to the hydraulic portion of the model.

3.4 POLICIES AND STANDARDS

The City's policies and standards serve as the basis by which future storm drainage systems are constructed. The policies and standards provide guidance to developers building within Silverton's city limits and urban growth boundary. It is imperative for these documents to be consistent with the City's goals for effective stormwater management. The City's existing stormwater policies, design standards, and construction standards were reviewed as part of the master plan effort. Deficiencies identified and recommended updates are summarized in Section 7.

3.4.1 CONVEYANCE SYSTEM DESIGN STANDARDS RECOMMENDATIONS

A summary of neighboring communities existing stormwater planning criteria is shown in Table 3-3 (Page 3-6). The following summary of recommended revisions to the policies and design standards has 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. As seen in the table, the NRCS TR-55 runoff model approach is commonly used in neighboring communities and uses the NRCS Type 1A storm distribution. Municipalities often allow surcharging in the stormwater system as the consequences of flooding of the stormwater system are less than that of surcharging in a sanitary sewer system.

Silverton's existing design standards require stormwater conveyance components be capable of passing runoff from the 25-year storm event (equal to 4.0 inches within 24-hours). In this SWMP, deficiencies in the existing stormwater system and capital improvement projects were developed based on the existing conveyance design standards of passing the 25-year storm event. Conveyance system components were deemed capable of passing the design storm event if there was no flooding or surcharging to within 0.5 feet of the rim elevation of any structure. While this SWMP was developed based on existing design standards, the City would like to consider modifying the design standards for stormwater conveyance systems to be capable of passing runoff from the 50-year storm event (equal to 4.5 inches within 24-hours). For this reason, the planning criteria in Table 3-3 recommends stormwater conveyance components be capable of passing the 50-year storm. The City can consider updating the design standards and future SWMP updates could evaluate the system and recommend improvements based on the 50-year storm event in lieu of the 25-year storm event. A further review of the City's stormwater design standards is included in Section 7.

3.4.2 PIPE SLOPES

The 10 States Standards are generally accepted in the industry when calculating minimum pipe slopes. It is recommended to adhere to these standards which account for a minimum velocity of 2 feet per second for a full pipe (assuming a roughness of 0.013). Silverton's current engineering design standards require a minimum pipe velocity of 2.5 feet per second. Table 3-2 summarizes the minimum pipe slopes currently included in the City's design standards compared with the 10 States Standards. Adhering to the City's existing minimum slopes for stormwater pipes is recommended.

TABLE 3-2: MINIMUM RECOMMENDED PIPE SLOPES

Pipe Diameter (in)	10 State Standards Minimum Slope (%)	City of Silveton Minimum Slope (%)
12	0.22	0.3
15	0.15	0.23
18	0.12	0.18
21	0.1	0.14
24	0.08	0.12
27 & Larger	0.07	0.1

3.4.3 STORMWATER DETENTION FACILITY POLICY RECOMMENDATIONS

Stormwater detention facilities should be used to control stormwater runoff where development's include parking lots with 2,500 square feet or more of planned impervious area, where developments need flow control to prevent the capacity of the downstream system from being exceeded, or where developments include subdivisions with four or more units. The detention ponds and associated piping and control structures should be placed within the public right-of-way in order to maintain the facility. Detention ponds should be designed to pass the 25-year storm event and safely pass the 100-year storm event though a maintained overflow system. Detention ponds should limit post-development peak flows to be equal to the 5-year storm event pre-development peak flows unless it can be satisfactorily demonstrated that there will be no impacts to properties downstream. Additionally, the 2-year post-development peak discharge should equal the 2-year pre-development peak discharge.

3.4.4 STORMWATER QUALITY POLICY RECOMMENDATIONS

Stormwater quality treatment is recommended as part of each phase of development. Catch basins and detention pipes do not provide significant water quality treatment. Additional treatment devices are recommended to be included in each development and may include vegetated swales, extended dry basins, in-line filter systems, or other low impact development (LID) approaches. LID is an approach to land development (or re-development) that works with nature to manage stormwater as close to its source as possible. LID employs principles such as preserving and recreating natural landscape features and minimizing effective imperviousness to create functional and appealing site drainage that treat stormwater as a resource rather than a waste product. Additional discussion of LIDs is included in Section 7. Currently, the City does not have stormwater quality management design standards. It is recommended the City evaluate and develop stormwater quality design standards. Typically, this will include the development or adoption of a stormwater management manual (SWMM) in addition to stormwater quality design standards. Further discussion is included in Section 7.

3.4.5 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 Total Maximum Daily Load (TMDL) and water quality management plan (WQMP) in the Willamette Basin, Molalla-Pudding Subbasin, 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).

The City has a TMDL Implementation Plan which outlines management strategies to improve water quality. The City reports on management strategy progress annually and completes a plan review and revision process every five years. The City last completed an annual report for the reporting period July 2018–June 2019. Any review or revisions of the City's stormwater policies and standards should reflect current TMDL and WQMPs requirements as applicable.

TABLE 3-3: PLANNING CRITERIA SUMMARY

Planning Criteria						
Planning Criteria	**Silverton Recommended**	**Silverton (Existing)**	**ODOT**	**Salem**	**Newberg**	**Stayton**
Runoff Model Approach	NRCS TR-55 & Rational Method	Rational Method	NRCS TR-55	Rational Method, SBUH, SWMM, or NRCS TR-55	Rational Method, SBUH, SWMM, or NRCS TR-55	Multiple
Storm Distribution	24-HOUR, NRCS 1A	ODOT Zone 8 IDF	24-HOUR, NRCS 1A	24-HOUR, NRCS 1A	24-HOUR, NRCS 1A	Multiple
Min. Tc	5 Minutes	10 minutes	NS	5 minutes	5 minutes	Multiple
24 hr Storm Precipitation	NOAA	NOAA	NOAA	NOAA	NOAA	Multiple
PVC "n" Value	0.013	0.013	NS	Varies	0.013	0.013
Min. Pipe Diameter	12"	12"	12"	12"	NS	12"
Minimum Freeboard in Open Channels (ft)	1	NS	NS	1	1	1
Minimum Freeboard in Detention Facility (ft)	1	NS	1	1	1	1
Surcharging Allowed	To within 0.5 feet of the rim elevation	NS	To within 0.5 feet of the rim elevation	NS	To within 2 feet of the rim elevation	To rim elevation
Design Storm for Conveyance	50-Year	25-Year	10-Year	50-years	50-Year	25
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	100-year	25-Year	50-year
Detention Facility Peak Discharge	Meet the existing 5-year pre-development criteria as well as 2-year post development should equal the 2-year pre-development storm runoff	Limit post-development to the more stringent of the 5-year pre-development or the remaining downstream capacity.	NS	Limit post-development flows to be equal to or less than the pre-development flows during 10-year event	Limit backwater in downstream systems during 25-year event	Equal to pre-development for 2-,5-,10-, and 50-year storm. 25-year post-development equal to 10-year pre-development
Stormwater Quality Requirements	Develop stormwater quality standards and stormwater management manual fitting Silverton soil types	None	Follow ODOT Hydraulics Manual - Section 14	Stormwater Source Controls (Administrative Rule Ch. 109 Division 012)	Follow PW Design Standards	Portland SWMM and PW Design Standards
1) NS = none specified , SBUH = Santa Barbara Unit Hydrograph, ODOT = Oregon Department of Transportation, SWMM = Stormwater Management Model, IDF = Intensity-Duration-Frequency						

SECTION 4 - MODEL DEVELOPMENT

An accurate computer model of the stormwater system serves as a planning tool and provides the basis for a solid stormwater master plan (SWMP). The model also 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. Due to there being countless variables with broad ranges of reasonable values in each system, a well-coordinated and strategic data collection effort is required along with practical assumptions and good judgement for data that cannot be feasibly obtained. The software modeling package InfoSWMM (Suite 14.7, Update #2) was utilized to update the City's existing stormwater model. 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 consists of 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. The section below outlines the model update process, including data collection and how key assumptions were incorporated to develop the Silverton 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 for the City of Silverton.

4.1.1 BASIN AND BOUNDARY CONDITIONS

The previous SWMP delineated the area within the urban growth boundary into five major drainage basins as shown in Figure 5 in Appendix A. These five major drainage basins were further divided into subbasins and incorporated into the model. The previous basin delineations were reviewed in comparison with the most recent contour and land use data available from the City. Subbasin boundaries were adjusted as necessary based on the more recent data and generally only included adjustments where development has occurred since the last SWMP. The updated subbasin boundaries are shown in Figure 7 in Appendix A. The following assumptions were made for basin and boundary conditions:

- All upland stormwater not draining to known stormwater system components are assumed to drain directly to the receiving water body (Silver Creek, Abiqua Creek, Brush Creek, and tributaries of) and therefore, no hydraulic components were included in the model.
- Silver Creek and tributaries of Abiqua Creek were assumed to have sufficient capacity to handle all runoff discharged from the model outfalls and flooding of these features was not evaluated.
- Outfalls to Silver Creek were modeled with fixed stage base flood elevation (BFE) as taken from Federal Emergency Management Agency (FEMA) flood insurance rate map (FIRM) panels and FEMA's Flood Insurance Study (FIS) for Marion County. The 2-year event was assumed to be a free outfall while the 5-year, 10-year, 50-year, and 100-year storms had modeled fixed stage flood elevations from the Marion County FIS. The 25-year storm event flood elevation was interpolated between the 10-year and 50-year flood elevations. The 5-year

storm event flooding elevation was based on the 5-year water surface elevation (WSE) at the water treatment plant intake structure from the hydraulic report, which was completed for the replacement of the intake structure in March 2021. The WSE profile was traced upstream and downstream assuming the same slope as the 10-year flood profile from the FEMA FIS. All other outfalls were modeled as free discharge (no backwater).

- Detention ponds disconnected from any downstream collection networks were assumed to have sufficient capacity to handle all runoff discharged from the model outfalls.

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.

4.2 MODEL UPDATE

The previous stormwater model was updated to reflect changes to the existing stormwater system since the 2012 SWMP. The changes include improvements to the stormwater system and new development that has occurred since 2012. The most significant development occurred around Pioneer Lake where the fourth and fifth phases of the development were completed. This added additional trunklines along Meadow Avenue, Ike Mooney Road, and residential streets southeast of Ike Mooney Road. The City also completed upgrades to McClain Street where stormwater trunklines were installed from Main Street draining northwest to North James Street. Improvements were also made to N 2nd Street where 30-inch diameter pipes were installed from Lincoln Street to Hobart Road. The modeled stormwater system is shown in Figure 6 in Appendix A with trunklines added since the 2012 SWMP shown in yellow.

Selected manholes and catch basins within the stormwater system were surveyed to compare elevations and configurations in the stormwater model (based on current City GIS data) with the field data. Survey points were strategically selected where pipe alignment was unclear, where elevations may be in different vertical datums, or to assess the vertical datum of a pipe network. The hydraulic model components were updated accordingly from the survey data. The vertical datum used in the model is called the National American Vertical Datum 1988 (NAVD88).

Hydrologic parameters were updated as necessary as subbasin boundaries were changed by new stormwater infrastructure. Where basin boundaries were adjusted, the curve number (CNs) and times of concentration were re-calculated based on the new basin area. Hydrologic parameters of subbasins that did not have boundary updates were reviewed and compared with neighboring basins with similar land use. The CNs for some subbasins were adjusted to better represent the existing land use within the subbasin. The initial abstraction, which is the depth of rainfall that is caught in voids and depressions before reaching the stormwater system, was modified from the 2012 model to the default value as recommended in the NRCS TR-55 methodology and is based upon the subbasins CNs. The modification to the initial abstraction was done in order to be consistent with the NRCS TR-55 methodology. The time of concentrations were adjusted in the InfoSWMM model to match the peak runoff flows as calculated from the 2012 model. The times of concentrations were increased by a tiered factor with lower times of concentrations being adjusted the most and longer times of concentrations having minimal adjustment. Additional model calibration was completed using new flow monitoring data as described in the following sections.

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, as well as, 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 6 in Appendix A. Three of the four flow monitoring locations were placed at the same location as the flow monitoring from the 2012 SWMP. The fourth location was placed along Ike Mooney Road as there was no flow monitoring in this part of the stormwater system from the 2012 monitoring.

Monitoring was performed during the winter months because that is when larger storm events typically occur. The monitors were installed in early February 2021 and monitored flows for six weeks before being removed in late March 2021. Hach FL900AV flow monitors were used and recorded depth, velocity, and flow in 5-minute increments. The cumulative rainfall was also recorded with a rain gage in 0.01 inch increments at the water treatment plant (WTP) for the duration of the monitoring period. Note, the rain gage was knocked over during an ice storm event from February 12th through the 15th and rainfall data for this period of time is unavailable.

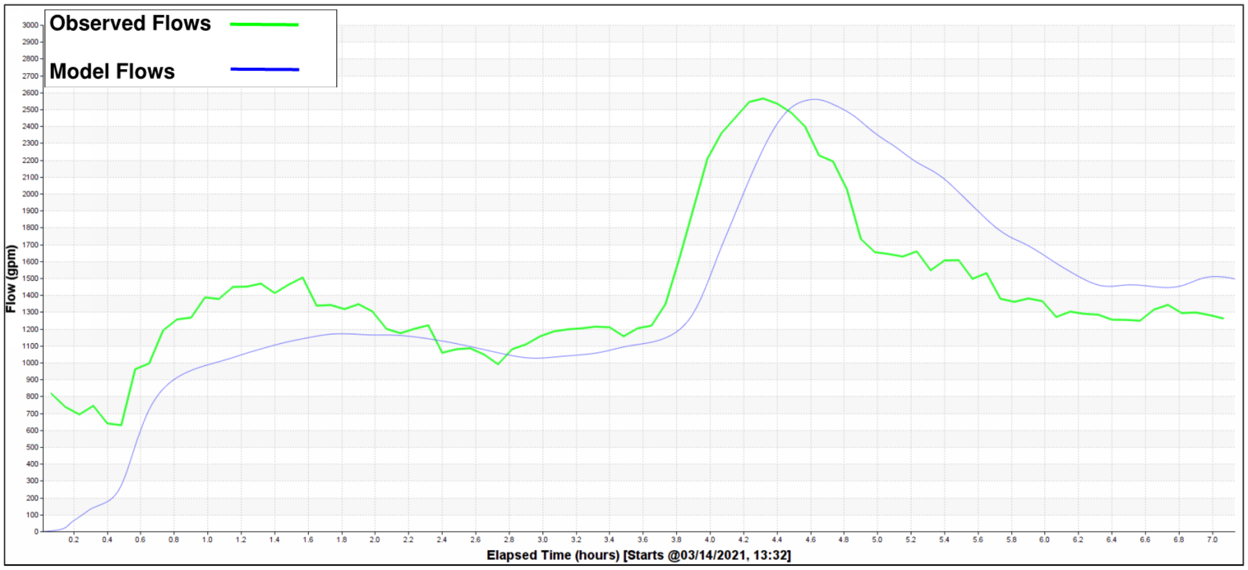
4.4 CALIBRATION

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 2.2 inches of rainfall during the monitoring period, with two events each over 0.4 inches and one event at approximately 0.3 inches. The highest of these three events (referred to as Event 2) was used to calibrate the model with a total cumulative rainfall of 0.49 inches over 8.5 hours and the other two storm events (referred to as Event 1 and Event 3) were 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). The rainfall data recorded was input 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 CNs of the sub-basins, and baseflows into the pipe network. Initial abstraction is typically calculated and is dependent on the CNs. The initial abstraction in this study was calculated using the TR-55 method. The CNs were increased for Site 1 and Site 2, decreased for Site 3, and no adjustments were made to Site 4. All adjustments were 5% or less change in CNs. Baseflows (representing 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.

The model did not require extensive calibration efforts as the model was calibrated for use in the 2012 stormwater master plan. Figure 4-1 shows an example of the final calibrated flow graphs for Site 4. The remaining sites and events can be found in Appendix B.

FIGURE 4-1: SITE 4 EXAMPLE FINAL CALIBRATION GRAPH



To calibrate the remaining subbasins, which do not contribute runoff to a flow monitor site, the characteristics were not adjusted from the 2012 model parameters besides the changes discussed in Section 4.2. The final step in calibrating the stormwater system model was to incorporate City staff knowledge and experience of their system. The 2-year and 5-year storm events were simulated in the model to identify area with flooding or 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 produces modeled peak flow slightly higher than observed peak flows to provide a conservative evaluation of the stormwater system.

