City of Albany, Oregon
Stormwater Master Plan

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PUBLIC WORKS - ENGINEERING
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1.0 Executive Summary

The City of Albany completed its last comprehensive stormwater infrastructure analysis as part of the 1988 Drainage Master Plan. The 1988 plan focused on existing stormwater conveyance deficiencies and planning for future stormwater infrastructure in undeveloped areas of the city. The plan was not fully implemented and no longer represents current stormwater conveyance conditions. Due to changing conditions, development, new regulations, and more advanced methods of analysis since the completion of the 1988 report, a reevaluation of the City's current stormwater infrastructure and plan for future growth was needed.

This 2021 Stormwater Master Plan report provides an updated assessment of Albany's stormwater conveyance infrastructure and a preliminary list of capital improvement projects addressing the needs of Albany's future land use condition, referred to as the build-out condition, with the application of Albany's flood control detention standards. The primary focus of this master plan is on the conveyance capacity of the existing and build-out stormwater system. The location of deficiencies, recommended capital improvement projects, and associated project costs are provided. Prioritization categories are also provided that are intended to assist in future project selection. This report does not address other aspects of the system such as water quality treatment or operations and maintenance (O&M). This report also summarizes the previous foundational work conducted in evaluation of the City's stormwater network.

2.0 Introduction and Background

2.1 General Summary of City

The City of Albany sits in the heart of Oregon's Willamette Valley, on the banks of the Willamette River and its tributary, the Calapooia River. Albany lies within both Benton and Linn counties and with a population of 54,935 (July 1, 2020 PSU Certified Estimate), is the 11th largest city in Oregon, the largest city in Linn County, and the second largest city in Benton County. Since incorporation in 1864, Albany has grown south and east, first with the railroads, then state highways and Interstate 5, and north across the Willamette into the farms and hillsides of North Albany. Major employers include healthcare, industry, education, retail, and government.

2.2 Stormwater System Summary

The Willamette River serves as the final receiving waterway for all runoff from the City. South of the Willamette River, five larger creeks convey runoff from the City. These include Truax, Burkhart, Cox, Periwinkle, and Oak Creeks. These creeks originate in farmlands south and east of Albany. North of the Willamette River in North Albany, there are seven smaller waterways that drain southeast to the Willamette River and one along the western boundary of the urban growth boundary (UGB), which flows southwest to the Willamette River.

The City's stormwater system is primarily dedicated to stormwater collection and conveyance and is separate from the sanitary sewer system. As of Fiscal Year 2020, stormwater assets total nearly 11 million dollars. This includes approximately 139 miles of stormwater pipes, 70 miles of ditches, 2,495 manholes, 4,447 catch basins, and 331 stormwater quality facilities. Historically, Albany has not been able to properly maintain stormwater assets due to lack of adequate funding. Past maintenance has included only minor cleaning, response to emergency floods and spills, and street sweeping. These activities have only been accomplished with money that would have otherwise been used for sewers and streets. Consequently, infrastructure continues to deteriorate. By 2018, with only 50 percent of the system inspected and assigned a condition rating, eight miles of pipe had been identified as failed or anticipated to fail in the next 10 years. Another nearly one mile of pipe was identified as needing significant maintenance and repair to address root intrusion, a leading cause of reduced pipe capacity and increased flow to the system from groundwater.

Current resources are not adequate for required O&M, capital improvements, and for compliance with new state and federal regulations. In 2017, implementation of a stormwater fee allowed the City to start building dedicated funds focused on maintenance and administrative tasks associated with regulatory requirements. With the adoption of this master plan, City Council can consider implementing a stormwater SDC. This SDC would be used as another component for funding needed stormwater capital projects.

2.3 Summary of Stormwater System Development Efforts

The primary focus of this master plan is the conveyance capacity of the existing and future stormwater system. It does not address other aspects of the system such as water quality treatment or O&M. However, development of the supporting information for this master plan is the result of a long-term effort overlapping with other activities such as the implementation of the City's 2017 stormwater utility fee. These activities have included regulatory research, a City-wide assessment of impervious surfaces, and GIS database improvements. Below is a short summary of the major reports which have collectively contributed to this Stormwater Master Plan. More detail is included in the respective sections of this report. All individual reports referenced below are included in Appendix D.

2.3.1 Regulatory Program Research (Cardno WRG, 2010)

This report researched stormwater related state and federal regulatory programs. This included research into the Clean Water Act, National Pollutant Discharge Elimination System (NPDES) Stormwater Program, Willamette Basin Total Maximum Daily Load (TMDL) Program, Endangered Species Act (ESA), National Flood Insurance Program (NFIP), and Oregon Comprehensive Land Use Planning. See Section 3.0 Policy and Regulatory Guidance and the full report in the Appendix D for more information.

2.3.2 Jurisdictional Research (Cardno WRG, 2010)

To determine appropriate design storms, detention, and infiltration requirements for the City, this report summarized stormwater ordinances from other jurisdictions in Oregon and Washington, with the primary purpose to provide a basis for comparison to Albany. See Section 6.0 Evaluation Criteria and the full report in the Appendix D for more information.

2.3.3 Albany Ordinance and Program Research (Cardno WRG, 2010)

This report provided an overview and comparison of the existing stormwater program and ordinances with federal and state mandates as well as voluntary stormwater management options. This included research into the following City documents; *Albany Municipal Code-Title 12 Surface Water*, *Engineering Standards - Division E - Stormwater Management*, *Albany Development Code Article 12.530-12.585 Storm Drainage*, *Standard Construction Specification-Division 4 Sanitary Sewers & Storm Drains*, *Albany Comprehensive Plan*, *North Albany Refinement Plan*, *City of Albany Strategic Plan*, *and the 1988 Drainage Master Plan*. See Section 3.0 Policy and Regulatory Guidance and the full report in the Appendix D for more information.

2.3.4 Design Storm Event Evaluation (Cardno WRG, 2010)

This report assessed what design storms are appropriate for evaluating the existing and future stormwater system. A comparison of prevalent methods employed within the Pacific Northwest was completed. Based on the analysis, design storm events were recommended, and a brief description of prevalent hydraulic methods used for conveyance design was provided. This work resulted in the adoption of the design storm events into the current stormwater engineering standards, which are used in this master plan evaluation. See Section 6.0 Evaluation Criteria and the full report in the Appendix D for more information.

2.3.5 Infiltration Evaluation (Cardno WRG, 2010)

The purpose of this report was to determine whether infiltration basins were a viable type of stormwater management facility for the City and, if so, provide the necessary criteria in determining where infiltration facilities are appropriate. While this work was more specific to developing water quality facility design guidelines, the land use and soils investigation provided data that was utilized in the development of the existing stormwater model. See the full report in the Appendix D for more information.

2.3.6 Water Quality Storm Event (Cardno WRG, 2011)

This memo focused on developing the water quality storm event used to size water quality facilities for the City. The report recommended a water quality precipitation depth of one inch. The one-inch depth accounted for 93 percent of all 24-hour rainfall depths recorded between 1949 and 2010. This event is less than the two-year event, which is the low end for conveyance design standards pertinent to the work in this report. However, it is mentioned here due to its relevance to everyday stormwater design. See the full report in the Appendix D for more information.

2.3.7 Rainfall Depth (Cardno WRG, 2011)

Similar to the *Water Quality Storm Event* evaluation, the *Rainfall Depth* evaluation determined the rainfall depths for the 2-, 10-, 25-, 50-, and 100-year return intervals for the city of Albany. The rainfall depths collected from within North Albany represented the highest rates in the City and were used to represent the entire City. See Section 6.0 Evaluation Criteria and the full report in the Appendix D for more information.

2.3.8 Hydraulic Model Development (Cardno WRG, 2011)

In 2011, Cardno WRG began refinement of a XPSWMM hydraulic model completed earlier in 2010 by Crawford Engineering. The 2010 version consisted of five creeks and existing piping within the city of Albany. The 2011 model became the foundation for development of the six independent hydraulic models representing the city's six major drainage basins. The 2011 work was then refined in the 2013 report discussed below in Section 2.3.11. See the full report in Appendix D for more information.

2.3.9 Zoning Percent Imperviousness Evaluation (Cardno WRG, 2012)

This evaluation provided recommended impervious percentages to be used in the build-out analysis. These recommendations were based on a comparison between the development code and observed existing impervious percentages. In most situations where the observed values were lower than the allowable value, the higher allowable value was selected. Over 20 different sub-zone categories were assigned specific impervious percentages. See Section 4.5 Zoning and the full report in the Appendix D for more information.

