Stormwater Master Plan

Prepared for the
City of Milwaukie, Oregon
January 2014

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FINAL

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Prepared for

City of Milwaukie, Oregon

January 2014

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List of Abbreviations

2004 Plan	2004 Stormwater Master Plan
BMP	best management practice
CIP	capital improvement project
City	City of Milwaukie
CN	curve number
CUAB	Citizen Utility Advisory Board
CWA	Clean Water Act
DEQ	Oregon Department of Environmental Quality
ESU	effective stormwater unit
F	Fahrenheit
FTE	full-time employee
GIS	Geographic Information System
GWPD	Groundwater Protectiveness Demonstration
LIDAR	Light Detection and Ranging
LOS	level of service
MS4	municipal separate storm sewer system
NOAA	National Oceanographic and Atmosphere Administration
NPDES	National Pollutant Discharge Elimination System
NRCS	National Resource Conservation Service
OAR	Oregon Administrative Rules
Plan	2012 Stormwater Master Plan
ROW	right-of-way
SCS	Soil Conservation Service
SDC	service development charge
SDWA	Safe Drinking Water Act
SWMP	Stormwater Management Plan
TMDL	total maximum daily load
UIC	underground injection control
WPCF	Water Pollution Control Facility
WPCF UIC Permit	Water Pollution Control Facilities Permit for Class V Stormwater Underground Injection Control Systems

Executive Summary

Introduction

In 2012, the city of Milwaukie (City) began efforts to update its Stormwater Master Plan. The previous Stormwater Master Plan was developed in 2004. The need for the update was driven by (1) the changing regulations for underground injection controls (UICs) and the City's National Pollutant Discharge Elimination System (NPDES) municipal separate storm sewer (MS4) permit requirements, and (2) funding challenges preventing the City from implementing capital improvement projects (CIPs) as identified in the 2004 Master Plan.

This 2012 Milwaukie Stormwater Master Plan (Plan) is intended to help the City in the development, prioritization, and scheduling of a 10-year stormwater CIP. The Plan objectives include the following:

- Update the 2004 XP-SWMM hydrologic/hydraulic model to reflect infrastructure improvement projects since 2004 and updated system information from the City's Geographic Information System (GIS).
- Evaluate the City's UICs in light of the requirements of the water pollution control facility (WPCF) UIC Permit Draft (July 2012).
- Develop CIPs and associated cost estimates to address updated UIC and NPDES regulatory requirements.
- Develop CIPs and associated cost estimates to address identified system capacity deficiencies under existing and future development scenarios. Where feasible, flood control CIPs and water quality CIPs will be integrated into a single CIP to address multiple objectives.
- Evaluate the City's current methods of tracking system assets and assessing maintenance needs.
- Evaluate current staffing levels and future staffing needs in consideration of updated regulatory requirements and proposed CIP implementation.
- Review and update the City's stormwater utility rates and system development charges (SDCs) in consideration of updated staffing needs and proposed CIPs.

This Plan documents the methods and results of the storm system capacity evaluation and the stormwater quality/retrofit assessment conducted for the City. This Plan also identifies and prioritizes capital improvement projects (CIPs) to address identified system capacity deficiencies and water quality opportunity areas. Finally, this Plan identifies stormwater program implementation needs in the form of staffing and funding recommendations.

Study Area Characteristics and Regulatory Drivers

Study Area Characteristics

The City is approximately 4.8 square miles in area. Two major tributaries to the Willamette River flow through the city: Johnson Creek, along the northern city boundary, and Kellogg Creek, along the southern city boundary.

Topography in the city is influenced by the Johnson Creek and Kellogg Creek drainage systems. The eastern portion of the city (approximately one third of the total city area), between Johnson Creek and Minthorn Creek, is topographically isolated from the major drainages and water bodies. This area includes a majority of the City's UICs (drywells).

The City is primarily developed, with only about 5 percent of the city area identified as vacant land. Vacant lands are located primarily along the southern and eastern city boundaries. Single-family residential land use is the primary land use within the city. Industrial development is located along the Highway 99E and Highway 224 corridors. Other land use categories include commercial, multifamily residential, multi-use commercial (which includes the City's town center), and public facilities (which includes parks and open space).

The City's storm drainage system is composed of approximately 50 miles of pipe and open-channel system, 800 manholes (nodes), five detention ponds, and 196 UICs.

Regulatory Drivers

The City was reissued its Phase I NPDES MS4 permit on March 16, 2012, which requires implementation of stormwater strategies to reduce pollutants to the stormwater system. One requirement of the reissued permit is completion of a stormwater retrofit assessment by July 1, 2015, in order to identify areas in the city underserved or lacking structural stormwater facilities. This effort is included as part of this Plan, and was used to identify CIPs to address water quality.

The City, along with other Oregon jurisdictions, has been working with DEQ to establish conditions of a WPCF UIC Permit Draft to regulate the discharge of stormwater to UICs. The current WPCF UIC Permit Draft (dated July 2012) requires jurisdictions to conduct a system-wide assessment of their UICs and conduct analysis of UICs if the UICs are located near water wells. This effort is included as part of this Plan, in order to identify UICs requiring decommissioning. Decommissioning of UICs is documented in the CIP.

Study Methods

Development of this Plan includes the evaluation of the capacity of the City's public stormwater drainage system, evaluation of the City's UICs, and evaluation of water quality retrofit opportunities. Each evaluation results in the identification of CIP opportunity areas that are subsequently refined, combined, and ranked to produce the final CIP list.

System Capacity Evaluation

The City's public stormwater drainage system was evaluated using a computer model to simulate hydrologic and hydraulic conditions of the system. The stormwater drainage system evaluation was conducted as an update to the system evaluation effort conducted in 2004, in order to reflect changes to the City's drainage system and allow for the simulation of a future development condition. XP-SWMM was the modeling software used to evaluate the drainage system in 2004, and it was also used for this effort. The model version was updated to XP Software's XP-SWMM v2012.

The City's study area is divided into major drainage basins associated with Johnson Creek, the Willamette River, Lower Kellogg Creek, Middle Mt. Scott Creek, and City UICs. A total of 76 subbasins contributing to a piped or channelized conveyance system and 16 subbasins contributing to area served by UICs were included in the model. The subbasin delineation developed for the 2004 model was refined and used for the 2012 Plan.

Information on the City's stormwater drainage system (i.e., pipe locations, sizes, types, etc.) was originally included in the 2004 model. Since 2004, the City has been actively updating its GIS to reflect the addition of new and identified infrastructure. The City provided these updates in GIS, and such updates were incorporated into the model. Approximately 16 miles of pipe were modeled as part of this Plan, consisting of 15-inch-diameter pipe and greater. A total of 15 system outfalls (five to Johnson Creek, one to the Willamette River, and nine to the Kellogg-Mt-Scott drainage system) were modeled.

The water quality, 2-year, 5-year, 10-year, 25-year, and 100-year design storms were simulated using XP-SWMM for current and future development conditions. Model results indicate a total of 12 flooding "problem areas" that were further evaluated as part of CIP development and included in the final CIP list.

UIC Evaluation

In conjunction with the draft UIC WPCF permit template (dated July 2012), the City is required to conduct a system-wide assessment of its UICs and retrofit/decommission UICs not compliant with conditions of the permit.

The City conducted a preliminary UIC system-wide assessment using a summary of the UIC system developed in 2005. Based on the preliminary system-wide assessment, a total of 36 UICs are identified as "at-risk" due to insufficient setback and/ or separation distances from drinking water wells (setback and separation limits are defined in the draft UIC WPCF permit template). Additional information will be needed to complete the system-wide assessment prior to submittal to DEQ. Specifically, completion of the water well location inventory and verification of depth to groundwater for select (32) UICs is needed.

An unsaturated zone groundwater protectiveness demonstration (GWPD) model was developed for the City to simulate the vertical transport of pollutants in saturated soils. Development of a GWPD addresses the City's draft permit requirements related to those "at-risk" UICs within a water well setback. Results from the GWPD include a minimum protective vertical separate distance to attenuate typical stormwater pollutants. Per the analysis, a minimum separation distance of 1 foot is recommended.

Results from the preliminary system-wide assessment and GWPD were used to determine whether retrofit or decommissioning of UICs is required. Of the 36 identified "at-risk" UICs, 33 of the UICs are determined to be compliant with permit requirements, per results of the GWPD. Three of the "at-risk" UICs are still categorized as "at-risk". As part of this Plan development, two of the remaining "at-risk" UICs are identified for decommissioning due to their location within the Plan study area and ability to address water quality objectives in addition to decommissioning.

Water Quality Retrofit Evaluation

As part of this Plan development, identification of water quality retrofit/ water quality project opportunity areas was conducted to address the City's NPDES MS4 permit requirement. Such water quality projects would be combined with identified system capacity and UIC decommissioning projects to allow proposed CIPs to address multiple objectives.

The City's water quality retrofit strategy is to target high pollutant generating areas where existing stormwater treatment is currently limited, in order to improve overall surface water quality conditions. Water quality retrofit measures will focus on the use of infiltration-based facilities (e.g., vegetated infiltration basins, rain gardens, planters) to provide runoff volume reduction in addition to conventional treatment.

Water quality opportunity areas were initially identified through a review of information from the City's GIS system including aerial photos, the location of existing water quality facilities, existing vacant areas, publically owned lands, existing and future condition land uses, storm system layout, topography, and locations where flood control or UIC decommissioning is required.

An initial water quality retrofit opportunity list was developed and reviewed with City staff. Project feasibility and practicability was discussed, and additional water quality opportunity areas were identified. Based on City feedback and field reconnaissance, a total of nine water quality retrofit projects were identified for inclusion in the final CIP list

Study Results

An integrated CIP development approach was used to develop the final CIP list. Integrated CIP development refers to the selection and design of CIPs to address multiple objectives including flood control, regulatory requirements, and water quality improvements.

The flood control, UIC decommissioning, and water quality CIP projects were consolidated to reflect consistent contributing areas. CIP design concepts and approaches were revisited during CIP integration to develop a formalized CIP design for each opportunity area. A total of 17 multi-objective CIPs are identified for prioritization and cost estimation as part of this Plan. Table ES-1 summarizes the identified CIPs. Figure ES-1 provides the general vicinity of each CIP location.

City maintenance and engineering staff scored and ranked CIPs using criteria that included historical/persistent problems, flooding/safety issues, regulatory compliance, ongoing maintenance, water quality improvement, project concurrence, and system sustainability. Each project was scored on a scale of 1 to 3, using general scoring conditions. Initial ranking results were adjusted to account for schedule or required project concurrence, resulting in the final CIP prioritization (Table ES-1).

Table ES-1. CIP Priority Ranking

Priority ranking	Ranking by score	CIP no.	CIP name	Overall score	Estimated cost, $
1	1	13-1	UIC Decommissioning on Lloyd	36	793,700
2	4	13-3	Railroad Avenue at Stanley[a]	29	357,300
3	7	13-4	Railroad Avenue Channel[a]	26	52,900
4	2	5-1	Meek Street	31	3,088,200
5	3	5-2	Harrison Street Outfall	30	619,400
6	5	14-1	Apple Storm Improvements	28	180,100
7	8	G2	36th near King Road	25	104,600
8	8	G3	55th near Monroe Street	25	23,000
8	8	13-2	Linwood Elementary	25	469,700
10	11	1-1	Willow Detention Pond Retrofit	23	68,600
10	11	G1	47th and Llewellyn	23	155,600
				High-priority project cost:	5,913,100
12	13	1-2	Stanley-Willow UIC Decommissioning	21	100,200
12	13	6-1	Washington Street	21	1,804,100
12	6	6-2	Washington Green Streets[b]	27	511,300
15	15	15-1	Hemlock Street	18	560,600
16	16	4-1	Main Street at Milport Road	17	241,200
17	17	12-1	International Way and Wister	15	90,000
				Total project cost:	9,220,500

[a] *Due to project concurrence issues and project cost savings, these CIPs are recommended for construction in conjunction with CIP 13-1.*

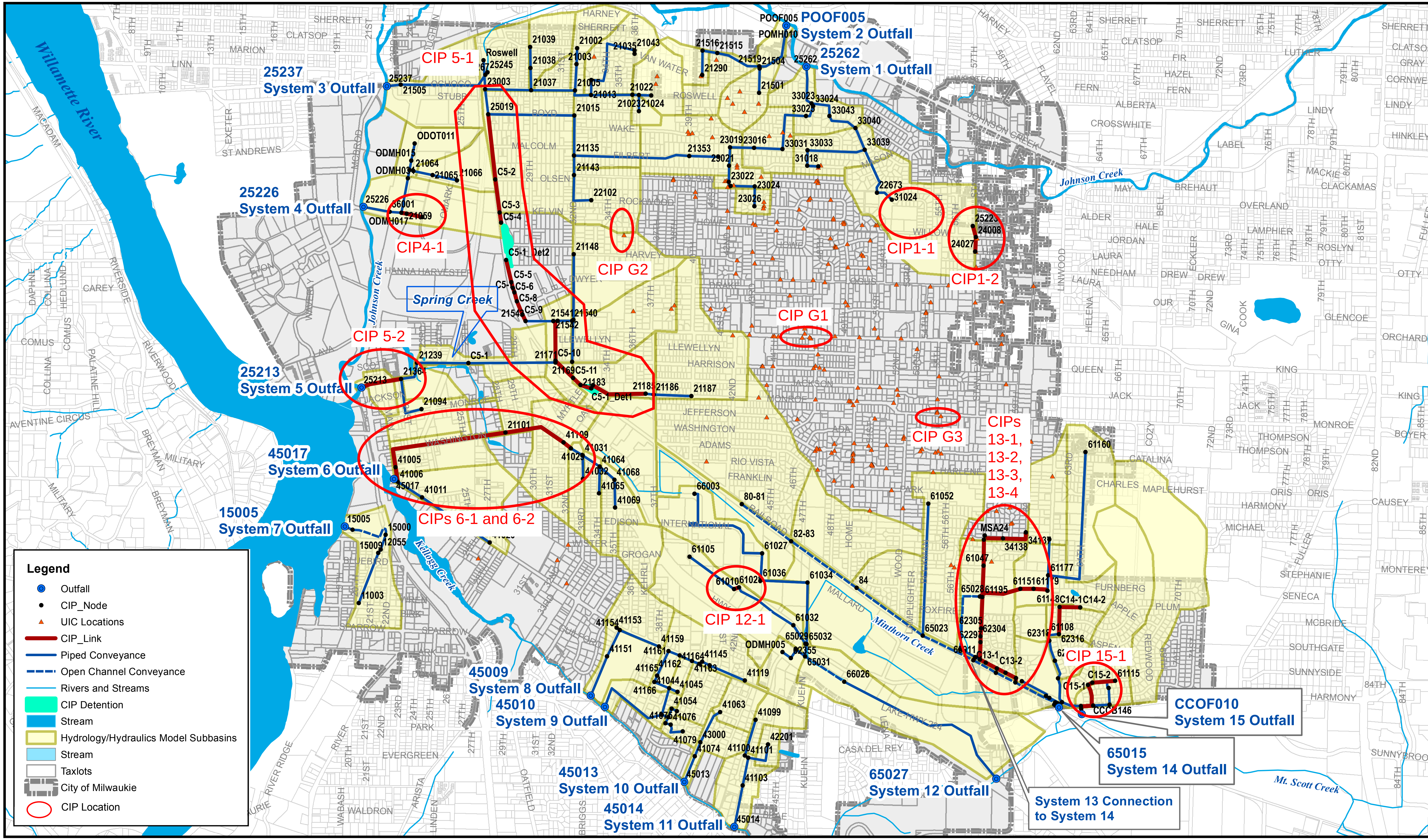
[b] *Due to concurrence with anticipated construction of CIP 6-1, this project was prioritized in accordance with the priority schedule for CIP 6-1.*

Study Implementation

In conjunction with development of this Plan, staffing resources and stormwater funding were assessed to determine whether adjustments to staffing and/or funding is needed in order to implement new regulatory requirements (i.e., the City's reissued NPDES MS4 permit and pending UIC WPCF permit), long-term infrastructure management, and identified CIPs.

The stormwater staffing analysis assumes that existing City staff is able to implement the current stormwater program (pre-2012 conditions). Additional activities (regulatory and CIP focused) not previously conducted by the City under current staffing were used to create the estimates of additional staff resource needs. Based on the staffing analysis, it is estimated that over the next 5 years, between 1.4 and 2.1 additional FTE will be required for maintenance staff and approximately 0.7 additional FTE will be required for engineering staff.

Staffing needs, proposed capital expenditures, and ongoing operational costs were considered in the evaluation of the stormwater utility fee and SDCs. Four levels of service (LOS) categories were developed to establish funding schemes over the 10-year CIP program. LOS considered staffing, capital projects, maintenance, regulatory compliance, proactive system replacement, and vehicle replacement. Debt and cash funding scenarios were analyzed for each of the four LOS categories. Over the 10-year CIP planning period, stormwater utility rate increases ranged from$3.30 (for the current LOS and cash funding scenario) to$25.00 (for the proactive LOS and cash funding scenario). Changes to the calculation assessment methodologies resulted in a reduction in SDC from$1,184/ESU to $765/ESU. Selection of an approved funding strategy is in progress.



Brown AND Caldwell

March 19th, 2013

CITY OF MILWAUKIE
STORMWATER MASTER PLAN UPDATE
CIP LOCATIONS
FIGURE ES-1

Section 1

Introduction

This 2012 Milwaukie Stormwater Master Plan (Plan) documents the methods and results of the storm system capacity evaluation and the stormwater quality/retrofit assessment conducted for the City of Milwaukie, Oregon (City). The Plan identifies and prioritizes capital improvement projects (CIPs) to address identified system capacity deficiencies and water quality opportunity areas. The Plan also identifies stormwater program implementation needs in the form of staffing and funding recommendations.

This Plan serves as an update to the City's 2004 Stormwater Master Plan (2004 Plan). The study area includes land within the city limits that drain to Johnson Creek, Kellogg Creek, Mt. Scott Creek, and the Willamette River. The study area excludes the eastern portion of the city that primarily discharges to underground injection control (UIC) facilities. The study area also excludes the area in the southwest portion of the City that directly discharges to receiving waters with very little public conveyance system.

This section provides a summary of the project need, the project objectives and approach, and a summary of how the Plan is organized.

1.1 Need for the Plan

In 2004, the city of Milwaukie updated its Stormwater Master Plan to address identified stormwater capacity deficiencies and water quality issues, driven by pending regulations associated with UICs and the City's National Pollutant Discharge Elimination System (NPDES) municipal separate storm sewer system (MS4) permit. CIPs developed for the 2004 Plan reflected the need to decommission a majority of City-owned UICs.

Since 2004, regulatory requirements for Milwaukie have changed. The City was reissued its NPDES MS4 permit in March 2012, which requires completion of a water quality retrofit assessment and identification of a water quality improvement project to be initiated during the permit term. In July 2012, the Oregon Department of Environmental Quality (DEQ) issued a draft *Water Pollution Control Facilities Permit for Class V Stormwater Underground Injection Control Systems* (WPCF UIC Permit Draft) that contains revised requirements for UICs (as compared to assumptions in the 2004 Plan).

In 2012, the City began efforts to update the 2004 Plan. The need for the update was driven by (1) the changing regulations for UICs and the City's NPDES MS4 permit requirements and (2) funding challenges preventing the City from implementing CIPs as identified in the 2004 Master Plan.

The City's overarching goal for the master plan update is to conduct a comprehensive evaluation of its stormwater program and stormwater system, focusing on opportunities to improve water quality and system performance, and prioritize CIPs that can be installed on a realistic implementation schedule.

1.2 Plan Objectives

This Plan is intended to help the City in the development, prioritization, and scheduling of a 10-year stormwater CIP. The Plan objectives include the following:

- Update the 2004 XP-SWMM hydrologic/hydraulic model to reflect infrastructure improvement projects since 2004 and updated system information from the City's Geographic Information System (GIS).

- Evaluate the City's UICs in light of the requirements of the WPCF UIC Permit Draft (July 2012).
- Develop CIPs and associated cost estimates to address updated UIC and NPDES regulatory requirements.
- Develop CIPs and associated cost estimates to address identified system capacity deficiencies under existing and future development scenarios. Where feasible, flood control CIPs and water quality CIPs will be integrated into a single CIP to address multiple objectives.
- Evaluate the City's current methods of tracking system assets and assessing maintenance needs.
- Evaluate current staffing levels and future staffing needs in consideration of updated regulatory requirements and proposed CIP implementation.
- Review and update the City's stormwater utility rates in consideration of updated staffing needs and proposed CIPs.

1.3 Approach

The approach for developing the City of Milwaukie's updated Stormwater Master Plan (2012 Plan) is summarized in Figure 1-1. This approach was developed to meet the City's objectives, described above, in consideration of the changing regulatory drivers during the project schedule (i.e., the NPDES MS4 permit reissuance in March 2012 and the WPCF UIC Permit Draft in July 2012).

As shown in Figure 1-1, tasks were conducted in parallel to minimize schedule implications associated with data collection and system assessment efforts. Highlights of the project approach include the following:

1. Data collection was initiated at the beginning of the project but continued throughout the project duration in order to continually refine the XP-SWMM hydrologic and hydraulic model and provide information to aid in the UIC risk evaluation, CIP development, and stormwater utility rate evaluation.
2. CIP locations are identified to collectively address flood control, water quality retrofit, and UIC decommissioning needs. Development of a comprehensive CIP includes a water quality retrofit list to meet NPDES MS4 permit requirements.
3. The staffing analysis was completed following CIP development and prioritization, to reflect the maintenance and engineering staff time needed to implement proposed projects.
4. The utility rate evaluation and system development charge (SDC) evaluation was initiated after CIP development and completion of the staffing analysis, to ensure that the financial levels of service (LOS) analyzed correspond to specific program and project objectives.

Coordination with City staff was ongoing throughout the project duration in order to validate and verify assumptions related to the system configuration (e.g., elevations, naming, and functionality) and stormwater program implementation issues and concerns.

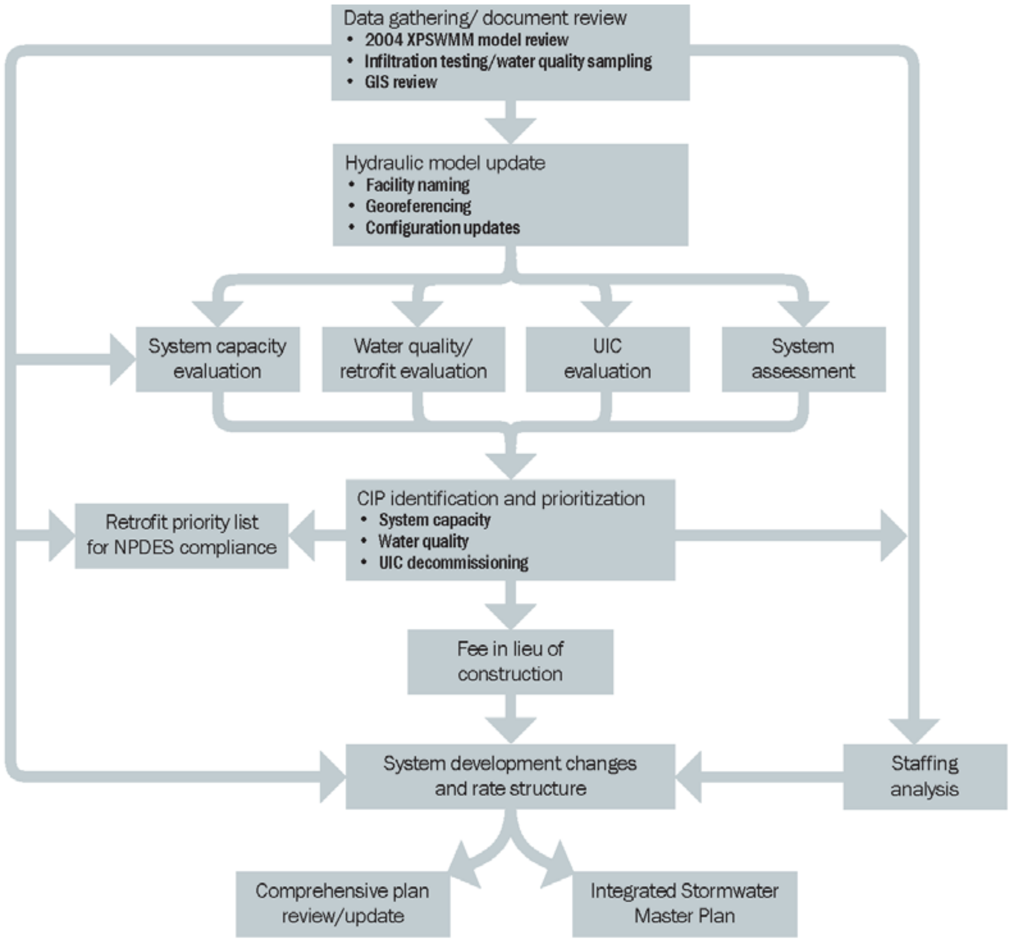


Figure 1-1. Stormwater Master Plan approach

1.4 Plan Organization

Following this introductory Section 1, the 2012 City of Milwaukie Stormwater Master Plan Update is organized as follows:

- Section 2 includes a description of the study area characteristics.
- Section 3 describes the modeling methods and results of the stormwater system capacity evaluation and includes identification of flood control CIP locations.
- Section 4 describes the results of the UIC risk evaluation including identification of UICs to decommission as part of the CIPs.
- Section 5 describes the water quality retrofit assessment and identification of water quality CIP locations.
- Section 6 summarizes the integrated CIP strategy to address system capacity deficiencies, water quality objectives, and UIC decommissioning needs.
- Section 7 describes the CIP prioritization approach.
- Section 8 describes the CIP implementation approach including results of the staffing analysis and stormwater utility rate evaluation.

Appendices A through G provide supporting information in conjunction with Sections 2 through 8.

Section 2

Study Area Characteristics

This section includes an overview of study area characteristics including location, topography, soils, land use, climate and rainfall, the stormwater collection system, water quality conditions and regulations, and groundwater/UIC system status.

2.1 Location

The city of Milwaukie is located in the northern portion of Clackamas County, Oregon (Figure 2-1). The city is bordered by the city of Portland to the north, unincorporated Clackamas County to the east, Oak Lodge to the south, and Johnson Creek and the Willamette River to the west.

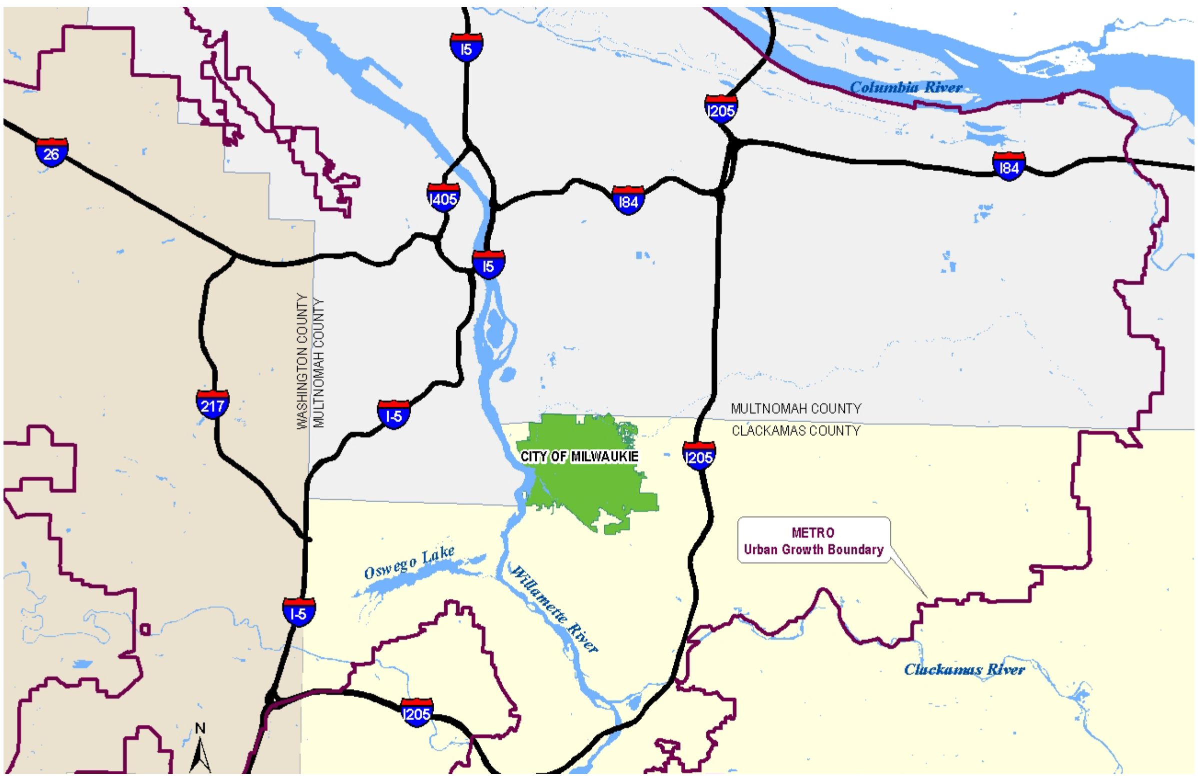


Figure 2-1. Vicinity map

The city is approximately 4.8 square miles in area. Two major tributaries to the Willamette River flow through the city: Johnson Creek, along the northern city boundary, and Kellogg Creek, along the southern city boundary. Smaller tributaries within the city limits include Minthorn Creek (a tributary to Kellogg Creek in the eastern portion of the city), Mt. Scott Creek (a tributary to Kellogg Creek in the eastern portion of the city), and Spring Creek (a tributary to Johnson Creek that enters Johnson Creek close to its confluence at the Willamette River).