SECTION 5 - EXISTING SYSTEM CONDITIONS

The City of Silverton's stormwater system consists of closed-conduit pipe, open-channels, catch basins, manholes, outfalls, and storage ponds. Runoff is routed to the stormwater system by various methods including curb and gutter, strategically placed catch basins, and using the natural topography in the City. The stormwater system is designed to convey the high runoff volumes from frequent storm events. The following section evaluates the existing stormwater system's ability to convey the design storm events based upon the planning criteria and model parameters discussed in previous sections.

5.1 EXISTING SYSTEM INVENTORY

The City's stormwater system consists of approximately 43 miles of closed conduit pipe and 25 miles of open channel. There are approximately 1,300 known catch basins, 150 cleanouts, 600 manholes, and 18 outfalls (as identified in the City GIS and include pipe outlets to ditch segments, etc.). There are two primary outfalls from the stormwater system aside from the 15 outfalls that directly go to Silver Creek. One, is at the northwest corner of the City on the west side of N James Street south of Jefferson Street that empties into a stream that eventually empties into Abiqua Creek. The second is north of Webb Lake on the north side of Hobart Road where three pipes empty into a small depression that drains to Abiqua Creek. The majority of the City's system is made up of polyvinyl chloride (PVC) and high-density polyethylene (HDPE) pipe material and the majority of pipe diameters range from 10-inches to 24-inches (62%), with the largest pipes being greater than 48-inches in diameter. The City's GIS database does not include an installation year for the pipelines; therefore, an inventory of the pipeline ages cannot be evaluated. It is recommended that the City update the GIS database as additional pipe information is acquired.

TABLE 5-1: EXISTING PIPE INVENTORY (LENGTHS IN FEET)

		Pipe Material							
		Concrete	PVC/HDPE	ADS	CMP	Ductile Iron	Unknown	Total	% of Total
Diameter (in)	≤6	50	20,040	4,450	70	70	5,870	**30,550**	**13%**
	8	1,010	10,680	470	0	410	8,170	**20,740**	**9%**
	10	6,820	16,090	0	0	750	7,270	**30,930**	**14%**
	12	10,580	32,320	30	10	860	8,910	**52,710**	**23%**
	15	1,930	8,050	0	0	30	2,760	**12,770**	**6%**
	18	4,600	11,180	0	270	670	5,390	**22,110**	**10%**
	21	730	1,690	0	10	0	260	**2,690**	**1%**
	24	3,440	10,050	320	60	90	3,430	**17,390**	**8%**
	30	3,690	4,330	0	0	200	490	**8,710**	**4%**
	36	780	2,910	0	1,100	90	0	**4,880**	**2%**
	≥48	150	6,210	0	2,590	0	0	**8,950**	**4%**
	Unknown	0	180	0	0	0	14,240	**14,420**	**6%**
	Total	**33,780**	**123,730**	**5,270**	**4,110**	**3,170**	**56,790**	**226,850**	**100%**
	% of Total	**15%**	**55%**	**2%**	**2%**	**1%**	**25%**	**100%**	**-**

There are 13 stormwater storage facilities throughout the system and the City assists with the maintenance of three of the ponds including the Abiqua Heights and the Oak Knoll ponds. The remainder of the storage facilities are maintained by the homeowners' associations (HOA). The storage facilities are described below:

- Webb Lake – The largest storage facility within the system and is a year-round lake. The lake is approximately 11 acres in surface area.
- Silver Cliff – Located in Silver Cliff Estates subdivision and is approximately 12,000 square feet in surface area. The pond drains into Olson's ditch which then flows into Webb Lake.
- Silverton Towne II Apartments – Consists of two ponds for a total of approximately 5,000 square feet in surface area.
- Silverton High School – Approximately 20,000 square feet in surface area south of Krominga Drive. The high school property drains into this pond which then outlets to the south into Silver Creek.
- Oak Knoll – Consists of two detention ponds with a total surface area of 7,000 square feet. The ponds are filled with water year-round.
- Abiqua Heights – Consists of two detention ponds in series for a total surface area of approximately 35,000 square feet. The pond is filled with water year-round, and the outlet on the south side of the large pond drains into Silver Creek.
- Pioneer Lake – Approximately two acres in surface area and holds water year-round. The pond drains out the stormwater system through the Pioneer Village Development and into the Ike Mooney Road detention pond.
- Ike Mooney Road – Downstream from Pioneer Lake and is approximately 8,000 square feet. An outlet structure with multiple orifices controls flows discharged downstream into Silver Creek.
- Eureka Avenue – Smaller detention pond and is approximately 1,000 square feet. The pond is located between Eureka Avenue and Edgewood Drive.
- Lewis Street – Located at the corner of Lewis Street and 1st Street and is approximately 1,500 square feet in surface area.
- E Main Street – Located at the intersection of E Main Street and E Park Street. The pond is approximately 7,000 square feet in surface area.
- Community Center – Consists of both a detention pond and vegetated swale. The total surface is approximately 1,500 square feet.
- Roth's – Located near Roth's grocery store, the storage facility is approximately 1,500 square feet.

5.2 DRAINAGE BASIN ASSESSMENTS

The following sections are separated based on the City's five major drainage basins. Each of the sections discuss the general characteristics of the basin and the deficiencies identified in the existing system evaluation. Deficiencies include areas identified as not complying with the defined planning criteria such as flooding, surcharging to within 0.5 feet of the rim elevation, pipes reaching the end of their useful life, or pipelines under existing structures.

Six design storm events were simulated in the model and include the 2-year, 5-year, 10-year, 25-year, 50-year, and the 100-year storm event. The 50-year and 100-year storm events have the same total precipitation depth (per NOAA isopluvial charts), therefore the results from the 50-year and 100-year storm events are considered to be the same. As specified in the planning criteria, this SWMP evaluates the conveyance system (e.g., closed-conduit pipes and open channels) to be capable of passing up to the 25-year storm event. Surcharging or flooding identified in the conveyance system during the 50-year or 100-year storm event were not considered deficiencies unless otherwise specified in this report. Cases where flooding or surcharging in the 50-year or 100-year storm event could be considered a deficiency is when there is significant risk and major consequences if flooding were to occur. For example, at high traffic intersections where flooding would cause significant transportation impairments or risks.

The scope of this study included identifying deficiencies and proposing solutions to the deficiencies identified 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 in this report.

5.2.1 SOUTHEAST SILVER CREEK BASIN

Southeast Silver Creek Basin is approximately 670 acres and consists of mainly residential developments and undeveloped areas, which are covered by timber stands and some agricultural crops. The basin generally drains from the east and west boundaries to the middle of the basin where the residential developments have taken place. Flows are then routed through the development's stormwater conveyance system into Silver Creek. This basin includes two storage ponds and one of the ponds, Pioneer Lake, has been identified by the City as a problem area. Pioneer Lake is owned and maintained by the homeowners' association (HOA) with the exception of the outlet structure which is maintained by the City. When Pioneer Lake was incorporated into the Pioneer Village stormwater system, it was not properly lined with an impermeable layer. The City has seen flooding across Lakeview Drive from water seeping through the bottom or walls of Pioneer Lake. This specific problem was not included in the stormwater model, but improvements to address this deficiency will be discussed in later sections.

Two separate stormwater systems exist in this basin: a larger network consisting of approximately three miles of modeled conduit and a smaller network consisting of approximately one-third of a mile of modeled conduit. Flooding was projected in the two manholes upstream of the Silver Creek outfall and downstream of the detention pond off of Ike Mooney Road. This flooding is from backwater from Silver Creek's base flood elevation (BFE). Starting at the 100-year storm event, additional flooding was identified throughout the Pioneer Village development as shown in Figure 8 in Appendix A, however, as stated, this is not considered a deficiency. No additional flooding locations were identified in the Southeast Silver Creek Basin.

5.2.2 NORTHEAST SILVER CREEK BASIN

Northeast Silver Creek Basin encompasses approximately 540 acres and includes the area on the east/north side of Silver Creek that drains to the creek and is not included in the Southeast Silver Creek basin. Land within this basin is mostly developed with residential and some commercial development in the downtown area. Runoff naturally flows from north to south and then to the northwest toward Silver Creek. Developed areas intercept runoff and convey flows into Silver Creek through the existing stormwater system. This basin has two storage facilities: one toward the northeast basin boundary in Abiqua Heights and the other downstream of Silverton High School. Pipe networks not draining to storage facilities are discharged directly into Silver Creek. As stated in the 2012 SWMP, a significant amount of stormwater infrastructure within this basin is reaching the end of its useful life and improvements for age as well as capacity may be recommended. There are two locations where flooding occurs in existing trunklines from Silver Creek's BFE; the trunklines are not under sized for the projected peak flows. There are multiple areas within this basin where the City has seen historical flooding, for example, the City has seen significant flooding in the Abiqua Height development upstream of the storage pond. The model outputs also show flooding beginning in the 10-year storm in these segments of pipe. The City has also seen historical flooding along Koons Street to Cliff Court. There are no modeled pipes in this area northeast of Water Street, however, flooding was projected at Water Street and Koons Street in the 100-year storm event. Improvements will be evaluated to alleviate flooding upstream of Water Street to Cliff Court. Many improvements have been made to the stormwater system along Sheridan Street to its outfall at Silver Creek. This pipe network was not included in the model, but improvements will be evaluated to address existing deficiencies. The following additional locations were identified as undersized pipes for the design storms and **bolded** items (typical) represent areas where the City has seen flooding in the past. The flooding locations are summarized below (with the design storm where flooding is first predicted to occur indicated in parentheses) and illustrated in Figure 8 in Appendix A.

- S 3rd Street and Jersey Street to Mill Street and B Street (2-year)
- Silverton High School (5-year)
- Abiqua Heights, upstream of storage pond (10-year)
- Adams Avenue (10-year)
- Koons Street from Cliff Court to Water Street (25-year)
- Silverton High School, Kromminga Drive (25-year)
- Sheridan Street to the outfall at Silver Creek (city identified flooding)

The majority of the flooding identified in the model is a result of undersized pipes which cause water to back-up and flood upstream manholes. There are additional areas where localized ponding may occur because of a lack of stormwater infrastructure throughout the older parts of the City. It should be noted, the stormwater network draining Silverton High School is not maintained by the City. The City is not aware of any issues in the stormwater system.

5.2.3 WEBB LAKE BASIN

Runoff within the Webb Lake Basin is directed into Webb Lake where water then drains out from the north side of the lake to a small tributary of Abiqua Creek. It is located in the northeast part of the City and consists of approximately 650 acres. The basin consists of a mix of residential, industrial, and agricultural land use. Key infrastructure in this basin includes Olson's Ditch and ditch and culvert sections along Monitor Road which drain from the north side of Oak Street to Webb Lake. The City has historically seen problems around Steelhammer Road. The City's water treatment plant (WTP) currently discharges backwash and other plant operation water into the stormwater system on Main Street and Ames Street. The backwash flows were recorded in the flow monitoring period and peak flows range from six to seven cubic feet per second (cfs) for approximately 15 minutes. Additionally, there is a second level of observed flow equal to approximately one cfs for about three hours. Improvements at the WTP are currently underway, which will significantly reduce the amount of flows discharged to the stormwater system, therefore, the backwash influent was not included in the existing capacity evaluation. Additional discussion of potential WTP flow reduction and impacts on proposed alternatives in the basin are discussed in Section 7. Areas identified as flooding in the Webb Lake Basin are shown in Figure 8 in Appendix A and summarized below:

- Norway Street and Oak Street (2-year)
- Crestview Drive (2-year)
- Oak Street and Iowa Way (2-year)
- Olson's Ditch at Sage Street (2-Year)
- E Main Street, by WTP (5-year)
- Breyonna Way (5-year)
- Thyme Loop (5-year)
- N 2nd Street and Lincoln Street (10-year)
- Steelhammer Road and Levi Lane (10-year)
- Mill Street (25-year)

There are numerous residential developments where detention pipes were installed to limit post-development flows. Based on the numerous development stormwater reports, the detention storage pipes were only sized to store runoff from the area within the proposed development. The developments should also consider the contributing area upstream in the subbasin when sizing detention pipes. The detention pipe outlet control structures limit some of the flooding which would otherwise be occurring downstream in this basin. Other areas which flood are a result of underside pipelines and backwater is flooding at upstream manholes.

5.2.4 NORTH CENTRAL BASIN

The North Central Basin is approximately 220 acres and includes residential, commercial, and industrial land use. This basin is at the bottom of the valley and has gradual slopes to the northwest. The basin consists of two main trunklines, one running along Water Street draining northwest to James Street and the other smaller trunkline runs parallel with James Street toward the intersection with Jefferson Street. This basin contains a private property which historically has detained stormwater and was identified in the local wetlands inventory in 1998 (Gossack Property). Detention at this property has been estimated from a topographic survey completed by the property owner in 2016 as well as more detailed modeling of the system in this area completed by Keller Associates for the City of Silverton outside of this master planning project. The City reported flooding along N James Street from Schlador Street to Jefferson Street. The City also has seen flooding along N 2nd Street and at the Gossack Property. Flooding areas identified for the North Central Basin are shown in Figure 8 in Appendix A and include the following general locations:

- Lone Oaks Loop and 2nd Street to Bowtie Lane (2-year)
- Davisson Baseball Fields (downstream of Gossack Property) (2-year)
- N James Street and Schlador to Western Avenue (2-year)
- N 1st Street from High Street to Bowtie Lane (10-year)

Except for the Davisson Baseball Fields, most of the flooding is occurring at the upstream segments of the trunkline before pipe diameters increase. James Street has a 12-inch bottleneck before discharging to an open channel. The City has not seen flooding along N 1st Street, and this area was not identified as a problem area in the 2012 SWMP, however, the updated model projects flooding starting in the 10-year storm event.

5.2.5 WEST SILVER CREEK BASIN

West Silver Creek Basin lies on the opposite side of Silver Creek from the other major drainage basins and generally drains from south to north into Silver Creek. The basin consists of a significant amount of commercial and residential land use and includes four modeled pipelines. The City has seen flooding in the parking lot between McClaine Street and Westfield Street. The model projects flooding downstream of this parking lot due to an undersized 12-inch pipe. Flooding occurs at the outfall off of Monson Road and the outfall north of Brook Street from backwater from Silver Creek. The deficiencies identified in the model are provided in Figure 8 in Appendix A and are summarized below:

- McClaine Street and Railway Street (2-year)
- Monson Road (2-Year)
- Westfield Street and McClaine Street (10-year)
- Between Silverton Road NE and Railway Street (10-year)

Monson Street consists primarily of open channel and the modeled open channels are undersized for the projected flows. The existing pipes directly downstream of McClaine Street and Wilson Street are undersized and flooding occurs at a single manhole. The remaining flooding locations also appear to be undersized and flood in the upstream manholes. It should be noted, Monson Road is not maintained by the City and is maintained by Marion County.

SECTION 6 - ALTERNATIVES ANALYSIS

The section below discusses solutions intended to resolve system deficiencies identified in Section 5. In general, one to two alternatives were evaluated for each of the identified problem areas. Alternatives considered in this evaluation included parallel/replacement of conveyance systems, flow rerouting, and detention storage facilities. New pipelines were sized to convey the peak flow during a 25-year storm event with a d/D of less than 1 (e.g., no surcharging in the new pipes), unless otherwise mentioned in the project descriptions. 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.

6.1 SOUTHEAST SILVER CREEK

As discussed in Section 5, no capacity related deficiencies were identified in the Southeast Silver Creek drainage basin. The storage facilities and hydraulic conveyance network are appropriately sized to convey the 25-year, 24-hour design storm event. Flooding was identified in the downstream segments of the pipe network because of backwater from Silver Creek's modeled fixed flood elevation. Improvements to address flooding from Silver Creek was not included in the scope of this study.

Historical issues were identified by the City at the Pioneer Lake storage pond. Water seeps from the sides and the bottom of the pond and resurfaces in between residential structures and along Lakeview Drive on the southeast side of the pond. Two alternatives are recommended to address the excess seepage from Pioneer Lake.