2.3.10 January Storm Calibration (Cardno WRG, 2012)

During a three-day period in January 2012, over 7.5 inches of rain fell on the City. This storm was significant not only due to its size, but also in that it allowed the City to calibrate the stormwater model to a well-documented, 50-year storm event. The model was previously calibrated to four storm events approximating a two-year frequency storm, and this large storm event provided an opportunity for further calibration to ensure the model represented the full range of flow conditions. Additional USGS measurements allowed the development of stage-discharge curves, and the models Manning's "n" values were adjusted. See Section 5.0 Model Stormwater Runoff and the full report in the Appendix D for more information.

2.3.11 Existing System Hydraulic Model Development & Calibration (Cardno, 2013)

This 2013 report continued the work that was started in the *2011 Hydraulic Model Development* report summarized in Section 2.3.8 of this report. This model was used to identify system deficiencies and capital improvement projects for the existing stormwater system. The report was organized into three chapters. Chapter 1 provided a general overview of the purpose for the 1D and 1D/2D modeling, the area modeled and a general description of how a 1D/2D model was developed. Chapter 2 provided a description of the variables and parameters used to develop the models. Chapter 3 provided a description of the model calibration process, model results, and 2D inundation maps. See Section 5.0 Model Stormwater Runoff and the full report in the Appendix D for more information.

2.3.12 Stormwater Infrastructure Assessment & Preliminary CIP Recommendations (Cardno, 2019)

The report was completed in 2019 and was built upon the *2013 Existing System Hydraulic Model Development & Calibration* report. This report identified existing and build-out deficiencies and provided a preliminary list of CIPs and cost estimates for both. Completion of the build-out CIP in this report was not inclusive of the City's flow control detention standards. This final step in the master plan CIP was completed in the 2021 report discussed further below. See Section 7.0 Existing System Deficiencies and the full report in the Appendix D for more information.

2.3.13 Final Stormwater Infrastructure Assessment & CIP Recommendations (Cardno, 2021)

This 2021 report provided the final updated infrastructure assessment of Albany's storm network, and a preliminary list of CIPs to address the needs of the City's future land use condition referred to as the build-out condition with the application of the City's flood control detention standards. The assessment was conducted using a numerical hydrologic and hydraulic model analysis that includes all storm piping of 10-inch diameter and greater, bridge and culverts, and Albany's major streams. As recommended in Cardno's memorandum, *Design Storm Event Evaluations*, the analysis identified conveyance deficiencies using the City's existing design criteria, including application detention standards to new development. Build-out deficiencies are discussed in Section 8.0 Build-Out System Deficiencies, and recommended CIPs are discussed in Section 9.0 Capital Improvement Projects. See Appendix D for the full report.

3.0 Policy and Regulatory Guidance

3.1 Early Water Policy

Early water policy in Oregon was primarily related to assuring the availability of water, not its condition. The principle of prior appropriation was adopted by the Oregon legislature in 1909 with the enactment of the Oregon Water Code. The code declared Oregon's water a public resource and introduced state control over the right to use water and required a permit for anyone to use it.

Policy related to the quality of waterways was largely nonexistent in Oregon until the 1930s. Public awareness of the excessive pollution in the more populated areas of the Willamette Basin resulted in establishment of the Oregon State Sanitary Authority (OSSA) in 1939. The OSSA developed and adopted water quality regulations prohibiting the discharge of untreated municipal or industrial waste.

Federal interest in water quality was established with the Federal Water Pollution Control Act (FWPCA) of 1948. With the establishment of OSSA and the FWPCA, the period from the 1940s to the 1960s saw a transition from the direct discharge of municipal and industrial wastewater to Oregon's waterways, to construction of municipal wastewater plants and industrial application of similar primary treatment processes. In 1969, the Oregon legislature replaced the OSSA with the Department of Environmental Quality (DEQ).

3.2 Clean Water Act

Federally, growing public awareness and concern for controlling water pollution led to the creation of the Environmental Protection Agency (EPA) in 1970. Subsequent amendments to the FWPCA in 1972, when the law became commonly known as the Clean Water Act (CWA), also created the National Pollutant Discharge Elimination System (NPDES). The NPDES program created a permitting system to regulate point sources (discernible conveyance such as a pipe, ditch, and channels) discharging pollutants to waters of the United States.

Little attention had been given to non-point source pollution up to this point. Non-point pollution resulted from runoff of stormwater from urban areas, agricultural lands, forests, and construction sites. The Water Quality Act of 1987 reflected concerns over the extensive contamination of stormwater discharges from municipal and industrial sources as well as the need to bring these sources within the NPDES permit program.

The State of Oregon, through the DEQ, has accepted delegation from EPA, meaning they are responsible for implementing the federal regulations at the state level. DEQ has adopted two stormwater regulations that affect the City of Albany: the Willamette River Basin Total Maximum Daily Load (TMDL) and the NPDES MS4 (municipal separate storm sewer systems) Phase II. Albany first began implementing regulatory elements of stormwater management in 2008 following the development and adoption of the 2006 Willamette River TMDL.

With Albany's current population exceeding 50,000, DEQ listed the city as a new permittee in the 2018 revised NPDES MS4 Phase II permit. This NPDES permit requires a Stormwater Management Plan specific to Albany. At the time of the development of this master plan, Albany staff and legal counsel are closely monitoring the DEQ permit development process.

3.3 State and Local Regulations and Policies

The City of Albany's Stormwater Master Plan is affected by several other state and local regulations and policies. These range from state planning goals to City municipal code and comprehensive plan. Below are brief summaries of selected law, policy, and guidance.

3.3.1 State Land Use Planning Goals

The foundation of statewide programs for land use planning in Oregon is a set of 19 Statewide Land Use Planning Goals. The goals express state policies on land use and related topics. The incentive and purpose of the stormwater master plan is related to multiple state planning goals including Goal 2 - Land Use Planning; Goal 5 - Natural Resources, Scenic and Historic Areas, and Open Spaces; and Goal 11 - Public Facilities and Services. Local comprehensive plans must be consistent with the Statewide Planning Goals. Plans are reviewed for such consistency by the state's Land Conservation and Development Commission (LCDC).

3.3.2 Oregon Administrative Rule (OAR) and Oregon Revised Statute (ORS)

State land use Goal 11 requires any city with a population greater than 2,500 to create a public facility plan that meets its current and long-range needs. The stated purpose of OAR 660-011 is to aid in achieving the requirements of Goal 11. OAR 660-011 states that "the purpose of the facilities plan is to help assure that urban development in such urban growth boundaries is guided and supported by types and levels of urban facilities and services appropriate for the needs and requirements of the urban areas to be serviced, and that those facilities and services are provided in a timely, orderly and efficient arrangement, as required by Goal 11." Additionally, ORS 223.297-223.314 requires that a city may not impose SDCs without a capital facility plan that lists the capital improvements to be funded by the SDC.

3.3.3 Strategic Plan

The Strategic Plan is designed to reflect the City's Mission and Vision Statement. Related to infrastructure management, the City has a goal of providing safe, sufficient, and reliable drinking water, sewage disposal, and drainage systems. Objective EG-7 includes completing this stormwater master plan.

3.3.4 Municipal Code

The Municipal Code (MC) provides local ordinances and the legal framework for the City. The MC provides sections on finances, business licenses, public protection, development standards, and public improvement standards. The MC includes information on mandating stormwater management in Title 12 - Surface Water.

3.3.5 Comprehensive Plan

Albany's Comprehensive Plan provides a framework for making better decisions about land use and resources. It provides guidance on both short- and long-term development to shape the City in a "positive and productive manner." Chapter 6 includes information on Storm Drainage. The document specifies the City's goal of eliminating existing drainage problems and the policies needed to meet this goal.

3.3.6 Development Code

The Albany Development Code sets forth and coordinates City regulations governing the development and use of land. It provides specific direction to implement the policies of the Comprehensive Plan. The Development Code provides stormwater requirements in Storm Drainage Sections 12.530 to 12.585. This document specifies the allowable development practices related to stormwater.

3.3.7 Engineering Standards

Division E of the City's Engineering Standards provides stormwater management engineering standards and guidelines for both public and private development within the City of Albany. The standards provide a consistent policy under which certain physical aspects of stormwater management will be implemented. Most of the elements contained in the standards are public works oriented and most are related to the development or platting process; however, it is intended that they apply to both public and private work.

4.0 Urban Hydrology

The water cycle, or hydrologic cycle, is the term used for the continuous process of water's movement in the atmosphere, on land and in the ground. The hydrologic cycle is a complex series of processes that includes precipitation, evaporation, evapotranspiration, infiltration, overland flow, groundwater flow, and stream flow. Rainfall exceeding the soil's capacity for infiltration and storage results in runoff to streams or other watercourses. Development alters the natural processes in various ways. One of the primary ways development can alter the system is by increasing impervious surfaces, which in turn reduces areas that infiltrate. Development has historically managed this altered system with a focus on routing the added runoff as fast as possible to the nearest waterway. This shift in the balance from infiltration to a rapid and direct discharge has multiple consequences to the natural balance of the system. Primarily, and for the purposes of this master plan, it has led to increasing the peak flow, erosion, and flooding of the receiving waterways.