2.2 Topography

The topography in the city of Milwaukie is influenced by the Johnson Creek and Mt. Scott/Kellogg Creek drainage systems. Johnson Creek runs west along the city's northern boundary to its confluence with the Willamette River. Area from the northern and western portions of the city (approximately one third of the total city area) discharges to the Johnson Creek drainage system, with elevations ranging from 30 to 190 feet.

Mt. Scott Creek, a tributary to Kellogg Creek, runs west along the southeastern city boundary, combining with Kellogg Creek south of the city, just outside of the city limits. Kellogg Creek runs west along the southwestern city boundary to its confluence with the Willamette River, approximately 1,500 feet south of the Johnson Creek confluence. Area from the southern portion of the city (approximately one third of the total city area) discharges to the Kellogg-Mt. Scott drainage system, with elevations ranging from 30 feet to 200 feet.

The eastern portion of the city (approximately one third of the total city area), between Johnson Creek and Minthorn Creek, is topographically isolated from the major drainages and water bodies. This area includes a majority of the City's UICs (drywells). Limited stormwater infrastructure (e.g., pipes, catch basins) is present in this area.

Figure 2-2, located at the end of this section, illustrates the topography in the city of Milwaukie.

2.3 Soils

According to the National Resources Conservation Service (NRCS) Soil Survey, the predominant soil types in the city of Milwaukie are Latourell and Quatama loam, Woodburn silt loam, and Wapato silty clay loam. The Latourell loam has moderate soil permeability (hydrologic soil group B), and the Quatama loam, Wapato silty clay loam, and Woodburn silt loam have slow soil permeability (hydrologic soil group C). The eastern portion of the city, where the majority of UICs are located, is primarily composed of Latourell loam.

Soil classification is an important characteristic to consider when determining runoff flow rates and volumes. Soil classification was used to assign pervious area runoff curve numbers (CN) for hydrologic calculations. CN values were assigned for subbasins and values were calibrated as part of the 2004 Plan. CN values were not updated as part of this Plan.

2.4 Climate and Rainfall

The city of Milwaukie experiences a similar temperate climate to the surrounding Portland metropolitan area, with relatively warm, dry summers and mild, wet winters. Winter temperatures average approximately 40 degrees Fahrenheit (F) and summer temperatures average approximately 70 degrees F.

The average annual precipitation for the Portland metropolitan area ranges from 37 to 43 inches, with most of the rainfall occurring between November and April.

2.5 Land Use

The city of Milwaukie is primarily developed, with only about 5 percent of the city area identified as vacant lands. Vacant lands are scattered throughout the city, primarily along the southern and eastern city boundaries.

Single-family residential land use is the primary land use within the city. A significant amount of industrial development is located along the Highway 99E and Highway 224 corridors. Other land use categories include commercial, multifamily residential, multi-use commercial (which includes the City's town center), and public facilities (which includes parks and open space).

City-provided land use coverage is used to assign the impervious area percentages applicable to existing and future development conditions for hydrologic modeling. All vacant lands are assumed to be developed in the future condition.

Figure 2-3, at the end of this section, shows the land use coverage within the city of Milwaukie.

2.6 Drainage System

Per the City-provided GIS, the City's storm drainage system is composed of approximately 50 miles of pipe and open-channel system, 800 manholes (nodes), five detention ponds, and 196 UICs. Approximately 16 miles of pipe were modeled as part of this Plan, composed primarily of 15-inch-diameter pipe and greater.

Johnson Creek, along the city's northern and western boundaries, and Kellogg-Mt. Scott Creek, along the city's southern boundary, are the City's primary receiving waters that receive piped drainage. A total of 15 system outfalls (5 to Johnson Creek, 1 to the Willamette River, and 9 to the Kellogg-Mt-Scott drainage system) define 15 piped systems that discharge to receiving waters.

Subbasins were originally delineated as part of the 2004 Plan. The same delineation was used for this plan with some minor adjustments to account for variations in drainage patterns (see Section 3.2.2.1). Several subbasins were included in the hydrologic modeling effort only, that have limited piped infrastructure and/or mainly discharge to UICs. Hydrologic information for these subbasins may be used to support future UIC decommissioning efforts or infrastructure improvements. There were also several subbasins that were not reflected in the hydrologic or hydraulic modeling effort. Review of these subbasins indicates that stormwater runoff enters the receiving water directly and does not enter a modeled conveyance system.

For purposes of the hydraulic modeling effort, the drainage system information was developed using the hydraulic model prepared for the 2004 Plan and City-provided GIS data of existing stormwater infrastructure, as-built information, aerial imagery, and anecdotal information from City staff.

Figure 2-4, located at the end of this section, shows the modeled stormwater drainage system including pipes, open channel, and UICs. Only one of the detention facilities, Roswell Detention Pond, was included in the model. Figure 2-4 also shows the subbasin delineation.

2.7 Stormwater Quality

The Oregon DEQ is responsible for implementing provisions of the Federal Clean Water Act (CWA) pertaining to stormwater discharge and surface water quality. DEQ conducts permitting for activities that discharge to surface waters, establishes water quality criteria for water bodies based on designated beneficial use, and conducts water quality assessments and evaluations to determine whether a water body adheres to water quality standards.

Section 303(d) of the CWA requires states to develop a list of water bodies that do not meet water quality standards. DEQ develops such a list for Oregon, which is used to identify and prioritize water bodies for development of a pollution reduction plan or total maximum daily load (TMDL). TMDLs identify the assimilation capacity of a water body for a particular pollutant and establish pollutant load allocations for sources of discharge to such water body.

Table 2-1 identifies the 303(d) parameters and TMDLs that are applicable to the City of Milwaukie. The Willamette River TMDL includes Kellogg Creek, Mt. Scott Creek, and Minthorn Creek as tributaries.

Table 2-1. Summary of TMDL and 303(d) Listed Streams for Milwaukie

Monitored water body	Bacteria	Temperature	Mercury	PCBs	PAHs	DDE/DDT	Dieldrin	Iron	Manganese
TMDLs									
Willamette River (and tributaries) (2006)	✓	✓	✓						
Johnson Creek (2006)	✓	✓	✓			✓	✓		
Additional 303(d) listed streams/parameters									
Johnson Creek				✓	✓				
Willamette River (lower) and tributaries				✓	✓	✓	✓	✓	✓

The City implements requirements of its Willamette River and Johnson Creek TMDLs under its Willamette River TMDL Implementation Plan (effective date March 2009). Activities described in the Willamette River TMDL Implementation Plan address temperature and bacteria pollutant sources.

2.8 Regulatory Drivers

Changes to the City's water quality regulations, affecting stormwater discharges to surface water and groundwater, and associated changes to the City's NPDES MS4 and UIC WPCF permit, were primary drivers for updating the 2004 Plan.

2.8.1 NPDES MS4 Permit

The City was reissued its Phase I NPDES MS4 permit on March 16, 2012. The City's reissued NPDES MS4 permit contains a variety of requirements to address the following categories/ activities:

- Illicit Discharge Detection and Elimination
- Industrial and Commercial Facilities
- Construction Site Runoff Control
- Public Education and Outreach
- Public Involvement
- Post-Construction Site Runoff Control
- Pollution Prevention for Municipal Operations
- Stormwater Management Facility Operations and Maintenance

Implementation of the NPDES MS4 permit is described in the City's Stormwater Management Plan (SWMP) (effective date May 2012). The SWMP includes measurable goals, responsible parties, and tracking measures to assess progress of implementing the activities (best management practices [BMPs]) to address requirements. The NPDES MS4 permit and the City's SWMP require the City to select, design, install, and maintain structural stormwater facilities for water quality improvement. Figure 2-5 at the end of this section shows the existing structural stormwater facility coverage in the city.

Over the permit term, the City is required to construct additional structural control facilities to improve water quality. The City's NPDES MS4 permit requires the City to complete a stormwater retrofit assessment by July 1, 2015, to identify areas in the city underserved or lacking structural stormwater facilities. Additionally, the City's NPDES MS4 permit requires calculation of TMDL pollutant load reduction benchmarks, to show progress toward meeting applicable TMDL requirements. Such progress is observed through implementation of structural stormwater facilities and pollutant source control measures (e.g., public education, street sweeping, etc.) that are targeted at addressing TMDL pollutants (see Table 2-1).

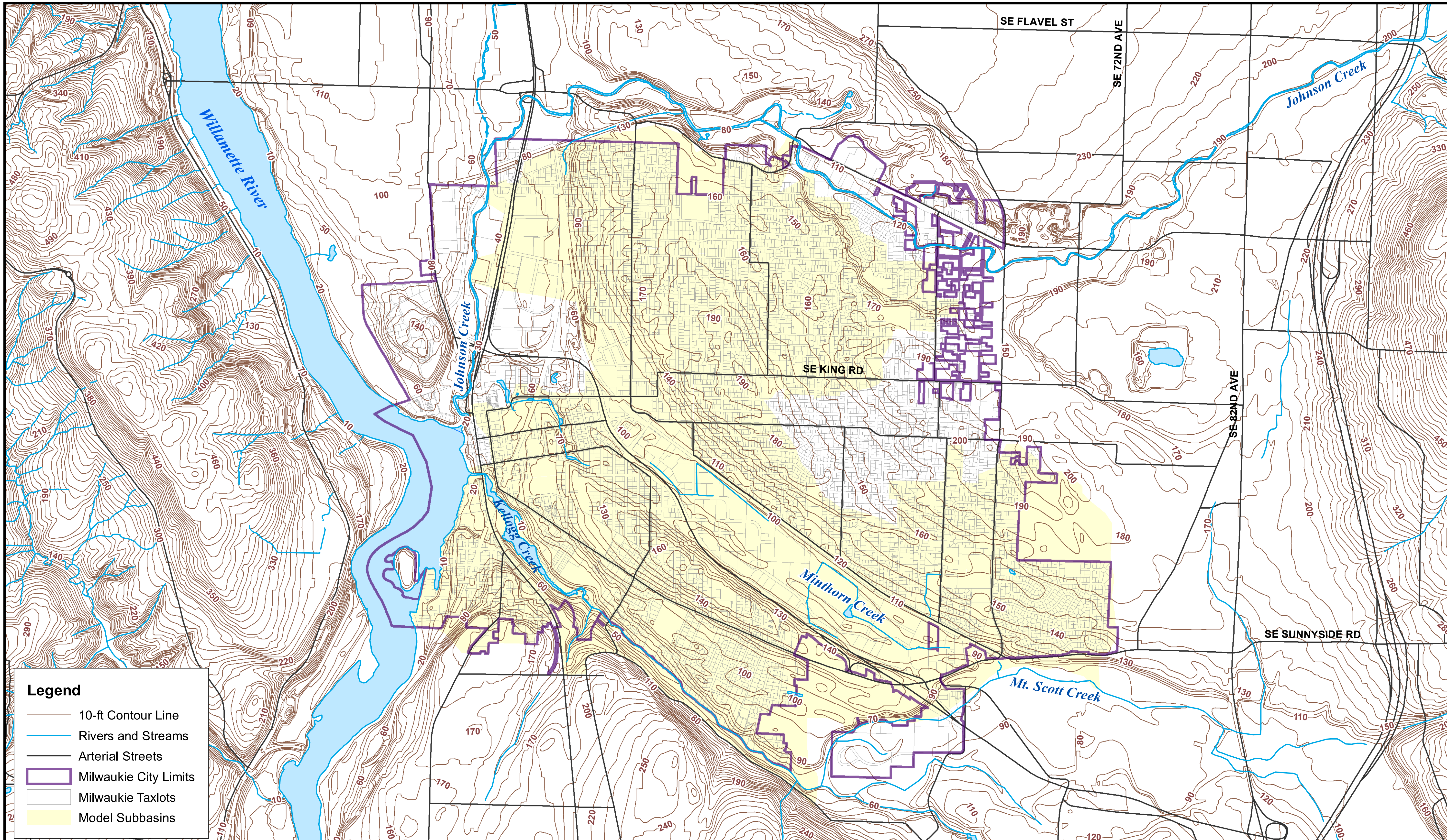
2.8.2 UIC WPCF Permit

The City uses 196 (recorded) UIC devices to manage stormwater runoff from public rights-of-way (ROW). A UIC is any facility designed for the subsurface infiltration of fluids. Figures 2-4 and 2-5 show the locations of UICs in the city.

UICs are regulated by DEQ under the Safe Drinking Water Act (SDWA). Because the City's UICs infiltrate only stormwater from public ROWs, DEQ considers them to be Class V injection systems under Oregon Administrative Rules (OAR) 340-044-0011(5)(d).

The City, along with other Oregon jurisdictions, has been working with DEQ to establish conditions of a WPCF UIC Permit Draft to regulate the discharge of stormwater to UICs. DEQ issued a WPCF UIC Permit Draft in July 2012. The UIC WPCF Permit Draft contains revised requirements for UICs, when compared with the assumptions of the 2004 Plan. Unlike the assumptions in 2004, UICs with limited separation distance to groundwater are allowed, thus changing the need to implement a majority of CIPs from the 2004 Plan that were related to the decommissioning of UICs.

Additionally, the WPCF UIC Permit Draft requires jurisdictions to conduct a system-wide assessment of their UICs and conduct analysis of UICs if the UICs are located near water wells. Additional detail is provided in Section 4.



Brown AND Caldwell

March 19th, 2013

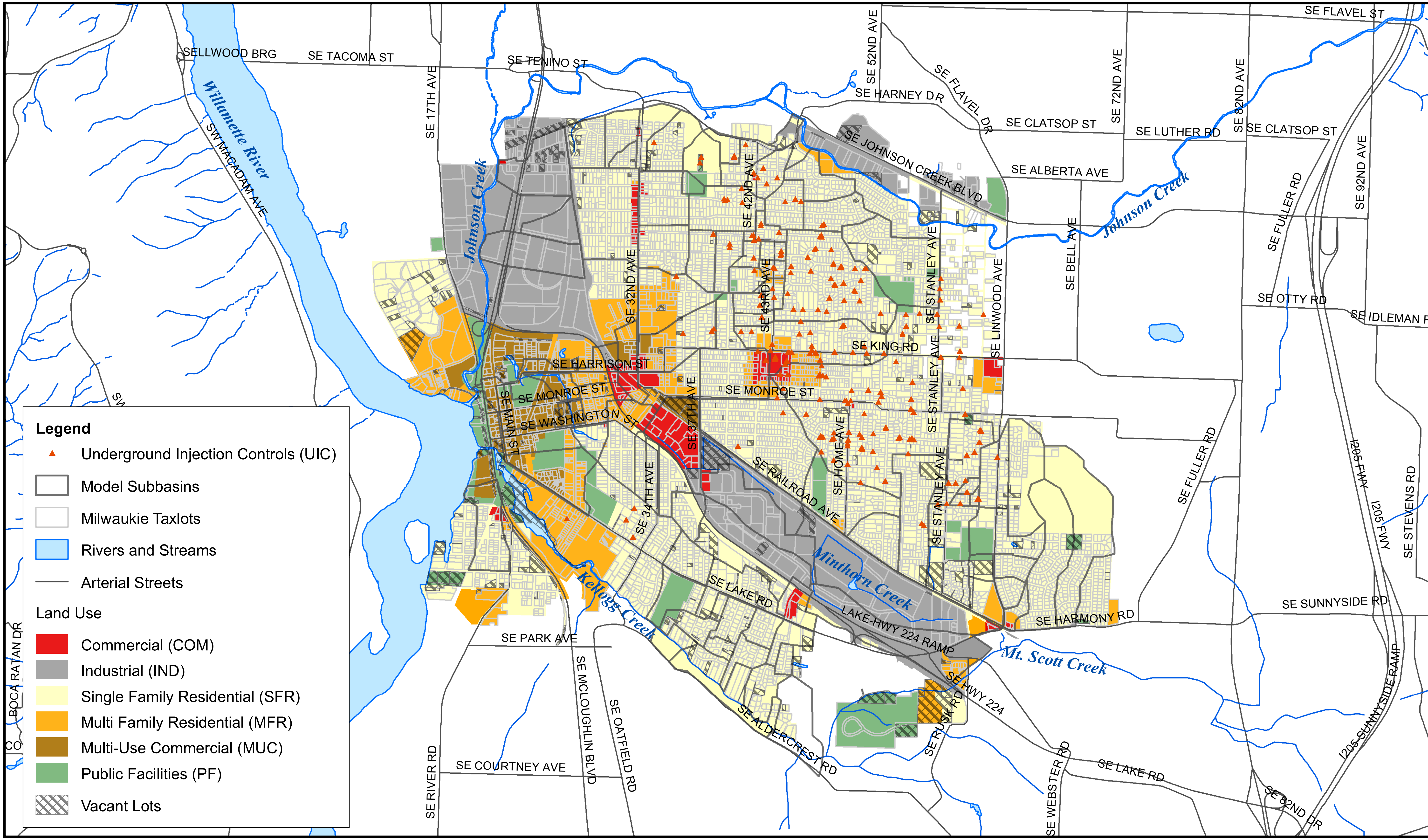
0 2,000 4,000 Feet

N

MILWAUKIE, OREGON FOUNDED 1847

CITY OF MILWAUKIE
STORMWATER MASTER PLAN UPDATE

TOPOGRAPHY
FIGURE 2-2



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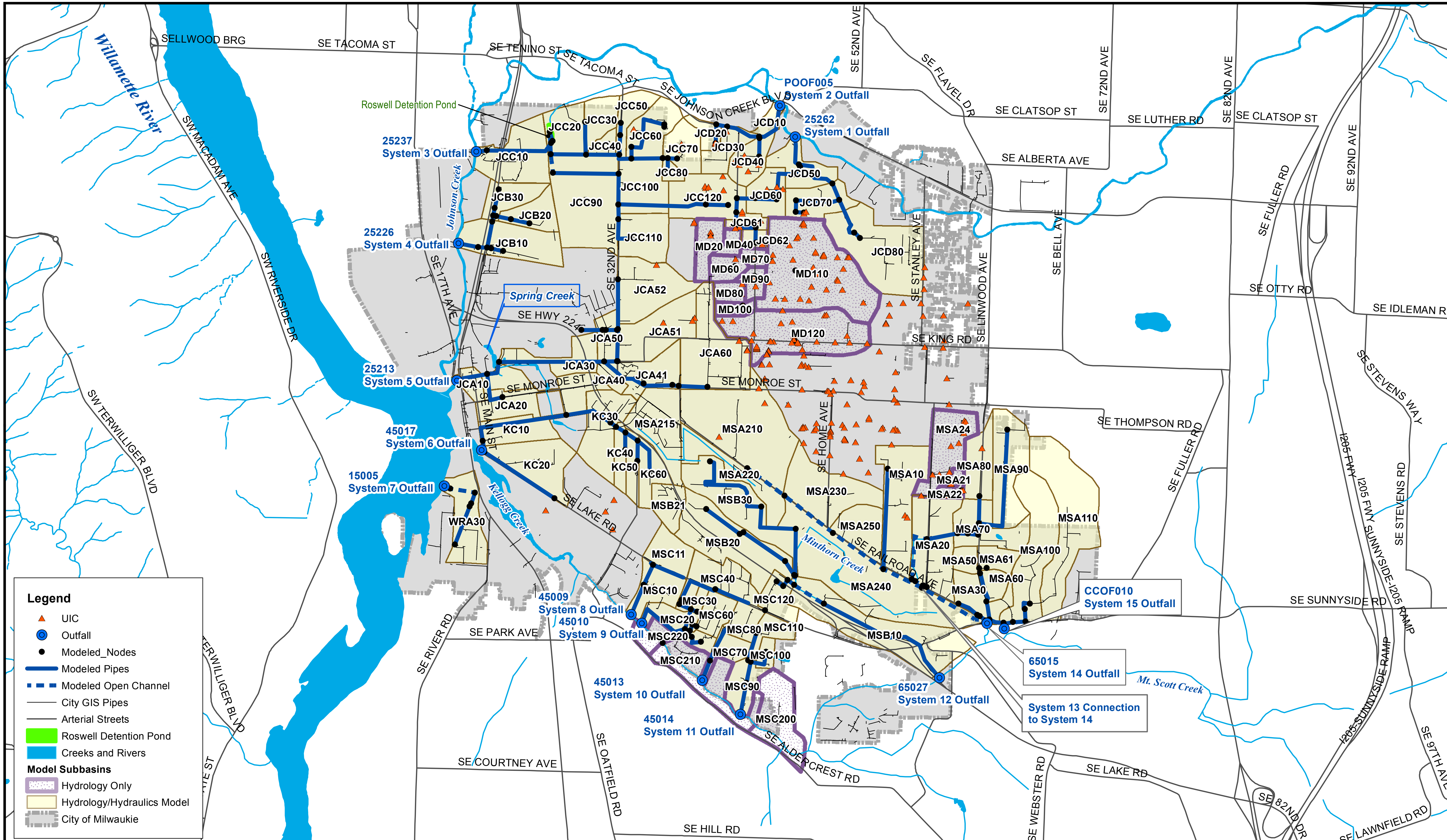
CITY OF MILWAUKIE
STORMWATER MASTER PLAN UPDATE
LAND USE
FIGURE 2-3



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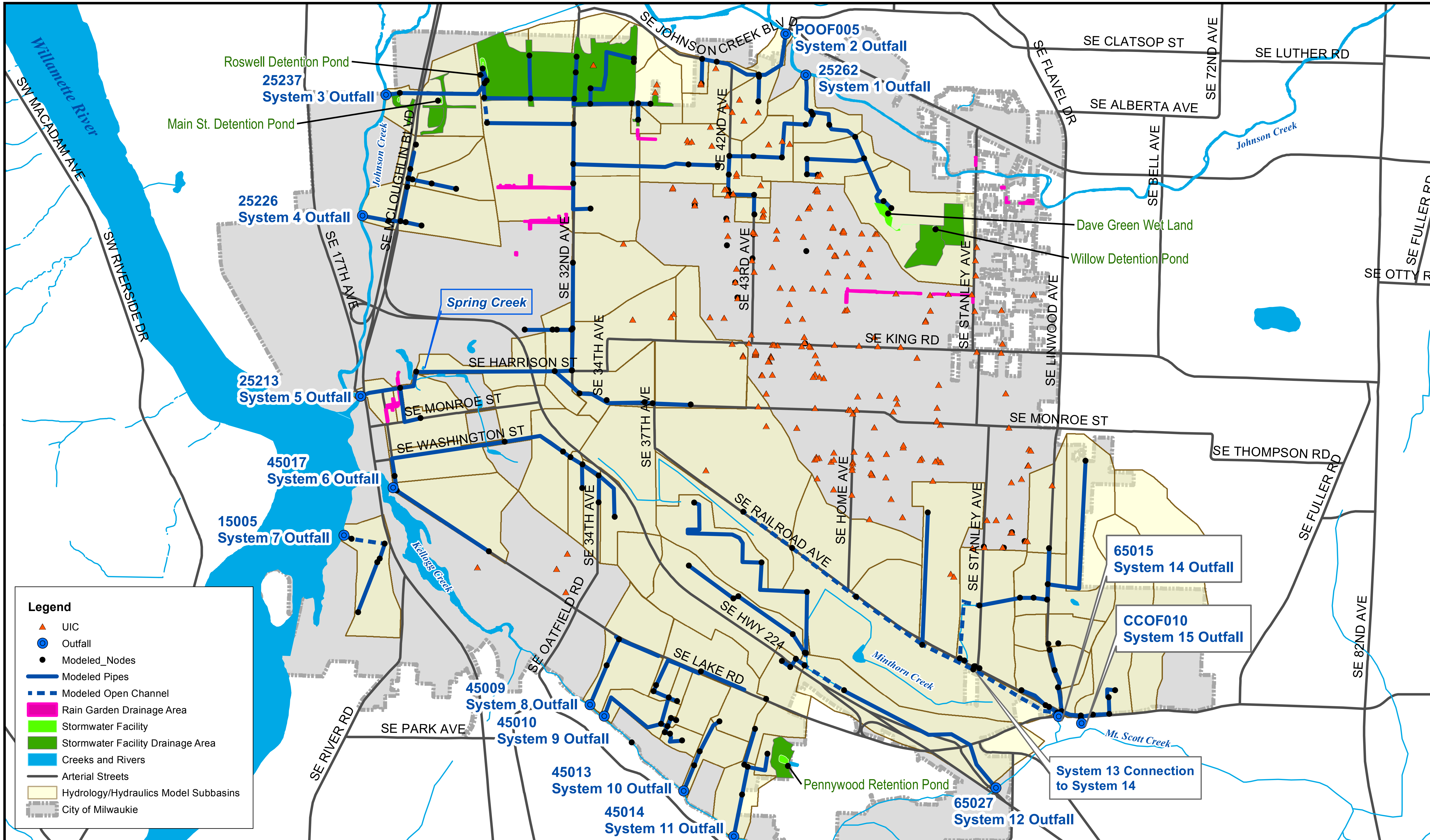
STORMWATER MASTER PLAN UPDATE

MODELED SYSTEM
FIGURE 2-4



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CITY OF MILWAUKIE
STORMWATER MASTER PLAN UPDATE

BMP COVERAGE
FIGURE 2-5

Section 3

Storm System Capacity Evaluation

To identify flooding problems and opportunities for CIPs, the City's public stormwater drainage system was evaluated using a hydrologic and hydraulic model. The stormwater drainage system was evaluated under existing and future development scenarios. This section provides a description of hydrologic and hydraulic modeling methods used for the system capacity evaluation and provides a summary of results.

3.1 City of Milwaukie Study Area

As described in Section 2, this Plan reflects an update to the Stormwater Master Plan effort conducted in 2004. Geographic coverage of the study area was not changed from the 2004 Plan. The total study area is approximately 2,165 acres and excludes a portion of city, along the eastern city boundary, that discharges solely to UICs. The study area also excludes the area in the southwestern portion of the city that directly discharges to receiving waters with very little public conveyance system.

The majority of the study area (approximately two thirds) is collected and conveyed in a pipe or open-channel system and outfalls to Johnson Creek to the north and west, Kellogg Creek to the south, and Mt. Scott Creek to the southeast. A small area in the southwest portion of the city discharges directly to the Willamette River.

3.2 XP-SWMM Model Development

To evaluate the capacity of the City's stormwater drainage system, the computer model previously developed for the 2004 Plan was utilized. XP-SWMM was the modeling software used to evaluate the drainage system in 2004 and was also used for this effort. The model version was updated to XP Software's XP-SWMM v2012.

The 2004 model was updated to reflect changes to the City's drainage system since 2004 and to allow for the simulation of a future development condition. General model adjustments include the following:

- The addition of a future development condition to reflect the City's comprehensive plan designated land use for each modeled subbasin
- Refinement to the modeled open-channel conveyance cross sections along Railroad Avenue
- Updated pipe size and elevation information, per the City's GIS and anecdotal information provided by City staff
- The addition of X and Y coordinates to the modeled system
- Adjustment of the model node names to coordinate with the City GIS naming convention

Detail related to model adjustments is provided in the following sections. The Plan did not include field survey information or revisions to the subbasin hydrologic parameters, with the exception of the future impervious percentages assigned to reflect the City's comprehensive plan designated land use.

Model input parameters and modeling methods listed below are described in the following sections:

- Meteorological Data (e.g., rainfall) (Section 3.2.1)
- Hydrologic Data (e.g., area, impervious area [as a percent], infiltration parameters) (Section 3.2.2)
- Hydraulic Data (e.g., pipe size, material, length and invert elevations) (Section 3.2.3)

3.2.1 Meteorological Data

Design storms are precipitation patterns typically used to evaluate the capacity of storm drainage systems and design capital improvements for the desired level of flood protection.