Alternative 1 – Install an impervious liner on the sides and bottom of Pioneer Lake to prevent seepage out of the pond.

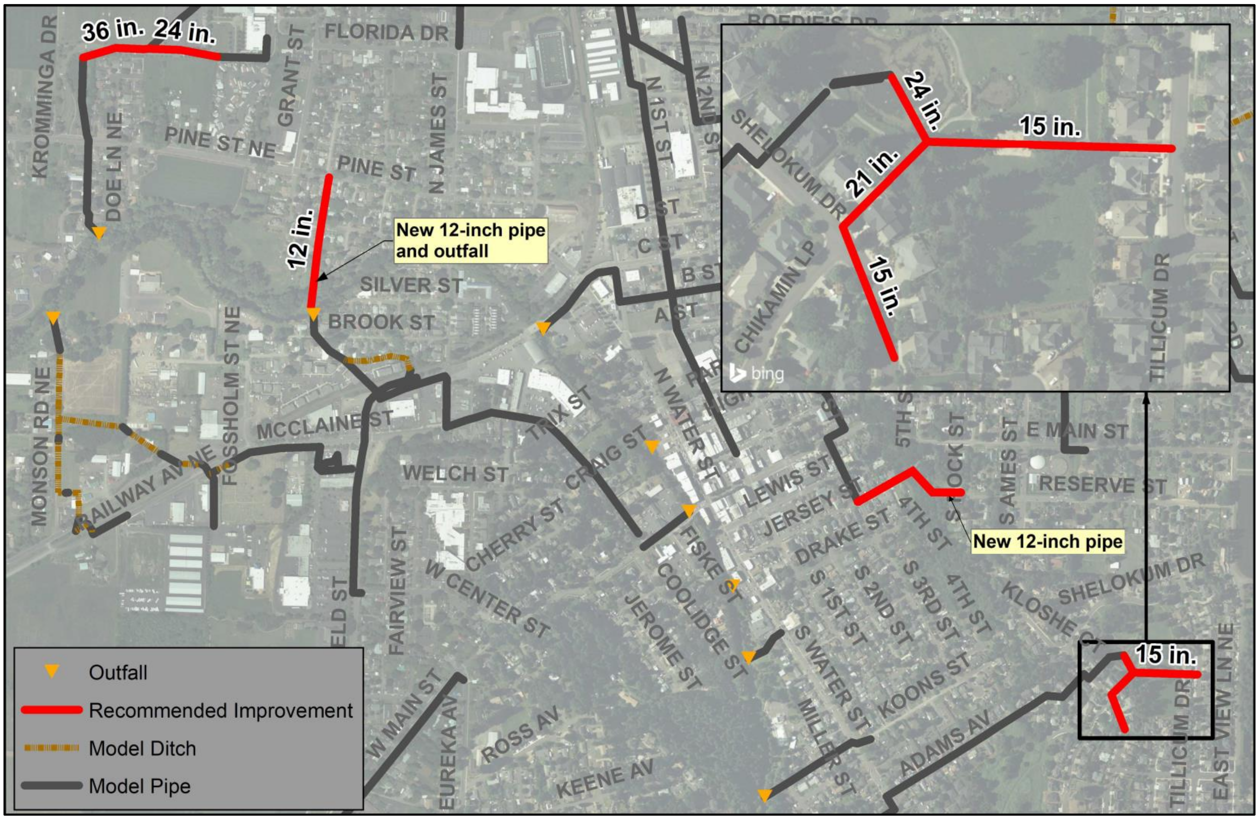
Alternative 2 – Install an infiltration trench in the area with known seepage to collect water and direct it into the existing stormwater conveyance network. A French drain or other type of pervious conveyance system is recommended to collect the water.

Recommendation – Alternative 2 requires the least amount of ground disturbance and is less costly, however, installing a drainage system such as this could result in complete drainage of Pioneer Lake. Alternative 1 would require draining Pioneer Lake while the liner is installed. Installing a liner may also eliminate any existing infiltration which naturally occurs to empty the pond when the water surface is below the outlet structure. It is recommended that a geotechnical investigation be completed to determine the root cause of the seepage across Lakeview Drive. Results from the geotechnical investigation should be used to determine the most effective alternative listed above or if any additional improvements should be considered. Note, the City does not own or maintain the Pioneer Lake storage pond; therefore, the City should coordinate with the owners of the lake to implement this improvement.

6.2 NORTHEAST SILVER CREEK

Several capacity-related deficiencies were identified within the Northeast Silver Creek drainage basin. A number of these deficiencies were identified as historical flooding locations by the City, and one of these locations reported by the City included flooding along Koons Street from Cliff Court to Water Street. Multiple, feasible alternatives were not identified to address the deficiency areas shown below in Figure 6-1. It is recommended to upsize the existing pipe networks to address these deficiencies, such as a new 12-inch pipe along Sheridan Street from Pine Street to a new outfall. The City's GIS indicates an existing 18-inch pipeline along Koons Street and the model results show this pipeline has sufficient capacity to convey the peak flows. It is recommended that this pipeline be inspected to identify potential blockages or other maintenance related issues resulting in flooding.

FIGURE 6-1: NORTHEAST SILVER CREEK RECOMMENDED UPSIZING



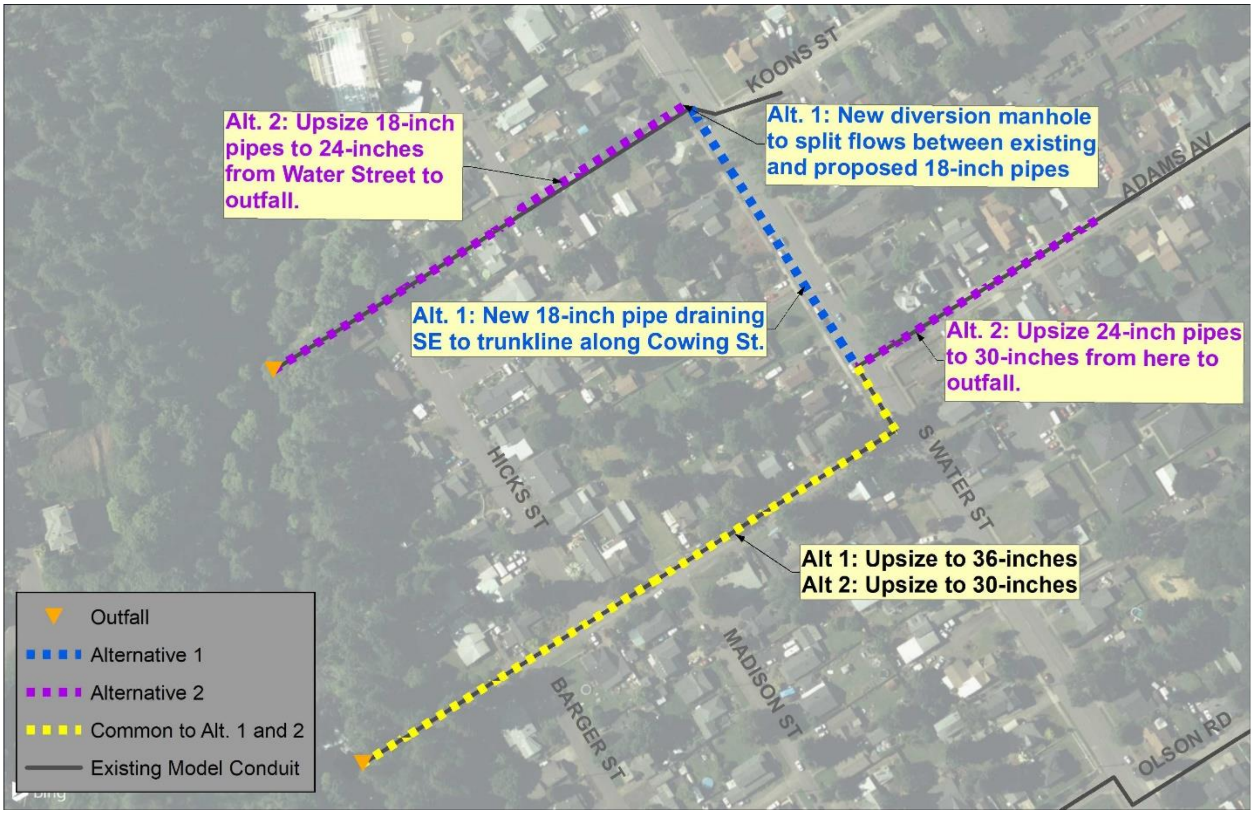
6.2.1 ADAMS AVENUE, KOONS STREET, AND COWING STREET ALTERNATIVES

Two alternatives were evaluated for the recommended improvements along Adams Avenue, Water Street, and Koons Street. The two alternatives are summarized below and are illustrated in Figure 6-2. Both alternatives would include upsizing the existing pipes along Water Street and Cowing Street to the outfall. Alternative 1 upsizes the pipe to 36-inches and Alternative 2 upsizes the pipe to 30-inches.

Alternative 1 – Install new 18-inch pipe along Water Street re-routing flows from Koons Street to an upsized 36-inch pipe along Cowing Street to the outfall.

Alternative 2 – Upsize the 24-inch pipe to 30-inches along Adams Avenue to Water Street and to the outfall. Additionally, upsize the pipes downstream of Koons Street from 18-inches to 24-inches.

FIGURE 6-2: ADAMS, KOONS, AND COWING STREET ALTERNATIVES



Recommendation – Alternative 1 requires less total length of upsizing and the project would be completely within the existing right-of-way. This alternative includes the construction of a new pipeline along Water Street and would require an alignment which satisfies the setback requirements for existing utilities. Alternative 2 consists of upsizing pipes within the existing alignments and trenchless pipe installation techniques could be considered. However, the total length of pipe upsizing is greater than Alternative 1. Alternative 1 is recommended because of the reduced length of pipeline improvements and corresponding lower capital cost.

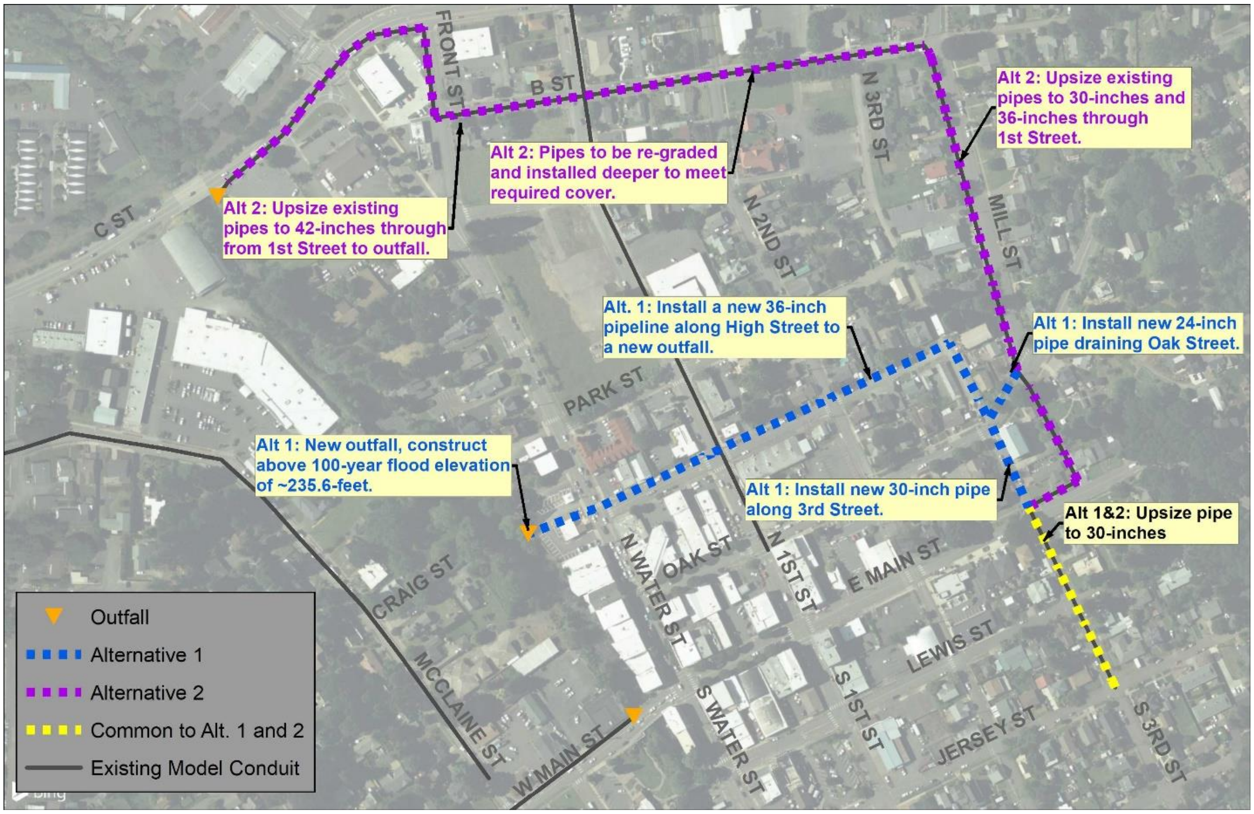
6.2.2 MILL STREET AND B STREET ALTERNATIVES

Two alternatives were evaluated to correct deficiencies identified along N 3rd Street to the outfall along C Street. The two alternatives are summarized below and illustrated in Figure 6-3.

Alternative 1 – Install a new 36-inch pipe from the intersection of N 3rd Street and Oak Street draining north along N 3rd Street, then west along High Street to a new outfall into Silver Creek. Upstream pipes along S 3rd Street from Jersey to Oak Street should be upsized to 30-inches and realigned within the 3rd Street right-of-way. Additionally, install a new 24-inch pipe draining Oak Street to the new trunkline.

Alternative 2 – Similar to Alternative 1, upsize the existing stormwater pipes along S 3rd Street and Mill Street from Jersey Street to B Street to 30-inches and 36-inches. Upsize the existing stormwater pipes from along B Street from Mill Street to N 1st Street to 36-inches. Upsize the existing stormwater pipes from N 1st Street to the outfall with 42-inch pipes.

FIGURE 6-3: MILL STREET AND B STREET ALTERNATIVES

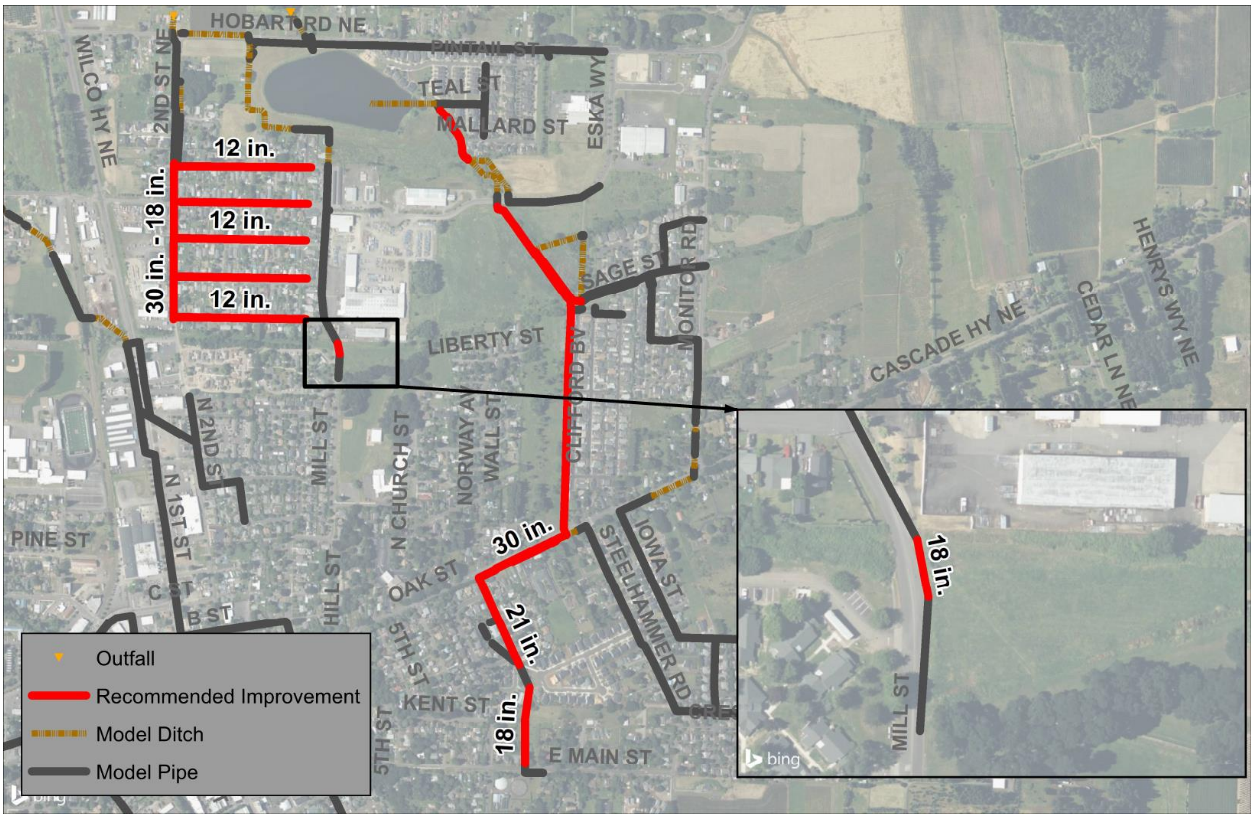


Recommendation – Alternative 1 creates a new outfall off of High Street into Silver Creek and would require additional permitting through the Army Corps of Engineers (USACE), Oregon Department of Lands (DSL), and Oregon Department of Environmental Quality (DEQ). Alternative 2 would require a similar level of effort for permitting because the pipeline would need to be upsized through the outfall. Alternative 1 consists of less overall length of pipe to be upsized and the largest diameter pipe is 36-inches. Alternative 1 is recommended because it requires less overall pipe installation, and the outfall should be constructed above the ordinary high-water mark (OHW) to minimize the amount of permitting required.