Various methodologies are available to estimate runoff utilizing defined conditions and certain assumptions. The following section includes the basic components used in the methodology chosen for the City's master plan.

4.1 Precipitation

Precipitation is water released from clouds in the form of rain, freezing rain, sleet, snow, or hail. It is the main step in the water cycle that provides the connection of atmospheric water back to the Earth. The primary form of precipitation in the City of Albany is rain. Approximately 42 inches of rain falls on the City of Albany each year.

Precipitation data was collected and analyzed for the master plan for a variety of reasons. Data was collected from about 2008 to 2012 from eight rainfall gages.

The *2010 Design Storm Event Evaluation* determined if the City's current design storm events and the methods used to estimate runoff were appropriate for evaluating the stormwater system. The precipitation component of this report confirmed the recurrence intervals for storms and the associated infrastructure components that are designed to have the capacity to convey runoff from that storm. The recurrence interval is defined as the probability of an event to be equaled or exceeded in any given year. For example, a 2-year event has been determined to have a 50 percent chance of being equaled or exceeded in any given year, and a 100-year event has a 1 percent chance of being equaled or exceeded in any given year. The report recommended the City should maintain its current standards as they were appropriate for the City and was also within the range of other jurisdictions.

In 2011, the City updated the 24-hour rainfall depths for the 2-, 5-, 10-, 25-, 50-, and 100-year storm events. These rainfall depths were determined using the State of Oregon's Regional Precipitation-Frequency Atlas (January 2008) and rainfall data collected at the City's eight rain gauge sites. See Table 4.1 below for the City's cumulative 24-hour rainfall depths and associated return intervals.

Return Interval (year)	Cumulative 24-hour Rainfall (inches)
2	2.47
5	2.86
10	3.37
25	3.94
50	4.38
100	4.83

Table 4.1 - 24-hour Rainfall Depths

The remaining rainfall analysis associated with the master plan was used to provide real-world data to calibrate the results of the computer modeling. The calibration storms were selected from a range of significant storms that occurred from December 2008 through January 2012. Five storm events were selected for the analysis and included the time spans of:

- December 31, 2008 to January 2, 2009
- November 6, 2009 to November 9, 2009
- March 25, 2010 to March 31, 2010
- February 27, 2011 to March 1, 2011
- January 17, 2012 to January 19, 2012

Each storm is identified by the month in which the storm event began (December, November, March, February, and January). A total rainfall depth of 1.92, 2.04, 4.17 and 2.92 inches occurred for the respective December, November, March, and February storm events. These events approximate a two-year storm event. In January 2012, the city of Albany experienced a 50-year frequency storm (*January Storm Calibration Report (2012))*. This was well documented by the City's 8 rain gauges, 20 stream gauges, and 5 pipe gauges. USGS collected flow measurements at many of the stream gauge locations over the course of the three-day storm. Additionally, a photo log and a citizen call-in log of flooding locations was developed.

This large storm event provided a significant opportunity for further calibration to ensure the model accurately represented the full range of flow conditions.

4.2 Basins

A drainage basin, or watershed, is a defined area for which there is one outlet for water to flow. The size of the basin is dictated by the study area or the point of interest for which determining hydrologic characteristics is desired. The study area for the master plan is the entire City of Albany UGB. The UGB is split in a general east to west direction by the Willamette River, which serves as the eventual receiving waterway for all runoff from the City. On the south side of the Willamette River, five larger creeks provide drainage for the City. These include Truax, Burkhart, Cox, Periwinkle, and Oak Creeks. These creeks originate in farmlands south and east of Albany. On the north side of the Willamette River in North Albany, there are seven smaller waterways that drain southeast to the Willamette River and one along the western boundary of the UGB which flows southwest to the Willamette River.

In the case of the City's evaluation for this master plan, six main drainage basins were defined incorporating most of the UGB. Basin delineation was completed automatically via software in less urbanized areas and manually in the more urbanized areas that have more complex drainage patterns. The automated delineation software was also used to determine other basin parameters such as the slope, width, and lengths of the basin, each an important parameter used in estimating runoff. The six final basins include Burkhart-Truax, Cox, Periwinkle, Oak, North Albany, and Willamette River. For Truax, Burkhart, Cox, Periwinkle, and Oak Creeks, the UGB only includes a portion of the total basin. Drainage entering these basins from outside the UGB was estimated and included at the upstream end of each basin where it enters the UGB.

Basins are shown in Figure 4.2 below. Basin area totals are summarized below in Table 4.2. The total Albany UGB area is 13,900 acres (21.7 square miles). Approximately 930 acres within the UGB drains away from the identified watersheds and is not included in the drainage area. See the *Existing System Hydraulic Model Development and Calibration* report in Appendix D for more information.

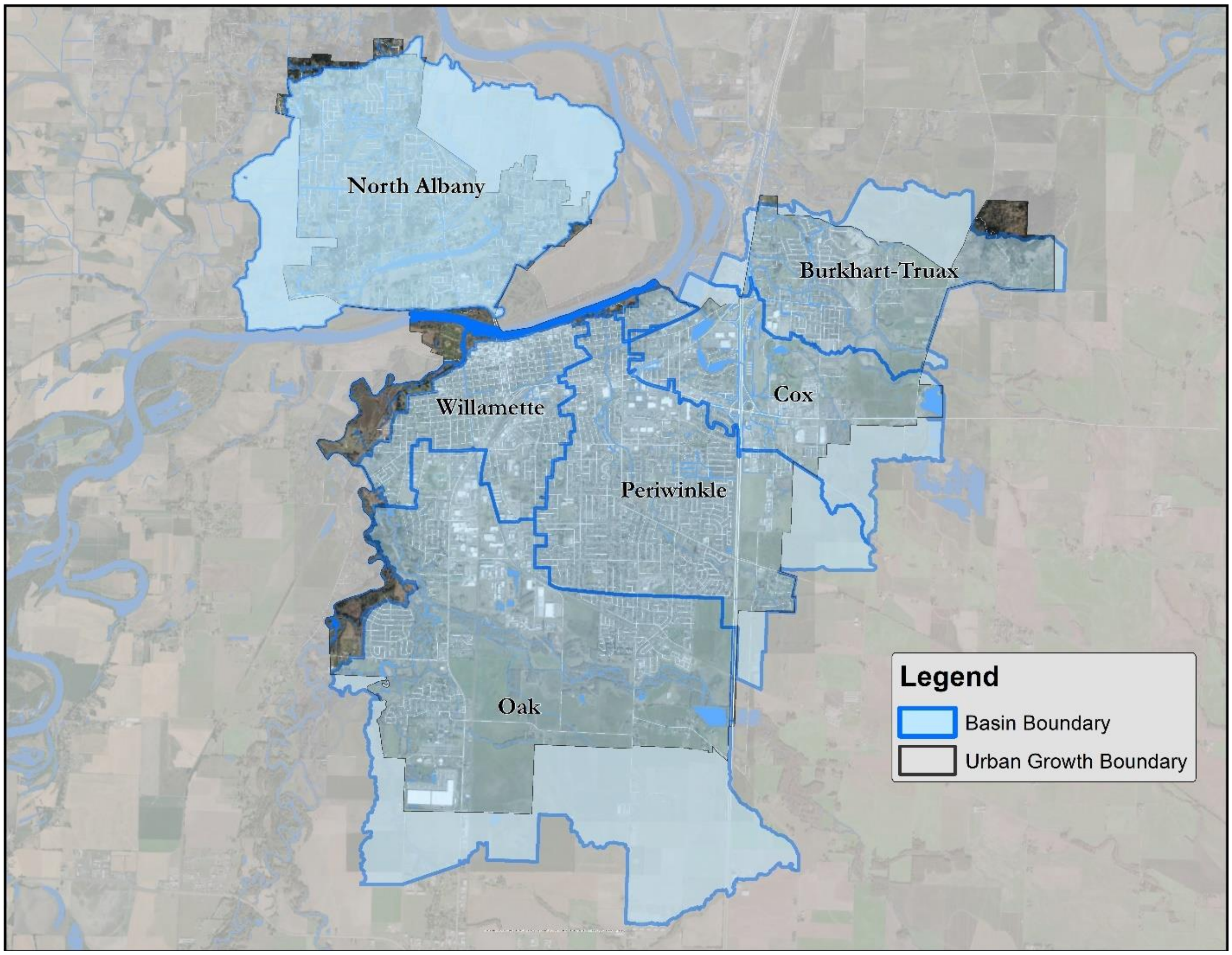

Figure 4.2 – City of Albany Basin Areas

Basin	Study Area Inside UGB (ac)	Study Area Outside UGB (ac)	Total Study Area (ac)
Burkhart-Truax	1,335	484	1,819
Cox	1,395	412	1,807
Periwinkle	2,490	395	2,885
North Albany	2,393	1,392	3,785
Willamette	1,279	0	1,279
Oak	4,080	2,052	6,132
Total	12,972	4,735	17,707

Table 4.2 - Basin Areas

4.3 Pervious Surfaces

Pervious surfaces can be open fields, lawns, forests, gardens, mulched areas, and man-made items such as permeable pavers or porous asphalt. From the perspective of a simplified hydrologic cycle, pervious surfaces provide an opportunity for natural infiltration, depression storage, and an attenuation in the time of travel for runoff. Depression storage is the process of surface ponding and evaporation. All depression storage must be filled before runoff begins. The role that pervious surfaces provide is affected by many items including topography, vegetation, soils, and the season.