Design storms evaluated for this study include the water quality, 2-year, 5-year, 10-year, 25-year, and 100-year, 24-hour duration design storms. The 2004 Plan did not assess the water quality, 2-year, or 5-year design storms.

The rainfall depths for these design storms were based on isopluvial maps published in the National Oceanographic and Atmosphere Administration (NOAA) Atlas 2, Volume X. The rainfall distribution for these design storms are based on the Soil and Conservation Service (SCS) 24-hour, Type IA distribution, which is applicable to western Oregon, Washington, and northwestern California.

Table 3-1 lists the precipitation depths for each design storm used in the model.

Table 3-1. Design Storm Depths

Design storm event	Rainfall depth, inches
Water quality, 24-hour	1.0
2-year, 24-hour	2.4
5-year, 24-hour	3.0
10-year, 24-hour	3.5
25-year, 24-hour	4.0
100-year, 24-hour	4.7

3.2.2 Hydrologic Data

This section includes a summary of subbasin delineations and model input parameters used to define the hydrologic characteristics of the subbasins.

3.2.2.1 Subbasin Delineation

The City's study area is divided into major drainage basins associated with Johnson Creek, the Willamette River, Lower Kellogg Creek, Middle Mt. Scott Creek, and City UICs. The major drainage basins are subdivided into 76 subbasins contributing to a conveyance system and 16 subbasins, which currently contribute to UICs and were modeled for hydrology only. Subbasins are named based on their respective major drainage basin.

The subbasin delineations used in the model are based on the 2004 model, except where the City provided additional information that supported subdividing the original subbasins to incorporate updated pipe system information (e.g., CIPs that were constructed and UICs that were decommissioned). Additionally, in some cases, the inlet node (discharge location) to the City's modeled system was reassigned for a subbasin to reflect actual drainage conditions and topographic constraints.

Table 3-2 summarizes the modifications to the 2004 subbasin delineation.

Table 3-2. Modifications to 2004 Milwaukie Subbasin Delineation		
2004 subbasin name	2012 subbasin name	Description of change
MD30	JCD61	Drainage from MD30 was incorporated into the piped system following installation of a portion of CIP 1 per the 2004 Master Plan.
MD50	JCD62	Drainage from MD50 was incorporated into the piped system following installation of a portion of CIP 1 per the 2004 Master Plan.
MSC10	MSC10, MSC11	Drainage from MSC10 from the 2004 model was subdivided into MSC10 and MSC11 to model the newly constructed pipe system on Lake Road.
Not reported	MSA 250	Topography for this subbasin resulted in changing the inlet node from 82–83 to 84.
Not reported	MSA215	Topography for this subbasin resulted in changing the inlet node from 78–79 to 66003.
Not reported	MSA240	Topography and site conditions for this subbasin resulted in changing the inlet node from 84 to 65039.
Not reported	Subbasins modeled for hydrology only	Flow (and associated input parameters) for subbasins which did not contribute to a piped system were not included in the 2004 Plan documentation. These subbasins are included in the hydrologic results tables (Appendix A).

3.2.2.2 Input Parameters

The SCS CN hydrology method is used in XP-SWMM to generate a stormwater runoff hydrograph for each subbasin. This method requires that the following parameters are specified for each subbasin:

- Subbasin name
- Area of subbasin (acres)
- Hydraulically connected impervious percentage (percent)
- Average ground slope (dimensionless, ft/ft)
- Pervious area CN (dimensionless)
- Time of concentration (minutes)
- Initial abstraction (dimensionless, in./in.)

For each parameter, a discussion is presented below describing the methods that were used to generate the values used in XP-SWMM. If the model deviated from the 2004 model assumptions, the changes are listed.

3.2.2.2.1 Subbasin Name

The subbasin name was assigned using a two-letter abbreviation for the major basin (e.g., JC for Johnson Creek). Major basin names and codes are shown in Table 3-3. A third letter was used to identify each significant drainage area within the major basin. Following the two- or three-letter abbreviations, numbers starting with 10 and increasing in increments of 10 were assigned to each subbasin. In cases where subbasins were subdivided following the 2004 Plan, the unit digit was used to differentiate subbasins.

Table 3-3. Basin Names and Codes

Basin name	Basin code
Johnson Creek	JC
Lower Kellogg Creek	KC
Milwaukie Drywell	MD
Middle Mt. Scott	MS
Willamette River	WR

3.2.2.2.2 Subbasin Area

The subbasin areas were calculated using GIS based on the 2004 subbasin delineation and associated adjustments described in Section 3.2.2.1.

3.2.2.2.3 Subbasin Impervious Percentage

Effective impervious percentage is the portion of impervious area that is directly connected to the drainage collection system. For example, curb-and-gutter streets are directly connected to the drainage collection system and represent "effective impervious area." However, a sidewalk that is separated from the street by vegetation is not considered to be directly connected because runoff has the opportunity to infiltrate. The City does not have citywide specific information for effective impervious surface so instead bases impervious estimates on land use, and assumes that the amount of impervious area in a subbasin would vary depending on land use.

The 2004 Plan and model used an area-weighted impervious percentage for each subbasin based on the land use coverage. In order to calibrate the model, the impervious percentage for each subbasin was adjusted to match the model results with City-observed flooding during a storm event on January 31, 2003. The area-weighted impervious percentages were reduced by 80 percent in some subbasins in order to match model results with locations of City-observed flooding. The 2004 Plan assumed full buildout conditions; therefore, only the adjusted impervious percentages following calibration of the model were used in model simulations. The adjusted impervious percentage from the 2004 Plan and model was used to reflect existing development conditions for this Plan.

Although the 2004 Plan assumed the City was fully built out, redevelopment activities and street improvements typically increase the "effective impervious area" to the storm drainage system. Currently, many areas of City lack curb and gutter streets, but street improvements would add curb and gutter. Infill redevelopment activity reflects construction of larger, new houses on the same size lot as the original, smaller house. These changes increase the amount of impervious surface and the connectivity of the impervious surface.

In order to develop the Plan to address the potential for fully connected, effective impervious surface throughout the city, an area-weighted impervious percentage was calculated for each subbasin using the land use-based impervious percentages from the 2004 Plan (Table 3-4). Per coordination with the City, the average impervious percentage of industrial land was adjusted to 75 percent from 65 percent for this effort.

Table 3-4. Impervious Percentage and Land Use Coverage			
Land use	Abbreviation	Average impervious percentage	Percentage of the study area
Single-family residential	SFR	35	63%
Multifamily residential	MFR	75	10%
Industrial	IND	75	15%
Commercial	COM	75	3%
Multi-use commercial	MUC	75	4%
Public facilities	PF	45	6%

3.2.2.2.4 Subbasin Slope

The subbasin slope is the average slope along the pathway of overland flow to the inlet of the drainage system. The slope for each subbasin is based on the 2004 model and Plan, but for new or subdivided subbasin (see Section 3.2.2.1), the slope was calculated from the digital topographic information contained in the GIS.

3.2.2.2.5 Pervious Area Curve Number

The pervious area CN is a dimensionless number that depends on hydrologic soil group, cover type, and antecedent moisture conditions.

Runoff CNs for pervious areas were estimated for the 2004 Plan from typical runoff CN tables provided in the SCS Technical Release 55, titled “Urban Hydrology for Small Watersheds”, dated June 1986. All CN values assume average antecedent moisture conditions. The CN was another calibration parameter per the 2004 Plan and model and was adjusted to match City-observed flooding. The final pervious CN assigned to each subbasin is based on the 2004 model and Plan and used for both existing and future development condition model scenarios.

3.2.2.2.6 Time of Concentration (Units = Minutes)

The time of concentration is the time for runoff to travel from the most distant point of the watershed to the point in question. The time of concentration is computed by summing all the travel times for consecutive components of the drainage system (i.e., sheet flow, shallow concentrated flow, open-channel flow, and pipe flow). The time of concentration for each subbasin is based on the 2004 model and Plan, but for new or subdivided subbasins (see Section 3.2.2.1), the time of concentration was recalculated using the digital topographic information contained in the GIS.

3.2.2.2.7 Initial Abstraction

Initial abstraction defines the fraction of precipitation that is lost to interception and depression storage before runoff is generated in the model by precipitation which is not infiltrated. A value of 0.2 was used for all subbasins, consistent with the 2004 Plan and model.

3.2.3 Hydraulic Data

This section describes the naming convention used in the Plan for conveyance system components and describes the model input parameters used to characterize the hydraulic characteristics of the system. The hydraulic input parameters are based primarily on 2004 Plan and model, and any revisions are discussed below.

3.2.3.1 Conveyance System (Conduit) Naming Convention

The conveyance system naming convention employed during the 2004 Plan was used. Conveyance system naming is based on the associated subbasin for the segment; pipe segments within the same subbasin are then defined with a letter designation (e.g., JCD50b). The letter designation is assigned from downstream (letter a) to upstream within the subbasin (letter b, c, d, etc.).

3.2.3.2 Input Parameters

The hydraulic analysis of the City's piped conveyance and open-channel conveyance system requires the definition of various parameters listed below:

- Node naming convention and georeferencing
- Addition of modeled nodes and modeled system refinement
- Ground and invert elevations
- Pipe shape, size, and material
- Length of segment (feet)

Generally, the hydraulic input parameters defined in the 2004 Plan and model were maintained. However, in some cases, adjustments to the hydraulic input parameters from the 2004 Plan and model were made. Adjustments include (1) updated pipe size, channel cross sections, and elevation information per new system information; (2) updated node identification (naming) to correspond to updated City GIS; and (3) georeferencing the modeled nodes (i.e., assign X and Y coordinates in the model) such that the modeled system can be accurately mapped and correspond to the City's GIS.

3.2.3.2.1 Node (Manhole) Naming Convention and Georeferencing

Since 2004, the City has been actively updating its GIS to reflect the addition of new and identified infrastructure. As such, some node names originally used in the 2004 Plan and model are not reflected in the City's GIS.

In order to georeference the model nodes to correspond to the City's GIS and create maps from the model reflecting the modeled system, the node naming convention had to be resolved between the 2004 Plan and model and the City's GIS. The version of the XP-SWMM model used for the 2004 Plan does not have the same mapping capability and conformance with GIS as XP-SWMM v2012, which was used for this Plan and model.

From the 2004 Plan and model, node names consistent with the City's current (2012) GIS were maintained. Nodes from the 2004 Plan and model that did not have consistent names per the City's GIS were reviewed in detail. In most cases, a corresponding node and node name was identified from the City's GIS, and the node name was updated. In a few cases, a representative, corresponding node could not be identified in the City's GIS. In those cases, the City conducted field investigations to confirm whether a node was in fact present. If present, the City's GIS was updated and a node name assigned to the 2004 model that was consistent with the City's GIS.

Table 3-5 summarizes the node naming changes from the 2004 model to the current 2012 model. Once the node names were updated, X and Y coordinates from the City's GIS were assigned to the model nodes.

Table 3-5. Modifications to Model Node Names	
2004 model	2012 model
301	21505
22165	21340
61105	61105
42292	41137
405	ODMH015
403	ODMH016
400	ODMH017
61038	ODMH005
61037	ODMH004
21520	21519
21504	23047
21526	POMH001
25271	POOF005
25270	POMH010
22673	31023
66009	66023
62175	CCCB159
62174	CCCB161
65016	CCOF010
62171	CCCB146
62166	CCCB154
66007	66026
104	CCIN002
26009	36001
404	ODMH031

3.2.3.2.2 Addition of Modeled Nodes and Modeled System Refinement

The overall coverage of the 2004 Plan and model was not increased for this Plan. However, the modeled system was refined and nodes were added for consistency with the City's GIS. These modifications were conducted for the following:

- Inclusion of constructed elements of CIP 1: Brookside Storm Improvements and CIP-2 Meek Street and 32nd Avenue Pipe Improvements from the 2004 Master Plan.
- Inclusion of as-built information associated with the Lake Road project.
- Refinement of the modeled system to reflect changing pipe sizes along a singled modeled segment.
- Removal of Kellogg Creek from the model, to improve model stability and because CIP development was not anticipated for Kellogg Creek itself.

- Establishment of a fixed tailwater elevation at the top of pipe for outfalls on Johnson Creek and Kellogg Creek. Outfalls on Mt. Scott Creek are modeled as freely discharging.
- Inclusion of the Railroad Avenue channel.

3.2.3.2.3 Ground and Invert Elevations

Ground and invert elevations from the 2004 model were maintained. For nodes adjusted or added to the model (see description in Section 3.2.3.2.1 and 3.2.3.2.2), ground elevation information was estimated using City-provided 5-foot contours. Invert elevations were established based on City-provided measure-down information, either available in the City's current GIS or collected by field staff upon request.

As part of the Plan and model, refinement to the cross-sections for open channel segments was requested by the City using available Light Detection and Ranging (LIDAR) information. LIDAR was used to refine the longitudinal slope of the open channel, but due to issues with the resolution of LIDAR cross sections, field visits were conducted to confirm the side slopes and bottom widths of the open channel segments.

3.2.3.2.4 Shape, Size, and Material

Pipe shape, size, and material assumptions from the 2004 Plan and model were maintained. For segments adjusted or added (see description in Sections 3.2.3.2.1 and 3.2.3.2.2), the information was either included based on the City's GIS or collected by the City staff upon request. Pipes of 15-inch diameter and greater were included in the model. Table 3-6 summarizes the Manning's roughness coefficient "n" assumed for each pipe material.

Table 3-6. Manning Roughness Coefficients

Material	Manning's n
Concrete pipe	0.014
Corrugated metal pipe	0.024
Plastic	0.011
Open channels	0.035
New pipe added for CIPs	0.013

Open channels were modeled as trapezoidal channels. Longitudinal slopes were refined based on LIDAR information, and cross-section information refined based on field inspections of the channels.

3.2.3.2.5 Segment Length

The length of each pipe or open channel segment was maintained from the 2004 Plan and model. For segments added or adjusted, the pipe length was taken from the City's GIS. Some pipe lengths were extended or combined with other segments to ensure continuity in the system.

3.3 Drainage Standards

The City's Public Works Standards, Section 2: Stormwater, was referenced for general design criteria related to stormwater infrastructure. Such information includes pipe size, detention and water quality facility sizing, Manning's roughness coefficient "n," cover, and structure placement and spacing.

Applicable design criteria are listed below in Table 3-7 and used for the design of CIPs (see Section 6).

Table 3-7. Drainage Standards and Design Criteria	
Criteria	Value
Water quality facility design	Shall meet requirements of the current City of Portland Stormwater Management Manual
Pipe size	Minimum 12-inches in diameter (for public main lines)
Manning's roughness	0.013
Conveyance design storm	Minimum 100-year
Manhole spacing	Maximum 400 feet
Minimum pipe cover	30 inches

The current Public Works Standards reference a 100-year design storm for conveyance system piping. The level of protection used in the 2004 Plan, as well as for the previous 1997 Plan, is based on the following:

- Storm sewer pipes draining less than 640 acres: 25-year, 24-hour design storm
- Storm sewer pipes draining greater than 640 acres: 50-year, 24-hour design storm
- Open channels draining less than 250 acres: 25-year, 24-hour design storm
- Open channels draining greater than 250 acres: 50-year, 24-hour design storm
- Open channels draining greater than 640 acres: 100-year, 24-hour design storm

Due to the size of the subbasins, the 2004 Plan used the 25-year, 24-hour design storm. For consistency with the previous master plans, the system evaluation and CIP design is based on the 25-year, 24-hour storm event.

3.4 Flood Control Model Results

XP-SWMM v2012 was used to simulate the water quality, 2-year, 5-year, 10-year, 25-year, and 100-year design storms for the current and future development conditions.

Results of the hydrologic and hydraulic simulations are tabulated in Appendix A (Table A-1 for hydrologic results and Table A-2 for hydraulic results). For reporting purposes, the hydrologic results reflect all simulated design storms, and the hydraulic results tables reflect just the 10-year and 25-year flows used to identify capacity deficiencies and size CIPs.

The hydrologic results table (Table A-1) is sorted by system outfall and includes subbasin name, modeled inlet node ID, subbasin area, pervious curve number, impervious area, and associated design flow. The hydraulic results table (Table A-2) is also sorted by system outfall and includes conduit name, upstream and downstream node ID, length, size, invert and ground elevations, and 10-year and 25-year peak flow and water surface elevation.

Due to the use of the SCS CN method and the low impervious percentage and CN assumed for select subbasins under the existing development condition, some subbasins have no reported flow during the water quality, 2-year, and 5-year design storm. Based on the limited runoff producing area, the small design storm depth, and the CN assumptions, runoff generated from impervious surfaces in the model would be stored in void space present in the pervious area.[1]

[1] "Urban Hydrology for Small Watersheds", Technical Release 55 from the United States Department of Agriculture, Soil Conservation Service, Engineering Department. Dated June 1986, Table 2-1.

3.4.1 Initial Identification of Flooding Problems

Flooding problems are identified where flow exits the system by overtopping manholes and entering road surfaces. Surcharging is considered acceptable as long as flow does not enter the roadway. For open channel segments, flooding was identified by water overtopping the banks.

As shown in Table A-2, a total of 27 modeled conduits totaling 17,000 feet in length were predicted to flood during either the existing or future development scenarios. For purposes of reporting results and facilitating discussion with City staff, conduits were geographically grouped into “flooding problem areas.” Figure 3-1 shows the modeled flooding locations under the existing development condition and Figure 3-2 shows the project flooding locations under the future development condition. Both figures are located at the end of this section.

A meeting was held with City staff on October 25, 2012, to review the initial XP-SWMM model results. City staff provided comment and discussion about each identified, modeled flooding area. Additional flooding areas that are not reflected in modeled results were also identified by City staff and included due to the frequency of complaints received. Based on City feedback and, in some cases, field reconnaissance, a recommendation to include a CIP for the flooding area was made.

Table 3-8 summarizes the identified flooding problem area by system number (outfall number). The flooding frequency and scenario is identified and the source of the capacity deficiency is provided. The CIP recommendation is also provided.

Table 3-8. Initial Flood Control CIP Opportunity Areas

System number by outfall	Conduit name[a]	Flooding frequency and scenario	Source of capacity deficiency	City feedback	CIP recommended? (Y/N)	CIP description
1	JCD80a	Future 25-year	Existing 18" pipe (JCD80a) is relatively flat and results in predicted flooding.	• Overflow discharges to an existing wetland (no anticipated property damage). • An existing siphon (not modeled) is present to regulate flow. • Flooding in this area reflected in 2004 MP (CIP-9).	N	N/A
4	JCB10c and JCB10d	Future 10-year and 25-year	Existing 18" pipe (JCB10c) and elliptical 24" x 12" (JCB10d) are under capacity and results in predicted flooding.	• Recent redevelopment activities have occurred onsite. • Flooding in this area reflected in 2004 MP (CIP-15).	Y	Pipe upsize
5	Multiple (see Meek Street CIP)	Existing 10-year and 25-year Future 10-year and 25-year	Modeled flooding throughout the Meek Street, Monroe Street and 32nd Avenue area (see CIP-2 and CIP-10 from the 2004 MP).	• A portion of original CIP constructed along Meek Street installed with incorrect elevations. Current manhole plug prevents flows from entering newly installed pipe. • New CIP design/cost estimate to reflect continuation of the conveyance to Roswell Detention Pond. • Harrison Street was just repaved (not ideal to redisturb).	Y	Detention facilities and pipe upsize
6	KC20c, KC10b, and KC30a	Existing 10-year and 25-year Future 10-year and 25-year	• Existing 21" pipe (KC10a) and 18" pipes (KC10b and KC30c) are under capacity and results in predicted flooding. • Replacement of KC10a eliminates flooding on KC20c.	Flooding in this area reflected in 2004 MP (CIP-8)	Y	Pipe upsize
7	WRA30e	Existing 10-year and 25-year Future 10-year and 25-year	WRA30e is composed of multiple pipe segments. A constriction (15" pipe) is located (node 11003-15009) along the segment and results in predicted flooding along the segment.	• Downstream open channel adjacent to railroad tracks. Limited offsite flooding potential. • Per field survey, no constriction present. • Flooding in this area reflected in 2004 MP (CIP-14).	N	N/A
12	MSB20d and MSB20e	Future 25-year	MSB20d is negatively sloped and causing backwater conditions and predicted flooding along MSB20d and MSB 20e.	• City confirmed negative slope. • Minor flooding < 2 cfs requires a CIP.	Y	Pipe replacement/ upsize
12	MSB30c and MSB30d	Future 25-year	MSB30c is negatively sloped and causing backwater conditions and predicted flooding along MSB30c and MSB30d.	• City confirmed that no negative slope exists. • Minor flooding < 1 cfs does not require CIP.	N	N/A
13	UICs 34155 and 34137	Reported by City staff	Two existing UICs (UIC 34155 and 34137) are not operational. Attempts to retrofit these UICs by City staff have been ineffective.	• Two additional UICs (34167 and 34138) may also be decommissioned due to their location along Lloyd Street. • Decommissioning these UICs was proposed in the 2004 Master Plan (CIP-3).	Y	UIC decommissioning and pipe installation

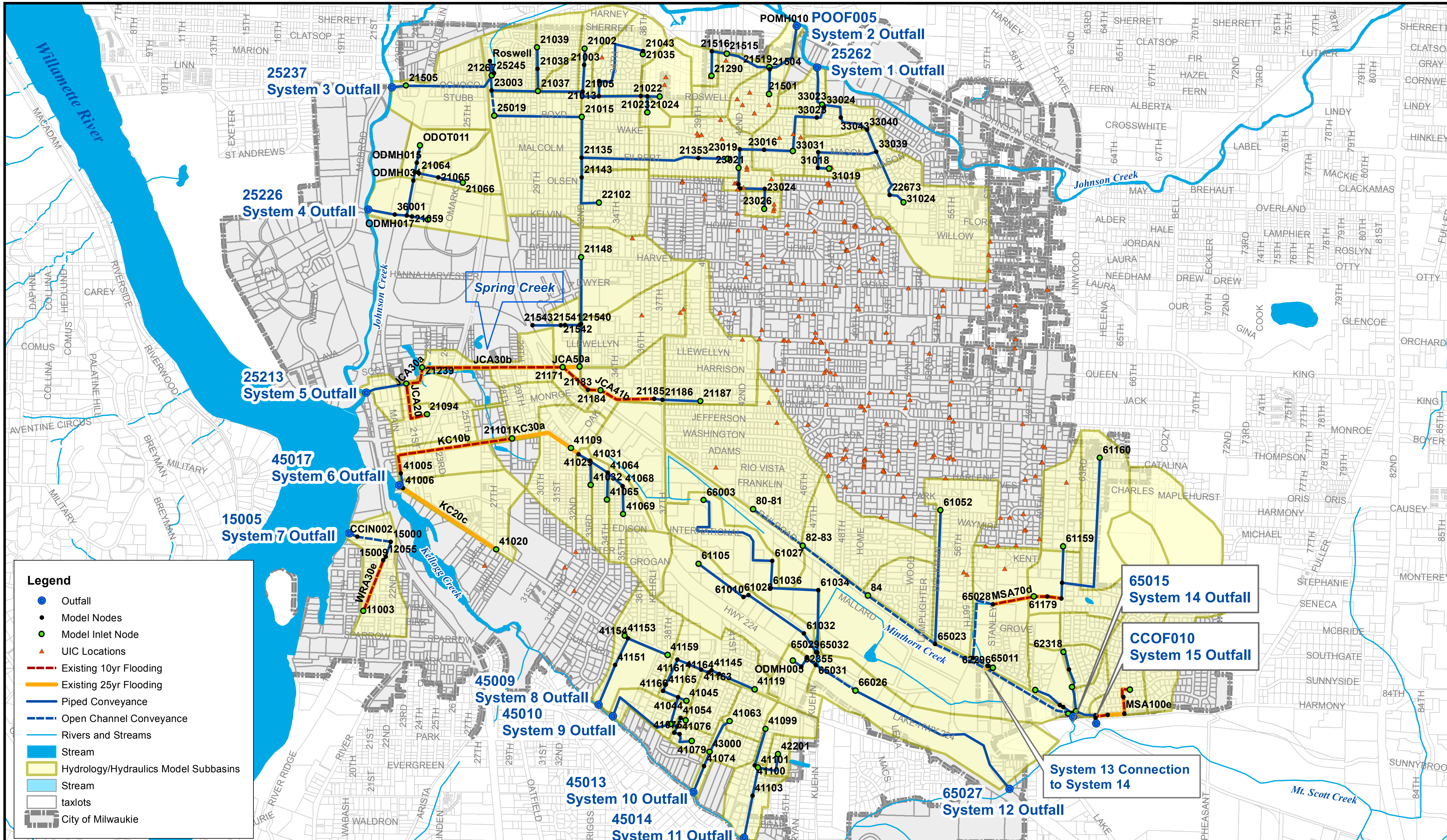
Table 3-8. Initial Flood Control CIP Opportunity Areas						
System number by outfall	Conduit name[a]	Flooding frequency and scenario	Source of capacity deficiency	City feedback	CIP recommended? (Y/N)	CIP description
13	MSA80c and MSA70d	Existing 10-year and 25-year Future 10-year and 25-year	MSA80c is negatively sloped and causing backwater conditions and predicted flooding along MSA80c and MSA70d.	• Pipe goes through Linwood Elementary School (possible construction issues). • School recently installed a rain garden onsite that may mitigate flow. • Flooding in this area reflected in 2004 MP (CIP-3 and CIP-13).	Y	Detention facility and/or pipe upsize
13	MSA20a	Existing 25-year Future 10-year and 25-year	MSA20a is under capacity, resulting in predicted flooding and modeled with no pipe cover.	• City confirmed limited pipe cover. • Flooding in this area reflected in 2004 MP (CIP-3).	Y	Pipe relocation and/or pipe upsize
14	No Piped System in Location	Reported by city staff	Localized flooding reported by City maintenance staff at Plum Drive and Apple Street.	A CIP to address flooding in this area was proposed in the 2004 Master Plan (CIP-4).	Y	Pipe installation
14	MSA40, MSA30a, and MSA50a	Future 25-year	MSA40 is under capacity, resulting in predicted flooding on MSA40, MSA30a, and MSA50a.	City reviewed the model outfall configuration and provided a revised configuration based on a field visit. When the revised outfall configuration was added to the model, no flooding occurred.	N	N/A
15	MSA100f, MSA100e, MSA100d, and MSA100c	Existing 10-year and 25-year Future 10-year and 25-year	Pipe segments are under capacity, resulting in predicted flooding at each segment.	• No anticipated schedule for annexation or development of upstream area. • Existing Furnberg Detention Facility may mitigate additional flows. • Flooding in this area reflected in 2004 MP (CIP-11).	Y	Pipe relocation and/or pipe upsize
Unmodeled	UIC 34076	Reported by city staff	Localized flooding reported by City maintenance staff at 44th and Llewellyn.	• Flooding is likely the result of too large contributing drainage area to the single UIC. • A CIP to address flooding in this area was proposed in the 2004 Master Plan (CIP-6).	Y	Installation of UICs
Unmodeled	UIC 24014	Reported by city staff	Localized flooding reported by City maintenance staff at 36th Avenue between King and Harvey Streets.	• Existing grade results and lack of nearby piped drainage system results in runoff pooling during rain events. • Vacant parcel and available ROW adjacent to UIC.	Y	Installation of vegetated infiltration facility to reduce runoff volume to UIC
Unmodeled	UIC 34094 and 34110	Reported by city staff	Localized flooding reported by City maintenance staff at 55th Avenue between King Street and Monroe Street.	An adjacent house currently sits below street grade and experiences flooding.	Y	Installation of soakage trench to reduce runoff volume to UIC

[a]*The conduit name is shown on Figures 3-1 and 3-2.*

3.4.2 Flood Control CIP Locations

Review of initial model results and coordination with City staff resulted in the identification of 12 flooding problem areas requiring CIP development (Table 3-8 above):

1. System 4: Conduit JCB10c and JCB10d
2. System 5: Multiple conduits associated with the Meek Street system
3. System 6: Conduit KC20c, KC10b, and KC30a
4. System 12: MSB20d and MSB20e
5. System 13: UICs on Lloyd Street (34155, 34137, 34167, and 34138)
6. System 13: Conduit MSA80c and MSA70d
7. System 13: Conduit MSA20a
8. System 14: Pipe extension down Apple Drive
9. System 15: Conduit MSA100f, MSA100e, MSA100d, and MSA100c
10. Unmodeled Area: UIC 34076 at 44th and Llewellyn
11. Unmodeled Area: UIC 24014 on 36th Avenue between King and Harvey Streets
12. Unmodeled Area: UIC 34094 and 34110 on 55th Avenue between King and Monroe Streets