6.3 WEBB LAKE BASIN

Several improvements recommended within the Webb Lake Basin were evaluated to have a single, feasible alternative which generally consisted of upsizing the existing trunklines. A 10-inch bottleneck along Mill Street should be replaced with an 18-inch pipe to match the upstream and downstream pipe diameters. On N 2nd Street, the trunkline should be extended south along N 2nd Street to Whittier Street with pipes ranging in diameter from 18-inches near Whittier Street to 30-inches at Lincoln Street. Additionally, 12-inch trunklines should be installed along the Lincoln St, Jefferson St, Washington St, Chester St, and Whittier St to collect stormwater and convey into the new trunkline. The pipes from Main Street near the water treatment plant are undersized and should be upsized along Norway Street and Oak Street to Steelhammer Road. One of the more significant projects includes improving Olson's Ditch downstream of Oak Street and at Silver Creek Estates because a high volume of flow is being routed down Olson's Ditch. Energy dissipators such as check dams or rip rap should be installed throughout the ditch to prevent further erosion and high velocity flows. The channel downstream of Silver Creek Estates was indicated as overcapacity in the hydraulic model when flooding is alleviated upstream and because historical flooding has not been seen by the City, a more detailed survey and open channel hydraulic analysis should be completed on the ditch to assess the capacity of the ditch section. Water quality features should also be considered throughout the ditch section. The channel northwest of Sage Street was identified as wetlands by the USFWS, which means permitting through the USACE, DSL, and DEQ will likely be included with this improvement. Improving Olson's Ditch will slow the existing erosion of the ditch and also provide the City with opportunities to address water quality and prevent any future erosion within the ditch if it were not to be improved. The ditch segments from Oak Street to Eska Way and from north of Eska Way to Teal Drive should be surveyed to confirm they have the capacity to convey the peak flows. Given the existing model slopes, the approximate ditch dimensions to convey the design storm should be 4-feet in depth (provides for 1-foot of freeboard), 10-feet wide from bank to bank, approximately a 2H:1V sloped sides. More detailed descriptions of each of the improvements are discussed in Section 9. The proposed improvements are shown in Figure 6-4 below.

FIGURE 6-4: WEBB LAKE BASIN RECOMMENDED UPSIZING



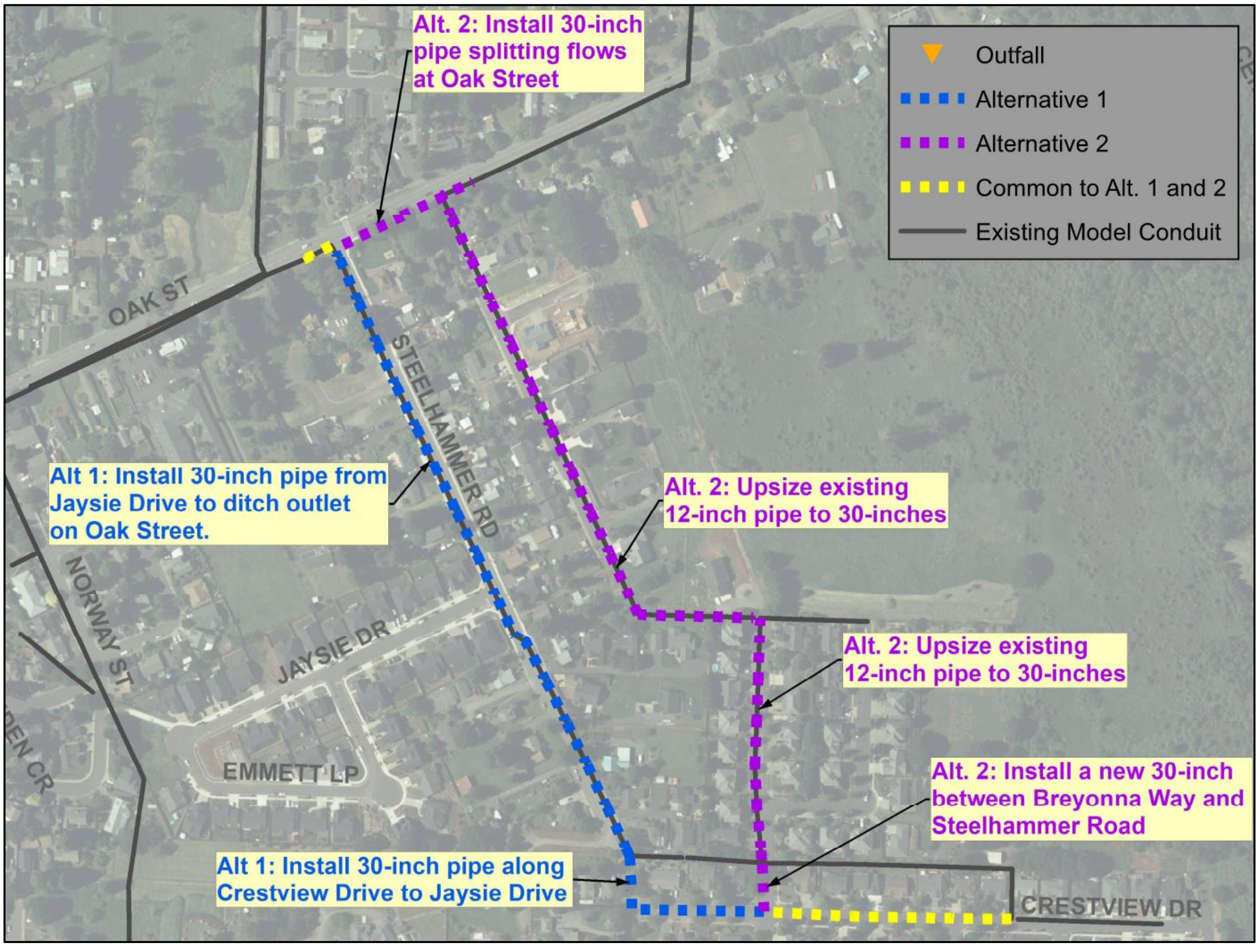
6.3.1 CRESTVIEW DRIVE, IOWA STREET, AND STEELHAMMER ROAD ALTERNATIVES

Two alternatives were evaluated to address the flooding identified along Crestview Drive, Iowa Street, and Steelhammer Road. The two alternatives are summarized below and illustrated in Figure 6-5.

Alternative 1 – Install a new 30-inch trunkline along Crestview Drive draining the existing detention pipe and upsize the existing pipes along Steelhammer Road to 30-inches. Upsize the 24-inch pipe draining southwest on Oak Street, which discharges into the ditch, to 30-inches.

Alternative 2 – Similar to Alternative 1, install a new 30-inch trunkline along Crestview Drive but install a new 30-inch trunkline draining north along Breyonna Way. Continue with the new 30-inch pipe north along Breyonna Way, to Iowa Street and split the flows at Oak Street through the existing ditch draining to the northeast and through a new 30-inch pipe draining southwest toward Olson's Ditch. Upsize the pipe on the southwest corner of Steelhammer Road and Oak Street with a 30-inch pipe.

FIGURE 6-5: CRESTVIEW, STEELHAMMER, AND IOWA STREET ALTERNATIVES

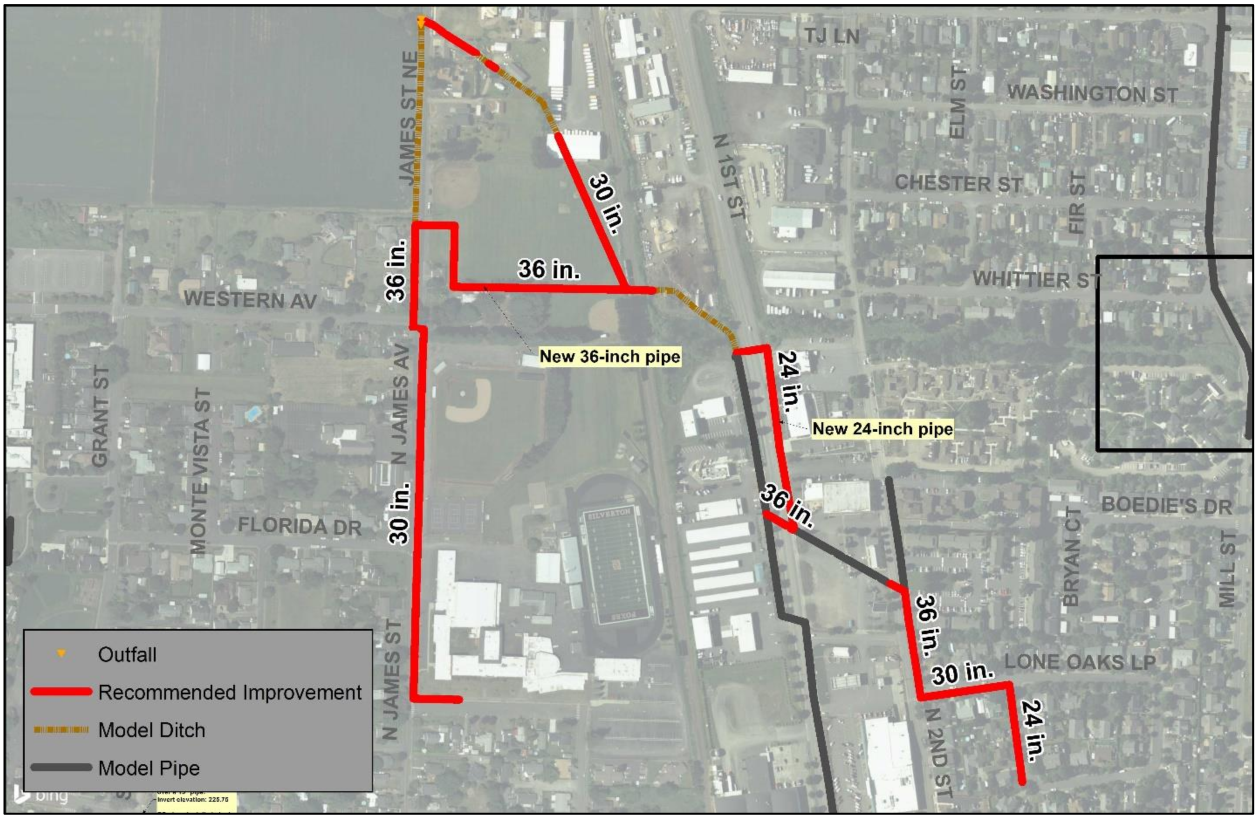


Recommendation – Alternative 1 consists of less overall length of pipe upsizing but this alternative replaces the recently installed 18-inch pipe along Steelhammer Road from Jaysie Drive to Oak Street. Alternative 2 consists of a greater overall length of upsized pipe but does not replace the new 18-inch pipe along Steelhammer Road and has potential to develop the east side of Iowa Street. Alternative 2 is recommended to replace older pipe and provide opportunity to upgrade Iowa Street. However, both these alternatives require improvements to the downstream Olson's Ditch.

6.4 NORTH CENTRAL BASIN

Several pipes are recommended to be upsized within the North Central Basin. Additionally, some new pipes are recommended to split flows between existing conveyance networks. A new pipe is recommended to be installed parallel to the existing trunkline along N 1st Street. An additional new pipe is recommended to be installed upstream of the Davisson Baseball Fields to prevent excess upsizing of the existing pipe network draining to the outfall west of James Street. The recommended upsizing and new pipes are shown below in Figure 6-7.

FIGURE 6-6: NORTH CENTRAL BASIN UPSIZING



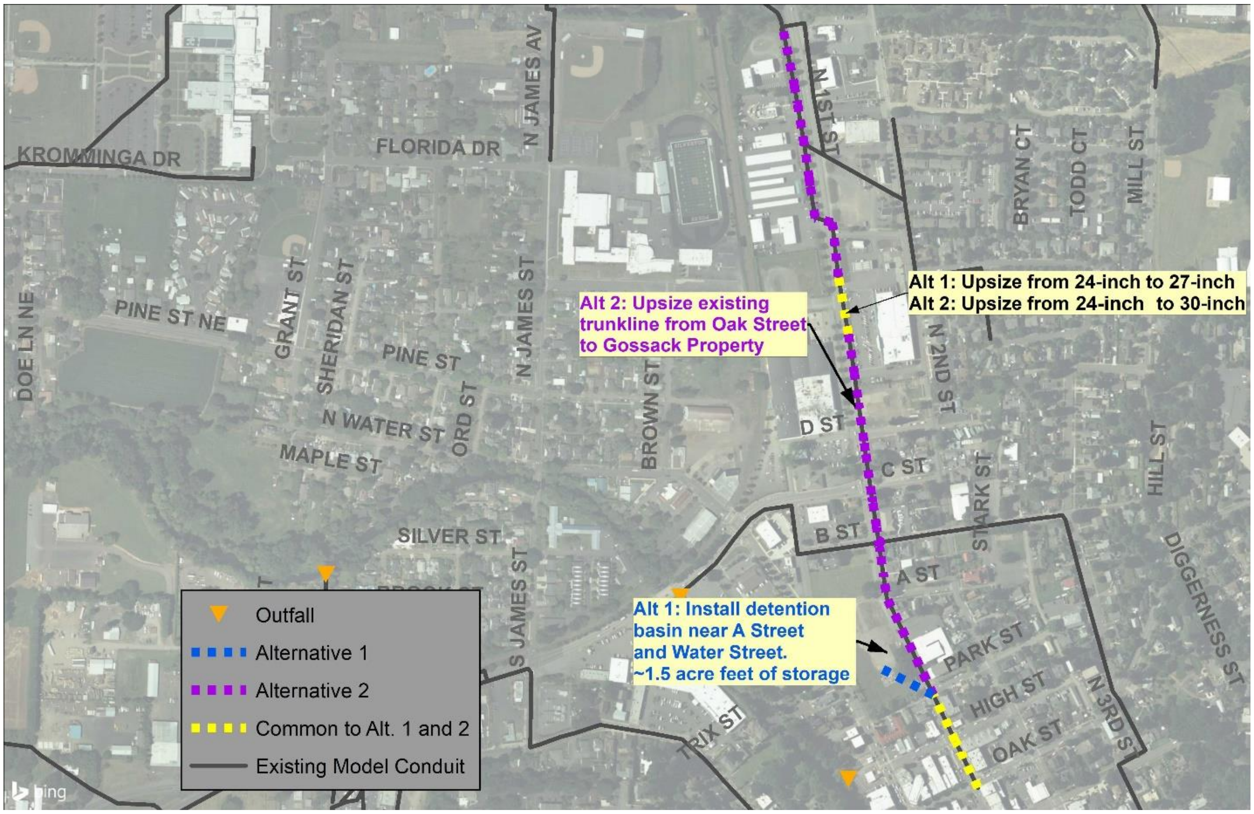
6.4.1 NORTH 1ST STREET ALTERNATIVES

Additional alternatives were evaluated in the upstream pipe network along N 1st Street. This trunkline was indicated as undersized, and two alternatives were evaluated to address the deficiencies. The two alternatives are summarized below and illustrated in Figure 6-8.