Topography data was assessed in the basin delineation process as previously discussed. Infiltration and other surface parameters affecting runoff from pervious surfaces were obtained from soil survey data provided by the Natural Resources Conservation Service (NRCS). Three predominant soil types were found within the City UGB: Gravelly Silt Loam, Silt Loam, and Silty Clay Loam. Infiltration capacity was estimated based on the published average saturated hydraulic conductivity. Depression storage and surface roughness (Manning's "n" value) were initially estimated based on experience and then were adjusted as part of the calibration process discussed in Section 5.3 Model Calibration.

4.4 Impervious Surfaces

Impervious surfaces reduce the infiltration capacity of a basin and increase runoff. Impervious surfaces include areas such as roofs, driveways, sidewalks, parking lots, and roads. In evaluating the impervious surfaces for this master plan, it was necessary to identify the existing impervious surface coverage and estimate the future impervious surface coverage predicted at the built-out condition as well.

Coverage of the City's existing impervious surfaces was assessed using GIS tax lot data, aerial photos, and impervious surface data collected during a 2010 Light Detention and Ranging (Lidar) survey. The highest impervious coverage was located within the downtown area, and the lowest impervious coverage was in North Albany. Additional information on the development of the impervious surface data can be found in the *Existing System Hydraulic Model Development & Calibration* report in Appendix D.

Table 4.4 below includes the summary of the existing impervious areas assigned in each basin.

Basin	Total basin area (ac)	Impervious area (ac)	Percent impervious per basin (%)
Burkhart-Truax	1,819	315	17%
Cox	1,807	484	27%
Periwinkle	2,885	1,107	38%
North Albany	3,785	554	15%
Willamette	1,279	676	53%
Oak	6,132	1,004	16%
Total	17,707	4,140	23%

Table 4.4 – Existing conditions impervious surface area summary

Expanding the existing impervious conditions to the future build-out impervious conditions focused on: (1) defining the existing parcels as undeveloped, partially developed, and fully developed; (2) identifying the location of future streets; and (3) quantifying the potential increase in impervious surface in parcels and streets at build-out. Fully developed existing parcels were identified to have no development potential. These could be parcels already at a maximum impervious coverage (see Section 4.5 Zoning) or could be open spaces and parks that already serve a dedicated purpose that would essentially eliminate the potential for new impervious surfaces to be built. Undeveloped or partially developed parcels were simply parcels with unrealized development potential. Some properties with substantial existing development were still considered to have additional development capacity.

Parcels with wetlands, steep slopes, partial open space zoning, or other natural features that may constrain development were not considered to have any less development potential than sites without these features. Cluster development provisions in the City's development code encourages protection of these resources through density transfers, and consequently, there is the potential for similar amounts of total impervious surface increases within a development when considering the parent parcel as whole. Equivalent impervious surfaces will not likely be realized across all parcels. However, allowing for development of these areas is a conservative approach appropriate for master planning purposes.

Much of the evaluation on predicting future impervious surfaces is based on parcel zoning. Zoning criteria explicitly provides percentages for maximum impervious surface coverage according to a parcels zoning designation. These values were compared to actual impervious surface coverage on developed parcels, resulting in a recommended future impervious area to assign to parcels that are partially or completely undeveloped. See the Section 4.5 Zoning below for more discussion on evaluating impervious surface coverage in parcels.

For impervious surfaces in existing right-of-way, such as streets, existing impervious surfaces were considered to represent build-out conditions, except for some major roads expected to receive urban conversions.

Table 4.4.1 below includes the summary of the future impervious surface coverage estimated for each basin. The percent increase in impervious surface from existing conditions to build-out conditions is included.

Basin	Total basin area (ac)	Impervious area (ac)	Percent impervious per basin (%)	Impervious percent increase from existing conditions (%)
Burkhart-Truax	1,589	842	53%	167%
Cox	1,800	786	44%	62%
Periwinkle	2,891	1,430	49%	29%
North Albany	3,786	1,142	30%	106%
Willamette	1,292	774	60%	14%
Oak	6,133	2,186	36%	118%
Total	17,491	7,160	41%	73%

Table 4.4.1 – Future conditions impervious surface area summary

4.5 Zoning

Zoning is the most common form of land-use regulation for municipalities to control development within their existing growth boundary. Zoning is part of a City's comprehensive plan and guides current and future development of public infrastructure, subdivisions, parks, industry, and other land use. City of Albany zoning is grouped into residential, commercial, and industrial, and mixed-use districts. Each of these major zone categories includes numerous sub-categories. Zoning serves as a tool for predicting the area of future impervious surface on a parcel, which is essential in planning for future stormwater infrastructure.

Zoning criteria provides percentages for maximum impervious surface coverage per each type of zone. Those lot coverages provide a measure of the maximum amount of impervious surface for a developing parcel within each zone. However, there are instances where simply relying on prescribed maximum lot coverage may not be appropriate. For example, other applicable development requirements may influence the ability to realize maximum coverages. Similarly, for new detached single-family residential developments the lot coverage requirements only apply to the newly created individual parcels, so roads and other impervious surfaces within the newly dedicated public right-of-way constructed on the parent parcel to serve the new home sites might be missed by simply applying the maximum lot coverage percentage for the zone. Consequently, it was important to consider the amount of impervious surfaces actually constructed on properties in each zone and compare that amount to the allowed maximum lot coverage to determine appropriate assumptions for future developments.

Where specific zoning had not yet been assigned, the City's Comprehensive Plan provided guidance to identify the zones in the area. The South Albany Area Plan (adopted into the Comprehensive Plan) was used to identify appropriate zoning in south Albany areas without assigned zoning. In east Albany, where a suite of zones, but not specific zones, have been identified in the urban fringe, the zone with the greatest impervious surface was selected to provide a conservative estimate. The exception being anticipated residential areas in the urban fringe of east Albany that may incorporate multifamily development among the various detached single-family residential zone options. For these areas, RS-5 was selected as it represented an average impervious surface coverage for the range of anticipated development. Additionally, Albany's Rural Residential (RR) zone represents an interim zoning only applied in North Albany. While there are pockets of undeveloped properties throughout this area, floodplains, steep slopes, wetlands, and existing development will significantly limit further urbanization. Once public utilities are provided, there may be pockets of dense development but, on average, this area is not expected to realize impervious surfaces greater than 50 percent. Rather than changing the zones, a 50 percent impervious surface assumption was assigned to RR zones.

In summary, the determination of future impervious area was based on the comparison of the actual existing zone coverage and zone coverage per code. In most cases the higher value in the comparison was chosen. Exceptions to this are discussed in detail in the *Stormwater Infrastructure Assessment and Preliminary CIP Recommendations* report included in the Appendix D.

5.0 Modeling Stormwater Runoff

5.1 Model Selection

The City of Albany's stormwater system includes over 139 miles of pipes, 4,447 catch basins and inlets, 70 miles of ditches, 2,495 manholes dedicated for the sole purpose of collecting and conveying stormwater from a complex, 21 square mile urban drainage basin. Without these facilities, streets would be dangerous and potentially impassable during rain events and runoff and flooding could cause widespread property damage. Proactive management and long-term planning of this complex and growing system is critical for the City. This requires identifying and prioritizing existing deficiencies and projecting for future infrastructure improvements as well. Use of a computer model is necessary to effectively accomplish this for a city the size of Albany.

XPSWMM was the hydrologic/hydraulic computer model selected for this master plan. XPSWMM is based on the EPA Storm Water Management Model (SWMM) developed in the 1970s and is a comprehensive industry standard urban runoff model for continuous or event-based simulations. XPSWMM runs dynamic hydraulic calculations that allows for a query of system performance variables, such as depth of flow and velocity, at any point in time during a storm event. XPSWMM is also capable of both 1D and 2D hydraulic modeling. Additionally, XPSWMM was selected for GIS integration, ease of report generation, and tools for data management.