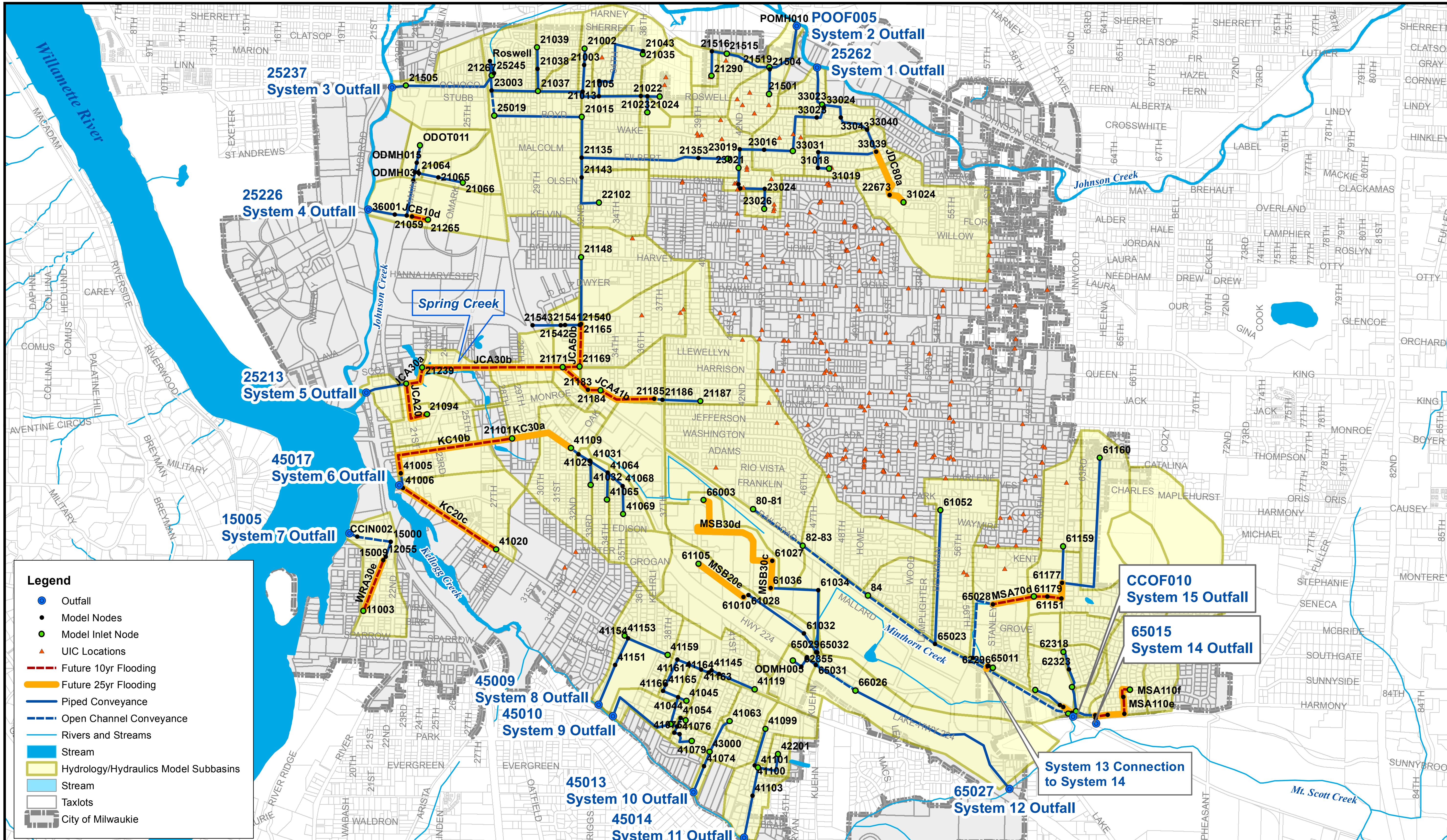
Brown AND Caldwell

March 19th, 2013

0 1,500 3,000 Feet

N

CITY OF MILWAUKIE
STORMWATER MASTER PLAN UPDATE
EXISTING FLOODING
FIGURE 3-1



Brown AND Caldwell

March 19th, 2013

0 1,500 3,000 Feet

N

CITY OF MILWAUKIE
STORMWATER MASTER PLAN UPDATE

FUTURE FLOODING
FIGURE 3-2

Section 4

UIC Risk Evaluation

In conjunction with the draft UIC WPCF permit template, issued by DEQ in July 2012, the City is required to conduct a system-wide assessment of its UICs and retrofit/decommission UICs determined not to be in compliance with conditions of the permit. In anticipation of these requirements, the City conducted a preliminary UIC system-wide assessment and an unsaturated Groundwater Protectiveness Demonstration (GWPD) as part of this Stormwater Master Plan update. Results are used to identify UICs that would potentially require retrofit or decommissioning due to inadequate vertical separation distance from the bottom of the UIC to groundwater.

This section provides results of the preliminary UIC system-wide assessment and describes results of the unsaturated GWPD. A detailed technical report describing the overall UIC risk evaluation is provided in Appendix B.

4.1 Preliminary System-wide Assessment

A preliminary, system-wide assessment was conducted to inventory the physical characteristics of the City's UICs. Per Schedule B in the July 2012 UIC WPCF draft permit template, a system-wide assessment must include the following:

1. An inventory of all UICs that receive stormwater or other fluids and their locations by latitude and longitude in decimal degrees
2. An estimate of vehicle trips per day for the area(s) drained by the UICs
3. An inventory of all UICs that discharge directly to groundwater
4. An inventory of all UICs within 500 feet of any water well and/or within the 2-year time-of-travel of a public water well
5. An inventory of all UICs that are prohibited by OAR 340-044-0015(2)
6. An inventory of all industrial and commercial properties with activities that have the potential to discharge to UICs that the City owns or operates

The City developed a summary of its UIC system in 2005 as a part of the City's UIC Stormwater Management Plan (HDR, 2005). This summary was used to conduct the preliminary system-wide assessment. For UICs identified as discharging directly to groundwater (item 3 above) or located within defined setback areas from water wells (item 4 above), the City is required to analyze potential impacts to groundwater.

4.1.1 Results

At this time, two UICs (UIC IDs 24027 and 44003) were identified that directly discharge to groundwater. Thirty-three UICs were identified that did not meet the required setback distance from water wells. Additionally, one UIC (UIC ID 24008) has minimal (< 1 foot) vertical separation distance to groundwater.

These 36 UICs (total) are identified as "at-risk" for purposes of this UIC risk evaluation. These "at-risk" UICs are shown in Appendix B, Figures 3 and 5. Designation as an "at-risk" UIC means that potential action by the City may be required, but UICs determined to be "at-risk" are not in direct violation of draft permit conditions.

4.1.2 Additional Data Needs

Based on current information, the system-wide assessment is not complete and additional "at-risk" UICs may be identified. Prior to submittal of a final system-wide assessment to DEQ, required with issuance of the City's UIC WPCF permit, the following information will need to be included/verified:

1. A complete water well location inventory and identification of UICs within those additional well setbacks.
2. Verification of the depth to groundwater for UICs with unknown depth per the City's 2005 UIC summary. Currently, a total of 32 UICs per the City's 2005 UIC summary have unknown depth.

4.2 GWPD Application

For those "at-risk" UICs located within a water well setback, one option to address the potential for groundwater contamination and address requirements of the draft UIC WPCF template is to conduct a protectiveness demonstration in order to show that the UICs do not impair groundwater quality or supply. To do this, a model is typically used to simulate the attenuation of stormwater pollutants in the subsurface.

An unsaturated zone GWPD model was developed for the City to simulate the vertical transport of pollutants in saturated soils. Results from the unsaturated zone GWPD include a minimum protective vertical separate distance to attenuate typical stormwater pollutants. Per the analysis, a minimum separation distance of 1 foot is recommended. Development of this unsaturated zone GWPD addresses the City's draft permit requirements related to those "at-risk" UICs within a water well setback.

4.3 UIC Risk Evaluation Results

Results from the preliminary system-wide assessment (Section 4.1) and GWPD (Section 4.2) were used to assess those identified "at-risk" UICs and determine whether retrofit or decommissioning would be required.

For the 33 UICs identified within a water well setback, results of the unsaturated zone GWPD indicate that a minimum of 1-foot vertical separation is required for groundwater protectiveness and pollutant attenuation. Of the 33 UICs designated as "at-risk" because of their setback distance to water wells, all 33 UICs appear to have greater than 1 foot of vertical separation and therefore, no retrofit or decommissioning of these UICs is necessary.

The draft UIC WPCF permit template does not prohibit UICs with limited vertical separation distance to groundwater. UICs with limited vertical separation distance to groundwater are problematic only if they are within a water well setback. The preliminary system-wide assessment (Section 4.1) identified three UICs with 1 foot or less vertical separation distance to groundwater. These UICs are not located within an identified water well setback, but the City's water well inventory is incomplete at this time. Therefore, these three UICs are still considered to be "at-risk."

Results of the UIC risk evaluation were discussed with the City at a meeting on October 25, 2012. Two of the three "at-risk" UICs (UIC IDs 24008 and 24027) are located within the Master Plan study area, and decommissioning of these UICs in conjunction with a water quality improvement CIP was requested. The other "at-risk" UIC (UIC ID 44003) is located outside of the study area. Although the water well inventory is incomplete, the location of this UIC would not likely be within a water well setback area. Therefore, retrofit or decommission of the UIC at this time was not proposed.

Table 4-1 summarizes the status of "at-risk" UICs considered for decommissioning in conjunction with a flood control or water quality CIP.

<table>
<tr><th colspan="6">Table 4-1. UIC Decommissioning CIP Locations</th></tr>
<tr><th>System number by outfall</th><th>UIC ID</th><th>Rationale for decommissioning</th><th>City feedback</th><th>CIP recommended? (Y/N)</th><th>CIP description</th></tr>
<tr><td>1</td><td>UIC 24008</td><td>Limited (< 1 foot) vertical separation distance to groundwater and incomplete well inventory at this time</td><td>• Periodic flooding identified in proximity of UICs
• Drainage area to UIC 24008 overlaps with drainage area to UIC 24027</td><td>Y</td><td rowspan="2">• Decommission.
• Due to UIC locations in close proximity, combine drainage areas into single water quality facility.</td></tr>
<tr><td>1</td><td>UIC 24027</td><td>No vertical separation distance to groundwater and incomplete well inventory at this time</td><td>• Periodic flooding identified in proximity of UICs
• Drainage area to UIC 24008 overlaps with drainage area to UIC 24027</td><td>Y</td></tr>
<tr><td>Unmodeled</td><td>44003</td><td>No vertical separation distance to groundwater and incomplete well inventory at this time</td><td>• Limited potential for identification of water wells in location
• Area is outside Master Plan study area</td><td>N</td><td>N/A</td></tr>
</table>

Section 5

Water Quality Retrofit Assessment

As part of this Plan and stormwater CIP development, an assessment and identification of water quality retrofits for inclusion in the CIP was conducted. Review and identification of water quality retrofits, including the definition of specific water quality retrofit projects and a timeline for implementation, are specific requirements of the City's reissued NPDES MS4 permit. Specific NPDES MS4 permit requirements (Schedule A.6.b) of the water quality retrofit assessment are listed below:

i. *Stormwater retrofit strategy statement and summary, including objectives and rationale*

ii. *Summary of current stormwater retrofit control measures being implemented, and current estimate of annual program resources directed to stormwater retrofits*

iii. *Identification of developed areas or land uses impacting water quality that are high-priority retrofit areas*

iv. *Consideration of new stormwater control measures*

v. *Preferred retrofit structural control measures, including rationale*

vi. *A retrofit control measure project or approach priority list, including rationale, identification, and map of potential stormwater retrofit locations where appropriate, and an estimated timeline and cost for implementation of each project and approach*

This section describes the objectives, methodology, final project identification (i.e., water quality retrofit list), and applicability to the City's NPDES MS4 permit requirement.

Water quality retrofit projects identified herein have been carried forward and coordinated with flood control CIP locations (identified in Section 3.4) and UIC decommissioning CIP locations (identified in Section 4.3) to develop a comprehensive project list to address stormwater quality and quantity management and NPDES MS4 permit compliance in the city (Section 6).

5.1 Objectives

The City's water quality retrofit strategy is to target high pollutant generating areas where existing stormwater treatment is currently limited, in order to make progress toward achieving TMDL pollutant load reduction and improve overall surface water quality conditions. Efforts will be focused on the use of infiltration-based facilities (e.g., vegetated infiltration basins, rain gardens, planters) to provide runoff volume reduction in addition to conventional treatment.

To the extent possible, water quality retrofit opportunity areas were identified in conjunction with existing system capacity deficiencies (Section 3) and UIC decommissioning needs (Section 4) to allow for the projects to address multiple objectives.

5.2 Methodology

Water quality opportunity areas were initially identified through a review of information from the City's GIS system including aerial photos, the location of existing water quality facilities, existing vacant areas, publically owned lands, existing and future condition land uses, storm system layout, topography, and locations where flood control or UIC decommissioning is required.

The City's stormwater collection and conveyance system discharges through 15 stormwater outfalls to Johnson Creek, Kellogg Creek, Mt. Scott Creek, and the Willamette River. Each of the 15 drainage systems was individually reviewed. The following steps were conducted to identify the initial opportunity areas for water quality retrofits.

Step 1 **Identify vacant lands.** Review of vacant lands was conducted to identify parcels where space may be available for siting of a new regional or local water quality facility. Publically owned vacant lands were prioritized. Vacant lands observed (based on aerial photographs) to be forested or riparian area were not considered to be a priority area, as such areas should be preserved.

Step 2 **Review land use.** High pollutant generating land uses (e.g., industrial, commercial) with high imperviousness values were prioritized for installation of a stormwater treatment facility.

Step 3 **Review existing water quality facilities.** Public water quality facilities within the city of Milwaukie include five regional detention ponds and multiple rain garden facilities installed as part of green street applications (Figure 2-5).

Regional detention ponds currently provide limited water quality benefits, as they were installed for flood control purposes only. Retrofit of these facilities may provide additional water quality benefit while treating a large contributing drainage area.

City-owned green street facilities treat area within the ROW only, as the City requires private development to treat and detain all runoff on site. These facilities are becoming more common in the city, but are limited in the size of the contributing drainage areas that would be addressed.

Existing detention pond facilities that have little water quality benefit were prioritized as water quality retrofit opportunities. Additionally, area not already treated by an existing water quality facility (e.g., green street) was prioritized for water quality retrofit. For purposes of TMDL pollutant load reduction estimates, more benefit is obtained by increasing the coverage of water quality facilities instead of applying multiple water quality facilities treating overlapping drainage areas.

Step 4 **Review proposed flood control/UIC decommissioning project needs.** The City of Milwaukie is coordinating its water quality retrofit assessment with the development of its updated Stormwater Master Plan. To the extent that a CIP can address multiple objectives, such CIP would be prioritized (see Section 7). Coordination is particularly beneficial for those flood control/pipe replacement projects isolated to the ROW, as new green street facilities (as currently used by the City) may be installed at the same time, resulting in schedule and cost efficiencies.

5.3 Water Quality Retrofit Assessment Results

This section presents the results of the water quality retrofit assessment, including a preliminary identification of water quality opportunity areas and selection of nine water quality retrofit opportunities requiring CIP development.

5.3.1 Initial Identification of Water Quality Opportunity Areas

In conjunction with the methodology described in Section 5.2, an initial water quality retrofit opportunity list was developed and reviewed with City staff at a workshop on October 25, 2012. During the workshop, project feasibility and practicability was discussed. Additional water quality opportunity areas identified by City staff were also discussed. Based on City feedback and, in some cases, field reconnaissance, a recommendation to include a CIP for the water quality opportunity area was made.

Table 5-1 summarizes the initially identified water quality opportunity area (by outfall number), the associated project descriptions, and feedback from City staff regarding feasibility. The CIP recommendation is also provided.

Table 5-1. Initial Water Quality CIP Opportunity Areas						
System number by outfall	Project name	Proposed project description	Project rationale	Coordination with identified flood control or UIC decommissioning projects?	City feedback	CIP recommended? (Y/N)
1	Willow Detention Pond Retrofit	Retrofit existing detention pond for water quality enhancement	• Pond collects a relatively large, untreated residential area. • Project may be coordinated with a flood control CIP.	Flood control: predicted flooding in segment JCD80a on Regents Drive	• Observed flooding is not due to a system capacity deficiency. No flood control CIP proposed for the area. • Pond access via easement through private property. Site visit confirms private fence may be barrier to access.	Y
1	Stanley-Willow UIC Decommis-sioning	Enhance existing Ball-Mitchell stormwater facility (in park)	• Existing facility provides little/no water quality benefit. • Facility may be used to collect and treat runoff associated with decommissioning the "at-risk" UICs (see Section 4)	UIC Decommissioning	• Current facility provides no flow control benefit and little water quality benefit (operates as a bioswale conveyance). • Area discharges downstream to Willow Detention Pond.	Y
3	Ochoco Detention Pond Retrofit	Retrofit existing detention pond for water quality enhancement	• Existing private pond functions as flood control only. • Pond collects high pollutant generating area (industrial land use) and discharges to Johnson Creek (existing TMDL).	No	Located on private property with limited adjacent space availability (developed industrial parcel).	N
3	Main Street Detention Pond Retrofit	Retrofit existing detention pond for water quality enhancement	• Existing public pond functions as flood control only. • Pond collects high pollutant generating area (industrial land use) and discharges to Johnson Creek (existing TMDL).	No	Surrounding vacant lands are privately held and this retrofit would require an upsize of the facility.	N
5	Monroe Street Green Street	Install rain gardens in the ROW along Monroe Street as part of the strategy to address capacity deficiencies at Meek Street	High pollutant load generating area (commercial/industrial land use).	Flood control: Meek Street flood control project	• Monroe Street recently paved. Not in City's best interest to dig up a recently improved street. • Consider use of detention ponds instead to help mitigate flows for the Meek Street project.	N
5	Meek Street Detention Facilities	Construct detention/water quality facility (ies) on publically owned, vacant parcels adjacent to the Meek Street flood control project	Facility may be used to minimize pipe upsize requirements associated with the Meek Street flood control project.	Flood control: Meek Street flood control project	Detention facility opportunity areas include public, vacant parcels at SE Campbell between 32nd and 34th Avenue and at Balfour in order to mitigate flows to the Roswell Detention Pond.	Y

Table 5-1. Initial Water Quality CIP Opportunity Areas

System number by outfall	Project name	Proposed project description	Project rationale	Coordination with identified flood control or UIC decommissioning projects?	City feedback	CIP recommended? (Y/N)
6	Washington Street Green Streets	Install rain gardens in the ROW along Washington Street as part of the strategy to address capacity deficiencies	High pollutant load generating area (commercial/industrial land use).	Flood control: predicted flooding along Washington Street in segments KC10b and KC30a	2004 MP identified the use of a 112 cartridge StormFilter. Green street application is preferred.	Y
12	Wister Way Retention Facility	Utilize existing, privately owned vacant parcel to install water quality and detention facility and minimize need for system capacity upgrades.	High pollutant load generating area (commercial/industrial land use).	Flood control: predicted flooding along International Way in segments MSB20d and MSB20e	• Site located adjacent to Highway 224. Expensive property acquisition. • Site grading would be difficult and limited space availability.	N
13	Railroad Avenue channel restoration	Restore existing channel	Channel has significant sediment deposition and non-native vegetation, limiting its capacity.	No	Channel is located adjacent to railroad ballast, which may present difficulties in conducting maintenance.	Y
13	UIC Decommis-sioning on Lloyd Street	Install a rain garden or bioswale to treat runoff associated with decommissioning of non operational UICs on Lloyd Street	Facility may be used to collect and treat runoff associated with decommissioning UICs identified as a maintenance concern (see Section 3)	UIC Decommissioning	Potential project locations include the City-owned parcel containing the drinking water reservoir at Harlow Street and Stanley or the ROW adjacent to the Linwood Elementary School entrance off Stanley Avenue.	Y
15	Furnberg Street Retention Facility Retrofit	Retrofit existing public pond to serve as a regional stormwater facility	• Large area currently outside the City limits would result in significant increase in flow if annexed into the City. • Project may be coordinated with a flood control CIP.	Flood control: predicted flooding along Hemlock Street at segment MSA100f, MSA100e, MSA100d, and MSA100c	• No anticipated schedule for annexation or development of upstream area. • Existing Furnberg Detention Facility may already mitigate potential flows.	N
Unmodeled	UIC 34076	Install additional UICs to alleviate localized flooding reported	Flooding is likely the result of too large contributing drainage area to the single UIC.	Flood control: reported flooding by City maintenance staff at 44th and Llewellyn	A CIP to address flooding in this area was proposed in the 2004 Master Plan (CIP-6).	Y
Unmodeled	UIC 24014	Install vegetated infiltration facility to reduce runoff volume to UIC	Existing grade and lack of nearby piped drainage system results in runoff pooling during rain events.	Flood control: reported flooding by City maintenance staff at 36th Avenue between King and Harvey Streets.	Vacant parcel and available ROW adjacent to UIC.	Y
Unmodeled	UIC 34094 and 34110	Install of soakage trench to reduce runoff volume to UIC	Existing grade and lack of nearby piped drainage system results in runoff pooling during rain events.	Flood control: reported flooding by City maintenance staff at 55th Avenue between King Street and Monroe Street.	An adjacent house currently sits below street grade and experiences flooding	Y

5.3.2 Water Quality CIP Locations

Review of initial water quality retrofit CIP opportunity areas with City staff resulted in the identification of the following nine water quality retrofit opportunities requiring CIP development (see Table 5-1 above):

1. Willow Detention Pond Retrofit
2. Stanley-Willow UIC Decommissioning
3. Meek Street Detention Facilities
4. Washington Street Green Streets
5. Railroad Avenue Channel Restoration
6. UIC Decommissioning on Lloyd Street
7. Unmodeled Area: UIC 34076 at 44th and Llewellyn
8. Unmodeled Area: UIC 24014 on 36th Avenue between King and Harvey Streets
9. Unmodeled Area: UIC 34094 and 34110 on 55th Avenue between King and Monroe Streets

The final water quality retrofit project list is contained in Section 6 (Table 6-1), as identified by those projects designated as a water quality project and retrofit project for the NPDES permit compliance.

Section 6

Capital Improvement Projects

This section identifies the flood control and water quality CIPs designed to address flooding (Section 3), UICs identified for decommissioning (Section 4), and water quality retrofit opportunities (Section 5). To the extent possible, CIPs were developed as integrated solutions to address multiple objectives (e.g., flood control, water quality, etc.).

6.1 Integrated CIP Development

Integrated CIP development refers to the selection and design of CIPs to address multiple objectives including flood control, regulatory requirements, and water quality improvements.

An integrated CIP development approach was used during the identification of the water quality retrofit CIP opportunity areas (as described in Section 5). Areas where flood control or UIC decommissioning was needed were prioritized for purposes of targeting a water quality retrofit CIP opportunity area.

As described in Section 3.4.2, a total of 12 flood control CIP locations were identified. As described in Section 4.3, two UICs requiring decommissioning were identified. As described in Section 5.3.2, a total of nine water quality CIP locations were identified. These flood control, UIC decommissioning, and water quality CIP locations were consolidated to reflect consistent contributing areas. CIP design concepts and approaches described in Sections 3, 4, and 5 were revisited during CIP integration to develop a formalized CIP design for each opportunity area.

A comprehensive summary of identified flood control, water quality, and UIC decommissioning CIPs is provided in Table 6-1. A total of 17 CIPs are identified. Consolidation of flood control, UIC decommissioning, and water quality retrofit CIP opportunity areas (where applicable) results in a single, multi-objective CIP. Table 6-1 includes a problem description and project description for each CIP. CIPs are sorted and named by system (outfall) number. Projects not affiliated with a specific system number are named as general (G) G1, G2, and G3.

Table 6-1 indicates whether the CIP addresses flood control, water quality, or UIC decommissioning, and specifies whether the CIP would qualify as a water quality retrofit for NPDES MS4 permit compliance.

Figure 6-1 at the end of this section shows the location of each CIP. Detailed CIP fact sheets are provided in Appendix C and include additional design detail, cost information, and a map locating the specific system improvements.

6.2 CIP Sizing and Design Assumptions

This section includes a summary of the CIP sizing and design criteria based on the type of system improvement proposed. System improvements include pipe upsizing and pipe replacement, vegetation and infiltration enhancement of existing detention ponds, installation of new detention facilities, installation of rain gardens or stormwater planters, and installation of UICs. Proposed CIPs may reflect a combination of system improvements.

Revised hydraulic results tables reflecting inclusion of system improvements for flow control (e.g., pipe replacement and detention facility installation) are included in Appendix D (Table D-1). Pipe conduits associated with a CIP are designated with a “C” prefix in Table D-1.

6.2.1 Pipe Installation

Pipe installation is required for 15 of the 17 CIPs. New and replaced pipes are sized to eliminate modeled system flooding for the peak (25-year) design storm event under future development conditions.

Design criteria outlined in the City's Public Works Standards: Section 2 for conventional (pipe, manhole) stormwater infrastructure were used for CIP design (see Section 3.3). Pipe improvements were evaluated using XP-SWMM to ensure that installation of the CIP (i.e., relief of the constriction) did not result in downstream flooding.

6.2.2 Detention Ponds

Two new detention ponds, associated with CIP 5-1, are proposed to mitigate flow to the downstream conveyance system. One of the detention ponds, located at SE Campbell, is sized solely to mitigate flow to the existing pipe system along Meek Street, allowing the existing pipe to be used as part of the CIP. The other detention pond, at Balfour, is sized to mitigate flow to the downstream system, which drains to System 3. The City's sizing criteria for detention ponds was not specifically adhered to, given the space and configuration limitations associated with application of the two ponds. Design of the new detention ponds includes installation of amended soil for improved infiltration for the Balfour facility and landscape plantings for both facilities to enhance treatment capabilities.

Two detention pond retrofits are proposed for water quality improvement: CIPs 1-1 and 1-2. CIP 1-1 includes installation of 18 inches of amended soil, 18 inches of drain rock, and water quality facility plantings along the pond bottom. The City of Portland's 2008 Stormwater Management Manual (2008 SWMM) (standard detail SW-140 for a water quality retention pond) was referenced for design criteria. CIP 1-2 includes enhancement of an existing detention feature to receive additional flow associated with UIC decommissioning. The existing detention feature is not a designed detention pond (intended to store and discharge flow at a set rate), but functions more as a drainage swale. Improvements to the facility are limited to water quality facility plantings along the facility bottom.

6.2.3 Rain Gardens and Planters

Rain gardens and planters were sized based on the City of Portland's simplified method, as documented in the 2008 SWMM, using a 6 percent sizing factor on the contributing impervious area. 2008 SWMM standard details SW-312 and SW-140 were referenced for applicable design criteria.

6.2.4 Underground Injection Controls

UICs were sized based on the 2008 SWMM, Exhibit 2-31.

6.3 Unit Cost Estimates for CIP Development

Unit cost information for construction elements of the CIP facilities was compiled from recent, local, planning and design projects for the City of Portland (2010), City of Eugene (2007), and Clean Water Services (2012). Specific material costs for pipes and structures were confirmed in the RS Means Construction Cost Data (2012).

Preliminary CIP cost estimates are based on the unit cost information for construction elements plus a 30 percent contingency. Engineering and permitting and construction administration costs are based on a general percentage of the total construction cost. Land acquisition and easement costs are not included in the estimates, as most projects proposed are located on City property or within the City ROW. Unit cost information and individual cost estimates for CIPs are included in Appendix E.