Alternative 1 – Upsize the existing 18-inch pipes along N 1st Street from Oak Street to Park Street to 21-inches and install a new storage pond at the corner of A Street and Water Street. This property has been identified by the City to be the location for the new City hall and a park/stormwater facility. The modeled storage volume to minimize upsizing along N 1st Street is approximately 1.5 acre-feet. This reduces downstream upsizing required and reduces peak flows by approximately 4,000 gpm (11.2 CFS). There is a single 24-inch segment of pipe which should be upsized to 27-inches to limit surcharging and flooding in the trunkline. Upsizing this pipe to 27-inches does not alleviate all surcharging in the trunkline, but the HGL is below 0.5 feet of the rim elevation. If this pipe is upsized to 30-inches, the pipe does not surcharge, however, the downstream pipes are 27-inches, and it would create a bottleneck. For this reason, a 27-inch pipe is recommended, and it utilizes allowable surcharging in the pipelines.

Alternative 2 – Upsize the existing stormwater trunkline from Oak Street to Park Street to 21-inches, similarly to Alternative 1. Upsize the pipes from B Street to Bowtie Lane to 30-inches. Upsize the pipes from Bowtie Lane to the Gossack Property to 42-inch pipes.

FIGURE 6-7: NORTH 1ST STREET ALTERNATIVES

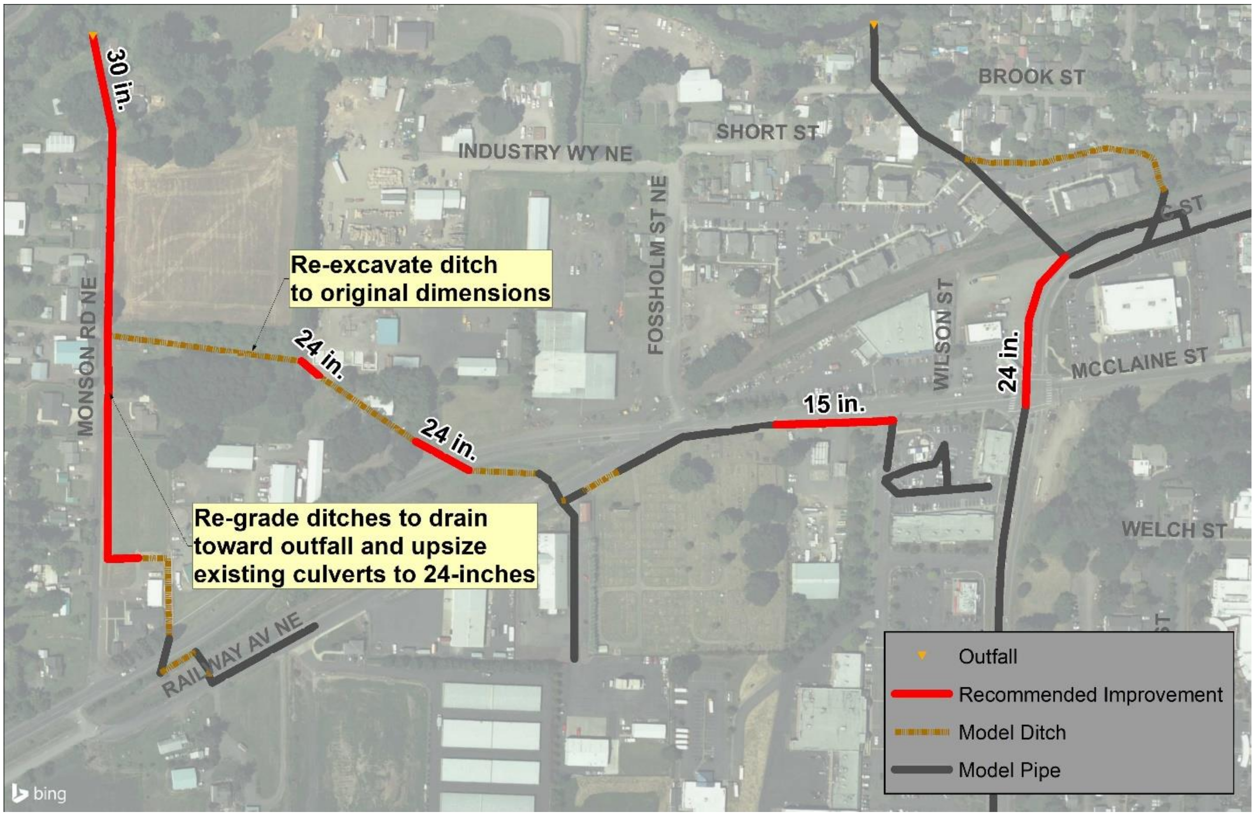


Recommendation – Alternative 1 requires significantly less length of pipe to be upsized because of the proposed storage. The storage pond may require additional annual maintenance, however, peak flows to the downstream network are lowered enough to minimize the need for upsizing downstream on N 1st Street. For these reasons, Alternative 1 is recommended to alleviate potential flooding along N 1st Street.

6.5 WEST SILVER CREEK BASIN

Flooding identified in the West Silver Creek Basin was generally addressed by upsizing the existing pipes and culverts. Although, some ditch improvements are recommended along Monson Road where adverse grades route flows away from the outfall. Additionally, the ditch from McClaine Street draining toward Monson Road should be improved to convey peak stormwater flows without backing up. This ditch is within Marion County and the County should coordinate with the property owners to implement the proposed improvements. A more detailed description of each of the recommended upsizing is provided in Section 9. Figure 6-9 illustrates the recommended pipe upsizing in this basin.

FIGURE 6-8: WEST SILVER CREEK BASIN RECOMMENDED UPSIZING



SECTION 7 - DESIGN STANDARDS AND LOW-IMPACT DESIGN (LID)

The City of Silverton's existing stormwater design standards were reviewed for new development as they pertain to stormwater conveyance and water quality to identify potential deficiencies and provide recommendations for updates. A summary of the review and recommended updates are described in this section.

The following documents were examined during this review effort:

- Silverton Public Works Design Standards | Division 1 – General Requirements
- Silverton Public Works Design Standards | Division 3 – Stormwater Management
- Appendix A, Standard Details | Division 3 – Stormwater Management

Note that the recommendations below do not include legal services. Developing draft language and development details for revisions to the comprehensive plan, municipal code, and City standards is not included in this section. 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 documents.

7.1 SILVERTON PWDS | DIVISION 1 – GENERAL REQUIREMENTS

Division 1 of the City of Silverton's Public Works Design Standards (PWDS) outlines the policy by which physical aspects of public utility design is to be implemented in the City of Silverton.

7.1.1 SECTION 1.4 – DEFINITIONS AND TERMS

Recommendation #1

<u>PWDS 1.4.a.6:</u>

Design Engineer is defined as "The engineer licensed by the State of Oregon as an engineer under whose direction plans, profiles, and details for work are prepared, and submitted to the City Engineer for review and approval." It is recommended this section note that the plans, profiles, and details should bear the seal and signature of a professional engineer licensed in the state of Oregon.

Recommendation #2

It is recommended that the list of definitions and terms be reordered so that the terms are presented in alphabetical order.

7.1.2 SECTION 1.5 – LOCATION OF UTILITIES WITHIN RIGHT-OF-WAY OR EASEMENT

Recommendation #3

It is recommended that the City use this section to provide a reference to OAR 333-061-005, which dictates crossing requirements and a minimum 10-ft horizontal separation of water and sanitary sewer pipelines.

7.1.3 SECTION 1.9 – REVIEW PROCEDURE

Recommendation #4

<u>PWDS 1.9.a:</u>

A reference is provided to Appendix G for "detailed provisions covering the review procedures and permitting requirements for street, site and utility construction." This reference appears to need updating as Appendix G is not posted on Silverton's PWDS webpage.

PWDS 1.9.c and d:

Recommend updating City preferences on requirements for developers to submit. For example, remove mylar as-built requirement and add requirement to submit one hard copy, one PDF electronic copy, and one CAD file.

7.1.4 SECTION 1.10 – SUBMITTAL REQUIREMENTS

Recommendation #5

PWDS 1.10.b.1 through PWDS 1.10.b.15:

It is recommended that Material Specifications be added to the list of requirements.

Recommendation #6

PWDS 1.10.f:

It is recommended the list dictate that for large projects, and as required for clarity, an overall site grading plan is required with separate sheets for enlarged grading plans displayed at scales such that grading details can be easily distinguished.

Recommendation #7

PWDS 1.10.h.3.a:

It is recommended that sump invert elevations be included as a requirement for profile views.

Recommendation #8

PWDS 1.10.j.1:

This bullet point details requirements for Drainage Calculations. It is recommended the City add a reference to Division 3, where further details of calculation requirements can be found.

7.1.5 SECTION 1.13 – CONSTRUCTION OBSERVATION, INSPECTION & TESTING

PWDS 1.13.c.h:

It is recommended to include language stating submittals should be reviewed to ensure compliance with the Construction Documents in addition to City Standards.

7.2 SILVERTON PWDS | DIVISION 3 – STORMWATER MANAGEMENT

Division 3 of the City of Silverton's PWDS outlines the standards that govern all construction and upgrading of all public and private drainage facilities in the City of Silverton and applicable work within its service areas. These Standards apply to all drainage facilities which impact any public storm drain system, public right-of-way or easement dedicated to or located within the City and within all off-street parking and loading areas. This section of the Stormwater Master Plan discusses recommendations regarding Division 3 (Stormwater Management) of the City of Silverton's PWDS.

7.2.1 SECTION 3.1 – PURPOSE

Recommendation #9

PWDS 3.1.a:

As water quality has become more of a discussion item in public works design standards, it is recommended that the City of Silverton amend the list to include an additional bullet point regarding storm water quality. This note may read "Maintain and improve the water quality in, and the beneficial uses of, Silverton's waterways, lakes, ponds, wetlands, and other natural drainage resources." Addition of this note may also be applicable to Silverton's Total Maximum Daily Load (TMDL) requirements.

Recommendation #10

PWDS 3.1.a.7 and 3.1.a.8:

These bullet points discuss future maintenance and design life goals of Silverton's stormwater system. It is recommended that these bullet points be combined into one bullet point. This bullet point may read "Be designed in a manner to allow economical future maintenance and minimize life cycle cost."

Recommendation #11

Refer to item 3.1.a.3

This bullet point states that one of the purposes of these Design Standards is to "prevent the uncontrolled or irresponsible discharge of stormwater onto adjoining public or private property," And it is recommended that the City use this bullet point to demonstrate compliance with Oregon Drainage Law. 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.

7.2.2 SECTION 3.8 – MATERIALS

Recommendation #12

Section 3.14 of the Silverton PWDS dictates minimum pipe cover and refers to section 3.8 for provisions on pipe cover requirements based on pipe material. Depending on how the reader interprets Silverton's PWDS, there may be discrepancies between section 3.8 and section 3.14. For example, section 3.14 states that "under normal conditions minimum cover shall be 24-inches above the top of the pipe in paved areas and 30-inches at all other locations." The first row of the table in section 3.8 is dictating pipe material for a cover depth of less than 1 ½-inches, which would not be permitted at any location under normal conditions. To address this, it is recommended that Section 3.8 dictate "cover depth for storm drainpipe shall conform to section 3.14 of this document."

Recommendation #13

PWDS 3.8.c.2.b.2:

This bullet point states that "gaskets shall conform to material requirements of ASTM C-361". ASTM C-361 is a specification covering reinforced concrete pipe intended to be used for the construction of pressure pipelines with low internal hydrostatic heads. ASTM C-443 and ASTM C-1619 provide specifications that O-rings and gaskets could conform to.

Recommendation #14

PWDS 3.8.c.4.a:

"SDR 35" is duplicated twice in the list.

Recommendation #15

PWDS 3.8.c.4:

It is recommended this list include the following: Gaskets for PVC pipe joints shall conform to ASTM-F477.

7.2.3 SECTION 3.9 – GENERAL DESIGN CONSIDERATIONS

Recommendation #16

It is recommended that the City provide a statement requiring City Engineer approval prior to issuance of development permits, such as: "The City Engineer shall approve all storm drainage plans and proposed systems prior to issuance of development permits. Such plans and systems shall bear the stamp and signature of a registered professional engineer."

Recommendation #17

It is recommended that the City provide a statement prohibiting cross connections, such as: "Stormwater; including street, parking lot, roof, foundation drainage; shall not be discharged into the sanitary 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."

Recommendation #18

The list of following minimum factors to address in the design of storm drainage systems and determination of design flows may include surface characteristics of the drainage basin.

Recommendation #19

PWDS 3.9.d.1:

The list of following minimum factors to address in the design of storm drainage systems and determination of design flows may include remaining capacity of the existing storm drains.

7.2.4 SECTION 3.10 – DESIGN CALCULATIONS AND CAPACITY

Recommendation #20

The City of Silverton PWDS dictates that peak design discharges shall be computed using the rational formula, Q=CiA, where Q = flow, C = runoff coefficient, i = rainfall intensity, and A = area. The PWDS currently states that Q is typically in cfs and A is typically in acres. It is recommended that Silverton also note that i is typically in inches per hour and C is unitless.

Recommendation #21

Design documents from other government bodies typically indicate that the Rational Method formula also includes a runoff coefficient adjustment factor. The runoff coefficient adjustment factor accounts for reduction of infiltration and other losses during high intensity storms – it is more conservative to include the runoff coefficient adjustment factor in the equation. Typical runoff coefficient adjustment factors are included in Table 7-1.

TABLE 7-1: TYPICALL RUNOFF COEFFICIENT ADJUSTMENT FACTORS

Design Storm Recurrence Interval	Runoff Coefficient Adjustment Factor
10 years or less	1.0
25 years	1.1
50 years	1.2
100 years	1.25

Recommendation #22

Silverton PWDS refers to the utilization of a "Rainfall intensity-duration-frequency (IDF) curve." Current Oregon Department of Transportation (ODOT) standards now refer to these plots as "Rainfall intensity-duration-recurrence interval (IDR) curve."

Recommendation #23

Section 3.10 of the Silverton PWDS may dictate that where a drainage area is composed of subareas with different runoff coefficients, a composite coefficient for the total area is computed by dividing the summation of the products of the subareas and their coefficients by the total area. This is demonstrated in the equation below:

$$Composite\ C = \frac{\sum(C_{Individual\ Areas})(A_{Individual\ Areas})}{A_{Total\ Area}}$$

Recommendation #24

The only design calculation methodology accepted in the City of Silverton's PWDS is the rational formula, however, it is recommended that the City investigate permitting other calculation methods. Clean Water Services Design Standards could be used as a reference for standards that permit the rational method for sites up-to 1 acre and provide guidance on the Santa-Barba Urban Hydrograph (SBUH) method, the TR-55 method, and the EPA SWMM method for other sites. If alternative methodologies are permitted, then the reference to the ODOT hydraulics manual would need to include "where applicable." Additionally, note that 24-hour design storm depths must be specified for the SBUH and TR-55 method.

Recommendation #25

Two tables, "ODOT Zone 8 IDF Curve Tabular Data (Silverton)" and "Runoff Coefficients", provided in Section 3.10 could be removed from the Silverton PWDS – Reference is provided to the ODOT hydraulics manual. If the City chooses to continue providing these tables in PWDS, they should be examined for consistency with the most up to date ODOT tables.

7.2.5 SECTION 3.11 – OPEN CHANNELS

The City of Silverton's policy is to generally limit the creation of new open channels. However, design provisions are provided for instances where the creation of a new open channel is permitted by the City.