5.2 Model Development

Development of the model includes three primary components: hydrology, hydraulics, and boundary conditions. Additional detail on each component is included in the *Existing System Hydraulic Model Development & Calibration* report included in the Appendix D.

5.2.1 Hydrologic Analysis

The hydrologic analysis defines the amount of runoff generated within each basin or watershed. Hydrologic parameters include basin area, impervious percentage, surface storage, and infiltration. More detail on these parameters has been previously discussed in Section 4.0 Urban Hydrology.

5.2.2 Hydraulic Analysis

The hydraulic analysis defines how runoff moves through the watershed. Hydraulic model components include closed conduits and open channels. Hydraulic parameters include conduit geometry and friction coefficients. The City also conducted a 2D modeling in a selection of areas susceptible to more frequent flooding. 2D modeling can evaluate overland flow (i.e., flooding) characteristics such as depth and velocities and flow paths. Surface data (Lidar) was utilized to build the surface grids to conduct the 2D hydraulic modeling. Six 1D hydraulic models along with four 1D/2D hydraulic models were created to represent Albany's major watersheds. Specifically, the six 1D models were used to identify capital improvement projects and serve as the foundation for evaluating the effects of stormwater detention standards. The four 1D/2D models were used to accurately model areas prone to flooding to better prioritize stormwater improvements in those areas.

5.2.3 Boundary Conditions

The third component in the development of the model was identifying and applying boundary conditions. Boundary conditions define the hydrologic/hydraulic conditions at the upstream and downstream limits of a model study area. Boundary conditions essentially bracket the ends of the waterway that is being analyzed so that upstream or downstream influences are taken into effect. The City of Albany study area is defined by the current UGB. Burkhart, Truax, Cox, Periwinkle, and Oak Creeks have headwaters outside the UGB. This required an upstream boundary conditions for those streams at the point they enter the study area. The streams in North Albany and Cathey Creek are completely contained within the study area, so no definition of an upstream boundary conditions was required for those streams. Downstream boundary conditions were controlled for most streams by the Willamette River. The exception is Cathey Creek, which is controlled by Oak Creek, and flows into the Calapooia River and then to the Willamette River a short distance further downstream.

5.3 Model Calibration

An accurate model requires both reliable hydrologic data and a truthful depiction of physical conditions. Five storms were used to calibrate the hydraulic model of each basin. These included four storms that approximate a 2-year storm frequency and one storm that approximated a 50-year storm frequency. The calibration approach began with identifying discrepancies within the model. Where discrepancies occurred, further investigations were completed to determine whether the discrepancy was a model calibration issue or if there was something in the field creating the discrepancy, such as incorrect inverts, pipe slopes, or partially blocked pipes. Structures were identified and presented to City staff for field verification by either surveying the structure or locating as-built drawings. Drainage reports were obtained where available and contributing area confirmed. Once field conditions were confirmed the model was calibrated with a review of roughness, weir coefficients, and other losses. Finally, the model was refined with infiltration parameters.

6.0 Evaluation Criteria

Identification of system deficiencies and the evaluation of potential improvements utilizes specific design criteria relating the performance of infrastructure to a specific storm event. This information is summarized in the sections below and included in the *Stormwater Infrastructure Assessment & Preliminary CIP Recommendations* report included in the Appendix D.

6.1 Design Storms

Components of the stormwater system are sized to have the capacity for a specific storm event. The design storm selected is a function of the desired level of service and related risk. Pipes that serve large areas or serve special functions are typically sized to meet larger, less frequent design storms due to their level of significance and consequences of failure. The *Design Storm Event Evaluation* (Cardno WRG, 2010) assessed what design storms were appropriate for evaluating the existing and future stormwater system and is included in Appendix D.

Division E of the City's Engineering Standards includes the Engineering Standards for Stormwater Management. Table 6.1 below lists the applicable conveyance standards as outlined within the current Engineering Standards (October 2019).

Element	Definition	24-hour Design Storm
Feeder	Pipe/ditch of any size that serves a private development or single subdivision of 5 acres of less	10-year
Collector	Pipe/ditch of any size that serves multiple private developments/subdivision or a single private development or subdivision equal to or greater than 5 acres within the same drainage sub-basin.	25-year
Trunk	Drainage improvements that serve more than 100 acres and/or multiple drainage sub-basins as defined in the City's Storm Drain Master Plan(s) or as otherwise required by the City Engineer.	50-year

Table 6.1 - Conveyance standards

Design storms are also important to consider when evaluating bridges and culverts used for open channel crossings. 100-year storm events are used for bridges and culverts over 48 inches in diameter. Culverts under 48 inches in diameter use the same standards as pipes and ditches.

6.2 Applying Design Storms

The design storm information presented in Section 6.1 includes a cumulative depth of rain and a recurrence interval. When determining the runoff from this event, the cumulative rainfall depth is distributed over a 24-hour curve representing the rising limb, peak, and falling limb of the rainfall event. These curves are provided by the NRCS and each applies to a specific region. The City of Albany uses the Type 1A curve. The typical distribution representative in the City for a 25-year storm event is shown in Figure 6.2 below.

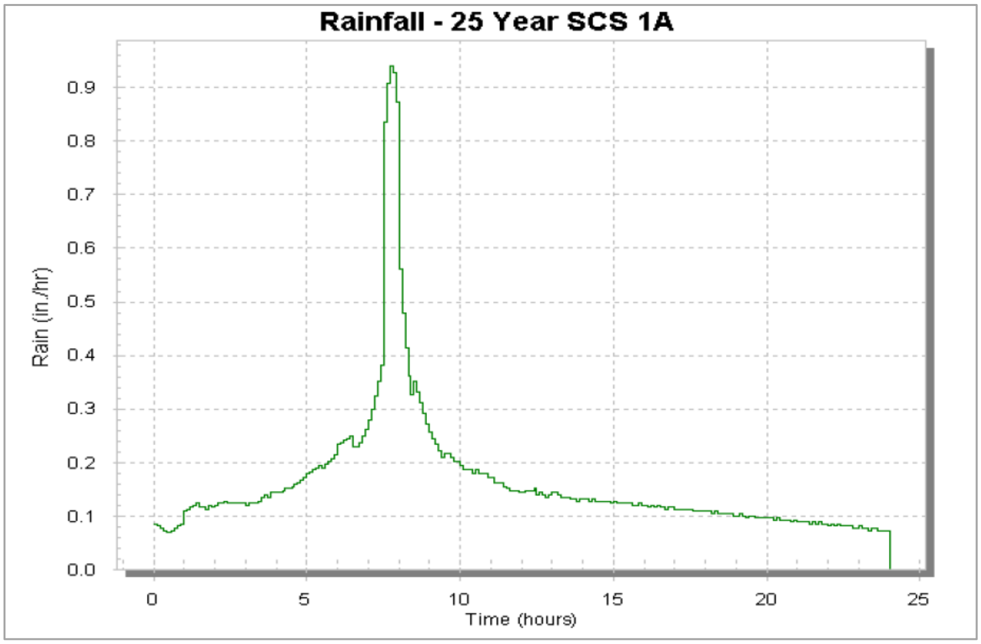

Figure 6.2 - 25-Year NRCS Type 1A Rainfall Distribution

6.3 Detention Standards

In the context of this stormwater master plan, stormwater detention is a flow rate control mechanism that can be utilized to reduce post-development peak flow rates leaving a site. Typically, these post-development flow rates are detained to the pre-development flow rate leaving the site. This is done for multiple storm events. This attenuation of flow leaving a site results in an accumulation of runoff on site, so ponds (or underground pipes, etc.) are required to store this extra volume of runoff until the storm has passed and the pond can drain. The intent of the detention standard is to protect downstream facilities and receiving waterways from an increase in peak flows and potential flooding. Note that the current standards are for attenuation of peak flow rates only, not flow duration.

An example comparison of pre-, post- and a detained post hydrograph is shown in Figure 6.3.