Table 6-1. Project Summary

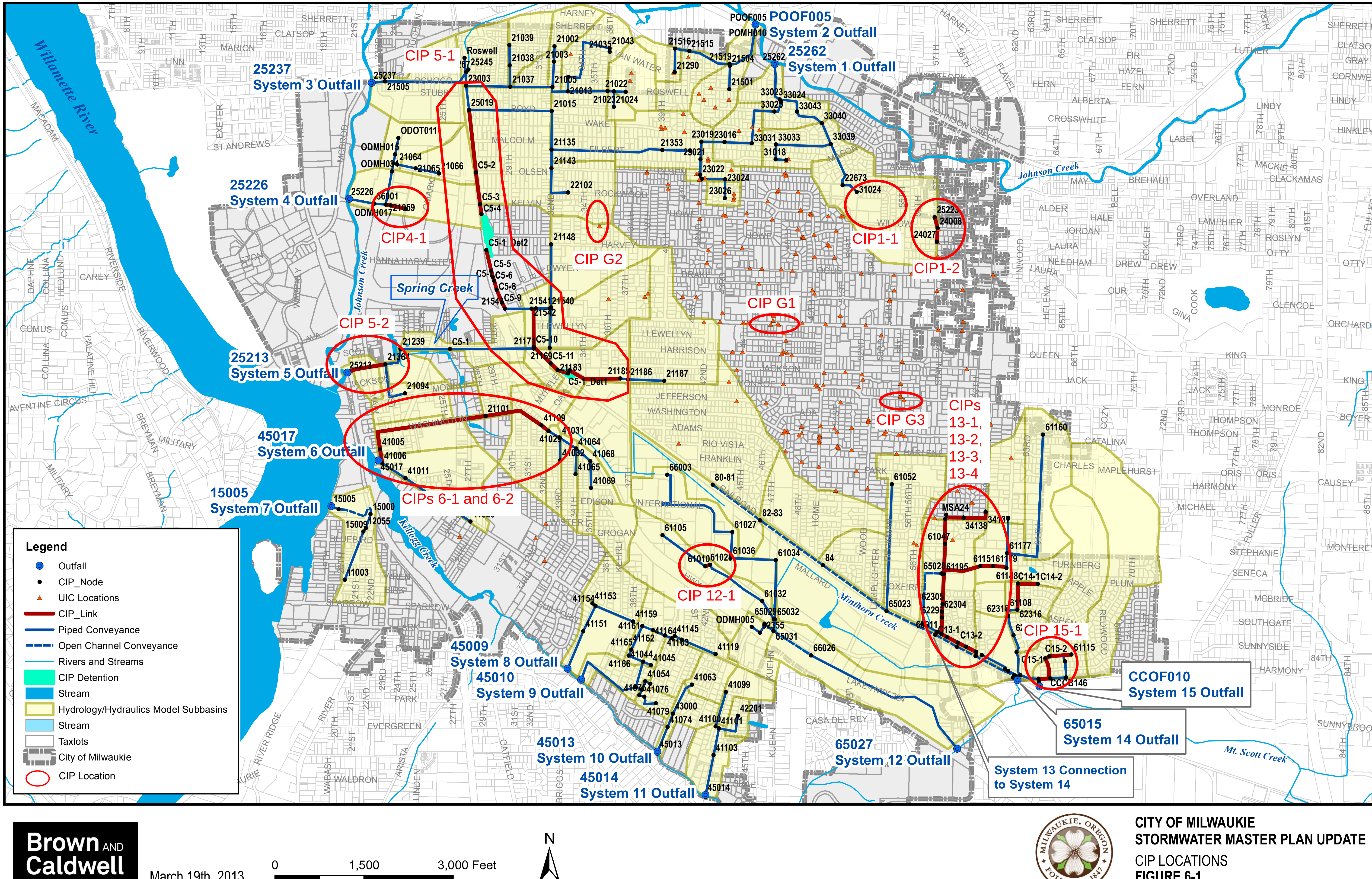
CIP No.	CIP type	CIP name	Proposed CIP location	Event(s) deficiency occurs	WQ retrofit for NPDES permit	Problem description	CIP description	Length of pipe installation, ft	Associated subbasins	Contributing drainage area, acres	Capital implementation cost total,$
System 1											
1-1	WQ	Willow Detention Pond Retrofit	55th Avenue, south of Firwood Street	Fut 25-yr	X	The existing Willow Detention Pond is located at the end of 55th Avenue, south of Firwood Street. The pond appears to drain approximately 15 acres of residential area in subbasin JCD80. As-built information on the pond inlet and outlet structure was not available at the time of this study; however, it is assumed that the pond was designed for flood control and was not constructed with water quality features.	Enhance treatment capability of existing pond through vegetation enhancement and promoting infiltration. Predicted flooding is not expected due to the pipe configuration and receiving wetland downstream of the facility. The CIP was not designed to address the model predicted flooding. No asbuilt information for Willow Pond currently available. May consider future upsizing of existing Willow Detention Pond to address larger contributing drainage area associated with subbasins JCD90 and JCD91 (from UIC # 24008 and #24027) (see CIP 1-2), but not included as part of this project.	0	JCD80, JCD90, JCD91	64.8	68,600
1-2	WQ, UIC	Stanley-Willow UIC Decommissioning	Stanley Avenue and Ball-Mitchell Park		X	Upstream UICs 24008 and 24027 have limited vertical separation distance and were identified as “at-risk” per the City's GWPD.	Route drainage area from UIC 24008 and 24027 to existing Ball-Mitchell stormwater facility. Add vegetation to bottom of pond to enhance treatment capability of through filtration.	425	JCD90, JCD91	3.9	100,200
System 4											
4-1	FC	Main Street at Milport Road	East of McLoughlin Blvd at Milport Road	Fut 10-yr, Fut 25-yr		The 12" x 24" elliptical CMP associated with modeled conduit JCB10d (21265-21059) and the 18" concrete pipe associated with modeled conduit JCB10c (21059-ODMH017) are under capacity, causing predicted flooding along JCB10d between SE Main and SE Omark and in the parking lot between an industrial building and SE Main Street.	This CIP includes replacement of JCB10d and JCB10c from MH21265 to MHODMH017 with 380 feet of 30" concrete pipe using the same upstream and downstream invert elevations. Replacement of model conduits JCB10d and JCB10c (defined by the upstream node to downstream node number) includes replacement of seven manholes.	380	JCB10	35.2	241,200
System 5											
5-1	FC, WQ	Meek Street	Monroe Street to Meek Street along Railroad	Exst 10-yr, Exst 25-yr, Fut 10-yr, Fut 25-yr	X	The majority of System 5 is predicted to flood. CIP-2 in the 2004 Master Plan recommended routing a bypass for flow from Monroe Street, east of SE 32nd Ave to an ODOT system to the north of Meek Street. This CIP was partially constructed on Meek Street, but not connected to the storm drain system.	The Meek Street pipe system was constructed in 2005 with inadequate slope to maintain the existing concept per CIP-2 from the 2004 MP. This CIP includes replacement the existing pipe system down Monroe from 37th Avenue to 32nd Avenue. A detention facility at SE Campbell between 32nd Avenue and 34th Avenue is designed to mitigate peak flow north to the Meek Street pipe system. Installation of new pipe from Harrison to Meek along Murphy is required. New pipe will also be installed to parallel existing railroad tracks from Meek to Balfour. Installation of a new manhole west of 32nd Avenue to separate Harrison Street system; installation of a new manhole at Meek and 32nd Avenue to separate 32nd Avenue system north of Meek (to new Meek Street pipe) and south of Meek (to new pipe parallel to railroad) is required. Vegetated area at Balfour will be utilized for water quality, flow control, and infiltration. A 36" pipe was designed to connect flow to the Roswell Detention Facility.	5,171	JCA60, JCA52, JCS51, JCA50, JCA41, JCA40, JCA30	188.2	3,088,200
5-2	FC	Harrison Street Outfall	Harrison Street from outfall to 21st Ave	Exst 10-yr, Exst 25-yr, Fut 10-yr, Fut 25-yr		CIP 5-2 addresses the majority of the flooding along Harrison Street following construction of CIP 5-1. Following installation of CIP 5-1 in the model, flooding is still predicted on 21st Street along modeled conduit JCA20 (21094_21364) and on Harrison Street along modeled conduits JCA30a (21239_21364) and JCA30b (CIP5_1_21239). In conjunction with light rail expansion, the existing 18" down Harrison will be replaced with a 24" pipe from 23rd to 26th Avenue (not reflected in the cost of this CIP).	This CIP includes replacement of 696 feet of existing 24" concrete pipe with 696 feet of 36" along JCA10, from MH21364 to the outfall at Johnson Creek, which extends 40 feet from MH25213.	696	JCA40, JCA30, JCA20, JCA10	60.8	619,400

Table 6-1. Project Summary

CIP No.	CIP type	CIP name	Proposed CIP location	Event(s) deficiency occurs	WQ retrofit for NPDES permit	Problem description	CIP description	Length of pipe installation, ft	Associated subbasins	Contributing drainage area, acres	Capital implementation cost total,$
System 6											
6-1	FC	Washington Street	Washington Street from 28th Ave to Kellogg Lake	Exst 10-yr, Exst 25-yr, Fut 10-yr, Fut 25-yr		The 21" pipe KC10a on Main Street near Kellogg Lake and the 18" pipes KC10b and KC30a along Washington Street are under capacity, which is causing predicted flooding along Washington Street between Main Street and Hwy 224.	This CIP includes replacement of 239 feet of existing 21" concrete pipe with 30" pipe along KC10a from MH41005 to 41006. This CIP also includes replacement of 3,312 feet of existing 18" concrete pipe with 24" concrete pipe along KC10b from MH41109 to MH41005 and KC30a from MH41029 to 41109.	3551	KC10, KC30, KC40, KC50, KC60	130.9	1,804,100
6-2	WQ	Washington Green Streets	Washington Street from 23rd Ave to Oak St	NA	X	The contributing area from Washington Street is a high pollutant load generating area. Currently, the TriMet Light Rail Project is installing green street features to provide water quality treatment from Main Street to 23rd Avenue along Washington Street.	This CIP includes an extension of the green street features being installed by TriMet, from 23rd to Oak along Washington Street. The installation of CIP 6-1 will involve pipe replacement and repaving a portion of Washington Street, which provides an opportunity to complete green street features while the pipe replacement construction is occurring.	NA	KC30, KC40, KC50, KC60	62.6	511,300
System 12											
12-1	FC	International Way and Wister Street	International Way and Wister Street	Fut 25-yr		The 24" MSB20d at International Way is negatively sloped and MSB20e and MSB20d are under capacity, resulting in predicted flooding along MSB20e.	Replace 80 feet of existing 24" pipe with a 48" pipe along MSB20d from MH61010 to MH61028.	80	MSB20, MSB21	64.6	90,000
System 13											
13-1	UIC, WQ, FC	UIC decommissioning on Lloyd	4 UICs along Lloyd Street and Stanley Avenue from Lloyd Street to Railroad Avenue	NA	X	UIC 34155 (west of Stanley Avenue) and UIC 34137 (intersection of 60th Avenue and Lloyd Street) are not operational, as reported by City maintenance staff. The City has attempted to retrofit these UICs; however, the UICs are still not functioning properly and flooding has been reported at the intersection of Lloyd Street and Stanley Avenue. UICs 34167 and 34138 are also included in this CIP due to their location along Lloyd Street.	This CIP includes decommissioning of four UICs and installation of 787 feet of new 12"HDPE pipe along Lloyd Street from 60th Avenue west of Stanley Avenue. Along Stanley Avenue from Lloyd Street to Railroad Avenue, this CIP also includes replacement of existing concrete pipe with 1,314 feet of new 12"HDPE pipe and 499 feet of 18"HDPE pipe. To address water quality of new contributing area previously captured by UICs, this CIP includes installation of a rain garden. The preliminary (for purposes of the CIP cost estimate) is the ROW adjacent to the Linwood Elementary School entrance off Stanley Avenue. As an alternative, the City-owned parcel containing the drinking water reservoir at Harlow Street and Stanley may be considered.	2895	MSA22, MSA23, MSA24, MSA25, MSA26, MSA27	49.0	793,700
13-2	FC	Linwood Avenue	At Linwood Elementary School between Linwood Avenue and Stanley Avenue	Exst 10-yr, Exst 25-yr, Fut 10-yr, Fut 25-yr	Possible	The 15" concrete pipe associated with modeled conduit MSA80b (61148_61179) and the 18" concrete pipes associated with modeled conduits MSA80a (61179_61151) and MSA70d (61151_65028) are under capacity. Flooding is predicted along this reach, which is located between Linwood Avenue and Stanley Ave on the Linwood Elementary School grounds. Capacity limitations are caused by undersized piping along MSA80b, MSA80a and MSA70d.	This CIP includes conducting a planning level study to initially evaluate options for flood mitigation. Pipe surcharge currently discharges to existing raingarden, ball fields, and open channel area. A planning study would to consider cost benefit options for partial pipe reconstruction and day lighting to channel for water quality and flood control, full pipe replacement, and grant funding opportunities for school district to expand existing onsite raingardens. The CIP cost estimate assumes full pipe replacement. Replace 683 feet of existing 18" pipe with 30" pipe along MSA70d. Replace 186 feet of existing 18" pipe with 24" pipe along MSA80a. Replace 243 feet of existing 15" pipe with 24" pipe along MSA80b.	1112	MSA90, MSA80, MSA70	85.2	469,700
13-3	FC	Railroad Avenue at Stanley	Railroad Avenue, near Stanley Avenue	Exst 25-yr, Fut 10-yr, Fut 25-yr		The 18" culvert associated with modeled conduit MSA20a (66023_65033) is under capacity, causing predicted flooding along MSA20a over Railroad Avenue. Flooding was also observed during a storm event on November 19 and 20, 2012.	This CIP includes abandoning the existing culvert under Stanley Avenue at Railroad Avenue. Flow from the channel on the west side of Stanley is routed through two new 60 feet parallel reinforced concrete culverts (18" diameter) under Railroad Avenue on the west side of Stanley in the same location as the existing 18" culvert. Flow from Stanley as described in CIP 13-1 is routed through a new 660 feet of 18" HDPE pipeline on the north side of Railroad Avenue from a new manhole at 62296 to a new manhole at C13-4. Intermediate manholes are placed to accept flows from Maple Street, Ash Street, and Grove Street. At new MHC13-4, flow is routed through a new 60 feet of reinforced concrete culvert (18" diameter), where this CIP outfalls to the Railroad Avenue channel.	840	MSA22, MSA23, MSA24, MSA25, MSA26, MSA27, MSA31, MSA70, MSA71, MSA72, MSA80, MSA90	134.2	357,300
13-4	WQ, Maint	Railroad Avenue Channel	Existing conveyance ditch along Railroad Avenue	NA	X	The existing channel along the north side of Railroad Avenue receives drainage from a large portion of the City. Limited maintenance appears to be conducted, which is limiting the ability of the channel to convey stormwater and provide water quality benefit.	This CIP includes targeted maintenance activities including hand removal of non-native vegetation, sediment removal, and replanting activities. Maintenance activities to focus on approximately 2,000 linear feet of channel between Wood Avenue and Grove Loop.	2000	MSA250, MSA230, MSA220, MSA215, MSA210	200.7	52,900

Table 6-1. Project Summary

CIP No.	CIP type	CIP name	Proposed CIP location	Event(s) deficiency occurs	WQ retrofit for NPDES permit	Problem description	CIP description	Length of pipe installation, ft	Associated subbasins	Contributing drainage area, acres	Capital implementation cost total,$
System 14											
14-1	FC	Plum and Apple Street	Apple Street near Plum Drive and extending to Juniper Street near Aspen Street	NA		Localized flooding is reported by City maintenance staff.	This CIP includes installation of 780 feet of new 12" HDPE pipe from the intersection of Plum and Apple Street to Juniper and Aspen Street	780	MSA61	9.6	180,100
System 15											
15-1	FC	Hemlock Street to Harmony Road	Intersection of Hemlock Street and Sequoia Avenue, then along an easement to Harmony Road	Exst 10-yr, Exst 25-yr, Fut 10-yr, Fut 25-yr		The 15" pipe segments associated with model conduits MSA100f (61115_61118), MSA100e (61118_CCCB154), and the 18" pipe segments associated with model conduits MSA100d (CCCB154_CCCB146), MSA100c (CCCB146_CCCB159), and MSA100b (CCCB159_CCCB161) are under capacity, causing predicted flooding from Hemlock Street, through private property to Harmony Way.	This CIP includes replacement and realignment of this pipeline, which is currently located in backyards from Hemlock Street to Harmony Way. When constructed, this pipeline will replace a portion of the pipeline along Cedarcrest Drive, from Hemlock Street to Harmony Way. The diameter and elevation of this pipe is currently unknown, and should be identified in the design stage. Design assumptions assume area outside UGB is brought in and no flow control provided (would change need for 30" pipe).	1036	MSA100, MSA110	116	560,600
Other											
G1	FC, UIC	47th and Llewellyn	UIC at intersection of Llewellyn and 47th Avenue	NA		The City reports flooding at the intersection of 47th and Llewellyn, near UIC 34076.	Due to the existing grade and lack of a nearby piped drainage system, this CIP includes the installation of additional UICs with associated inlets and inlet lead lines to alleviate flooding at 47th and Llewellyn.	150	NA	8	155,600
G2	WQ, FC, UIC	36th near King	UIC on 36th Ave around Dwyer Street	NA	X	The City reports flooding between King Road and Harvey Street, at UIC 24014. This UIC is located at a low point in elevation along 36th Avenue, between Harvey and King.	Due to the existing grade and lack of a nearby piped drainage system, this CIP includes installation of a raingarden or other stormwater feature to minimize flow into the UIC and provide water quality treatment of contributing impervious area within the ROW.	NA	NA	3.5	104,600
G3	FC, UIC	Flooding on 55th Ave between King Street and Monroe Street	Street flooding along 55th Avenue	NA	X	The city reports flooding at the intersection along 55th Avenue, possibly due to a non functioning UICs. House currently sits below grade, which is the source of the complaints. No curbed streets in area and flat grade.	Utilize available, ROW area to install a soakage trench with perforated pipe to minimize flow into UIC.	125	NA	2.5	23,000



Brown AND Caldwell

March 19th, 2013

CITY OF MILWAUKIE
STORMWATER MASTER PLAN UPDATE

CIP LOCATIONS
FIGURE 6-1

Section 7

CIP Prioritization

This section summarizes the process that the City used to prioritize identified CIPs in order to schedule project funding.

7.1 Prioritization Criteria and Scoring

As described in Section 6, a total of 17 CIPs were developed to address flood control, UIC decommissioning needs, and water quality retrofit within the city of Milwaukie. To the extent possible, individual CIPs were developed to address multiple objectives (e.g., addressing flood control, regulatory compliance, water quality improvement, etc.).

During a CIP prioritization workshop December 21, 2012, City maintenance and engineering staff selected applicable criteria with which to evaluate the multi-objective CIPs (see Table 7-1). Identified criteria include historical/persistent problems, flooding/safety issues, regulatory compliance, ongoing maintenance, water quality improvement, project concurrence, and system sustainability. Identified criteria can overlap (e.g., water quality improvements would also address regulatory compliance). Such overlap created an indirect weighting of project scores based on the City's deemed importance of the overlapping issue.

Each project is scored on a scale of 1 to 3. In order to ensure consistency in how scores were selected, general conditions were defined for each score under each criterion. Table 7-1 summarizes the resulting prioritization criteria and scoring guidelines.

Table 7-1. Multi-Objective CIP Prioritization Criteria and Scoring

Criterion	Scoring definition		
	Score = 3	Score = 2	Score = 1
Historical problem/ persistent problem	Identified as a CIP in the 2004 Stormwater Master Plan		New CIP per the 2012 system evaluation
Flooding issue/safety concern	• Significant hazard or threat to public safety or property • Flooding currently observed	• Potential hazard or threat to public safety or property • Future flooding potential	No safety hazard addressed with CIP
WPCF/NPDES Permit requirements	Addresses NPDES Permit requirement related to (water quality) retrofits or addresses need to decommission at-risk UICs		Does not directly address WPCF/NPDES permit requirements
Ongoing maintenance need	• City staff frequently responds to citizen complaints in the area • Frequent onsite response/ maintenance required	• City staff occasionally responds to citizen complaints in the area • Onsite response/maintenance not always required	City staff does not maintain facility outside of typical maintenance cycle
Water quality improvement	Facility installation will directly reduce TMDL/303(d) pollutants to receiving water bodies	• Facility installation may improve water quality, but is not designed specifically for water quality improvement	CIP does not address water quality control

Table 7-1. Multi-Objective CIP Prioritization Criteria and Scoring			
Criterion	Scoring definition		
	Score = 3	Score = 2	Score = 1
Concurrence	Required pre-requisite or preliminary project for other prioritized CIPs	CIP construction may occur in conjunction with other CIP construction efforts (wastewater, roadway)	CIP construction scheduling would not impact or be impacted by other stormwater or infrastructure projects
Sustainability	CIP would provide long-term benefits (aesthetics, livability, etc.)		CIP would address immediate need but may not enhance or improve over the long term

City maintenance staff and City engineering staff independently evaluated each CIP and scored based on criteria identified in Table 7-1. Raw scores from both maintenance and engineering staff are provided in Table 7-2. Project scores were relatively consistent between departments for most criteria. Score variability is primarily observed for the water quality improvement and sustainability criteria. Maintenance staff and engineering staff scores were added for all criteria to result in an overall CIP score.

Table 7-2. Raw CIP Scoring[a]																
CIP number	CIP name	Overall score	Criteria													
			Historical problem/ persistent problem		Flooding issue/ safety concern		WPCF/ NPDES permit requirements		Ongoing maintenance need		Water quality improvement		Concurrence		Sustainability	
			EGR	MNT	EGR	MNT	EGR	MNT	EGR	MNT	EGR	MNT	EGR	MNT	EGR	MNT
1-1	Willow Detention Pond Retrofit	23	1	1	1	1	3	3	1	1	3	2	1	1	3	1
1-2	Stanley-Willow UIC Decommissioning	21	1	1	1	1	3	3	1	1	1	2	1	1	3	1
4-1	Main Street at Milport Road	17	3	1	2	1	1	1	1	1	1	1	1	1	1	1
5-1	Meek Street	31	3	3	3	3	3	1	2	3	3	1	2	1	2	1
5-2	Harrison Street Outfall	30	2	3	3	3	1	3	2	2	1	2	3	2	2	1
6-1	Washington Street	21	3	3	2	1	1	1	1	1	1	2	1	2	1	1
6-2	Washington Green Streets	27	1	1	1	1	3	3	1	1	3	3	1	2	3	3
12-1	International Way and Wister	15	1	1	2	1	1	1	1	1	1	1	1	1	1	1
13-1	UIC Decommissioning on Lloyd	36	3	3	3	3	3	3	3	3	2	2	1	2	2	3
13-2	Linwood Elementary	25	3	2	2	2	2	2	1	1	1	2	1	3	2	1
13-3	Railroad Avenue at Stanley	29	3	2	3	3	1	1	3	2	1	1	3	3	2	1
13-4	Railroad Avenue	26	1	1	3	3	2	1	3	2	2	1	2	2	2	1

Table 7-2. Raw CIP Scoring[a]

CIP number	CIP name	Overall score	Criteria													
			Historical problem/ persistent problem		Flooding issue/ safety concern		WPCF/ NPDES permit requirements		Ongoing maintenance need		Water quality improvement		Concurrence		Sustainability	
			EGR	MNT	EGR	MNT	EGR	MNT	EGR	MNT	EGR	MNT	EGR	MNT	EGR	MNT
	Channel															
14-1	Apple Storm Improvements	28	3	3	3	3	1	1	3	3	1	2	1	1	2	1
15-1	Hemlock Street	18	1	1	2	3	1	1	1	1	1	2	1	1	1	1
G1	47th and Llewellyn	23	1	1	3	3	1	1	3	3	1	1	1	1	2	1
G2	36th near King Road	25	1	1	3	3	2	1	3	3	2	1	1	1	2	1
G3	55th near Monroe Street	25	1	1	3	3	2	1	3	3	2	1	1	1	2	1

[a]Scoring under the EGR was completed by City engineering staff; scoring under the MNT columns was completed by City maintenance staff.

7.2 Project Prioritization and Final CIP Priority Ranking

Based on the project scoring (Table 7-2 above), CIPs were scored and ranked. Initial ranking results identified that a majority of the more expensive, longer-duration projects received the highest scores whereas some lower-cost, shorter-duration projects received lower scores. This does not accurately reflect the City's objective and overall project priority. Additionally, some projects that should be scheduled or conducted concurrently had variable scores such that if project scheduling was established directly on the raw scores, the projects would not be constructed at the same time.

City staff reviewed the initial ranking and adjusted it as follows:

1. CIP 13-1 (UIC Decommissioning on Lloyd) is currently scheduled, per the City's existing CIP, to be constructed in 2013/2014. CIP 13-1 is directly upstream of CIP 13-3 and 13-4. Due to project constructability and cost implications, CIP 13-3 and 13-4 rankings were adjusted to reflect construction of all three CIPs at the same time.
2. CIPs G1, G2, and G3 are relatively low-cost projects that were identified by maintenance staff due to the frequency that unscheduled maintenance required in those project locations. Although the projects would not alleviate a widespread problem or address a large contributing drainage area, these projects are considered "low-hanging fruit" that could alleviate maintenance requirements for the City and be more easily scheduled and implemented due to their cost.
3. CIP 6-2 (Washington Street Green Streets) was initially scored and ranked as a higher-priority project. Construction of this project would be most cost-effective if scheduled with the Washington Street pipe replacement project (CIP 6-1), a high-cost and lower-scoring project. Therefore, the ranking of CIP 6-2 was adjusted to reflect construction concurrently with CIP 6-1.

The final CIP priority ranking is provided in Table 7-3. For comparison, the project rank by score is also listed. High-priority projects and associated project costs were used in the development and analysis of the stormwater utility fee (see Section 8.2).

Table 7-3. CIP Priority Ranking

Priority ranking	Ranking by score	CIP no.	CIP name	Overall score	Estimated cost, $	Combined score (by criteria)						
						Historical problem/ persistent problem	Flooding issue/ safety concern	WPCF/NPDES permit requirements	Ongoing maintenance need	Water quality improvement	Con-currence	Sustain-ability
1	1	13-1	UIC Decommissioning on Lloyd	36	793,700	6	6	6	6	4	3	5
2	4	13-3	Railroad Avenue at Stanley[a]	29	357,300	5	6	2	5	2	6	6
3	7	13-4	Railroad Avenue Channel[a]	26	52,900	2	6	3	5	3	4	3
4	2	5-1	Meek Street	31	3,088,200	6	6	4	5	4	3	3
5	3	5-2	Harrison Street Outfall	30	619,400	5	6	4	4	3	5	3
6	5	14-1	Apple Storm Improvements	28	180,100	6	6	2	6	3	2	3
7	8	G2	36th near King Road	25	104,600	2	6	3	6	3	2	3
8	8	G3	55th near Monroe Street	25	23,000	2	6	3	6	3	2	3
8	8	13-2	Linwood Elementary	25	469,700	5	4	4	2	3	4	3
10	11	1-1	Willow Detention Pond Retrofit	23	68,600	2	2	6	2	5	2	4
10	11	G1	47th and Llewellyn	23	155,600	2	6	2	6	2	2	3
				High-priority project cost:	5,913,100							
12	13	1-2	Stanley-Willow UIC Decommissioning	21	100,200	2	2	6	2	3	2	4
12	13	6-1	Washington Street	21	1,804,100	6	3	2	2	3	3	2
12	6	6-2	Washington Green Streets[b]	27	511,300	2	2	6	2	6	3	6
15	15	15-1	Hemlock Street	18	560,600	2	5	2	2	3	2	2
16	16	4-1	Main Street at Milport Road	17	241,200	4	3	4	2	3	2	2
17	17	12-1	International Way and Wister	15	90,000	2	3	2	2	2	2	2
				Total project cost:	9,220,500							

[a]*Due to project concurrence issues and project cost savings, these CIPs are recommended for construction in conjunction with CIP 13-1.*

[b]*Due to concurrence with anticipated construction of CIP 6-1, this project was prioritized in accordance with the priority schedule for CIP 6-1.*

Section 8

CIP Implementation

Staffing resources and current stormwater utility funding were assessed to determine whether adjustments to staffing and/or funding levels are needed in order to implement the Plan and associated CIPs. Staffing needs, proposed capital expenditures, and ongoing operational costs were considered in the evaluation of the stormwater utility fee and system development charges (Section 8.2).

8.1 Staffing Analysis

Stormwater staffing levels were evaluated to determine staffing implications associated with new regulatory requirements (i.e., the City's reissued NPDES MS4 permit and pending UIC WPCF permit) and proposed CIPs developed under this Plan.

8.1.1 Background

A total of 5.25 full-time employees (FTE) are currently funded out of the stormwater utility. Staff is responsible for overall stormwater system maintenance and select regulatory compliance activities including illicit discharge investigations, stormwater monitoring, and maintenance activity tracking. Maintenance staff includes 0.5 FTE stormwater supervisor, 4.0 FTE utility workers, and a 0.5 FTE utility specialist. An additional 0.25 FTE is allocated for summer/part-time help.

Engineering staff are currently funded out of the general fund although their time is partially spent on stormwater work. Regulatory support and CIP engineering activities (e.g., project management, design support) in support of this Plan will also be required of engineering staff; therefore, engineering staff was also included in the staffing analysis.

8.1.2 Assumptions

As part of the Plan development, interviews were conducted with maintenance and engineering staff related to their individual job responsibilities, time sheet accounting, overall time management, and observed issues and limitations implementing their assignments. Such information was used to verify which activities to include in the staffing analysis and how such activities are implemented (maintenance or engineering).