Recommendation #26

Additional requirements that the City could include are as follows:

- Natural bank stabilization measures (i.e., slope pull-back, willow mats, rock barbs, or re-vegetation with localized native plant species) shall be used.
- In a reach where the bank slope may steepen more than 3H:1V, erosion control protection will be required.
- Areas of extreme curvature, changes in channel cross-section, or low-flow channels with flow velocities exceeding three feet per second shall be designed and constructed with bank stabilization to allow for potential scouring from turbulent flows.
- Banks shall be designed with a minimum one foot of free board above the capacity design storm specified.
- Manning's Roughness Coefficient ("n") shall generally comply with the current ODOT Hydraulics Manual.
- Outfalls to channels shall be constructed to minimize the potential for erosion and other potential damage to the banks of the receiving open channel. Outfall designs shall prevent erosion and scouring upstream and downstream of the outfall structure.
- Outfalls shall be located at the ordinary high-water elevation. The area between the ordinary high-water level and stream bed shall be stabilized with material to dissipate energy.

Recommendation #27

PWDS 3.11.e:

This bullet point provides a reference to "Detail 3.62." This is likely supposed to read "Detail 362."

7.2.6 SECTION 3.12 – ALIGNMENT AND LOCATION

Recommendation #28

Although provisions for future growth are provided in Silverton PWDS Division 1, they may be repeated here by providing a general statement regarding future growth considerations – "Storm drain alignments shall accommodate future planned projects such as street widening, changes in horizontal or vertical street alignment, and master plan water, sewer, or other storm facilities."

Recommendation #29

It is recommended that the City specify some provisions regarding utility crossings. Typical industry standards are as follows: "Utility crossings shall be 90-degree angles and in no case, less than 70 degrees."

7.2.7 SECTION 3.13 – MINIMUM PIPE SIZE

Recommendation #30

Although provisions for future growth are provided in Silverton PWDS Division 1, they may be repeated here by providing a statement regarding providing for future growth – "Storm drainage facilities shall be designed and constructed to accommodate all future, full build-out flows generated from upstream property based upon the most recent approved City and/or County Comprehensive Land Use Plan and applicable Stormwater Master Plan".

7.2.8 SECTION 3.14 – MINIMUM COVER

Recommendation #31

See Section 7.2.2 in this report section for additional discussion of pipe cover. Pipe cover requirements are provided in Section 3.8 of Silverton's PWDS and again in Section 3.14. Section 3.8 provides pipe cover requirements that appear to be based on the structural capacity of pipes. Section 3.14 provides pipe cover requirements that appear to be based on Public Works Department guidance and construction preference. It should be clearly noted that Section 3.14 provides cover requirements under normal conditions. Section 3.8 should only be consulted where exceptions have been permitted by the City Engineer.

Recommendation #32

Although provisions for future growth are provided in Silverton PWDS Division 1, they may be repeated here by providing a statement regarding accounting for future growth – "It must be demonstrated the storm drain is at sufficient depth to properly drain the remainder of the upstream contributing basin."

7.2.9 SECTION 3.16 – UNDERGROUND WARNING TAPE & TRACER WIRE

Recommendation #33

It is recommended that this section dictate that the splicing of tracer wire is prohibited.

7.2.10 SECTION 3.17 – MANHOLES AND CATCH BASINS

Recommendation #34

PWDS 3.17.a.2.d:

This bullet point states that manholes shall be provided "at a spacing no greater than five hundred (500) feet. For maintenance and longevity of the useful life of pipelines, 400' foot spacing is typical. Providing manholes every 300' is optimal".

Recommendation #35

PWDS 3.17.b.3.a:

This bullet point states that "the maximum length of curb and gutter which may be drained by a catch basin is 500 feet or determined by a spread analysis." Different lengths may be provided depending on the grade of the surface. The recommended intervals are 300 feet for road longitudinal grades greater than 5%, and 400 feet for road longitudinal grades less than 5%.

Recommendation #36

PWDS 3.17.f:

This bullet point states, "Bore and Castings." "Castings" is likely supposed to be "Casings."

7.2.11 SECTION 3.18 – DETENTION FACILITIES

Recommendation #37

PWDS 3.18.c:

This bullet point reads "Detention Facility Siting" but is likely missing a section below it. Aside from the header, there is no content provided.

Recommendation #38

The existing code states that "developers proposing to not provide detention or control shall, on a case-by-case basis, be responsible for demonstrating to the satisfaction of the City Engineer that such control is not beneficial to the City Stormwater System." This could be expanded upon by noting that:

Developers may be required to show the development will not adversely impact downstream properties and downstream capacity on a case-by-case basis. When downstream capacity issues are identified through operational knowledge, flood compliant calls, or the Stormwater Master Plan, the developer will be responsible for performing an analysis of the downstream stormwater system, and either make the needed capacity improvements, provide additional on-site detention, or provide other means to mitigate the downstream impacts.

A downstream capacity analysis shall:

1) Be based on peak flows at the point of discharge.

2) Evaluate the system's conveyance capacity from the point of discharge to 1/4 mile downstream or to a distance where the project site contributes less than 15 percent of the upstream drainage basin area, whichever is greater.

3) Use the Manning's Formula for evaluating the capacity of pipes, ditches, and waterways. Backwater effects shall be included in determining capacity for waterways with drainage areas greater than 150 acres, using HEC-RAS or an equivalent computer modeling software.

7.2.12 SECTION 3.18 – DETENTION POND DESIGN REQUIREMENTS

Recommendation #39

The number designation of this section, 3.18, is the same as the numbering of the previous section. This section should be shifted to "3.19 – Detention Pond Design Requirements." Note that following sections also need to have their numbering adjusted.

Recommendation #40

PWDS 3.18.b:

Update requirements to specify 25-year, post-development peak discharge shall be equal to or less than 5-year, pre-development peak runoff. Recommend adding requirement of 2-year, post-development peak discharge shall be equal to or less than 2-year, pre-development peak runoff.

PWDS 3.18.c.8.b.4:

This bullet point specifies that the minimum free board during the design storm event shall be a minimum of six inches on secondary spillways. It is recommended the allowable freeboard be increased to one foot during the design storm event.

Recommendation #41

It is recommended the City require a maintenance agreement from the owner of private detention pond facilities.

7.2.13 SECTION 3.19 – PRIVATE STORM DRAINAGE COLLECTION SYSTEMS

Recommendation #42

As with private detention pond facilities, it is also recommended that the City require a maintenance agreement from the owner of private storm drainage collection systems.

7.2.14 SECTION 3.22 – LOW-IMPACT DEVELOPMENT INTEGRATED MANAGEMENT PRACTICES

Recommendation #43

PWDS 3.22.a:

Includes reference to “Appendix H (under development)”. Recommend City continue to develop and implement Appendix H. Additional discussion on low impact development in Section 7.4.

7.2.15 ADDITIONAL RECOMMENDATIONS

There are not requirements for water quality in the current design standards. It is recommended the City develop standards for water quality requirements in the future.

7.3 SILVERTON PWDS APPENDIX A, STANDARD DETAILS | DIVISION 3 - STORMWATER MANAGEMENT

Recommendations and notes on standard details related to stormwater infrastructure can be found in Appendix C.

7.4 LOW-IMPACT DEVELOPMENT (LID) DISCUSSION AND RESOURCES

Low impact development (LID) or low impact development approaches (LIDAs) refers to systems and practices that use or mimic natural processes to minimize stormwater runoff from a development (or re-development) and manage stormwater as close to its source as possible. Techniques and tools to maximize infiltration, evapotranspiration, or use of stormwater are used to protect water quality and associated aquatic habitat. LID employs principles such as preserving and recreating natural landscape features, minimizing effective imperviousness to create functional and appealing site drainage that treat stormwater as a resource rather than a waste product. Some common facilities that follow the principles of LID include bioretention ponds, rain gardens, rain barrels, permeable pavement, and landscape filter strips. The EPA defines a best management practice (BMP) as a “technique, measure or structural control that is used for a given set of conditions to manage the quantity and improve the quality of stormwater runoff in the most cost-effective manner.” BMPs are techniques or tools used to control stormwater runoff, sediment control and soil stabilization and are often utilized as part of LID. The term can also be applied to management decisions that prevent or reduce nonpoint source pollution.

As mentioned in the previous section, currently the City of Silverton design standards on Low-Impact Development Integrated Management Practices (PWDS Div 3.22, Appendix H) are under development. The City is in the gathering information stage of developing stormwater quality and LID standards. Water quality regulatory requirements and considerations are expected to continue to increase and become more stringent. LID standards and guidance could become an important part of the City’s stormwater management program, however, developing LID design standards can be challenging for municipalities. Typically, this process would include a comprehensive review of City codes, development of LID standards, development of a stormwater management manual (SWMM), and education and engagement of key stakeholders to facilitate support and greater LID use in the community.

As the City continues to explore LID and the City’s management strategies for stormwater, the EPA Urban Runoff: Low Impact Development website (https://www.epa.gov/nps/urban-runoff-low-impact-development) has a wealth of information, tools, and guidance developed to support municipalities in integrating LID into City development. In addition to technical resources, the EPA has developed 12 “LID Barrier Buster” fact sheets that address common concerns and misconceptions around LID implementation, which these short information sheets can be used to help educate and inform both City staff and the general public. Some of the barriers addressed include cost, effectiveness, aesthetics, and revising local codes to facilitate LID. Another resource developed more locally is the Low Impact Development Approaches (LIDAs) Handbook published by Clean Water Services in 2021 (http://www.cleanwaterservices.org/LIDA). The handbook was developed as a tool to promote and encourage LIDAs. Some of the topics covered include site planning with LIDs, LID design process, and common LID fact sheets. It is recommended the City continue gathering information and facilitating discussions around LID and BMPs to explore how they can play a role in City stormwater management in the future.

SECTION 8 - MAINTENANCE EVALUATION, FUNDING OPPORTUNITIES

This section discusses existing stormwater system maintenance activities being performed by the City of Silverton, identifies deficiencies in existing staffing levels, provides recommendations for increased maintenance practices, and discusses the staffing level needed to complete them. Additionally, this chapter discusses potential funding opportunities for City stormwater capital improvement projects and provides a discussion regarding the potential implementation of a Fee in Lieu of Construction (FILOC) program.

8.1 MAINTENANCE EVALUATION

The City Public Works (PW) Operations staff are responsible for the operations and maintenance (O&M) of the stormwater system. On August 25th, 2021, PW Operations staff were interviewed 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 stormwater system. In general, the City of Silverton's PW Operations staff provide support for several City activities that are not directly related to public utility O&M (i.e., parks, City event setup/takedown, building maintenance, etc.). Construction inspection and permitting services are performed through the City's Engineering department. The sections below provide more detail regarding existing stormwater system staffing and recommendations.

8.1.1 EXISTING STORMWATER MAINTENANCE AND STAFFING

During staff interviews, the general roles, and responsibilities of the PW Operations staff for the stormwater system O&M were summarized. There are currently no budgeted Full Time Equivalent (FTE) explicitly for stormwater O&M. The City currently uses street maintenance funds to pay for stormwater O&M. The PW department has an annual budget of $5,000 for stormwater O&M materials and equipment, but no funding for stormwater staff specifically. The O&M of the stormwater facilities falls on the PW utilities group regardless. Six (6.0) full-time employees (FTEs) work in the PW utilities group with no distinction between utility type (water, sewer, street, storm). Rather, employees perform work on utilities depending on system priorities and planned maintenance activities. The current PW crew does a good job of organizing and completing stormwater facilities O&M within their existing budgeted FTE. They have been working to develop and implement annual systems to keep up on maintenance activities with their limited staff. A list of stormwater O&M activities and approximate time, frequency, and size of crew was developed to evaluate the approximate annual labor hours spent on regular stormwater O&M. The primary O&M activities include visually inspecting and cleaning catch basins; visually inspecting (no closed-circuit television (CCTV)) and cleaning stormwater pipes; cleaning open conveyance ditches; maintaining three detention facilities; responding to problematic areas; in-house rehabilitation and replacement of facilities; street sweeping; loading debris from street sweeping; emergency repairs; and supporting contractors with tie-ins, taps, utility locates, etc. It is estimated that approximately 2.3 FTE is spent annually on these regular stormwater collection O&M activities.

As previously noted, Silverton does not distinguish between utility types in the PW budget for FTEs. Two (2) Crew Leaders and four (4) field crew members (six in total) perform maintenance tasks on all utilities. In addition to maintaining utilities, PW Operations staff are requested to complete significant tasks and projects outside of utility O&M. Some of these tasks include, but are not limited to, park projects and maintenance; City event setup and takedown; and building maintenance. It is estimated that PW Operations staff spend 30-35% of their time completing work that is not directly related to utility O&M.

During staff interviews, it was noted that Silverton's PW utility crew has been comprised of 6.0 FTEs for over 20 years. Over the past 20 years, the population of Silverton has grown from approximately 6,710 (1999 Oregon Population Report, Portland State University) to 10,520 (2020 Certified Population Estimates July 1, 2020, Portland State University); a growth of 3,810 people.

In addition to lack of adequate staffing and increased responsibilities, the PW crew is relatively small and highly influenced by staff sick leave and vacation. The PW crew is susceptible to disruptions from crew members taking earned time off or sick leave and cannot typically absorb the work that a missing crew member could complete.

Deficiencies in maintenance equipment were also noted during staff interviews, such as the City does not own proper equipment to CCTV inspect storm lines. The City owns a vactor truck that is utilized for cleaning stormwater pipelines, but staff report problems with the maneuverability of the truck and the ability to access facilities with it. Additionally, the truck is old and inefficient; therefore, requiring refilling of water frequently. If the truck needs maintenance, there is no alternate available to City staff. Ditches and detention facilities are mostly maintained with weed whackers, as the City's mower is not compact enough to access them.

8.1.2 RECOMMENDED STORMWATER MAINTENANCE AND STAFFING

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

- Conduct regular cleaning of stormwater assets
- Remove blockages efficiently and in a timely manner
- Minimize flooding
- Reduce the amount of open channel conveyance of stormwater (installing closed conduit)

A summary of general recommended O&M activities to achieve these LOS goals and follow industry good practice is listed as follows:

- Clean and inspect manholes and cleanouts on a 2-year cycle (approximately ½ system annually)
- Clean and inspect catch basins on a 2-year cycle (approximately ½ system annually)
- Clean storm lines with jetter and CCTV inspect on a 5-year cycle (approximately 1/5 system annually)
- Maintain detention facilities annually
- Maintain staff and equipment to complete rehabilitation and replacement of facilities in-house
- Perform street sweeping seasonally with high frequency in downtown area; load and dispose of debris collected
- Maintain staff and equipment to complete emergency repairs in a timely manner
- Maintain staff and equipment to address problematic areas as needed
- Support contractors

Using similar expected labor hours for activities as the existing staffing evaluation, and using reference values from other staffing analyses, it is estimated that approximately 4.0 FTE are needed to meet the O&M described above to meet the desired LOS goals.

As discussed previously, there are currently no FTE budgeted for stormwater system maintenance tasks and street maintenance funds are currently used to fund stormwater O&M staff. It is recommended the City utilize stormwater funds to pay for additional stormwater staffing. The current 6.0 FTEs for the PW utilities are responsible for all utilities and requested tasks not directly related to utility O&M and cannot absorb and complete all recommended O&M of stormwater facilities. Additional staff on the PW crew paid for by stormwater funds would help alleviate some of the challenges and disruptions from employees taking their earned vacation and sick leave. The City should reevaluate staffing requirements and needs every two to three years. It would be expected that the City would need to increase budgeted staffing for the stormwater facilities to meet the desired LOS.

In addition to the increased staffing level outlined in the preceding paragraph, the City could benefit from investing in new equipment. The City does not have the equipment needed to perform in-house CCTV inspection of pipelines. If the City's sweeper truck or vactor truck break down or need repairs, PW Operations staff do not have a backup method for performing the necessary work. Investing in a smaller, more mobile vactor equipment (tow-behind) would provide a backup to the vactor truck and allow staff to maintain assets more efficiently when only reduced access is available.

Additionally, PW Operations staff expressed the desire to upgrade and increase the existing stormwater collection network because there are many locations in the City where stormwater pipes are believed to be undersized, or where sufficient stormwater infrastructure does not exist. For example, flows on Water Street travel upwards of one mile (overland flow) before reaching a catch basin. During high rainfall events, this overland flow has been observed by PW Operations staff to be upwards of four feet wide. The stormwater connection to a County ditch, near James Street, is lower than the ditch itself. This causes flooding issues at the ditch. PW Operations staff desire to replace much of the open channel conveyance with buried closed conduit pipelines to reduce O&M challenges. A discussion of potential funding opportunities for stormwater capital improvement projects is presented next in Section 8.2.