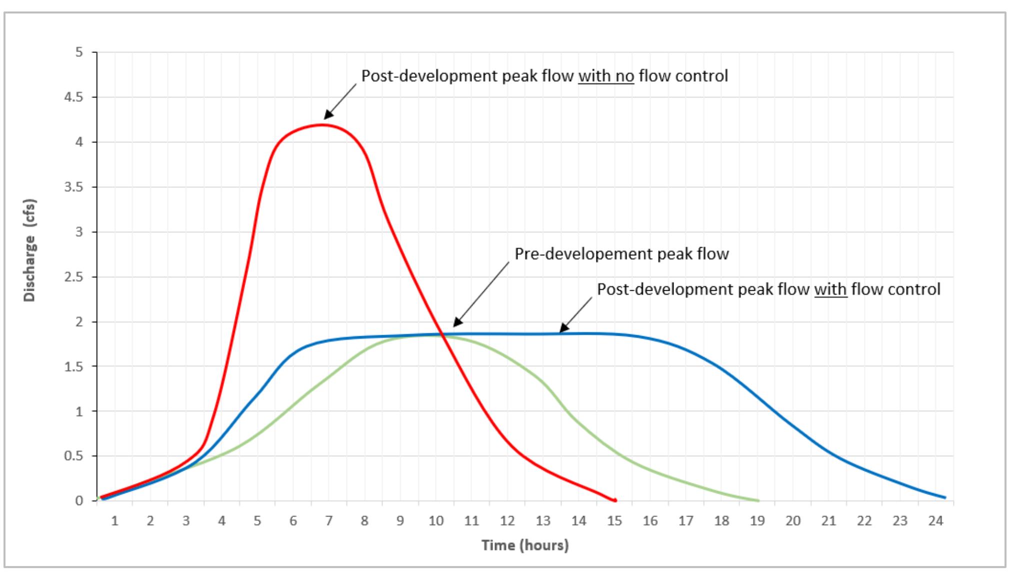

Figure 6.3 – Example comparison hydrograph of pre-, post-, and detained post-runoff

City of Albany's Engineering Standards Division E – Stormwater Management Section 8.01.D, states the following:

- Detention basins will be required to detain post-developed runoff from the 2-year, 5-year, 10-year, and 25-year, 24-hour storm to pre-developed quantities. If the project area is greater than 100 acres or covers multiple drainage sub-basins, then the 50-year, 24-hour storm must also be detained to pre-developed peak volumes.

As part of the build-out deficiency and CIP process, detention standards were applied to the runoff generated from future development on a site-by-site basis.

6.4 Identifying Deficiencies & Required Capital Improvements

The design storms identified above are processed in XPSWMM and used to evaluate the adequacy of the stormwater system and to size improvements. Existing pipes that surcharged to within less than one foot of freeboard, or those that flooded, were identified as deficient. In some instances, pipes surcharged due to backwater from where they discharged to a receiving waterway. In those instances, while they may appear deficient based on the evaluation criteria, there are no conveyance related solutions to provide additional capacity. Therefore, no solutions were provided.

In addition to conveyance deficiencies, there are locations throughout Albany that developed without a dedicated stormwater system. Many of these areas developed while under county jurisdiction and later annexed into the city of Albany, of which Northeast Albany is an example. The lack of infrastructure in an already developed area is considered an existing deficiency. That does not mean, however, every street without a stormwater system is considered deficient. Deficiencies such as these are only shown in areas with known drainage problems.

In most instances, new pipes proposed in the capital improvements lists, have been sized to pass the design storm without surcharging. This is true for both pipe replacement projects and new pipes. In some cases, this is not possible due to high backwater conditions or minimal pipe slopes needed to meet challenging topographic conditions. In these cases, pipes were designed to provide a minimum of one foot of freeboard for the required design storm.

7.0 Existing System Deficiencies

Existing deficiencies are identified in developed areas with and without existing dedicated stormwater infrastructure. Deficiencies may result from an absence of dedicated stormwater infrastructure, insufficient pipe capacity, and/or downstream conditions that create surcharging above allowable freeboard in the upstream pipe network. Periwinkle Creek has the most wide-spread deficiencies of all the modeled drainage basins. Deficiencies may also include improvements necessary to serve already developed areas without dedicated stormwater infrastructure.

A summary of existing system deficiencies for each basin is included below. Additional background is provided in the *Stormwater Infrastructure Assessment & Preliminary CIP Recommendations* (Cardno, 2019) report included in Appendix D.

7.1 Burkhart-Truax Basin

The most significant deficiencies in this basin occur in the system serving the residential lots bounded on the west side by Clover Ridge Road, on the north by Alameda Avenue on the east by Stormy Street, and on the south by Edgewater Drive. This system discharges directly to Burkhart Creek roughly 300 feet upstream of the Clover Ridge Road culvert.

Deficiencies are caused by a combination of insufficient pipe capacity in Breezy Way, and backwater from Burkhart Creek caused by head losses across the Clover Ridge Road culvert and a private culvert located 400 feet downstream of Clover Ridge Road. Other deficiencies in this basin include unimproved streets such as Century Drive, Bernard Avenue, Eleanor Avenue, Earl Avenue, Charlotte Street, and Marilyn Street.

The extent of existing deficiencies in the Burkhart-Truax basin is shown in Figure 7.1, B*urkart-Truax Basin Existing Deficiencies* in Appendix A, followed by the deficiency data table for the basin in Table 7.1. Additional information on existing deficiencies is provided in the *Stormwater Infrastructure Assessment & Preliminary CIP Recommendations* (Cardno, 2019) report included in Appendix D.

7.2 Cox Creek Basin

The most significant deficiencies in this basin occur within the Albany Municipal Airport and along Price Road adjacent to Timber-Linn Park.

Deficiencies in Price Road are caused by backwater from Cox Creek. Deficiencies in the airport are caused by a combination of backwater from Cox Creek and Swan Lake, and from on-site pipe deficiencies. Another deficiency is the section of Center Street from 14th Avenue to Highway 20.

The extent of existing deficiencies in the Cox Creek basin is shown in Figure 7.2, Cox Creek Basin Existing Deficiencies in Appendix A, followed by the deficiency data table for the basin in Table 7.2. Additional information on existing deficiencies is provided in the *Stormwater Infrastructure Assessment & Preliminary CIP Recommendations* (Cardno, 2019) report included in Appendix D.

7.3 North Albany Basin

The most significant deficiencies in this basin occur within two residential areas. The first is bounded on the west by Crocker Lane, on the south by Gibson Hill Road, and on the northeast by Violet Avenue. The second is bounded on the west side by Grandview Drive, on the north side by Dover Lane, on the east side by Whitmore Avenue, and on the south side by Gibson Hill Road. These system deficiencies are a result of inadequate pipe capacity through a large portion of both networks.

The extent of existing deficiencies in the North Albany basin is shown in Figure 7.3, North Albany Basin Existing Deficiencies in Appendix A, followed by the deficiency data table in Table 7.3.

Additional information on existing deficiencies is provided in the *Stormwater Infrastructure Assessment & Preliminary CIP Recommendations* (Cardno, 2019) report included in Appendix D.

7.4 Oak Creek Basin

The most significant deficiencies in the Oak Creek basin occur along Elm Street and Queen Avenue bounded by Broadway Street to the west and Pacific Boulevard (Highway 99E) to the east.

This deficiency is caused by backwater effects from Cathey Creek and insufficient pipe capacity in Queen Avenue and Elm Street. Backwater effects in Cathey Creek are made worse by high flows from Pacific Avenue (Highway 99E) and flow restrictions across culverts in Umatilla Street and Liberty Street.

The extent of existing deficiencies in the Oak Creek basin is shown in Figure 7.4, Oak Creek Basin Existing Deficiencies in Appendix A, followed by the deficiency data table in Table 7.4. Additional information on existing deficiencies is provided in the *Stormwater Infrastructure Assessment & Preliminary CIP Recommendations* (Cardno, 2019) report included in Appendix D.

7.5 Periwinkle Creek Basin

Periwinkle Creek has the most wide-spread deficiencies of all the drainage basins. The worst deficiencies occur throughout the network bounded by the Santiam-Albany Canal to the south, Marion Street to the west, Columbus Street to the east, and Periwinkle Creek to the north and northeast. Issues include wide-spread flooding as identified in the *Existing Conditions Hydraulic Model Development & Calibration* report.

These deficiencies occur due to a combination of backwater effects from Periwinkle Creek and inadequate pipe capacity. Many of these pipes have been in service over 50 years.

The extent of existing deficiencies in the Periwinkle Creek basin is shown in Figure 7.5, Periwinkle Creek Basin Existing Deficiencies in Appendix A, followed by the deficiency data table in Table 7.5. Additional information on existing deficiencies is provided in the Stormwater *Infrastructure Assessment & Preliminary CIP Recommendations* (Cardno, 2019) report included in Appendix D.

7.6 Willamette River Basin

The most significant deficiencies in the Willamette River basin occur in two locations. The first is a residential area bounded by 13th Avenue to the north, Lafayette Street to the east, Queen Avenue to the south, and Jackson Street to the west. Issues in this location include wide-spread flooding as demonstrated in the *Existing Conditions Hydraulic Model Development & Calibration* report. The second location occurs along Madison Street, Hill Street, and Main Street between the railroad and the Willamette River. These deficiencies are a result of inadequate pipe capacity. Many of the deficient pipes have been in service over 50 years.

The extent of existing deficiencies in the Willamette River basin is shown in Figure 7.6, Willamette River Basin Existing Deficiencies in Appendix A, followed by the deficiency data table in Table 7.6. Additional information on existing deficiencies is provided in the Stormwater *Infrastructure Assessment & Preliminary CIP Recommendations* (Cardno, 2019) report included in Appendix D.