The City of Milwaukie uses the Hanson system to track stormwater assets and also log maintenance staff hours. An annual report (from March 2011 to March 2012) was provided from the City. This information was used in conjunction with the City's 2011–12 NPDES MS4 annual report, which documents the amount of maintenance (e.g., miles of road swept, number of catch basins cleaned, etc.) conducted. Both sources were used to developed approximate maintenance staff time estimates for various activities.

Detailed CIP cost estimates (Appendix E) include estimates for engineering/permitting activities and construction administration activities required for implementation of the CIP. For each CIP, City engineering staff is expected to require 100 percent of the construction administration budget and, depending on the CIP, a portion of the engineering/permitting budget if surveying or design services are expected to be done in-house.

Table 8-1 summarizes the maintenance and engineering cost assumptions used for the staffing analysis.

Table 8-1. Maintenance and Engineering Time Summary		
Activity	Staff resource	Average time calculation
Erosion control plan review	Maintenance	4 hours per application
Infrastructure inspection/maintenance	Maintenance	• 1 hour per sediment manhole • 0.5 hour per manhole • 1.5 hour per UIC or drywell • 20 feet per hour for culvert or ditch maintenance • 181 feet per hour for culvert or ditch inspections • 60 feet per hour for pipe cleaning
Stormwater facility inspections	Maintenance	4 hours per facility for inspections
Rain garden maintenance	Maintenance	50 ft_2 per hour
Development plan review	Engineering	20 hours per application

8.1.3 Analysis

Appendix F contains the staffing summary tables and results of the staffing analysis for maintenance (Table F-1) and engineering (Table F-2).

The staffing analysis assumes that existing City staff is able to implement the current stormwater program (pre-2012 conditions). Additional activities not previously conducted by the City under current staffing were used to create the estimates of additional staff resource needs. Additional activities include those associated with the reissued NPDES MS4 permit (in 2012), the pending UIC WPCF permit (in 2013), and implementation of the proposed CIPs (from 2013–23).

Specific activities and time assumptions are listed in Tables F-1 and F-2 by program activity. Because the City's NPDES MS4 permit and the City's pending UIC WPCF permit are on a 5-year permit cycle, a 5-year staff projection is shown. Time spent on regulatory activities is estimated over that 5-year permit term. Generally, activities are conducted annually so use of a 5-year term does not factor into the estimate of additional staffing needs.

Implementation of the proposed CIP is projected over a 10-year period. For maintenance staff, all associated CIP maintenance activities are calculated as an annual average. For engineering staff, to allow for staffing needs to be assessed on an annual basis, the total cost of the engineering/permitting and construction administration services for each CIP was averaged over a 10-year period. Because project duration varies and project scheduling is not finalized, this allowed for engineering staff needs to be estimated on an annual basis. The total cost was converted to an FTE assuming a cost of $100,000 per FTE. Averaging the engineering staff CIP cost over a 10-year period is a conservative estimate. Construction schedules will shift necessary staff resources across the 10-year CIP period and use of an average staff time estimate may be too low or too high in some years.

8.1.4 Results

Based on the staffing analysis, it is estimated that over the next 5 years, between 1.4 and 2.1 additional FTE will be required for maintenance staff and approximately 0.7 additional FTE will be required for engineering staff. These estimates are based on available documentation from the City, documented assumptions, and assumes completion of the proposed CIP over the 10-year planning period.

8.2 Utility Rate Study

In conjunction with development of the Plan, a review of the City's current stormwater utility fee and SDCs was conducted. A detailed technical memorandum describing the rate evaluation is provided in Appendix G.

The existing fee structures for the City were adopted in 2004. As of March 2013, the City's current stormwater utility fee is$11.44 per effective stormwater unit (ESU) and the current SDC is$1,184 per ESU.

8.2.1 Level of Service Estimates

Using CIP cost information (Section 6), results of the staffing analysis (Section 8.1) and estimated operating expenditures, four LOS categories were developed to establish funding schemes over the 10-year CIP program. Description of the LOS categories is provided in Table 8-2. LOS considered staffing, capital projects, maintenance, regulatory compliance, proactive system replacement, and vehicle replacement. Current LOS assumes no increase in staffing, capital projects, or deviation from existing program implementation. The proactive LOS assumes completion of all proposed CIPs within the 10-year planning period and proactive system replacement activities.

Table 8-2. Funding Analysis Level of Service

Level	Staffing	Capital projects	Maintenance	TMDL/NPDES	System replacement	Vehicle replacement
Current	• Meet historical programmatic needs. • No additional staff.	Implement CIPs 13-1 and 5-1.	Maintain conventional system components	Meet historical permit needs.	System replacement when failure occurs.	• Replace existing vactor truck with dedicated funds. • Continue allocating$50,000/yr for vehicle replacement (assumes 12-year replacement cycle).
Minimum	• Meet programmatic needs per newly issued permits. • Address CIPs 13-1, 13-3, 13-4, and 5-1.	Implement CIPs 13-1, 13-3, 13-4 and 5-1.	Maintain conventional and vegetated system components (e.g., rain gardens)	• Meet new permit requirements related to system evaluation and monitoring. • Conduct water quality retrofits in accordance with permit requirements.	System replacement when failure occurs.	• Replace existing vactor truck with dedicated funds. • Continue allocating$50,000/yr for vehicle replacement (assumes 12-year replacement cycle).
Recommended	• Meet new programmatic needs per newly issued permits. • Address higher-priority CIPs.	Construct higher-priority CIPs over a 10-year planning horizon. Construct all CIPs in the future.	Maintain conventional and vegetated system components (e.g., rain gardens)	• Meet new permit requirements related to system evaluation and monitoring. • Conduct water quality retrofits in accordance with permit requirements.	• Replace 50% of the system over a 75-year period. • Assume$390,000/yr for replacement activities starting in FY 2017/18.	• Replace existing vactor truck with dedicated funds. • Continue allocating$50,000/yr for vehicle replacement (assumes 12-year replacement cycle).

Table 8-2. Funding Analysis Level of Service						
Level	Staffing	Capital projects	Maintenance	TMDL/NPDES	System replacement	Vehicle replacement
Proactive	• Meet new programmatic needs per newly issued permits • Address all CIPs.	Construct all CIPs over a 10-year planning horizon.	Maintain conventional and vegetated system components (e.g., rain gardens)	• Meet new permit requirements related to system evaluation and monitoring. • Conduct water quality retrofits in accordance with permit requirements.	• Replace 100% of the system over a 75-year period. • Assumes$780,000/yr for replacement activities starting in FY 2017/ 18.	• Replace existing vactor truck with dedicated funds. • Allocate$85,714/yr for vehicle replacement (assumes 7-year rotating cycle).

8.2.2 Rate Evaluation and Recommendation

Debt and cash funding scenarios were analyzed for each of the four LOS categories identified above. Results of the analysis are summarized in Table 8-3.

Table 8-3. Stormwater Utility Fee Evaluation (provided by FCS Group as part of the 2012 Plan development)										
Scenario	FY 2012–13	FY 2013–14	FY 2014–15	FY 2015–16	FY 2016–17	FY 2017–18	FY 2018–19	FY 2019–20	FY 2020–21	FY 2021–22
Current, cash	$11.44	$11.94	$12.47	$13.02	$13.58	$14.16	$14.73	$14.73	$14.73	$14.73
Minimum, debt	$11.44	$11.89	$12.35	$12.83	$13.33	$13.85	$14.35	$14.85	$15.37	$15.91
Minimum, cash	$11.44	$12.32	$13.27	$14.29	$15.39	$16.58	$17.84	$17.84	$17.84	$17.84
Recommended, debt	$11.44	$12.39	$13.41	$14.50	$15.69	$16.98	$17.49	$18.00	$18.52	$19.06
Recommended, cash	$11.44	$12.61	$13.89	$15.31	$16.86	$18.56	$20.43	$22.50	$23.40	$24.31
Proactive, debt	$11.44	$12.82	$14.36	$16.09	$18.02	$20.18	$22.54	$25.18	$28.10	$31.36
Proactive, cash	$11.44	$13.05	$14.89	$16.99	$19.39	$22.10	$25.20	$28.73	$32.69	$36.19

Over the 10-year CIP planning period, stormwater utility rate increases ranged from$3.30 (for the current LOS and cash funding scenario) to$25.00 (for the proactive LOS and cash funding scenario). Changes to the calculation assessment methodologies resulted in a reduction in SDC from $1,184/ESU to $765/ESU.

A meeting was held with the Citizen Utility Advisory Board (CUAB) on March 6, 2013. Discussion of the various funding scenarios and modeling assumptions was held. The CUAB moved forward with the decision to propose the “recommended” LOS and the cash funding rate structure.

Section 9

Limitations

This document was prepared solely for City of Milwaukie in accordance with professional standards at the time the services were performed and in accordance with the contract between City of Milwaukie and Brown and Caldwell dated March 20, 2012. This document is governed by the specific scope of work authorized by City of Milwaukie; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by City of Milwaukie and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

Appendix A: Hydrologic and Hydraulic Results Tables

Table A-1. Hydrologic Input Data and Results

					Impervious Area (%)			Existing Subbasin Peak Flow (cfs)						Future Subbasin Peak Flow (Cfs)					
Subbasin	Inlet Node	Area (acre)	Average Slope (%)	Pevious Curve Number	Existing Land Use	Future Land Use	Percent Increase	Water Quality Peak Flow (cfs)	2yr 24hr Peak Flow (cfs)	5yr 24hr Peak Flow (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	100yr 24hr Peak Flow (cfs)	Water Quality Peak Flow (cfs)	2yr 24hr Peak Flow (cfs)	5yr 24hr Peak Flow (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	100yr 24hr Peak Flow (cfs)
SYSTEM #1																			
JCD80	31024	60.9	0.9%	54.0	29.4	37.0	26%	0.0	1.2	2.4	4.7	7.9	13.1	0.0	1.5	4.0	7.2	10.9	16.8
JCD70	31019	20.6	0.7%	59.0	28.0	35.0	25%	0.0	0.5	1.8	3.2	4.8	7.4	0.0	1.0	2.6	4.2	6.0	8.8
JCD62	23026	5.2	0.5%	59.2	28.0	35.0	25%	0.0	0.1	0.5	0.8	1.2	1.9	0.0	0.3	0.7	1.1	1.5	2.2
JCD61	23021	7.7	0.2%	59.2	28.0	35.0	25%	0.0	0.2	0.7	1.2	1.8	2.8	0.0	0.4	1.0	1.6	2.2	3.3
JCD50	33023	19.6	1.4%	60.0	28.8	37.0	28%	0.0	0.5	1.6	2.7	4.1	6.2	0.0	1.0	2.3	3.7	5.2	7.5
JCD60	33031	17.5	0.3%	59.0	28.0	35.0	25%	0.0	0.4	1.0	1.8	2.7	4.1	0.0	0.6	1.4	2.3	3.3	4.9
SYSTEM #2																			
JCD40	21501	15.3	0.6%	59.0	28.6	36.0	26%	0.0	0.4	1.4	2.5	3.7	5.6	0.0	0.8	2.0	3.2	4.6	6.7
JCD20	21290	7.3	0.9%	53.0	28.0	35.0	25%	0.0	0.1	0.2	0.5	0.9	1.5	0.0	0.2	0.4	0.8	1.2	1.9
JCD30	21515	14.1	0.4%	57.0	28.0	35.0	25%	0.0	0.3	0.9	1.9	2.9	4.5	0.0	0.5	1.5	2.5	3.7	5.5
JCD10	21519	5.8	2.0%	57.0	39.5	51.0	29%	0.0	0.3	0.7	1.1	1.6	2.3	0.0	0.6	1.1	1.6	2.1	2.9
SYSTEM #3																			
JCC70	21021	16.3	0.5%	58.0	29.3	37.0	26%	0.0	0.4	0.9	1.7	2.6	4.0	0.0	0.6	1.4	2.3	3.3	4.9
JCC80	21024	4.0	0.2%	59.0	34.1	42.0	23%	0.0	0.1	0.3	0.5	0.7	1.0	0.0	0.2	0.4	0.6	0.9	1.2
JCC60	21035	22.8	0.4%	56.0	28.0	35.0	25%	0.0	0.5	1.0	1.9	3.0	4.9	0.0	0.6	1.5	2.6	4.0	6.0
JCC50	21002	13.5	0.3%	50.0	32.9	36.0	9%	0.0	0.2	0.4	0.8	1.4	2.3	0.0	0.3	0.5	1.0	1.6	2.7
JCC30	21039	14.5	0.8%	49.0	44.2	44.2	0%	0.0	0.4	1.0	1.7	2.6	3.9	0.0	0.4	1.0	1.7	2.6	3.9
JCC40	21037	5.4	0.8%	49.0	44.0	44.0	0%	0.0	0.1	0.4	0.8	1.1	1.7	0.0	0.1	0.4	0.8	1.1	1.7
JCC120	31003	28.2	0.2%	59.0	28.2	35.0	24%	0.0	0.7	1.7	3.0	4.6	7.1	0.0	1.0	2.4	4.0	5.7	8.5
JCC110	22102	24.3	0.7%	51.0	29.2	37.0	27%	0.0	0.4	0.7	1.3	2.4	4.2	0.0	0.5	1.2	2.3	3.6	5.8
JCC100	21015	27.9	0.5%	58.0	29.8	37.0	24%	0.0	0.7	1.9	3.4	5.2	8.0	0.0	1.1	2.8	4.6	6.6	9.7
JCC90	25019	62.0	1.3%	50.0	32.5	40.0	23%	0.0	1.1	2.0	4.2	7.4	12.8	0.0	1.4	3.7	7.0	10.9	17.1
JCC20	21267	19.6	1.8%	54.0	44.6	44.6	0%	0.0	1.2	2.8	4.4	6.1	8.9	0.0	1.2	2.8	4.4	6.1	8.9
JCC10	21505	36.2	0.7%	54.0	52.0	75.0	44%	0.1	3.6	7.0	10.3	13.9	19.2	0.7	9.8	14.8	19.0	23.4	29.6
SYSTEM #4																			
JCB10	21265	35.2	0.5%	64.0	52.0	75.0	44%	0.2	6.0	10.1	13.8	17.7	23.4	1.5	11.6	16.6	20.9	25.3	31.4
JCB20	21066	15.6	0.5%	50.0	52.0	75.0	44%	0.0	0.9	2.0	3.1	4.3	6.2	0.2	3.2	5.0	6.5	8.1	10.3
JCB30	ODOT011	15.6	0.3%	49.0	52.0	75.0	44%	0.0	1.0	2.3	3.6	5.0	7.2	0.2	3.8	5.8	7.6	9.4	12.0
SYSTEM #5																			
JCA52	21148	37.1	1.0%	49.8	36.9	58.0	57%	0.0	0.8	1.8	3.7	6.0	9.8	0.1	3.5	6.9	10.0	13.4	18.5
JCA40	21169	5.9	0.3%	59.2	60.0	75.0	25%	0.0	1.3	4.0	6.9	10.2	15.2	0.2	4.9	8.9	12.7	16.8	22.9
JCA51	21169	35.4	1.0%	52	37.4	54.0	44%												
JCA60	21187	49.1	0.7%	48.8	42.4	44.8	6%	0.0	1.2	4.0	7.4	11.2	17.1	0.0	1.4	4.9	8.4	12.4	18.5
JCA41	21184	22.0	1.0%	55.5	44.6	63.0	41%	0.0	1.5	3.3	5.2	7.2	10.2	0.1	4.0	6.5	8.9	11.3	14.9
JCA50	21171	10.0	0.3%	59.2	50.9	75.0	47%	0.0	1.2	2.2	3.2	4.2	5.7	0.3	2.9	4.3	5.5	6.7	8.4
JCA30	21239	28.7	0.7%	59.2	53.9	69.0	28%	0.1	4.1	7.2	10.0	13.1	17.5	0.3	7.1	10.8	14.1	17.5	22.4
JCA20	21094	19.0	0.9%	59.2	55.2	71.0	29%	0.1	2.3	4.0	5.6	7.3	9.8	0.3	4.1	6.2	8.1	10.0	12.7
JCA10	21364	7.2	0.5%	59.2	48.2	68.0	41%	0.0	0.8	1.5	2.2	3.0	4.1	0.1	1.8	2.7	3.6	4.5	5.7

Table A-1. Hydrologic Input Data and Results																			
					Impervious Area (%)			Existing Subbasin Peak Flow (cfs)						Future Subbasin Peak Flow (Cfs)					
Subbasin	Inlet Node	Area (acre)	Average Slope (%)	Pevious Curve Number	Existing Land Use	Future Land Use	Percent Increase	Water Quality Peak Flow (cfs)	2yr 24hr Peak Flow (cfs)	5yr 24hr Peak Flow (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	100yr 24hr Peak Flow (cfs)	Water Quality Peak Flow (cfs)	2yr 24hr Peak Flow (cfs)	5yr 24hr Peak Flow (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	100yr 24hr Peak Flow (cfs)
SYSTEM #6																			
KC60	41069	14.1	1.1%	56.0	40.1	40.1	0%	0.0	0.7	1.8	2.9	4.2	6.1	0.0	0.7	1.8	2.9	4.2	6.1
KC50	41065	9.4	1.2%	54.0	42.7	42.7	0%	0.0	0.5	1.2	1.9	2.8	4.1	0.0	0.5	1.2	1.9	2.8	4.1
KC40	41032	8.1	1.1%	54.0	44.0	44.0	0%	0.0	0.5	1.1	1.8	2.5	3.6	0.0	0.5	1.1	1.8	2.5	3.6
KC30	41109	31.0	0.8%	56.0	50.2	51.0	2%	0.1	3.2	6.3	9.1	12.2	16.9	0.1	3.4	6.4	9.3	12.5	17.1
KC10	21101	34.6	0.7%	53.0	54.6	69.0	26%	0.1	3.8	7.2	10.4	13.9	19.1	0.3	7.4	11.8	15.7	19.7	25.6
KC20	41020	33.7	1.1%	51.0	52.9	66.0	25%	0.1	2.7	5.7	8.5	11.7	16.3	0.2	5.7	9.5	13.0	16.6	21.9
SYSTEM #7																			
WRA30	11003	28.8	1.5%	59.0	44.5	44.5	0%	0.1	2.7	5.4	8.0	10.9	15.2	0.1	2.7	5.4	8.0	10.9	15.2
SYSTEM #8																			
MSC11	41153	18.7	1.5%	54.0	27.0	35.0	30%	0.0	0.3	0.7	1.8	3.0	5.0	0.0	0.4	1.5	2.8	4.2	6.5
MSC10	41159	16.4	1.5%	54.0	35.0	42.0	20%	0.0	0.4	1.3	2.4	3.7	5.7	0.0	0.8	2.0	3.3	4.7	7.0
SYSTEM #9																			
MSC40	41119	27.7	1.5%	50.0	28.0	35.0	25%	0.0	0.4	0.8	1.3	2.7	5.0	0.0	0.5	1.1	2.4	4.1	6.8
MSC30	41045	3.0	1.2%	56.0	28.0	35.0	25%	0.0	0.1	0.1	0.3	0.5	0.8	0.0	0.1	0.2	0.4	0.6	0.9
MSC60	41055	12.7	0.9%	57.0	28.0	35.0	25%	0.0	0.3	0.9	1.7	2.6	4.1	0.0	0.4	1.4	2.3	3.4	5.0
MSC50	41079	5.0	0.8%	59.0	28.0	35.0	25%	0.0	0.1	0.3	0.6	0.9	1.4	0.0	0.2	0.5	0.8	1.2	1.7
MSC20	41048	12.1	1.5%	59.0	29.0	36.0	24%	0.0	0.3	1.0	1.8	2.8	4.2	0.0	0.6	1.5	2.4	3.4	5.0
SYSTEM #10																			
MSC80	41063	10.3	1.2%	54.0	28.0	35.0	25%	0.0	0.2	0.4	1.0	1.7	2.8	0.0	0.2	0.8	1.5	2.3	3.6
MSC70	43000	10.8	0.8%	59.0	28.0	35.0	25%	0.0	0.3	0.7	1.3	1.9	3.0	0.0	0.4	1.0	1.7	2.4	3.6
SYSTEM #11																			
MSC100	42201	5.0	0.5%	59.0	28.0	35.0	25%	0.0	0.1	0.3	0.6	0.9	1.4	0.0	0.2	0.5	0.8	1.1	1.7
MSC110	41099	10.2	1.5%	55.0	28.0	35.0	25%	0.0	0.2	0.4	0.8	1.3	2.1	0.0	0.2	0.6	1.1	1.7	2.6
MSC90	41101	16.3	1.0%	59.0	28.0	35.0	25%	0.0	0.4	1.2	2.3	3.5	5.4	0.0	0.7	1.8	3.0	4.4	6.4
SYSTEM #12																			
MSB30	66003	43.3	0.4%	51.0	52.0	75.0	44%	0.1	3.5	7.4	11.2	15.4	21.7	0.6	11.3	17.2	22.4	27.7	35.2
MSB20	61105	51.6	1.7%	50.0	43.0	59.0	37%	0.0	1.5	4.2	7.8	12.1	18.8	0.2	5.2	10.4	15.4	21.0	29.2
MSB21	61105	13.0	2.1%	53	24.3	35.0	44%												
MSC120	ODMH005	13.4	1.6%	49.0	42.0	55.0	31%	0.0	0.3	0.9	1.6	2.5	4.0	0.0	0.9	2.0	3.0	4.2	5.9
MSB10	66026	66.2	1.4%	55.0	50.0	68.0	36%	0.2	5.0	10.2	15.3	20.8	29.1	0.5	12.0	19.1	25.5	32.2	41.7

Table A-1. Hydrologic Input Data and Results

					Impervious Area (%)			Existing Subbasin Peak Flow (cfs)						Future Subbasin Peak Flow (Cfs)					
Subbasin	Inlet Node	Area (acre)	Average Slope (%)	Pevious Curve Number	Existing Land Use	Future Land Use	Percent Increase	Water Quality Peak Flow (cfs)	2yr 24hr Peak Flow (cfs)	5yr 24hr Peak Flow (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	100yr 24hr Peak Flow (cfs)	Water Quality Peak Flow (cfs)	2yr 24hr Peak Flow (cfs)	5yr 24hr Peak Flow (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	100yr 24hr Peak Flow (cfs)
SYSTEM #13																			
MSA90	61160	37.2	0.7%	68.0	28.0	35.0	25%	0.1	2.5	5.3	7.9	10.7	15.0	0.1	3.4	6.4	9.2	12.2	16.8
MSA80	61159	20.8	0.4%	49.0	28.0	35.0	25%	0.0	0.3	0.6	0.9	1.5	2.9	0.0	0.4	0.7	1.4	2.4	4.0
MSA70	61151	27.2	0.6%	57.0	30.0	38.0	27%	0.0	0.6	1.7	3.1	4.9	7.6	0.0	1.0	2.7	4.5	6.4	9.5
MSA20	62296	42.9	0.7%	50.0	29.3	37.0	26%	0.0	0.7	1.3	2.4	4.7	8.6	0.0	0.9	2.2	4.5	7.3	11.8
MSA10	61052	46.9	0.6%	50.0	28.0	35.0	25%	0.0	0.7	1.3	2.1	3.7	6.9	0.0	0.9	1.8	3.4	5.6	9.4
MSA250	84	20.7	0.9%	44.8	22.4	35.0	56%	0.0	0.2	0.4	0.6	0.8	1.9	0.0	0.3	0.6	1.2	2.5	4.5
MSA230	82-83	41.1	0.9%	57.6	24.3	38.0	56%	0.0	0.8	1.7	3.4	5.7	9.2	0.0	1.5	3.9	6.4	9.2	13.6
MSA220	80-81	25.0	1.1%	48.0	41.6	41.6	0%	0.2	5.9	10.2	14.7	20.9	33.9	1.0	10.3	15.4	22.4	31.9	46.8
MSA210	80-81	79.6	1.4%	41	28.2	36.0	28%												
MSA215	80-81	34.3	0.8%	60	56.8	74.0	30%												
SYSTEM #14																			
MSA60	62318	7.7	0.4%	50.0	28.0	35.0	25%	0.0	0.3	0.5	1.0	2.1	3.7	0.0	0.3	0.8	1.9	3.0	5.0
MSA61	62318	9.6	0.4%	50	28.0	35.0	25%												
MSA50	62325	6.5	0.4%	39.2	24.0	38.0	58%	0.0	0.0	0.1	0.1	0.2	0.3	0.0	0.1	0.2	0.2	0.6	1.1
MSA40	62179	5.8	1.6%	50.0	40.0	51.0	28%	0.0	0.1	0.4	0.8	1.2	1.9	0.0	0.4	0.9	1.3	1.8	2.6
MSA30	62290	12.7	1.6%	49.0	41.9	52.0	24%	0.0	0.3	0.8	1.5	2.4	3.7	0.0	0.7	1.6	2.5	3.5	5.0
MSA240	65039	91.9	1.1%	58.4	41.0	73.0	78%	0.2	4.9	11.2	17.5	24.4	35.0	1.5	20.8	31.2	40.3	49.7	62.9
SYSTEM #15																			
MSA100	61115	49.8	0.7%	67.0	28.7	36.0	25%	0.3	6.2	12.8	19.5	26.8	37.9	0.4	8.4	16.0	23.3	31.1	42.8
MSA110	61115	66.3	0.6%	67	28.3	36.0	27%												
SUBBASINS MODELED FOR HYDROLOGY ONLY																			
MSC200	MSC200	32.1	1.4%	49.6	22.4	35.0	56%	0.0	0.4	0.7	1.1	1.8	3.8	0.0	0.6	1.2	2.5	4.2	7.1
MSC210	MSC210	33.9	2.1%	49.6	22.4	35.0	56%	0.0	0.4	0.8	1.2	2.1	4.6	0.0	0.7	1.3	3.0	5.2	8.7
MSC220	MSC220	9.6	2.5%	49.6	22.4	35.0	56%	0.0	0.1	0.2	0.3	0.6	1.3	0.0	0.2	0.4	0.8	1.4	2.4
MSA21	MSA21	2.7	0.5%	48.8	28.0	35.0	25%	0.0	0.0	0.1	0.1	0.2	0.5	0.0	0.1	0.1	0.2	0.4	0.7
MSA22	MSA22	2.1	0.8%	48.8	28.0	35.0	25%	0.0	0.0	0.1	0.1	0.2	0.4	0.0	0.0	0.1	0.2	0.3	0.6
MSA23	MSA23	1.5	0.5%	48.8	28.0	35.0	25%	0.0	0.0	0.0	0.1	0.2	0.3	0.0	0.0	0.1	0.1	0.2	0.4
MSA24	MSA24	29.6	0.5%	48.8	28.1	35.0	25%	0.0	0.4	0.8	1.3	2.5	4.9	0.0	0.6	1.1	2.3	4.0	6.8
MD20	MD20	13.8	0.4%	54.5	28.0	35.0	25%	0.0	0.3	0.5	1.2	2.0	3.3	0.0	0.3	0.9	1.8	2.7	4.2
MD40	MD40	5.5	0.6%	58.9	28.0	35.0	25%	0.0	0.1	0.5	0.9	1.3	2.0	0.0	0.3	0.7	1.1	1.6	2.3
MD60	MD60	9.1	0.9%	53.3	30.4	40.0	32%	0.0	0.2	0.4	0.9	1.5	2.5	0.0	0.3	0.9	1.5	2.2	3.4
MD70	MD70	4.6	0.1%	59.2	34.4	51.0	48%	0.0	0.2	0.6	0.9	1.3	2.0	0.0	0.6	1.1	1.5	2.0	2.8
MD80	MD80	6.7	1.2%	49.7	28.0	35.0	25%	0.0	0.1	0.2	0.3	0.7	1.3	0.0	0.1	0.3	0.6	1.1	1.8
MD90	MD90	7.3	0.4%	59.1	30.3	41.0	35%	0.0	0.2	0.7	1.2	1.7	2.6	0.0	0.5	1.1	1.7	2.3	3.3
MD100	MD100	5.3	0.9%	50.1	28.0	35.0	25%	0.0	0.1	0.1	0.3	0.6	1.1	0.0	0.1	0.2	0.5	0.9	1.4
MD110	MD110	87.3	0.3%	60.0	30.0	35.0	17%	0.1	2.6	7.6	13.2	19.4	29.1	0.1	3.9	9.8	15.8	22.5	32.7
MD120	MD120	60.0	0.8%	52.6	41.5	45.0	8%	0.0	2.0	6.4	10.8	15.8	23.5	0.1	3.0	7.8	12.6	17.8	25.8