8.2 POTENTIAL FUNDING OPPORTUNITIES

Current funding for stormwater utility comes from the stormwater utility fee. The current stormwater utility fee is $7.70/EDU, and an annual increase is included in the City code. However, City Council makes the final decision each year if rates will be increased. This section presents several additional opportunities to seek funding for stormwater capital improvement projects (CIP) and discusses the possibility of a FILOC program.

8.2.1 STORMWATER CIP FUNDING

Several potential funding opportunities for stormwater system improvements are described in this section. As the City begins to prepare and proceed with capital projects, it is recommended the City begin by setting up a one-stop meeting with Business Oregon. Business Oregon meets and helps communities to identify and assess potential funding sources for their infrastructure projects. Two of the first typical sources communities explore are summarized below and additional potential funding sources are included in Table 8.1.

Business Oregon Infrastructure Finance Programs

Business Oregon helps communities develop infrastructure, public facilities and address their utility and economic development needs through several programs. The Water/Wastewater Fund provides low-cost financing for design and construction of public infrastructure needed to ensure compliance with the Safe Drinking Water Act or the Clean Water Act. To be eligible, a capital improvement project or study must resolve an existing or potential hazard or noncompliance under federal/state standards pertaining to municipally owned utility systems for water, sewer, or stormwater. Typical projects funded by this program include Facility and Master Plans, Preliminary Engineering, Financial Investigations, Final Design, and Construction. The maximum loan is $10,000,000 per project with terms up to 25 years. Additionally, grants may be awarded to assure sufficient funding for distressed communities.

Clean Water State Revolving Fund

The Clean Water State Revolving Fund (CWSRF) program is a federal-state partnership that provides communities low-cost financing for a wide range of water quality infrastructure projects. A few of the eligible projects include assistance to any public, private, or nonprofit entity for measures to manage, reduce, treat, or recapture stormwater or subsurface drainage water; assistance to any public, private, or nonprofit entity for the implementation of a state nonpoint source pollution management program; and assistance to any public, private, or nonprofit entity for projects for reusing or recycling wastewater, stormwater, or subsurface drainage water. CWSRF offers a variety of financial assistance including loans, purchasing of debt, refinancing of debt, additional subsidization to help address affordability issues, etc.

TABLE 8-1: SUMMARY OF POTENTIAL STORMWATER FUNDING RESOURCES

Program	General Description	Contact
Conservation Reserve Enhancement Program (CREP)	Provides annual rent to landowners who enroll agricultural lands along streams. Also cost-shares conservation practices such as riparian tree planting, livestock watering facilities, and riparian fencing	NRCS, SWCDs, ODF
Conservation Reserve Program (CRP)	Competitive CRP provides annual rent to landowners who enroll highly erodible lands. Continuous CRP provides annual rent to landowners who enroll agricultural lands along seasonal or perennial streams. Also cost-shares conservation practices such as riparian plantings	NRCS, SWCDs
Conservation Stewardship Program (CSP)	Provides cost-share and incentive payments to landowners who have attained a certain level of stewardship and are willing to implement additional conservation practices	NRCS, SWCDs
Drinking Water Source Protection Fund	These funds allow states to provide loans for certain source water assessment implementation activities, including source water protection land acquisition and other types of incentive-based source water quality protection measures	Oregon Health Authority
Emergency Watershed Protection Program (EWP)	Available through the USDA-Natural Resources Conservation Service. Provides federal funds for emergency protection measures to safeguard lives and property from floods and the products of erosion created by natural disasters that cause a sudden impairment to a watershed	NRCS, SWCDs
Emergency Forest Restoration Program (EFRP)	Available through the USDA-Natural Resources Conservation Service. Helps owners of non-industrial private forests restore forest health damaged by natural disasters	USDA, ODF
Environmental Protection Agency Section 319 Grants	Funds projects that improve watershed functions and protect the quality of surface and groundwater, including restoration and education projects	DEQ, SWCDs, Watershed Councils
Environmental Quality Incentives Program (EQIP)	Cost-shares water quality and wildlife habitat improvement activities, including conservation tillage, nutrient and manure management, fish habitat improvements, and riparian plantings	NRCS, SWCDs
Farm and Ranchland Protection Program (FRPP)	Cost-shares purchases of agricultural conservation easements to protect agricultural land from development	NRCS, SWCDs, ODF
Federal Reforestation Tax Credit	Provides federal tax credit as incentive to plant trees	Internal Revenue Service

Grassland Reserve Program (GRP)	Provides incentives to landowners to protect and restore pastureland, rangeland, and certain other grasslands	NRCS, Farm Service Agency, SWCDs
Landowner Incentive Program (LIP)	Provides funds to enhance existing incentive programs for fish and wildlife habitat improvements	U.S. Fish and Wildlife Service, ODFW
Oregon Watershed Enhancement Board (OWEB)	Provides grants for a variety of restoration, assessment, monitoring, and education projects, as well as watershed council staff support. 25 percent local match requirement on all grants	SWCDs, Watershed Councils, OWEB
Oregon Watershed Enhancement Board Small Grant Program	Provides grants up to $10,000 for priority watershed enhancement projects identified by local focus group	SWCDs, Watershed Councils, OWEB
Partners for Wildlife Program	Provides financial and technical assistance to private and non-federal landowners to restore and improve wetlands, riparian areas, and upland habitats in partnership with the U.S. Fish and Wildlife Service and other cooperating groups	U.S. Fish and Wildlife Service, NRCS, SWCDs
Public Law 566 Watershed Program	Program available to state agencies and other eligible organizations for planning and implementing watershed improvement and management projects. Projects should reduce erosion, siltation, and flooding; provide for agricultural water management; or improve fish and wildlife resources	NRCS, SWCDs
Resource Conservation & Development (RC & D) Grants	Provides assistance to organizations within RC & D areas in accessing and managing grants	Resource Conservation and Development
State Forestation Tax Credit	Provides for reforestation of under-productive forestland not covered under the Oregon Forest Practices Act. Situations include brush and pasture conversions, fire damage areas, and insect and disease areas	ODF
Stewardship Program	Provides cost share dollars through USFS funds to family forest landowners to have management plans developed	ODF
State Tax Credit for Fish Habitat Improvements	Provides tax credit for part of the costs of voluntary fish habitat improvements and required fish screening devices	ODFW
Stewardship Incentive Program (SIP)	Cost-sharing program for landowners to protect and enhance forest resources. Eligible practices include tree planting, site preparation, pre-commercial thinning, and wildlife habitat improvements	NRCS, SWCDs, ODF
Wetlands Reserve Program (WRP)	Provides cost-sharing to landowners who restore wetlands on agricultural lands	NRCS, SWCDs
Wildlife Habitat Incentives Program	Provides cost-share for wildlife habitat enhancement activities	NRCS, SWCDs
Wildlife Habitat Tax Deferral Program	Maintains farm or forestry deferral for landowners who develop a wildlife management plan with the approval of the Oregon Department of Fish and Wildlife	ODFW, SWCDs, NRCS

Funding Resources for Watershed Protection and Restoration	EPA website containing numerous links to funding sources	

NRCS: Natural Resource Conservation Service
SWCD: Soil and Water Conservation District
ODF: Oregon Department of Forestry
USDA: United States Department of Agriculture
DEQ: Department of Environmental Quality
ODFW: Oregon Department of Fish and Wildlife
OWEB: Oregon Watershed Enhancement Board

8.2.2 FEE-IN-LIEU OF CONSTRUCTION FOR STORMWATER FACILITIES

A FILOC program, as pertaining to stormwater utility, is a payment collected by approval of a local jurisdiction as an alternative to meeting requirements of onsite stormwater control facilities. Typically, construction of compliant onsite stormwater facilities is preferred to collection of a FILOC payment. Site specific circumstances may make construction of sufficient onsite stormwater facilities inefficient or not practical. A FILOC program is a tool that the City could use to permit development on these sites and provide sufficient stormwater system upgrades at a more suitable location.

As part of this FILOC review, three FILOC programs in the surrounding communities were reviewed. These reference FILOC programs included the City of Salem, the City of Portland, and Clean Water Services. Table 8-2 summarizes major features of each of the FILOC programs.

TABLE 8-2: SUMMARY OF REFERENCE FILOC PROGRAMS

	City of Salem	City of Portland	Clean Water Services
FILOC References	• SCO Section 71.025 - Fee-in-lieu of construction • SCO Section 71.030 - Fee-in-lieu amount • SCO Section 200.405 - Fee-in-lieu of construction authorized • SCO Section 200.410 - Fee-in-lieu amount • SCO Section 200.415 - Payment of fee-in-lieu of construction as substantial compliance • SCR 200.420 - No limitation on authority	• City of Portland SWMM (2020) Section 1.8 - Special Circumstances	• Clean Water Services Design and Construction Standards for Sanitary Sewer and Surface Water Management (2019) Chapter 4 • Clean Water Services Stormwater Management Fee-In-Lieu Proposal Technical Memorandum (2019) • Clean Water Services Rates and Charges Resolution and Order No. 19-11
Requirements to Permit	•Determination of FILOC appropriateness by the director to depend on: • Such an agreement is in the public interest • Feasibility of constructing the stormwater facility on the site • Cost associated with construction, operations and maintenance • Benefits provided by the stormwater facility	• Two paths to approval: 1) Staff-Review Special Circumstances • Create, expand, or replace pavement in the sidewalk corridor behind an existing curb in the right-of-way • Create, expand, or replace pedestrian paths or walkways that cannot be otherwise managed • Add or replace impervious area to meet ADA requirements 2) Committee-Review Special Circumstances • Must demonstrate why a stormwater facility is not technically feasible for the area being managed • Must follow all instructions of review-committee's decision	• Clean Water Services must designate project as a Category 1 project - projects with lowest anticipated risk • Project results in less than 12,000 square feet of new or modified impervious surface area • Project is located within a District-approved sub-basin strategy area • Projects located where implementation of an on-site facility is impractical or ineffective • Onsite implementation will result in inefficient use of District or City resources • Projects likely to have negligible impact to the Receiving Reach
Rate Determination	• In accordance with a fee schedule approved by Council and will be based on 100 percent of the average cost of constructing an equivalent stormwater facility	• Calculated using square foot of unmanaged impervious area • Based on the average construction costs for the City to install stormwater management facilities through retrofitting existing impervious area • Current rates are published and adopted through Portland Environmental Services annual budget process	• Calculate using the amount of unmanaged impervious service on the site • Water Quality Fee-In-Lieu = $1.00 per square foot of unmanaged impervious area • Hydromodification Fee-In-Lieu = $1.00 per square foot of unmanaged impervious area • Combined Water Quality and hydromodification Fee-In-Lieu = $1.50 per square foot of unmanaged impervious area
FILOC Fund Allocation	• The Finance Officer shall deposit the fee-in-lieu into a trust and agency account, and the fee-in-lieu shall only be used to fund construction of the public improvement for which the fee was paid.	• Portland Environmental Services uses collected Offsite Stormwater Management Fees to construct stormwater management facilities to meet system-specific needs.	• None specified
Application Process	• None specified	• Applications are only reviewed in association with a development proposal, building permit, land use review, or public improvement • Design project to achieve on-site stormwater management to the maximum extent practicable • Complete Special Circumstances request as outlined in SWMM	• None specified
Preference	• Construction of the public improvement shall be preferred over the payment of a fee-in-lieu.	• Only permitted on sites where stormwater management has been achieved to the maximum extent feasible and further stormwater management is impracticable or sidewalk corridor projects as outlined in Staff-Review Special Circumstances	• Only permitted on small, low risk projects, where complete stormwater management is not feasible and/or effective

A FILOC program can be a tool to permit development projects that otherwise would not be feasible because of stormwater constraints. Before the City of Silverton chooses to implement a FILOC program, several items that should be considered are presented below.

Accounting

Implementing a FILOC program is likely to require increased accounting efforts by the City because funds paid into FILOC programs are susceptible to getting 'lost', misappropriated, etc. If the City is required to operate the existing stormwater system under a municipal separate storm sewer system (MS4), the Oregon Department of Environmental Quality (DEQ) and Environmental Protection Agency (EPA) will hold the City accountable for ensuring stormwater improvements are being made with all received FILOC funding. Typically, the City is required to use FILOC funds within a specified time period or the funds are returned. As a result, it could be a challenge for a City the size of Silverton to collect sufficient funds within this time period to complete effective, regional stormwater projects.

Preference for Public Improvements

In general, governing bodies make a FILOC costly/strict enough that developers preferred alternative is to comply with stormwater development standards if feasible. As stated in the City of Portland SWMM, a FILOC is only permitted where stormwater management has been achieved to the maximum extent feasible and further stormwater management is impracticable. City of Salem standards state that the construction of improvements is preferred over the paying of a FILOC. Clean Water Services only permits paying a FILOC on small, low risk projects. Generally, FILOC programs are not intended to be a common/favorable substitute for the construction of stormwater infrastructure, but rather, a tool that the City may use to permit development where the construction of stormwater infrastructure is not feasible.

Rate Determination

As seen in Table 8-2, reference governing bodies use a variety of methods for determining FILOC rates. Both the City of Salem and the City of Portland enforce FILOC fees that are based on the cost of constructing an equivalent stormwater facility. Clean Water Services determines FILOC fees at a pre-determined rate based on several fees applied to the square footage of impervious area on site. A FILOC rate must be fair to the City, existing rate/taxpayers, and developers. Implementing FILOC rates that match the estimated cost of constructing an equivalent stormwater facility often makes developers feel that they are paying a fair price; however, this may not account for additional responsibilities that the City is taking on. The burden of managing those funds, project administration, risk of constructing a new facility, etc. are placed on the City. All of the costs and risk associated with accepting a FILOC should be considered when assessing what the actual equivalent cost to construct an equivalent stormwater facility would be.

Burden Placed on the City

Prior to adopting a FILOC program, and accepting any FILOC request, additional analysis may be required to evaluate impacts to the future flows assumed in the system model for this planning project. For developments paying into a FILOC program rather than performing stormwater system improvements, the City is undertaking the burden of additional analysis, the monitoring of funds, and additional risk associated with construction of facilities.

Appropriation of Funds and Regionalization

FILOC is generally most effective for all parties involved when there are opportunities for system regionalization. Individual developments may forgo stormwater improvements to pay into the FILOC program, which would be used for regional stormwater improvements. As seen in Table 8-2, City of Salem and City of Portland standards specify that FILOC funds shall be used to fund the construction of public stormwater system improvements.

The City does not have a history of development being restricted or prevented due to stormwater constraints. There are many aspects and considerations the City should review and evaluate before developing a FILOC program. It is recommended the City consider other funding opportunities presented in Section 8.2.1 before considering implementation of a FILOC program.

SECTION 9 - CAPITAL IMPROVEMENT PLAN

This section summarizes recommended capital improvements with associated planning level cost estimates. Recommended improvements are illustrated in Figure 9 in Appendix A and the details of each improvement are presented in Appendix E. 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.

9.1 BASIS FOR ESTIMATE OF PROBABLE COST

Capital costs developed for the recommended improvements are Class 4 estimates as defined by the Association for Advancement of Cost Engineering (AACE). Actual construction costs may differ from the estimates presented, depending on specific design requirements and 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 costs will vary from the estimate 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. The total estimated probable project costs include contractor markups and 30 percent 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 contractors overhead and profit are worked into the line items.

9.2 SUMMARY OF COSTS (20-YEAR CIP)

The capital improvement plan (CIP) consists of projects necessary to alleviate identified flooding and surcharging for up to a 25-year storm event. Improvements were designed based on the existing City design standards. The projects identified in this study were prioritized by their urgency to mitigate the identified deficiencies. The prioritization criteria are shown in Table 9-1.

TABLE 9-1 CIP PRIORITIZATION CRITERIA

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

9.2.1 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. These projects are recommended to be implemented within 0 – 5 years of completion of this study.

<u>Rock Street Stormwater Improvements (Northeast Silver Creek): 1.1</u> – Install a new 12-inch pipe to drain Rock Street into the existing stormwater network along 3rd Street. This project should be

coordinated with Project 1.2 because this project connects to the existing pipe network along 3rd Street which has existing undersized pipes.