8.0 Build-Out System Deficiencies

Build-out deficiencies include previously identified existing deficiencies plus any new deficiencies resulting from additional runoff created by the build-out impervious surfaces. Similar to existing deficiencies, build-out deficiencies may result from an absence of dedicated stormwater infrastructure, insufficient pipe capacity, and/or downstream conditions that create surcharging above allowable freeboard. Future deficiencies were also considered for areas where new roadways are planned in *Albany's Transportation System Plan* (TSP). These future new roadways have stormwater pipes labeled as TSP-L##, with the "L##" corresponding to the future roadway identified in the TSP. Flow control has been applied to the build-out system deficiencies.

A summary of future system deficiencies for each basin is included below. Additional background is provided in the *Flood Control Assessment & Preliminary CIP Recommendations* (Cardno, 2021) report included in Appendix D.

8.1 Burkhart-Truax Basin

As with the existing conditions, the most significant deficiencies in this basin occur in the storm drain system serving the residential lots bounded by Clover Ridge Road to the west, Alameda Avenue to the north, Stormy Street to the east, and Edgewater Drive to the south. This system discharges directly to Burkhart Creek roughly 300 feet upstream of the Clover Ridge Road culvert.

These deficiencies are caused by a combination of insufficient pipe capacity in Breezy Way, and backwater from Burkhart Creek caused by head losses across the Clover Ridge culvert and a private culvert located 400 feet downstream of Clover Ridge Road. Other deficiencies in this model include the unimproved streets such as Century Drive, Bernard Avenue, Eleanor Avenue, Earl Avenue, Charlotte Street and Marilyn Street.

The extent of build-out deficiencies in the Burkhart-Truax basin is shown in Figure 8.1, Burkart-Truax Basin Build-Out Deficiencies in Appendix A, followed by the deficiency data table for the basin in Table 8.1. Additional background is provided in the *Flood Control Assessment & Preliminary CIP Recommendations* (Cardno, 2021) report included in Appendix D.

8.2 Cox Creek Basin

As with existing conditions, the most significant deficiencies in this basin occur within the Albany Municipal Airport and along Price Road adjacent to Timber-Linn Park.

Deficiencies in Price Road are caused by backwater from Cox Creek. Deficiencies in the airport are caused by a combination of backwater from Cox Creek and Swan Lake and from on-site pipe deficiencies. Another deficiency is the section of Center Street from 14th Avenue to Highway 20.

The extent of build-out deficiencies in the Cox Creek basin is shown in Figure 8.2, Cox Creek Basin Build-Out Deficiencies in Appendix A, followed by the deficiency data table for the basin in Table 8.2. Additional background is provided in the *Flood Control Assessment & Preliminary CIP Recommendations* (Cardno, 2021) report included in Appendix D.

8.3 North Albany Basin

North Albany has a significant amount of remaining development potential. This explains why deficiencies noted in the existing condition model propagate further, especially along Gibson Hill Road, and why new pipe extensions are necessary. The most significant deficiencies (based solely on deviation from design criteria) are expected to develop due to future improvements along North Albany Road between Thornton Lake and Highway 20.

The extent of build-out deficiencies in the North Albany basin is shown in Figure 8.3, North Albany Basin Build-Out Deficiencies in Appendix A, followed by the deficiency data table for the basin in Table 8.3. Additional background is provided in the *Flood Control Assessment & Preliminary CIP Recommendations* (Cardno, 2021) report included in Appendix D.

8.4 Oak Creek Basin

As was also shown under existing conditions, the most significant deficiencies (based solely on deviation from design criteria) in this basin at build-out occur along Elm Street and Queen Avenue bounded by Broadway Street to the west and Pacific Boulevard (Highway 99E) to the east.

This deficiency is caused by backwater from Cathey Creek and insufficient pipe capacity in Queen Avenue and Elm Street. Backwater effect in Cathey Creek is exacerbated by high flows from Pacific Avenue (Highway 99E) and flow restrictions across culverts in Umatilla Street and Liberty Street. In other areas, deficiencies shown for existing conditions propagate due to increased flow from the added impervious area through build-out.

The extent of build-out deficiencies in the Oak Creek basin is shown in Figure 8.4, Oak Creek Basin Build-Out Deficiencies in Appendix A, followed by the deficiency data table for the basin in Table 8.4. Additional background is provided in the *Flood Control Assessment & Preliminary CIP Recommendations* (Cardno, 2021) report included in Appendix D.

8.5 Periwinkle Creek Basin

Periwinkle Creek has the most wide-spread deficiencies of all the modeled basins. The worst deficiencies occur throughout the networks bounded by the Santiam-Albany Canal to the south, Marion Street to the west, Columbus Street to the east, and Periwinkle Creek to the north and northeast. Issues in this location include wide-spread flooding as demonstrated in the *Existing Conditions Hydraulic Model Development & Calibration Report.*

These deficiencies are a result of a combination of backwater effects from Periwinkle Creek and inadequate pipe conveyance. Many of these pipes have been in service over 50 years. Increased flow in the build-out condition in Periwinkle Creek cause a propagation of existing deficiencies due to high backwater conditions causing decreased flow capacity in trunk and collector lines.

The extent of build-out deficiencies in the Periwinkle Creek basin is shown in Figure 8.5, Periwinkle Creek Basin Build-Out Deficiencies in Appendix A, followed by the deficiency data table for the basin in Table 8.5. Additional background is provided in the *Flood Control Assessment & Preliminary CIP Recommendations* (Cardno, 2021) report included in Appendix D.

8.6 Willamette River Basin

The Willamette River basin is the most developed drainage basin in the City of Albany; this helps explain why future deficiencies do not deviate significantly from what is shown for the existing deficiencies.

The most significant deficiencies occur in two locations. The first is a residential area bounded by 13th Avenue to the north, Lafayette Street to the east, Queen Avenue to the south, and Jackson Street to the west. Issues in this location include wide-spread flooding as demonstrated in the *Existing Conditions Hydraulic Model Development & Calibration Report.* The second location occurs along Madison Street, Hill Street, and Main Street between the railroad and the Willamette River. These deficiencies are a result of inadequate pipe capacity. Many of the deficient pipes have been in service over 50 years.

The extent of build-out deficiencies in the Willamette River basin is shown in Figure 8.6, Willamette River Basin Build-Out Deficiencies in Appendix A, followed by the deficiency data table for the basin in Table 8.6. Additional background is provided in the *Flood Control Assessment & Preliminary CIP Recommendations* (Cardno, 2021) report included in Appendix D.

9.0 Capital Improvement Projects

Capital improvement projects were developed to address deficiencies identified in both the existing and build-out condition models across all six of the City's drainage basins.

9.1 Improvement Criteria

Potential capital improvements to address deficiencies were identified with the intent of identifying the least cost alternative for the parameters being considered with this preliminary analysis. Further cost saving alternatives will be considered in future master planning efforts.

Projects were developed to provide a minimum of one foot of freeboard for the appropriate design storm related to the pipe/structure classification. Consistent with Division E of the Engineering Standards, feeders were sized for the 10-year design storm, Collectors were sized for the 25-year, Trunk lines sized for the 50-year, and bridges and culverts (over 48 inches) were sized for the 100-year storm. Pipes were sized to maintain a minimum slope of 0.2 percent where at all possible. In extreme cases, where no other solution was possible, pipes were sized with a slope of **0.1 percent.** A minimum cover of three feet is provided for all new pipes. In cases where 3 feet of cover is not attainable due to downstream connections or shallow slopes, the system was adjusted to a minimum of **one foot** of cover.

Potential capital projects were evaluated using the following solutions, as applicable.

9.1.1 Pipe Replacements

Replacing existing undersized piping with appropriately sized infrastructure is the most common approach to address deficiencies.

9.1.2 Run Parallel Lines

Sometimes it is necessary to consider installing a parallel stormwater pipe to an existing pipe, in lieu of replacing the existing pipe. This is not the preferred approach as it results in twice the maintenance and capital costs over time. However, if additional capacity is critical and there are significant site constraints, such as cover limitations, then a parallel system may warrant consideration.

9.1.3 Reroute Stormwater Flows

Replacing an existing pipe may not always be the least cost option to addressing a deficiency. Rerouting stormwater flows to a nearby system with available long-term capacity may be a better alternative.

9.1.4 Extension of Service/New Stormwater Systems

System expansions are proposed in developed areas without dedicated stormwater infrastructure that experience flooding problems. Pipe extensions are proposed to serve land as it develops in the future. The number of new discharge locations will be limited to decrease the associated permitting challenges and costs.