Table A-2. Hydraulic Evaluation of Existing and Future Land Use Scenario for the Milwaukie Storm Drainage System																								
	Node						Invert Elevation (ft)		Ground Elevation (ft)		Exst 10 yr Max Water Surface Elevation (ft)		Exst 25 yr Max Water Surface Elevation (ft)		Fut 25 yr Max Water Surface Elevation (ft)		Fut 25 yr Max Water Surface Elevation (ft)							
Structure Name	US	DS	Length (ft)	Structure Size/Type	Capacity (cfs)	Slope (%)	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	Exst 10 yr Max Flow (cfs)	Exst 25 yr Max Flow (cfs)	Fut 10 yr Max Flow (cfs)	Fut 25 yr Max Flow (cfs)	When Hydraulically Deficient
SYSTEM #1																								
JCD62c	23026	23024	303	36-in Dia	29.5	0.19%	149.79	149.20	157.6	157.9	150.4	150.4	150.5	150.5	150.5	150.5	150.6	150.6	0.8	1.2	1.0	1.5	
JCD62b	23024	23023	388	36-in Dia	10.7	0.03%	149.90	149.80	157.9	155.6	150.4	150.1	150.5	150.1	150.5	150.1	150.6	150.2	0.7	1.1	1.0	1.5	
JCD62a	23023	23022	70	36-in Dia	35.8	0.29%	149.30	149.10	155.6	155.9	149.7	149.7	149.8	149.8	149.8	149.8	149.9	149.9	0.7	1.1	1.0	1.5	
JCD61b	23022	23021	250	36-in Dia	13.3	0.04%	149.00	148.90	155.9	159.9	149.7	149.7	149.8	149.8	149.8	149.7	149.9	149.8	0.7	1.2	1.0	1.5	
JCD61a	23021	23019	303	36-in Dia	56.9	0.53%	149.30	147.70	159.9	163.3	149.7	149.3	149.8	149.5	149.7	149.4	149.8	149.6	1.8	2.9	2.5	3.7	
JCD60c	23019	23016	318	36-in Dia	10.6	0.03%	147.08	147.00	163.3	169.2	149.3	149.3	149.5	149.5	149.4	149.4	149.6	149.6	1.5	2.8	2.4	3.6	
JCD60b	23016	33031	461	36-in Dia	36.6	0.30%	148.90	147.50	169.2	160.1	149.3	147.9	149.5	148.0	149.4	148.0	149.6	148.1	1.4	2.7	2.2	3.6	
JCD60a	33031	33025	908	36-in Dia	20.9	0.07%	144.14	143.50	160.1	154.0	145.2	143.7	145.4	143.8	145.3	143.8	145.5	143.8	2.9	4.3	3.8	5.4	
JCD50e	33025	33024	263	24-in Dia	103.2	14.79%	143.50	104.62	154.0	110.0	143.7	105.5	143.8	105.6	143.8	105.5	143.8	105.7	2.9	4.3	3.8	5.4	
JCD50d	33024	33023	51	24-in Dia	16.7	0.39%	104.62	104.42	110.0	111.0	105.5	105.4	105.6	105.5	105.5	105.5	105.7	105.6	2.9	4.3	3.8	5.4	
JCD80b.1	31024	22673	287	18-in Dia	5.5	0.20%	119.33	118.76	124.0	120.7	120.5	119.5	121.4	119.7	122.8	119.7	124.1	120.7	4.7	7.9	7.2	9.0	Fut 25-yr
JCD80b-rd	31024	22673	287	12-in Roadway		1.17%	124.00	120.65	124.0	120.7							124.1	120.7	0.0	0.0	0.0	2.9	
JCD80a.1	22673	33039	774	18-in Dia	10.4	1.14%	118.76	109.90	120.7	114.3	119.5	111.1	119.7	111.6	119.7	111.5	120.7	112.1	4.7	7.9	7.2	10.1	Fut 25-yr
JCD80a-rd	22673	33039	774	12-in Roadway		0.82%	120.65	114.30	120.7	114.3							120.7	114.3	0.0	0.0	0.0	0.5	
JCD70d.1	31019	31018	177	18-in Dia	8.7	0.80%	152.92	151.50	156.0	156.0	153.6	152.6	153.7	152.9	153.7	152.8	153.9	153.2	3.2	4.8	4.2	6.0	
JCD70d-rd	31019	31018	177	12-in Roadway		0.00%	156.00	156.00	156.0	156.0	152.6	152.6	152.9	152.9	152.8	152.8	153.2	153.2	0.0	0.0	0.0	0.0	
JCD70c	31018	33033	242	18-in Dia	2.3	0.03%	151.50	151.42	156.0	156.0	152.6	152.1	152.9	152.3	152.8	152.2	153.2	152.4	3.2	4.8	4.2	6.0	
JCD70b	33033	33039	924	24-in Dia	56.5	4.43%	151.08	110.13	156.0	114.3	151.4	111.1	151.5	111.6	151.4	111.5	151.5	112.1	3.2	4.8	4.2	6.0	
JCD70a.1	33039	33040	370	24-in Dia	7.6	0.08%	109.72	109.42	114.3	114.0	111.1	110.3	111.6	110.6	111.5	110.5	112.1	110.7	6.5	10.5	9.5	13.5	
JCD70a-rd	33039	33040	370	12-in Roadway		0.08%	114.30	114.00	114.3	114.0									0.0	0.0	0.0	0.0	
JCD50c	33040	33043	494	24-in Dia	16.8	0.64%	109.17	106.00	114.0	113.5	110.1	106.8	110.4	107.0	110.4	107.0	110.7	107.2	6.5	10.5	9.5	13.5	
JCD50b	33043	33023	476	36-in Dia	45.3	0.33%	106.00	104.42	113.5	111.0	106.8	105.4	107.0	105.5	107.0	105.5	107.2	105.6	6.5	10.5	9.5	13.4	
JCD50a	33023	25262	663	48-in Dia	116.4	0.47%	104.42	101.29	111.0	107.0	105.4	105.3	105.5	105.3	105.5	105.3	105.6	105.3	11.6	18.5	16.6	23.7	
SYSTEM #2																								
JCD20	21290	21516	413	18-in Dia	9.8	0.63%	142.89	140.30	150.0	151.5	143.1	140.5	143.2	140.6	143.2	140.6	143.3	140.6	0.5	0.9	0.8	1.2	
JCD30b	21516	21515	253	21-in Dia	15.6	1.11%	140.30	137.50	151.5	149.0	140.5	137.8	140.6	137.9	140.6	137.9	140.6	138.0	0.5	0.9	0.8	1.2	
JCD30a	21515	21519	726	24-in Dia	32.8	2.47%	137.50	119.60	149.0	128.0	137.8	120.2	137.9	120.3	137.9	120.3	138.0	120.4	2.0	3.4	3.0	4.5	
JCD40b	21501	21504	398	18-in Dia	28.0	5.05%	139.70	119.60	148.0	130.0	140.0	120.4	140.1	120.6	140.0	120.5	140.1	120.7	2.5	3.7	3.2	4.6	
JCD40a	21504	21519	31	24-in Dia	1.0	0.00%	119.60	119.60	130.0	128.0	120.4	120.2	120.6	120.3	120.5	120.3	120.7	120.4	2.5	3.7	3.2	4.6	
JCD10c	21519	POMH010	967	24-in Dia	34.0	2.62%	119.60	94.27	128.0	104.5	120.2	94.9	120.3	94.9	120.3	94.9	120.4	95.0	5.4	8.4	7.6	11.0	
JCD10b	POMH010	POOF005	24	24-in Dia	47.1	6.25%	94.30	92.80	104.5	104.5	94.9	94.8	94.9	94.8	94.9	94.8	95.0	94.8	5.4	8.4	7.6	11.0	
SYSTEM #3																								
JCC60c	21035	21043	46	18-in Dia	7.2	-0.54%	141.83	142.08	148.0	148.0	142.7	142.5	142.8	142.7	142.8	142.6	143.0	142.8	-1.9	-3.0	-2.6	-4.0	
JCC60b	21043	21025	1402	24-in Dia	16.2	0.60%	142.08	133.70	148.0	142.0	142.5	134.2	142.7	134.3	142.6	134.3	142.8	134.4	1.9	3.0	2.6	4.0	
JCC60a	21025	21013	243	30-in Dia	23.2	0.37%	133.70	132.80	142.0	139.5	134.2	133.7	134.3	133.9	134.3	133.8	134.4	134.0	1.9	3.0	2.6	3.9	
JCC70	21021	21023	206	15-in Dia	7.9	1.75%	147.30	143.70	154.0	152.5	147.7	144.6	147.8	144.9	147.8	144.8	147.9	145.2	1.7	2.6	2.3	3.3	
JCC80	21024	21023	257	15-in Dia	5.0	0.70%	145.50	143.70	151.7	152.5	145.8	144.6	145.8	144.9	145.8	144.8	145.9	145.2	0.5	0.7	0.6	0.9	
JCC60e	21023	21022	104	15-in Dia	1.9	0.10%	143.70	143.60	152.5	152.0	144.6	144.0	144.9	144.1	144.8	144.1	145.2	144.2	2.1	3.2	2.9	4.1	
JCC60d	21022	21013	676	18-in Dia	12.3	1.60%	143.60	132.80	152.0	139.5	144.0	133.7	144.1	133.9	144.1	133.8	144.2	134.0	2.1	3.2	2.9	4.1	
JCC50c	21013	21005	337	36-in Dia	33.8	0.30%	132.80	131.80	139.5	142.5	133.7	132.2	133.9	132.3	133.8	132.3	134.0	132.4	4.0	6.2	5.5	8.1	
JCC50b	21002	21003	257	15-in Dia	3.6	0.35%	138.90	138.00	143.0	144.0	139.4	138.3	139.6	138.3	139.5	138.3	139.6	138.4	0.8	1.4	1.0	1.6	
JCC50a	21003	21005	415	15-in Dia	9.3	1.49%	138.00	131.80	144.0	142.5	138.3	132.2	138.3	132.3	138.3	132.3	138.4	132.4	0.8	1.4	1.0	1.6	
JCC40	21005	21037	699	36-in Dia	114.7	3.44%	131.80	107.80	142.5	117.0	132.2	108.2	132.3	108.3	132.3	108.3	132.4	108.4	4.8	7.6	6.5	9.7	
JCC30a	21038	21037	354	24-in Dia	27.4	1.69%	113.80	107.80	125.3	117.0	114.1	108.2	114.2	108.3	114.1	108.3	114.2	108.4	1.7	2.6	1.7	2.6	
JCC30b	21039	21038	342	21-in Dia	18.9	1.67%	119.50	113.80	131.0	125.3	119.9	114.1	120.0	114.2	119.9	114.1	120.0	114.2	1.7	2.6	1.7	2.6	
JCC20c	21037	23003	745	36-in Dia	163.1	6.84%	107.80	56.90	117.0	65.0	108.2	58.9	108.3	59.4	108.3	59.2	108.4	59.8	6.9	10.8	8.7	12.9	
JCC110b	22102	21143	672	18-in Dia	10.2	1.09%	146.50	139.20	149.0	152.6	146.9	139.6	147.0	139.8	147.0	139.8	147.1	139.9	1.3	2.4	2.3	3.6	
JCC110a	21143	21135	325	24-in Dia	13.3	0.40%	139.20	137.90	152.6	145.8	139.6	138.4	139.8	138.5	139.8	138.5	139.9	138.6	1.3	2.4	2.3	3.6	
JCC120.1	31003	21353	467	15-in Dia	8.3	1.18%	152.00	146.50	155.8	154.4	152.5	147.1	152.7	147.3	152.6	147.2	152.8	147.3	3.0	4.6	4.0	5.7	
JCC120-rd	31003	21353	467	12-in Roadway		0.30%	155.80	154.40	155.8	154.4									0.0	0.0	0.0	0.0	
JCC100b	21353	21135	1867	24-in Dia	18.2	0.46%	146.50	137.90	154.4	145.8	147.1	138.4	147.3	138.5	147.2	138.5	147.3	138.6	3.0	4.6	4.0	5.7	

Table A-2. Hydraulic Evaluation of Existing and Future Land Use Scenario for the Milwaukie Storm Drainage System																							
	Node						Invert Elevation (ft)		Ground Elevation (ft)		Exst 10 yr Max Water Surface Elevation (ft)		Exst 25 yr Max Water Surface Elevation (ft)		Fut 25 yr Max Water Surface Elevation (ft)		Fut 25 yr Max Water Surface Elevation (ft)						
Structure Name	US	DS	Length (ft)	Structure Size/Type	Capacity (cfs)	Slope (%)	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	Exst 10 yr Max Flow (cfs)	Exst 25 yr Max Flow (cfs)	Fut 10 yr Max Flow (cfs)	Fut 25 yr Max Flow (cfs)	When Hydraulically Deficient
JCC100a.1	21135	21015	651	30-in Dia	50.5	1.75%	137.90	126.50	144.8	136.0	138.4	127.1	138.5	127.2	138.5	127.2	138.6	127.3	4.3	7.0	6.2	9.3	
JCC100a-rd	21135	21015	651	12-in Roadway		1.35%	144.80	136.00	144.8	136.0									0.0	0.0	0.0	0.0	
JCC90b.1	21015	25019	1404	24-in Dia	43.3	4.24%	126.50	67.00	136.0	70.0	127.1	67.6	127.2	67.8	127.2	67.8	127.3	67.9	7.3	11.5	10.2	15.1	
JCC90b-rd	21015	25019	1404	12-in Roadway		4.70%	136.00	70.00	136.0	70.0									0.0	0.0	0.0	0.0	
JCC90a	25019	23003	409	36-in Channel	333.0	2.47%	67.00	56.90	70.0	65.0	67.6	58.9	67.8	59.4	67.8	59.2	67.9	59.8	11.3	18.6	16.9	25.5	
JCC20b	23003	Roswell	279	48-in Dia	44.2	0.32%	56.90	56.00	65.0	60.0	58.9	57.2	59.4	57.6	59.2	57.5	59.8	57.8	18.0	28.9	25.0	37.6	
JCC20a	25245	21267	55	30-in Dia	61.6	2.62%	52.50	51.05	60.0	61.5	53.3	51.9	53.5	52.1	53.4	52.0	53.8	52.3	11.6	17.4	14.6	22.9	
JCC10b.1	21267	21505	1324	42-in Dia	92.6	0.98%	51.05	38.08	59.0	46.0	51.9	39.7	52.1	39.7	52.0	39.7	52.3	39.7	12.9	19.4	16.0	25.0	
JCC10b-rd	21267	21505	1324	30-in Roadway		0.98%	59.00	46.00	59.0	46.0									0.0	0.0	0.0	0.0	
JCC10a.1	21505	25237	242	48-in Dia	132.3	0.98%	38.08	35.70	46.0	40.0	39.7	39.7	39.7	39.7	39.7	39.7	39.7	39.7	15.6	23.4	23.3	31.3	
JCC10a-rd	21505	25237	242	30-in Roadway		2.48%	46.00	40.00	46.0	40.0	39.7	39.7	39.7	39.7	39.7	39.7	39.7	39.7	0.0	0.0	0.0	0.0	
SYSTEM #4																							
JCB10d.1	21265	21059	307	24-in Elliptical	10.3	0.65%	37.00	35.00	40.0	41.0	40.0	36.6	40.5	36.7	41.1	37.4	41.3	38.9	13.4	14.2	14.9	14.9	Fut 10-yr
JCB10d-rd	21265	21059	307	24-in Roadway		-0.33%	40.00	41.00	40.0	41.0	40.0	40.0	40.5	40.5	41.1	41.1	41.3	41.2	0.0	0.0	-4.2	-13.6	
JCB10c.1	21059	ODMH017	73	18-in Dia	10.3	0.69%	35.00	34.50	41.0	41.0	36.6	35.5	36.7	35.5	37.4	35.7	38.9	35.9	13.4	14.2	18.1	24.9	
JCB10c-rd	21059	ODMH017	73	24-in Roadway		0.00%	41.00	41.00	41.0	41.0	35.5	35.5	35.5	35.5	35.7	35.7	35.9	35.9	0.0	0.0	0.0	0.0	
JCB30b.1	ODOT011	ODMH015	302	24-in Dia	15.0	0.51%	41.82	40.28	45.7	44.2	42.5	40.9	42.7	41.0	42.9	41.2	43.0	41.3	3.6	5.0	7.6	9.4	
JCB30b-rd	ODOT011	ODMH015	302	12-in Roadway		0.50%	45.72	44.20	45.7	44.2									0.0	0.0	0.0	0.0	
JCB30a	ODMH015	ODMH016	160	24-in Dia	22.6	1.16%	40.36	38.50	45.2	43.5	40.9	39.5	41.0	39.7	41.2	40.0	41.3	40.2	3.6	5.0	7.6	9.4	
JCB20c	21066	21065	402	18-in Dia	9.6	0.97%	45.10	41.20	51.0	45.6	45.7	42.0	45.8	42.2	46.0	42.5	46.2	42.6	3.1	4.3	6.5	8.1	
JCB20b	21065	21064	318	21-in Dia	9.0	0.38%	41.20	40.00	45.6	44.0	42.0	40.5	42.2	40.6	42.5	40.7	42.6	40.9	3.1	4.3	6.5	8.1	
JCB20a	21064	ODMH016	69	18-in Dia	13.9	2.04%	40.00	38.60	44.0	43.5	40.5	39.5	40.6	39.7	40.7	40.0	40.9	40.2	3.1	4.3	6.5	8.1	
JCB10f	ODMH016	ODMH031	140	30-in Dia	24.9	0.43%	38.60	38.00	43.5	43.0	39.5	38.8	39.7	39.0	40.0	39.2	40.2	39.4	6.1	8.6	13.1	16.3	
JCB10e	ODMH031	ODMH017	556	36-in Dia	47.4	0.59%	37.75	34.50	43.0	41.0	38.5	35.5	38.6	35.5	38.8	35.7	39.0	35.9	6.1	8.6	13.1	16.3	
JCB10b	ODMH017	36001	161	42-in Dia	118.7	1.61%	34.50	31.90	41.0	41.8	35.5	33.0	35.5	33.1	35.7	33.3	35.9	33.5	19.4	22.8	31.2	40.7	
JCB10a	36001	25226	425	36-in Dia	73.3	1.40%	31.94	26.00	41.8	38.8	33.0	29.0	33.1	29.0	33.3	29.0	33.5	29.0	19.4	22.8	31.2	40.7	
SYSTEM #5																							
JCA50c.1	21148	21165	1212	15-in Dia	13.4	3.08%	137.40	100.01	144.0	107.0	137.8	102.8	138.0	106.4	138.2	107.1	143.8	107.1	3.7	6.0	10.0	13.4	
JCA50c-rd	21148	21165	1212	24-in Roadway		3.05%	144.00	107.00	144.0	107.0					138.2	107.1	143.8	107.1	0.0	0.0	0.0	0.0	
JCA50b.1	21165	21169	700	15-in Dia	6.4	0.71%	100.01	95.05	107.0	102.0	102.8	101.2	106.4	102.1	107.1	102.1	107.1	102.2	3.7	6.0	6.5	6.5	Fut 10-yr
JCA50b-rd	21165	21169	700	24-in Roadway		0.71%	107.00	102.00	107.0	102.0	NA	NA	106.4	102.1	107.1	102.1	107.1	102.2	0.0	0.0	3.5	6.9	
JCA50a.1	21169	21171	234	18-in Dia	10.3	1.12%	95.05	92.43	102.0	98.5	101.2	98.6	102.1	98.7	102.1	98.7	102.2	98.8	10.1	11.6	13.1	13.1	Exst 25-yr
JCA50a-rd	21169	21171	234	24-in Roadway		1.50%	102.00	98.50	102.0	98.5	101.2	98.6	102.1	98.7	102.1	98.7	102.2	98.8	0.0	4.2	10.4	17.6	
JCA60.1	21187	21186	738	18-in Dia	23.3	5.69%	162.70	120.70	166.0	124.0	163.4	121.2	163.6	121.3	163.4	121.2	163.6	121.3	7.4	11.2	8.4	12.4	
JCA60-rd	21187	21186	738	24-in Roadway		5.69%	166.00	124.00	166.0	124.0									0.0	0.0	0.0	0.0	
JCA41c.1	21186	21185	148	18-in Dia	33.1	7.09%	120.70	110.20	124.0	116.0	121.2	116.0	121.3	116.1	121.2	116.1	121.3	116.1	7.4	11.2	8.4	12.4	
JCA41c-rd	21186	21185	148	24-in Roadway		5.40%	124.00	116.00	124.0	116.0	121.2	116.0	121.3	116.1	121.2	116.1	121.3	116.1	0.0	0.0	0.0	0.0	
JCA41b.1	21185	21184	826	12-in Dia	5.7	1.81%	110.20	95.25	116.0	98.7	116.0	98.9	116.1	99.0	116.1	99.0	116.1	99.1	6.2	6.2	6.2	6.2	Exst 10-yr
JCA41b-rd	21185	21184	826	24-in Roadway		2.10%	116.00	98.68	116.0	98.7	116.0	98.9	116.1	99.0	116.1	99.0	116.1	99.1	1.1	5.0	2.1	6.2	
JCA41a.1	21184	21183	261	15-in Dia	6.1	0.64%	95.25	93.57	98.7	98.0	98.9	98.6	99.0	98.8	99.0	98.8	99.1	98.9	9.0	9.0	9.0	9.0	Exst 10-yr
JCA41a-rd	21184	21183	261	12-in Roadway		0.26%	98.68	98.00	98.7	98.0	98.9	98.6	99.0	98.8	99.0	98.8	99.1	98.9	9.2	16.0	14.8	21.5	
JCA40a.1	21183	21171	420	30-in Dia	15.3	0.10%	93.57	93.15	98.0	98.5	98.6	98.6	98.8	98.7	98.8	98.7	98.9	98.8	9.4	9.7	9.1	8.5	Exst 10-yr
JCA40a-rd	21183	21171	420	24-in Roadway		-0.12%	98.00	98.50	98.0	98.5	98.6	98.6	98.8	98.7	98.8	98.7	98.9	98.8	-4.3	-10.2	-10.2	-15.6	
JCA30b.1	21171	21239	2264	18-in Dia	16.5	2.88%	92.43	27.33	98.5	39.5	98.6	40.9	98.7	41.5	98.7	41.5	98.8	41.5	16.0	16.0	16.0	16.0	Exst 10-yr
JCA30b-rd	21171	21239	2264	24-in Roadway		2.61%	98.50	39.50	98.5	39.5	98.6	40.9	98.7	41.5	98.7	41.5	98.8	41.5	5.7	20.7	27.3	42.4	
JCA30a.1	21239	21364	440	24-in Dia	6.7	0.10%	27.02	26.57	39.5	40.5	40.9	40.8	41.5	41.5	41.5	41.6	41.5	41.6	19.5	19.5	19.6	19.5	Exst 10-yr
JCA30a-rd	21239	21364	458	24-in Roadway		-0.22%	39.50	40.50	39.5	40.5	40.9	40.8	41.5	41.5	41.5	41.6	41.5	41.6	-22.1	-42.8	-47.6	-56.0	
JCA20.1	21094	21364	785	15-in Dia	5.5	0.53%	34.14	30.00	42.0	40.5	42.1	40.8	42.2	41.5	42.2	41.6	42.2	41.6	5.3	4.9	4.6	4.5	Exst 10-yr
JCA20-rd	21094	21364	780	24-in Roadway		0.19%	42.00	40.50	42.0	40.5	42.1	40.8	42.2	41.5	42.2	41.6	42.2	41.6	1.9	5.0	5.7	7.6	
JCA10.1	21364	25213	696	24-in Dia	6.7	0.10%	26.57	25.86	40.5	44.0	40.8	27.9	41.5	27.9	41.6	27.9	41.6	27.9	28.1	29.0	29.0	29.0	
JCA10-rd	21364	25213	696	24-in Roadway		-0.50%	40.50	44.00	40.5	44.0	40.8	40.8	41.5	41.5	41.6	41.6	41.6	41.6	0.0	0.0	0.0	0.0	