2nd Street and Lincoln Street (Webb Lake): 1.2 – Install new stormwater pipes ranging in size from 18-inches to 30-inches along N 2nd Street from Whittier Street to the existing 30-inch pipe at the intersection of N 2nd Street and Lincoln Street. Project 3.5 can be completed following this project to reduce localized ponding on Lincoln, Jefferson, Washington, Chester, and Whittier Street.

Public Works Shop Decant Facility Roof Structure: 1.3 - The City's existing decant storage facility does not have a cover over the bays, and it is recommended to install a roof structure over the decant storage bays as well as install one new storage bay to increase storage capacity.

3rd Street and Jersey Street to Mill Street and B Street (Northeast Silver Creek): 1.4 – Upsize the existing 18-inch pipe along S 3rd Street from Jersey Street to Main Street to 30-inches and install new 30-inch pipe along S 3rd Street to Oak Street. Abandon the existing pipeline draining east along Main Street then north to the intersection of Oak Street and Mill Street. Install new 36-inch pipe from the new 30-inch pipe at N 3rd Street and Oak Street draining north to High Street. Install new 36-inch pipe draining southwest along High Street to a new outfall to Silver Creek. This project could be completed in conjunction with Project 1.3 because Project 1.3 connects to the storm network on 3rd Street.

Abiqua Heights, upstream of storage pond (Northeast Silver Creek): 1.5 – Upsize the existing 12-inch pipe to 15-inches and 18-inches upstream of the Abiqua Heights storage pond along Shelokum Drive. Additionally, upsize the existing 12-inch pipe which drains Tilicum Drive to the storage pond to 15-inches.

Koons Street and Adams Avenue to Silver Creek (Northeast Silver Creek): 1.6 – Confirm an existing 18-inch pipe exists along Koons Street from Cliff Court to Water Street; install new 18-inch pipe if it does not exist. Install a new diversion manhole near the intersection of Water Street and Koons Street to divert water between the existing outfall (crossing Miller Street and Hicks Street) and a new 18-inch pipeline along Water Street draining southeast to the existing outfall on Cowing Street. Upsize the existing 24-inch pipe along Cowing Street to the outfall to 36-inches to accommodate the increased flows from the diversion manhole.

Sheridan Street to Silver Creek (Northeast Silver Creek): 1.7 – Install a new 12-inch trunkline from the intersection of Pine Street and Sheridan Street draining south to Silver Creek. Additionally, install a new outfall to Silver Creek.

Olson's Ditch at Sage Street (Webb Lake): 1.8 – Improve Olson's Ditch where erosion has been observed. The existing modeled ditch cross sections from Oak Street to Sage Court suggest the ditch dimensions provide adequate capacity to convey the design storms. Improvements are recommended to reduce observed erosion and high-water velocities. The ditch should be lined with rip rap and energy dissipation structures to reduce water velocities. The City has not observed flooding in the ditch sections downstream of Sage Court (excluding directly at Sage Court discharge), however, the capacity of these existing ditches should be confirmed to be adequate to convey peak flows once the upstream bottlenecks are resolved. Model outputs suggest the ditch should be approximately 4 feet deep, with a 6-foot bottom and 16-foot top width. Note, these ditch sections are within designated wetlands and additional environmental permitting will be required before improvements are made within the wetland boundaries.

Crestview Drive, Breyonna Way, Iowa Street, and Oak Street (Webb Lake): 1.9 – Install a new 30-inch trunkline along Crestview Drive downstream of the detention pipe draining west toward Breyonna Way. Continue the new 30-inch trunkline down Breyonna Way, to Iowa Street and split the flows at Oak Street through the existing ditch draining to the northeast and through a new 30-inch pipe draining southwest toward Olson's Ditch. Upsize the pipe on the southwest corner of Steelhammer Road and Oak Street with a 30-inch pipe.

Lone Oaks Loop and N 2nd Street to Bowtie Lane (North Central): 1.10 – Upsize the existing 18-inch pipe along Lone Oaks Loop to 24-inch and 30-inches. Upsize the existing 24-inch pipes along N 2nd Street and connect to the existing arch pipe draining northwest toward N 1st Street. Install a diversion manhole on the east side of N 1st Street and a new 24-inch pipeline along the east side of N 1st Street to relieve flooding in the existing 36-inch pipeline along the west side. Install a new 24-inch pipe from the new pipeline draining west under N 1st Street and discharge on the upstream side of the Gossack Property.

Davisson Baseball Fields (North Central): 1.11 – Upsize the existing box culvert on the upstream (east) side of the Davisson Baseball Fields under the railroad to a 48-inch culvert or arch culvert of equal capacity. Upsize the existing 30-inch pipeline draining across Davisson Baseball Fields and upsize all the downstream 24-inch culverts to 30-inches. Additionally install a new 36-inch pipeline draining west across Davisson Baseball Fields and discharge into the existing open channel on the west side of James Street. Improve the existing open channel along the west side of James Street to a minimum size of 4 ft deep with a 4 ft bottom and 8 ft top width.

James Street and Schlador to Western Avenue (North Central): 1.12 – Upsize the existing 12-inch and 18-inch pipe to 30-inch pipeline along James Street from Schlador Avenue to Western Avenue, Upsize the existing pipe downstream (north) of Western Avenue with a 36-inch pipe and discharge to the improved ditch from Project 1.8.

Westfield Street and C Street (West Silver Creek): 1.13 – Upsize the existing 18-inch pipe along Westfield Street and C Street to 24-inches to the existing 24-inch pipe draining northwest off of C Street.

Pioneer Lake Geotechnical Investigation (Southeast Silver Creek): 1.14a – Complete a geotechnical investigation to assess the reason for the excess seepage across Lakeview Drive. As a part of the geotechnical investigation, consider the installation of a grout curtain to stop further seepage or consider completely lining Pioneer Lake.

Pioneer Lake Improvements (Southeast Silver Creek): 1.14b – Install a bentonite cutoff wall on the southern perimeter of Pioneer Lake to eliminate seepage across Lakeview Drive. This project assumes a 10-foot-deep cutoff wall around 250 ft of the southern perimeter of Pioneer Lake. Note, the project approach to eliminate seepage across Lakeview Drive may change depending on the results from the geotechnical investigation (Project 1.11a). An impermeable liner may be another improvement consideration if the geotechnical investigation does not determine groundwater influence in the pond.

9.2.2 PRIORITY 2 IMPROVEMENTS

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

Norway Street to Oak Street (Webb Lake): 2.1 – Upsize the existing 18-inch pipe from Sweden Circle to Norway Street at Denmark Loop to 21-inches. Upsize the existing 24-inch pipe to 30-inches from the intersection of Oak Street and Norway Street to the existing culvert draining north under Oak Street. Replace the existing culvert under Oak Street with a 36-inch culvert.

Main Street by Water Treatment Plant (Webb Lake): 2.2 – Upsize the existing 12-inch pipe to 18-inches from Main Street (near the water treatment plant) draining north to the existing 18-inch pipe near Sweden Circle.

McClaine Street and Railway Street (West Silver Creek): 2.3 – Upsize the existing 12-inch pipe along McClaine Street (downstream of the underground detention storage near Westfield Avenue) to 15-inches and connect to the existing 18-inch pipe along McClaine Street.

Monson Road (West Silver Creek): 2.4 – Improve the ditch sections along Monson Road to drain to the north toward Silver Creek. The upper sections of the ditch appear to drain away from Silver Creek. The model suggests the existing ditch cross sections have adequate capacity to convey the design storms; the ditches should be re-graded to drain to the north. Additionally, upsize the existing 18-inch outfall pipe to 30-inches.

Silverton High School, Kromminga Drive (Northeast Silver Creek): 2.5- Upsize the existing pipelines upstream of the Silverton High School Storage Pond along Kromminga Drive. The existing 18-inch pipe should be upsized to 24-inches and the existing 24-inch pipe should be upsized to 36-inches through the discharge into the storage pond.

Stormwater Master Plan Update: 2.6 – Update the stormwater master plan every 5-10 years to re-assess needs, priorities, and properly allocate budgets to address system deficiencies.

9.2.3 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 noted flooding. These projects are recommended to be completed within 10-20 years of completing this study.

Mill Street (Webb Lake): 3.1 – Upsize the existing 18-inch to 10-inch bottleneck along Mill Street under the railroad. The 10-inch should be replaced with an 18-inch pipe.

1st Street Detention Pond (North Central): 3.2 – Upsize the existing 18-inch pipe along N 1st Street from Oak Street to Park Street. Construct a new 1.5 acre-feet stormwater storage facility. The proposed property has been identified as the location for the future City Hall and a park/stormwater facility has previously been considered by the City. This stormwater storage would reduce peak flows downstream and eliminate the need to upsize downstream pipes.

Silverton Road NE/Railway Street (West Silver Creek): 3.3 – Upsize the existing pipe underneath McClaine Street to 24-inches and replace the downstream culvert with 24-inch pipe. The City reported the ditch which has previously drained stormwater to Monson Road and ultimately to Silver Creek has been filled in by the property owner. The ditch should be restored to its original dimensions by the County and the recommendation provided to the County was that they should establish an easement through the property if one does not exist.

Webb Lake Local Street Improvements (Webb Lake): 3.4 – Install stormwater infrastructure along Lincoln, Jefferson, Washington, Chester, and Whittier Street to reduce localized ponding. This project could be phased and completed in conjunction with local road reconstructions as necessary.

Stormwater Master Plan Update #2: 3.5 – Update the stormwater master plan every 5-10 years to re-assess needs, priorities, and properly allocate budgets to address system deficiencies.

A summary of the recommended improvements and associated capital costs are organized by priority in Table 9-2. Planning level cost estimates were developed using 2022 dollars and a detailed summary sheet for each improvement is provided in Appendix E.

TABLE 9-2: CAPITAL IMPROVEMENT PLAN (CIP)

Project ID	Project Name	Total Estimated Cost (2022 Dollars)	SDC Eligibility (%)	Cost Allocated to Growth	Cost Allocated to City
Priority 1 Improvements					
1.1	Rock Street Stormwater Improvements (Northeast Silver Creek)	$770,000	0%	$0	$770,000
1.2	2nd Street and Lincoln Street (Webb Lake)	$1,700,000	0%	$0	$1,700,000
1.3	Public Works Shop Decant Facility Roof Structure	$184,000	0%	$0	$184,000
1.4	3rd Street and Jersey Street to Mill and B Street (Northeast Silver Creek)	$3,600,000	0%	$0	$3,600,000
1.5	Abiqua Heights, upstream of storage pond (Northeast Silver Creek)	$900,000	11%	$100,000	$800,000
1.6	Koons Street and Adams Avenue to Silver Creek (Northeast Silver Creek)	$3,300,000	12%	$390,000	$2,910,000
1.7	Sheridan Street to Silver Creek (Northeast Silver Creek)	$710,000	0%	$0	$710,000
1.8	Olson's Ditch at Sage Street (Webb Lake)	$1,100,000	9%	$100,000	$1,000,000
1.9	Crestview Drive, Breyonna Way, Iowa Street, and Oak Street (Webb Lake)	$3,200,000	4%	$110,000	$3,090,000
1.10	Lone Oaks Loop and 2nd Street to Bowtie Lane (North Central)	$2,500,000	0%	$0	$2,500,000
1.11	Davisson Baseball Fields (North Central)	$2,700,000	3%	$90,000	$2,610,000
1.12	James Street and Schlador to Western Avenue (North Central)	$1,900,000	33%	$630,000	$1,270,000
1.13	Westfield Street and C Street (West Silver Creek)	$630,000	6%	$40,000	$590,000
1.14a	Pioneer Lake Geotechnical Investigation	$60,000	23%	$10,000	$50,000
1.14b	Pioneer Lake Improvements	$780,000	23%	$180,000	$600,000
	Total Priority 1 Improvement Costs (Rounded)	$24,000,000	-	$1,700,000	$22,400,000
Priority 2 Improvements					
2.1	Norway Street to Oak Street (Webb Lake)	$2,000,000	8%	$150,000	$1,850,000
2.2	Main Street by Water Treatment Plant (Webb Lake)	$490,000	9%	$40,000	$450,000
2.3	McClaine Street and Railway Street (West Silver Creek)	$460,000	0%	$0	$460,000
2.4	Monson Road (West Silver Creek)	$650,000	16%	$110,000	$540,000
2.5	Silverton High School, Kromminga Drive (Northeast Silver Creek)	$1,100,000	0%	$0	$1,100,000
2.6	Stormwater Master Plan Update	$200,000	100%	$200,000	$0
	Total Priority 2 Improvement Costs (Rounded)	$4,900,000	-	$500,000	$4,400,000
Priority 3 Improvements					
3.1	Mill Street (Webb Lake)	$350,000	0%	$0	$350,000
3.2	1st Street Detention Pond (North Central)	$1,500,000	0%	$0	$1,500,000
3.3	Between Silverton Road NE and Railway Street (West Silver Creek)	$790,000	16%	$130,000	$660,000
3.4	Webb Lake Local Street Improvements (Webb Lake)	$5,900,000	0%	$0	$5,900,000
3.5	Stormwater Master Plan Update #2	$330,000	100%	$330,000	$0
	Total Priority 3 Improvement Costs (Rounded)	$8,900,000	-	$460,000	$8,400,000
	Total Improvement Costs (Rounded)	**$37,800,000**	**-**	**$2,700,000**	**$35,200,000**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our opinion of probable 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 costs presented herein.

9.3 SYSTEM DEVELOPMENT CHARGES (SDC)

The City of Silverton establishes stormwater SDCs per Oregon Revised Statute (ORS) 223.297-314. The current improvement SDCs for development are based on estimated impervious surface area. The average amount of impervious area on a single family residential developed lot within the City is set at 3,121 square feet (SF). This average impervious area is used to calculate the number of equivalent service units (ESU) for each development. The number of ESUs is then multiplied by the unit rate to determine the SDC amount.

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 undeveloped areas within the City limits were reviewed. The SDC improvement amount is based on the percentage of estimated future development area within the capital improvement's contributing drainage basin. The SDC eligibility for each project is summarized in Table 9-2.

9.4 PLANNING RECOMMENDATIONS

It is recommended that the City update their planning documents every five to ten 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 and an update #2 as a Priority 3 improvement with an estimated cost of $330,000. Note the increased costs in the Priority 3 stormwater master plan update is to account for inflation.

9.5 OTHER ANNUAL COSTS

The stormwater conveyance system requires regular maintenance to ensure that pipelines, catch basins, and detention facilities flow freely during 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.

9.5.1 MAINTENANCE PROGRAM AND STAFFING

The recommended level of service, O&M, and staffing for the stormwater system is summarized in Section 8. As discussed in Section 8, it is estimated that approximately 4.0 FTE are needed to meet the recommended level of O&M to meet the City's level of service (LOS) goals. It is recommended that the City start by budgeting 2.0 FTE for stormwater O&M because this additional staff on the PW crew may help alleviate some of the challenges and disruptions from employees taking their earned vacation and sick leave. The City should reevaluate staffing requirements and needs every two to three years, and it would be expected that the City would need to increase budgeted staffing for the stormwater facilities to meet the desirable LOS.

9.5.2 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 15 miles of storm pipes, 600 manholes, and 1,300 catch basins. Assuming an average useful life of 75-years for pipelines and 50-years for manholes and catch basins, the replacement program should target approximately 1,000 feet of pipe, 26 catch basins, and 12 manholes per year. Assuming an average pipe replacement cost of $200 per foot, a catch basin cost of $3,200 each, and a manhole cost of $13,000, the City would need an annual replacement budget of approximately $440,000. Table 9-3 summarizes the annual replacement program's targets and associated costs.

TABLE 9-3: SUMMARY OF ANNUAL REPLACEMENT COSTS

Item	Lifespan	Unit Cost[1]	Annual Replacement Quantity	Annual Cost[1] (rounded)
Stormwater Pipelines (LF)	75 Years	$200	1,000	$200,000
Catch Basins	50 Years	$3,200	26	$80,000
Manholes	50 Years	$13,000	12	$160,000
			Total (Rounded)	$440,000

1) Storm pipes unit price is equal to average unit price of 12" to 36". Manhole unit price equal to average of 48", 60", and 72" manhole.