9.2 Prioritization

Numerous factors are involved in determining which project should be built first. Some of these factors are easily quantifiable, such as project cost, a measured deficiency in the capacity of a pipe, or the amount of stormwater that surcharges and leaves the system to cause flooding. However, other factors such as the overall benefit of one project being built prior to another may not be as straight forward to quantify for the purposes of equitable comparison on a City-wide basis. Other more complicated factors include potential costs saving of a project when combined with a water or sanitary sewer improvement. Other projects, such as TSP projects, are purely driven by development in a specific area.

Two categories were developed for prioritization of stormwater conveyance CIP projects.

- High priority projects
- Low priority projects

These two categories are intended to provide an objective and defensible method for the development of a hierarchy of stormwater conveyance improvements. Note that over time the priority of some projects is subject to change due to factors such as evolving development, changed conditions, and unanticipated future cost saving opportunities. Projects within the categories are not ranked. The two categories are intended to provide guidance in future selection and timing of stormwater CIP projects.

9.2.1 High priority projects

High priority projects include the projects that fix deficiencies that are estimated to surcharge the system and flood adjacent ground. Other sub-factors were also assigned to each High priority project. The sub-factors are intended to assist in quantifying the consequence from not implementing the improvement. These sub-factors include the following:

- Frequency - System deficiencies are each associated with a design storm frequency (see Section 6.1). The design storm frequency associated with the deficiency that the CIP is fixing has been included to assist with future project prioritization.
- Location - An inventory of street classifications (City GIS data, 2021) was also associated with each High priority project to assist with future project selection.

9.2.2 Low priority projects

Low priority projects were selected based on a variety of factors that, currently, place the project at a low priority. The primary factor is that these improvements are not addressing deficiencies that result in surface flooding at the design storm. Projects that currently exhibit the following characteristics are categorized as Low Priority projects.

- TSP projects
- CIP projects located in developed areas that have minimal (e.g., ditches) or no existing infrastructure but do not have any known immediate drainage needs.
- Projects associated with deficiencies that have been determined to be "Technically Deficient". These include deficiencies that still have freeboard and do not surcharge, or projects that have been determined to have a low priority due to other factors such as surcharging that flows to another acceptable outlet, surcharging volume is known to be very minor and acceptable, newer street and the deficiency is minor, etc.
- Projects that have been constructed during the development of this master plan.

As previously mentioned, evolving development, changing/deteriorating conditions, and unanticipated future cost saving opportunities could place some of these projects at a higher priority.

9.3 Cost Estimates

Planning level estimates for master plans are not designed to predict the low bid for a project. Rather, they represent planning level estimates of anticipated average bid prices. Estimates used for master planning typically range from 30 percent below to 50 percent above actual total project costs. The large range reflects that site specific design is not conducted at the master plan level and actual field conditions and site constraints identified during design can significantly impact actual project costs. As projects are considered for funding, more site-specific cost estimates should be conducted for budgeting purposes, and following design, further refined estimates should be produced prior to bidding. Total project cost estimates provided in this report include engineering design, legal, and administration (ELA), construction costs, and contingencies.

9.3.1 Construction Cost Estimates

Albany historically has not had a dedicated source of funding for stormwater improvements resulting in a lack of investment in storm drainage capital pipe replacement. The lack of funding results in not having a reliable source of local bid data to use for unit cost. Therefore, in 2013, the City of Albany gathered regional bid data for pipe installation costs and developed a per foot cost for various pipe sizes and depths. Those construction costs were adjusted for inflation (inflated to January 2021 using Engineering News Record (ENR) Construction Cost Index (CCI) for Seattle) and added to other estimates for related project costs to calculate the total project cost estimates provided below.

9.3.2 Engineering, Legal, and Administration (ELA)

ELA allowances are intended to cover costs related to engineering design, permitting, construction management, surveying, etc. An allowance for these services is provided for each project at 30 percent of the estimated construction cost.

9.3.3 Contingency Costs

A contingency is included with each total project cost estimate. Contingencies are calculated at 30 percent of the estimated construction cost. This contingency is reflective of the planning level definition of each project and the fact that no site-specific designs have been considered.

9.3.4 Property Acquisition Costs

No allowance has been made for property acquisition and/or easements. Although there may be situations where easements or property is needed to complete a project, these needs will not be identifiable until individual projects move forward to detailed design. It is anticipated that, in most cases, the cost of easements would fall within estimated contingencies.

9.3.5 Cost Basis

Construction costs change over time and it is, therefore, important to tie unit costs and total project cost estimates to an index. This practice provides a means of easily updating project costs over time in response to inflation. Estimates presented in this document are indexed to the January 2021 ENR CCI for Seattle. The Seattle CCI is used because it is the closest market index available and captures the change in construction costs for the Pacific Northwest. (Note that previous Cardno reports use January 2019 ENR Seattle CCI.)

9.3.6 Resulting Unit Costs

The unit costs shown in Table 9.3.6 represent total project costs, not just construction costs; they incorporate material and installation costs, ELA, and contingency.

Pipe Diameter Inches	Installation and Material Cost per foot of pipe			
	Depth Category - Feet			
	0-10	10-15	15-20	20-25
10	$305	$408	$512	$868
12	$308	$411	$515	$858
15	$347	$451	$556	$900
18	$364	$469	$575	$920
21	$371	$477	$584	$930
24	$416	$526	$636	$987
27	$436	$557	$658	$1,009
30	$497	$617	$735	$1,096
36	$534	$656	$777	$1,139
42	$594	$722	$848	$1,215
48	$596	$729	$859	$1,231
54	$660	$797	$932	$1,309
60	$695	$834	$971	$1,350
72	$807	$964	$1,113	$1,501
84	$902	$1,065	$1,220	$1,615

General Ditch Excavation 2:1 side slopes @ 4' deep 4' wide is $21 per foot

Price per foot Includes the following:

New Manhole every 400 feet
- 48 - Inch Manhole for pipes between 10" and 21"
- 60 - Inch Manhole for pipes between 24" and 42"
- 72 - Inch Manhole for 48" Pipes
- 84 - Inch Manhole for 54" & 60" Pipes
- 96 - Inch Manhole for 72" Pipes

Curb Inlet -2 per 400 foot of pipe

Pipe trench surface restoration

PVC pipe material for pipes < 48" and RCP Class III for pipes ≥ to 48"

30% mark up for Engineering, Legal and Administration

30% mark up for contingency

January 2021 ENR Seattle CCI 12,845.38

Table 9.3.6 – Albany CIP Master Cost Breakdown

9.4 System Development Charges

Albany's authority to establish SDCs is contained in the Albany Municipal Code. The original water and sewer SDCs were established in 1991, parks SDC in 1993, and the transportation SDC in 1994. SDC's are one-time charges assessed on new development (growth) to pay for the costs of expanding public facilities. Growth creates additional infrastructure demands, and SDCs provide a mechanism to allow new growth in a community to pay for its share of infrastructure costs rather than existing taxpayers or utility ratepayers. See Section 3.3 for more background on requirements related to SDCs.

Projects recommended in this plan provide capacity to accommodate existing peak flows as well as projected build-out peak flows. For projects that involve reconstruction of the existing system, SDC revenue can help fund portions of a project that provides the capacity necessary to meet future build-out peak flows. For improvement projects recommended in areas currently not served by existing storm drainage facilities and where these projects are larger than required to serve the adjacent development, SDC funding or credit may be available.

While individual projects may be eligible for full SDC funding, the amount of funding or credit available at the time of construction will depend on the adopted SDC methodology and SDC funded project list. It should be anticipated for most new projects the developer will be responsible for building or paying for the minimum equivalent share of the recommended project and SDC revenue or credit can be used to fund the oversized portion of the project.

The actual level of SDC funding or credit available for each project will be decided by Albany City Council through a separate process to develop and adopt a new Stormwater SDC Methodology.

9.5 Recommended Improvements

Recommended CIPs are included in Appendix B. Each CIP has a unique project identifier (ID) and name (e.g., NA-001 and 23rd Street & Broadway Street). The ID corresponds to the watershed and the name denotes the location. Basin Maps show the locations of each project. Total project costs estimates are provided, as well as individual project cost breakdowns. Additional tables and graphs are also provided to show basin by basin the cost of each project and the volume of flooding that is estimated to be eliminated by construction of the project. As discussed in Section 9.2 Prioritization, High Category projects are defined by the presence of surface flooding, and Low Category projects do not surcharge to the point of flooding.

See Appendix B for the CIP information listed below:

- Figures 9.5.1 through Figure 9.5.6 - Basin CIP Maps
- Table 9.5.7 - Total Projects Costs
- Table 9.5.8 - CIP Estimate Tables for all Flood Control Basins
- Figure 9.5.9 - Total Project Costs with Flood Volumes
- Tables 9.5.10 through 9.5.16 - Project Cost and Flood Volume Reduction Chart

Individual CIP project sheets are included in Appendix C.