Table A-2. Hydraulic Evaluation of Existing and Future Land Use Scenario for the Milwaukie Storm Drainage System																							
	Node						Invert Elevation (ft)		Ground Elevation (ft)		Exst 10 yr Max Water Surface Elevation (ft)		Exst 25 yr Max Water Surface Elevation (ft)		Fut 25 yr Max Water Surface Elevation (ft)		Fut 25 yr Max Water Surface Elevation (ft)						
Structure Name	US	DS	Length (ft)	Structure Size/Type	Capacity (cfs)	Slope (%)	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	Exst 10 yr Max Flow (cfs)	Exst 25 yr Max Flow (cfs)	Fut 10 yr Max Flow (cfs)	Fut 25 yr Max Flow (cfs)	When Hydraulically Deficient
SYSTEM #6																							
KC60b.1	41069	41068	466	15-in Dia	5.9	0.60%	96.30	93.50	100.0	102.0	99.1	98.0	100.0	98.7	98.8	98.0	100.0	98.7	3.2	4.2	3.1	4.2	
KC60b-rd	41069	41068	466	12-in Roadway		-0.43%	100.00	102.00	100.0	102.0							100.0	100.0	0.0	0.0	0.0	0.0	
KC60a.1	41068	41064	325	18-in Dia	9.5	0.58%	93.50	91.60	102.0	102.0	98.0	97.7	98.7	98.3	98.0	97.7	98.7	98.3	4.1	4.2	3.6	4.2	
KC60a-rd	41068	41064	325	12-in Roadway		0.00%	102.00	102.00	102.0	102.0	97.7	97.7	98.3	98.3	97.7	97.7	98.3	98.3	0.0	0.0	0.0	0.0	
KC50b.1	41065	41064	420	18-in Dia	11.8	0.90%	95.40	91.60	98.0	102.0	98.0	97.7	98.5	98.3	98.0	97.7	98.5	98.3	2.9	4.2	2.1	4.1	
KC50b-rd	41065	41064	420	12-in Roadway		-0.95%	98.00	102.00	98.0	102.0							98.5	98.3	0.0	0.0	0.0	0.0	
KC50a.1	41064	41031	319	24-in Dia	20.6	0.60%	91.60	89.70	102.0	100.5	97.7	97.7	98.3	98.1	97.7	97.6	98.3	98.1	5.3	6.8	-5.3	-7.5	
KC50a-rd	41064	41031	319	12-in Roadway		0.47%	102.00	100.50	102.0	100.5									0.0	0.0	0.0	0.0	
KC40b.1	41032	41031	384	18-in Dia	12.0	0.94%	93.30	89.70	96.0	100.5	97.0	97.7	97.0	98.1	97.0	97.6	97.0	98.1	5.3	-6.7	-5.0	-6.7	
KC40b-rd	41032	41031	384	12-in Roadway		-1.17%	96.00	100.50	96.0	100.5	97.0	97.7	97.0	98.1	97.0	97.6	97.0	98.1	0.0	0.0	0.0	0.0	
KC40a.1	41031	41029	234	24-in Dia	16.6	0.39%	89.70	88.80	100.5	98.0	97.7	97.7	98.1	98.1	97.6	97.7	98.1	98.1	7.8	6.2	7.1	6.6	
KC40a-rd	41031	41029	234	12-in Roadway		1.07%	100.50	98.00	100.5	98.0							98.1	98.1	0.0	0.0	0.0	0.0	
KC30b.1	41029	41109	164	18-in Dia	9.9	1.02%	88.80	87.12	98.0	98.0	97.7	97.8	98.1	98.1	97.7	97.8	98.1	98.1	7.8	6.3	7.1	6.6	Exst 25-yr
KC30b-rd	41029	41109	164	12-in Roadway		0.00%	98.00	98.00	98.0	98.0	97.8	97.8	98.1	98.1	97.8	97.8	98.1	98.1	0.0	-0.1	0.0	-0.1	
KC30a.1	41109	21101	1029	18-in Dia	8.1	0.43%	87.12	82.72	98.0	92.1	97.8	92.1	98.1	92.2	97.8	92.2	98.1	92.2	12.2	11.9	11.5	11.4	Exst 25-yr
KC30a-rd	41109	21101	1029	12-in Roadway		0.57%	98.00	92.10	98.0	92.1	97.8	92.1	98.1	92.2	97.8	92.2	98.1	92.2	0.0	2.2	0.0	2.5	
KC10b.1	21101	41005	2119	18-in Dia	17.8	2.04%	82.72	39.41	92.1	46.0	92.1	40.9	92.2	42.5	92.2	42.1	92.2	44.8	19.2	19.5	19.5	19.5	Exst 10-yr
KC10b-rd	21101	41005	2119	12-in Roadway		2.18%	92.10	46.00	92.1	46.0	92.1	46.0	92.2	46.1	92.2	46.1	92.2	46.1	0.3	5.5	4.3	11.2	
KC10a.1	41005	41006	239	21-in Dia	19.1	1.04%	39.41	36.92	46.0	44.0	40.9	38.4	42.5	38.6	42.1	38.6	44.8	38.7	19.4	24.4	23.2	29.7	
KC10a-rd	41005	41006	239	12-in Roadway		0.84%	46.00	44.00	46.0	44.0									0.0	0.0	0.0	0.0	
KC20c.1	41020	41006	1791	15-in Dia	10.4	1.85%	67.00	33.84	72.0	44.0	67.9	34.7	72.0	34.8	72.0	34.8	72.1	35.0	8.4	10.7	10.7	11.3	Exst 25-yr
KC20c-rd	41020	41006	1791	12-in Roadway		1.56%	72.00	44.00	72.0	44.0	NA	NA	72.0	44.0	72.0	44.0	72.1	44.1	0.0	0.2	1.3	4.2	
KC20a.1	41006	45017	64	24-in Dia	104.8	15.38%	33.84	24.00	44.0	40.0	34.7	24.7	34.8	24.8	34.8	24.8	35.0	24.9	27.7	35.2	34.9	44.9	
KC20a-rd	41006	45017	64	12-in Roadway		6.25%	44.00	40.00	44.0	40.0									0.0	0.0	0.0	0.0	
SYSTEM #7																							
WRA30e.1	11003	15009	883	18-in Dia	7.9	0.40%	54.00	50.45	60.0	56.0	60.1	50.8	60.1	50.8	60.1	50.8	60.1	50.8	6.6	7.1	6.6	7.1	Exst 10-yr
WRA30e-rd	11003	15009	883	12-in Roadway		0.45%	60.00	56.00	60.0	56.0	60.1	56.0	60.1	56.1	60.1	56.0	60.1	56.1	1.0	3.4	0.8	3.4	
WRA30d	15009	12055	70	36-in Channel	803.8	16.86%	50.45	38.65	56.0	54.0	50.8	40.0	50.8	41.7	50.8	40.0	50.8	41.7	7.6	10.4	7.4	10.5	
WRA30c	12055	15000	287	18-in Dia	8.8	0.50%	38.65	37.21	54.0	41.0	40.0	37.9	41.7	38.0	40.0	37.9	41.7	38.0	7.6	10.4	7.4	10.5	
WRA30b	15000	CCIN002	677	36-in Channel	241.9	1.43%	37.21	27.50	41.0	32.0	37.9	28.1	38.0	28.2	37.9	28.1	38.0	28.2	7.6	10.4	7.4	10.4	
WRA30a	CCIN002	15005	169	36-in Dia	98.1	7.41%	27.50	15.00	32.0	33.0	28.1	18.0	28.2	18.0	28.1	18.0	28.2	18.0	7.6	10.4	7.4	10.4	
SYSTEM #8																							
MSC10d	41153	41154	128	15-in Dia	7.9	1.08%	92.72	91.34	99.5	100.0	93.1	91.7	93.3	91.9	93.2	91.9	93.4	92.0	1.8	3.0	2.8	4.2	
MSC10c	41159	41154	689	15-in Dia	9.9	1.69%	103.00	91.34	110.7	100.0	103.4	91.8	103.5	91.9	103.5	91.8	103.6	91.9	2.4	3.7	3.3	4.7	
MSC10b	41154	41151	405	18-in Dia	14.8	2.30%	90.77	81.46	100.0	87.2	91.3	82.0	91.5	82.2	91.5	82.1	91.6	82.3	4.2	6.6	6.0	8.9	
MSC10a	41151	45009	678	24-in Dia	56.7	7.22%	80.96	32.00	87.2	55.0	81.3	32.4	81.4	32.5	81.4	32.4	81.5	32.5	4.1	6.6	6.0	8.9	
SYSTEM #9																							
MSC40i	41119	41149	631	15-in Dia	6.1	0.63%	121.20	117.20	125.0	122.9	121.6	117.6	121.8	117.8	121.8	117.7	122.0	117.9	1.3	2.7	2.4	4.1	
MSC40h	41149	41145	167	15-in Dia	8.3	1.19%	116.20	114.20	122.9	121.2	116.5	114.5	116.7	114.7	116.7	114.7	116.8	114.8	1.3	2.7	2.4	4.1	
MSC40g	41145	41164	43	15-in Dia	11.1	2.09%	114.00	113.10	121.2	121.0	114.3	113.4	114.4	113.5	114.4	113.5	114.5	113.6	1.3	2.7	2.4	4.1	
MSC40f	41164	41163	109	15-in Dia	6.4	0.70%	112.60	111.84	121.0	119.3	113.0	112.2	113.2	112.4	113.1	112.4	113.3	112.6	1.3	2.7	2.4	4.1	
MSC40e	41163	41162	223	18-in Dia	14.8	1.42%	111.64	108.47	119.3	116.5	111.9	108.8	112.1	108.9	112.1	108.9	112.2	109.0	1.3	2.7	2.4	4.1	
MSC40d	41162	41161	183	18-in Dia	16.5	1.76%	108.22	105.00	116.5	113.3	108.5	105.3	108.7	105.4	108.6	105.4	108.8	105.5	1.3	2.7	2.4	4.1	
MSC40c	41161	41165	465	18-in Dia	20.6	4.45%	104.00	83.30	113.3	88.6	104.3	83.6	104.4	83.7	104.3	83.6	104.5	83.8	1.3	2.7	2.4	4.1	
MSC40b	41165	41166	104	24-in Dia	19.0	0.50%	82.80	82.28	88.6	92.1	83.2	82.6	83.3	82.8	83.3	82.8	83.4	82.9	1.3	2.7	2.4	4.1	
MSC40a	41166	41044	245	24-in Dia	16.9	0.64%	82.08	80.50	92.1	90.5	82.5	80.9	82.6	81.0	82.6	81.0	82.8	81.2	1.3	2.7	2.4	4.1	
MSC30	41045	41044	148	18-in Dia	2.5	-0.07%	80.40	80.50	86.2	90.5	80.8	80.7	80.9	80.8	80.9	80.7	81.0	80.8	-0.3	-0.5	-0.4	-0.6	
MSC20c	41044	41048	447	30-in Dia	49.4	1.68%	80.20	72.70	90.5	78.0	80.5	73.2	80.6	73.3	80.6	73.3	80.7	73.4	1.6	3.1	2.8	4.7	
MSC60b	41055	41054	103	18-in Dia	0.4	0.00%	77.90	77.90	82.0	83.0	78.8	78.7	79.0	78.9	78.9	78.9	79.2	79.1	1.7	2.6	2.3	3.3	
MSC60a	41054	41053	121	18-in Dia	2.8	-0.08%	77.90	78.00	83.0	86.0	78.7	78.3	78.9	78.4	78.9	78.4	79.1	78.5	-1.7	-2.6	-2.3	-3.3	
MSC50c	41079	41076	1210	15-in Dia	5.5	0.53%	79.70	73.30	84.0	80.0	80.0	78.3	80.0	78.4	80.0	78.4	80.1	78.5	0.6	0.9	0.8	1.2	

Table A-2. Hydraulic Evaluation of Existing and Future Land Use Scenario for the Milwaukie Storm Drainage System

	Node						Invert Elevation (ft)		Ground Elevation (ft)		Exst 10 yr Max Water Surface Elevation (ft)		Exst 25 yr Max Water Surface Elevation (ft)		Fut 25 yr Max Water Surface Elevation (ft)		Fut 25 yr Max Water Surface Elevation (ft)						
Structure Name	US	DS	Length (ft)	Structure Size/Type	Capacity (cfs)	Slope (%)	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	Exst 10 yr Max Flow (cfs)	Exst 25 yr Max Flow (cfs)	Fut 10 yr Max Flow (cfs)	Fut 25 yr Max Flow (cfs)	When Hydraulically Deficient
MSC50b	41076	41075	90	18-in Dia	20.8	-2.77%	73.30	75.80	80.0	80.0	78.3	78.3	78.4	78.4	78.4	78.4	78.5	78.5	-0.6	-0.9	-0.8	-1.2	
MSC50a	41075	41053	119	24-in Dia	28.5	-1.86%	75.80	78.00	80.0	86.0	78.3	78.3	78.4	78.4	78.4	78.4	78.5	78.5	-0.6	-0.9	-0.8	-1.2	
MSC20b	41053	41048	229	24-in Dia	32.0	2.32%	78.00	72.70	86.0	78.0	78.3	73.2	78.4	73.3	78.4	73.3	78.5	73.4	2.0	3.2	2.8	4.1	
MSC20a	41048	45010	1300	30-in Dia	64.7	2.90%	72.70	35.00	78.0	45.0	73.2	35.4	73.3	35.6	73.3	35.6	73.4	35.7	4.6	7.9	7.0	10.9	
SYSTEM #10																							
MSC80	41063	43000	652	21-in Dia	14.7	1.00%	86.80	80.30	92.0	87.0	87.1	81.0	87.2	81.1	87.2	81.1	87.3	81.2	1.0	1.7	1.5	2.3	
MSC70b	43000	41074	231	21-in Dia	9.7	0.43%	80.30	79.30	87.0	89.0	81.0	79.6	81.1	79.7	81.1	79.6	81.2	79.7	2.0	3.0	2.7	3.9	
MSC70a	41074	45013	429	21-in Dia	35.0	5.67%	79.30	55.00	89.0	60.0	79.6	55.3	79.7	55.3	79.6	55.3	79.7	55.4	2.0	3.0	2.7	3.9	
SYSTEM #11																							
MSC110b	41099	41100	619	15-in Dia	7.9	1.73%	96.80	86.10	103.5	91.0	97.1	86.4	97.2	86.4	97.1	86.4	97.2	86.5	0.8	1.3	1.1	1.7	
MSC110a	41100	41101	47	18-in Dia	12.6	1.69%	86.10	85.30	91.0	91.8	86.4	85.8	86.4	86.0	86.4	85.9	86.5	86.1	0.8	1.3	1.1	1.7	
MSC100	42201	41101	483	15-in Dia	8.4	1.97%	94.80	85.30	98.0	91.8	95.0	85.8	95.1	86.0	95.1	85.9	95.1	86.1	0.6	0.9	0.8	1.1	
MSC90b	41101	41103	461	21-in Dia	16.4	1.24%	85.30	79.60	91.8	86.0	85.8	80.2	86.0	80.3	85.9	80.3	86.1	80.5	3.1	4.9	4.3	6.3	
MSC90a	41103	45014	711	24-in Dia	16.9	0.65%	79.60	75.00	86.0	80.0	80.2	75.6	80.3	75.7	80.3	75.7	80.5	75.8	3.1	4.9	4.3	6.3	
SYSTEM #12																							
MSB20e.1	61105	61010	889	24-in Dia	3.2	0.02%	80.80	80.60	90.0	86.0	83.5	82.0	85.2	82.4	87.5	82.8	90.1	83.3	7.8	12.1	15.4	18.5	Fut 25-yr
MSB20e-rd	61105	61010	889	12-in Roadway		0.45%	90.00	86.00	90.0	86.0							90.1	86.1	0.0	0.0	0.0	1.4	
MSB20d	61010	61028	79	24-in Dia	11.1	-0.28%	80.58	80.80	86.0	86.0	82.0	81.7	82.4	81.9	82.8	82.1	83.3	82.3	-7.8	-12.1	-15.4	-19.8	
MSB20c	61028	61032	1135	48-in Dia	67.6	0.26%	80.80	77.90	86.0	87.0	81.7	79.3	81.9	79.7	82.1	79.9	82.3	80.1	7.8	12.0	15.4	19.8	
MSB20b	61032	65029	358	54-in Dia	39.8	0.14%	77.90	77.40	87.0	84.0	79.3	78.1	79.7	78.2	79.9	78.4	80.1	78.8	7.7	11.9	15.3	19.8	
MSB20a	65029	65032	42	72-in Channel	597.1	0.22%	77.40	77.31	84.0	89.0	78.1	77.7	78.2	77.9	78.4	78.2	78.8	78.7	7.7	11.9	15.2	19.7	
MSB30d.1	66003	61027	2226	48-in Dia	12.6	0.03%	80.00	79.42	88.0	86.0	82.5	81.3	83.0	82.0	84.4	83.5	88.1	86.2	10.1	13.9	19.1	28.6	
MSB30d-rd	66003	61027	2226	12-in Roadway		0.09%	88.00	86.00	88.0	86.0							88.1	86.2	0.0	0.0	0.0	1.8	
MSB30c.1	61027	61036	430	24-in Dia	7.3	0.12%	79.42	78.90	86.0	86.0	81.3	80.1	82.0	80.3	83.5	80.6	86.2	80.9	8.5	11.1	16.0	22.3	Fut 25-yr
MSB30c-rd	61027	61036	430	12-in Roadway		0.00%	86.00	86.00	86.0	86.0	80.1	80.1	80.3	80.3	80.6	80.6	86.2	86.1	0.0	0.0	0.0	1.3	
MSB30b.1	61036	61034	760	48-in Dia	45.9	0.12%	78.90	78.00	86.0	86.0	80.1	79.0	80.3	79.2	80.6	79.4	80.9	79.7	8.5	11.1	16.0	23.0	
MSB30b-rd	61036	61034	760	12-in Roadway		0.00%	86.00	86.00	86.0	86.0	79.0	79.0	79.2	79.2	79.4	79.4	79.7	79.7	0.0	0.0	0.0	0.0	
MSB30a	61034	65032	382	48-in Dia	60.3	0.60%	78.00	75.70	87.0	89.0	79.0	77.5	79.2	77.9	79.4	78.2	79.7	78.7	8.5	11.0	15.9	22.9	
MSB10c	65032	65031	119	72-in Channel	357.6	0.08%	75.70	75.61	89.0	86.0	77.5	77.5	77.9	77.8	78.2	78.2	78.7	78.6	15.8	22.5	30.3	40.9	
MSC120c.1	ODMH005	62355	162	15-in Dia	6.7	1.24%	96.75	94.75	100.0	98.0	97.3	95.1	97.4	95.1	97.5	95.2	97.6	95.2	1.6	2.5	3.0	4.2	
MSC120c-rd	ODMH005	62355	162	12-in Roadway		1.24%	100.00	98.00	100.0	98.0									0.0	0.0	0.0	0.0	
MSC120b	62355	ODMH004	124	18-in Dia	18.7	10.82%	94.75	81.30	98.0	91.5	95.1	84.1	95.1	84.3	95.2	84.5	95.2	84.8	1.6	2.5	3.0	4.2	
MSC120a	ODMH004	65031	146	24-in Dia	15.1	-1.51%	81.30	83.50	91.5	86.0	84.1	83.9	84.3	84.1	84.5	84.1	84.8	84.2	-1.6	-2.5	-3.0	-4.2	
MSB10b	65031	66026	777	72-in Channel	47.1	0.00%	75.61	75.60	86.0	88.0	77.5	77.2	77.8	77.6	78.2	77.9	78.6	78.5	16.7	23.9	31.4	42.0	
MSB10a	66026	65027	3076	48-in Dia	88.7	0.44%	75.60	62.00	88.0	90.0	77.2	63.6	77.6	63.9	77.9	64.2	78.5	64.5	28.3	40.6	52.1	67.2	
SYSTEM #13																							
MSA90.1	61160	61177	2523	24-in Dia	20.3	0.93%	171.10	147.67	179.0	153.5	172.0	152.8	172.1	153.4	172.0	153.1	172.2	153.6	7.9	10.7	9.2	12.2	
MSA90-rd	61160	61177	2523	12-in Roadway		1.01%	179.00	153.50	179.0	153.5							172.2	153.6	0.0	0.0	0.0	0.0	
MSA80d	61159	61177	583	15-in Dia	13.2	4.85%	174.90	146.60	178.8	153.5	175.1	152.8	175.2	153.4	175.2	153.1	175.3	153.6	0.9	1.5	1.4	2.4	
MSA80c.1	61177	61148	253	24-in Dia	7.3	-0.12%	146.60	146.91	153.5	152.0	152.8	152.4	153.4	152.5	153.1	152.4	153.6	152.5	-8.4	-12.0	-10.4	-12.6	Fut 25-yr
MSA80c-rd	61177	61148	253	12-in Roadway		0.59%	153.50	152.00	153.5	152.0	152.8	152.4	153.4	152.5	153.1	152.4	153.6	152.5	0.0	0.0	0.0	1.9	
MSA80b.1	61148	61179	243	15-in Dia	2.4	0.10%	146.90	146.66	152.0	152.0	152.4	152.3	152.5	152.4	152.4	152.4	152.5	152.4	5.8	5.5	5.5	5.4	Exst10-yr
MSA80b-rd	61148	61179	243	12-in Roadway		0.00%	152.00	152.00	152.0	152.0	152.4	152.3	152.5	152.4	152.4	152.4	152.5	152.4	6.5	10.4	8.8	12.8	
MSA80A.1	61179	61151	186	18-in Dia	6.5	0.45%	146.66	145.83	152.0	152.0	152.3	152.1	152.4	152.2	152.4	152.1	152.4	152.2	6.5	6.3	6.3	6.1	Exst10-yr
MSA80A-rd	61179	61151	186	12-in Roadway		0.00%	152.00	152.00	152.0	152.0	152.3	152.1	152.4	152.2	152.4	152.2	152.4	152.2	4.2	8.4	6.8	10.9	
MSA70d.1	61151	65028	684	18-in Dia	8.3	0.44%	145.83	142.79	152.0	149.0	152.1	143.4	152.2	143.5	152.1	143.5	152.2	143.6	9.3	10.4	10.0	11.0	Exst10-yr
MSA70d-rd	61151	65028	684	12-in Roadway		0.44%	152.00	149.00	152.0	149.0	152.1	149.0	152.2	149.1	152.1	149.1	152.2	149.2	0.7	5.8	4.0	9.2	
MSA70c	65028	66010	1111	36-in Channel	367.9	3.31%	142.79	106.00	149.0	109.0	143.4	106.6	143.5	106.8	143.5	106.8	143.6	107.0	10.0	16.2	13.9	20.1	
MSA70b	66010	65034	55	30-in Dia	92.5	3.64%	106.00	104.00	109.0	107.0	106.6	104.7	106.8	104.8	106.8	104.8	107.0	104.9	10.0	16.2	13.9	20.1	
MSA70a	65034	66023	174	24-in Channel	99.9	1.41%	104.00	101.54	107.0	104.0	104.7	102.8	104.8	103.2	104.8	103.2	104.9	103.4	10.0	16.2	13.9	20.1	
MSA20c.1	62296	65011	56	15-in Dia	5.1	0.45%	102.20	101.95	104.0	104.1	102.9	102.8	103.5	103.2	103.3	103.2	104.0	103.4	2.4	4.7	4.5	7.3	
MSA20c-rd	62296	65011	56	12-in Roadway		-0.18%	104.00	104.10	104.0	104.1									0.0	0.0	0.0	0.0	

Table A-2. Hydraulic Evaluation of Existing and Future Land Use Scenario for the Milwaukie Storm Drainage System																							
	Node						Invert Elevation (ft)		Ground Elevation (ft)		Exst 10 yr Max Water Surface Elevation (ft)		Exst 25 yr Max Water Surface Elevation (ft)		Fut 25 yr Max Water Surface Elevation (ft)		Fut 25 yr Max Water Surface Elevation (ft)						
Structure Name	US	DS	Length (ft)	Structure Size/Type	Capacity (cfs)	Slope (%)	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	Exst 10 yr Max Flow (cfs)	Exst 25 yr Max Flow (cfs)	Fut 10 yr Max Flow (cfs)	Fut 25 yr Max Flow (cfs)	When Hydraulically Deficient
MSA20b	65011	66023	29	24-in Channel	97.3	1.41%	101.95	101.54	104.1	103.0	102.8	102.8	103.2	103.2	103.2	103.2	103.4	103.4	2.4	4.7	4.4	7.3	
MSA20a.1	66023	65033	59	18-in Dia	16.5	1.76%	101.54	100.50	103.0	103.0	102.8	101.5	103.2	102.0	103.2	102.0	103.4	102.5	12.1	15.8	15.2	15.7	Exst 25-yr
MSA20a-rd	66023	65033	59	12-in Roadway		0.07%	103.04	103.00	103.0	103.0			103.2	103.1	103.2	103.1	103.4	103.2	0.0	4.3	2.3	12.9	
MSA110b	65023	65033	918	24-in Channel	18.7	0.10%	100.27	99.35	103.3	103.0	102.1	101.5	102.7	102.0	102.7	102.0	103.3	102.5	15.5	24.7	25.6	37.7	
MSA10	61052	65023	2075	24-in Dia	33.3	2.51%	152.42	100.27	156.0	103.3	152.8	102.1	152.9	102.7	152.9	102.7	153.0	103.3	2.1	3.7	3.4	5.6	
MSA110c	84	65023	1320	36-in Channel	47.0	0.28%	104.00	100.27	107.0	103.3	105.5	102.1	106.0	102.7	106.1	102.7	106.5	103.3	13.8	21.4	23.0	33.3	
MSA110d	82-83	84	1309	36-in Channel	43.3	0.11%	105.50	104.00	108.5	107.0	107.3	105.5	107.7	106.0	107.8	106.1	108.2	106.5	14.2	21.8	23.3	33.6	
MSA110e	80-81	82-83	976	36-in Channel	58.4	0.15%	107.00	105.50	110.0	108.5	108.6	107.3	108.9	107.7	108.9	107.8	109.3	108.2	14.6	20.1	21.6	30.9	
SYSTEM #14																							
MSA110a	65033	61107	1578	48-in Channel	139.0	1.18%	99.35	80.70	103.0	84.7	101.5	81.9	102.0	82.2	102.0	82.2	102.5	82.6	26.9	42.0	41.1	60.4	
MSA60b	62318	62323	301	15-in Dia	11.5	3.65%	142.08	131.08	146.0	134.0	142.3	131.3	142.4	131.4	142.4	131.4	142.5	131.5	1.0	2.0	1.9	3.0	
MSA60a	62323	62325	323	18-in Dia	24.6	6.31%	129.67	109.33	134.0	112.0	129.9	109.5	130.0	109.6	130.0	109.6	130.0	109.7	1.0	2.0	1.9	3.0	
MSA50c.1	62325	62179	397	18-in Dia	26.2	7.11%	108.42	80.17	112.0	83.0	108.6	80.7	108.7	81.2	108.7	81.0	108.8	83.1	1.0	2.0	2.0	3.6	
MSA50c-rd	62325	62179	397	30-in Roadway		7.30%	112.00	83.00	112.0	83.0							108.7	83.1	0.0	0.0	0.0	0.0	
MSA50a.1	62179	61107	59	18-in Dia	25.9	7.09%	80.17	76.00	83.0	82.2	80.7	77.8	81.2	80.5	81.0	80.2	83.1	82.3	6.2	10.1	8.9	12.6	
MSA50a-rd	62179	61107	59	30-in Roadway		1.36%	83.00	82.20	83.0	82.2							83.1	82.3	0.0	0.0	0.0	2.2	
MSA50c.1	62325	62179	397	18-in Dia	26.2	7.11%	108.42	80.17	114.5	85.5	108.6	80.7	108.7	81.2	108.7	81.0	108.8	83.1	1.0	2.0	2.0	3.6	
MSA50b.1	CCCB159	62179	329	18-in Dia	15.5	2.53%	88.50	80.17	92.0	83.0	89.1	80.7	89.3	81.2	89.2	81.0	89.4	83.1	4.9	8.1	6.8	10.1	
MSA50b-rd	CCCB159	62179	329	30-in Roadway		2.74%	92.00	83.00	92.0	83.0							89.4	83.1	0.0	0.0	0.0	0.0	
MSA30c	62290	62284	490	15-in Dia	8.0	1.78%	89.50	80.75	93.0	82.5	90.0	81.0	90.1	81.1	90.1	81.1	90.2	82.4	1.5	2.4	2.5	4.2	
MSA30b.1	62284	62282	47	18-in Dia	20.4	4.39%	80.75	78.67	82.5	82.0	81.0	79.0	81.1	80.5	81.1	80.2	82.4	82.3	1.5	2.4	2.5	3.9	
MSA30b-rd	62284	62282	47	30-in Roadway		1.05%	82.50	82.00	82.5	82.0							82.4	82.3	0.0	0.0	0.0	0.0	
MSA30a.1	62282	61107	195	24-in Dia	24.7	1.37%	78.67	76.00	82.0	82.2	79.0	77.8	80.5	80.5	80.2	80.2	82.3	82.3	1.5	2.4	2.5	4.0	
MSA30a-rd	62282	61107	195	30-in Roadway		-0.10%	82.00	82.20	82.0	82.2							82.3	82.3	0.0	0.0	0.0	-1.3	
MSA240	65039	65015	83	72-in Box Culvert		2.00%	71.66	70.00	84.7	77.5	72.1	71.4	72.1	72.0	72.3	72.0	72.4	72.0	17.5	24.4	40.3	49.7	
MSA40.1	61107	65015	63	24-in Dia	41.4	2.40%	76.00	74.50	82.2	75.0	77.8	75.9	80.5	76.5	80.2	76.5	82.3	76.5	33.7	53.1	51.4	64.3	
MSA40-rd	61107	65015	63	30-in Roadway		11.52%	82.20	75.00	82.2	75.0							82.3	75.1	0.0	0.0	0.0	11.3	
SYSTEM #15																							
MSA100f.1	61115	61118	234	15-in Dia	4.9	0.41%	112.83	111.87	122.5	122.2	122.9	122.2	123.0	122.3	123.0	122.3	123.1	122.3	12.1	12.2	12.1	12.2	Exst 10-yr
MSA100f-rd	61115	61118	234	12-in Roadway		0.13%	122.50	122.20	122.5	122.2	122.9	122.5	123.0	122.5	123.0	122.5	123.1	122.6	15.6	22.9	19.4	27.1	
MSA100e.1	61118	CCCB154	287	15-in Dia	13.2	3.00%	111.78	103.17	122.2	107.0	122.2	104.3	122.3	107.1	122.3	107.0	122.3	107.1	19.0	19.0	19.0	19.0	Exst 10-yr
MSA100e-rd	61118	CCCB154	287	12-in Roadway		5.30%	122.20	107.00	122.2	107.0	122.2	107.0	122.3	107.1	122.3	107.1	122.3	107.1	0.4	9.7	6.1	14.0	
MSA100d.1	CCCB154	CCCB146	271	18-in Dia	25.0	4.06%	103.17	92.20	107.0	96.0	104.3	96.1	107.1	96.1	107.0	96.1	107.1	96.1	19.4	23.3	23.3	23.3	Exst 25-yr
MSA100d-rd	CCCB154	CCCB146	271	12-in Roadway		4.07%	107.00	96.00	107.0	96.0	104.3	96.1	107.1	96.1	107.0	96.1	107.1	96.1	0.0	3.5	0.0	7.8	
MSA100c.1	CCCB146	CCCB159	188	18-in Dia	17.4	1.97%	92.20	88.50	96.0	92.0	96.1	89.1	96.1	89.3	96.1	89.2	96.1	89.4	16.8	18.5	17.5	19.4	Exst 10-yr
MSA100c-rd	CCCB146	CCCB159	188	12-in Roadway		2.13%	96.00	92.00	96.0	92.0	96.1	92.1	96.1	92.1	96.1	92.1	96.1	92.1	2.6	8.6	6.0	11.7	
MSA100b.1	CCCB159	CCCB161	38	18-in Dia	37.3	14.64%	88.50	82.88	92.0	92.8	89.1	84.1	89.3	84.4	89.2	84.3	89.4	84.6	14.5	19.4	17.2	21.1	
MSA100b-rd	CCCB159	CCCB161	38	12-in Roadway		-2.08%	92.00	92.80	92.0	92.8									0.0	0.0	0.0	0.0	
MSA100a	CCCB161	CCOF010	87	24-in Dia	21.1	1.01%	82.88	82.00	92.8	91.0	84.1	83.2	84.4	83.5	84.3	83.4	84.6	83.6	14.5	19.4	17.2	21.1	

Appendix B: UIC Risk Evaluation

GSI Water Solutions, Inc.

Technical Memorandum

REGISTERED
OREGON
MATTHEW V. KOHLBECKER
G2248
GEOLOGIST
EXP: 4/30/13

To: Jim Harper, PE, Brown and Caldwell, Inc.
Angela Wieland, PE, Brown and Caldwell, Inc.

From: Matt Kohlbecker, RG, GSI Water Solutions, Inc.
Heidi Blischke, RG, GSI Water Solutions, Inc.

Date: January 16, 2013

Re: **Unsaturated Zone Groundwater Protectiveness Demonstration**
City of Milwaukie, Oregon

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1. Introduction

An Underground Injection Control (UIC) is any facility designed for the subsurface infiltration of fluids. The City of Milwaukie (City), Oregon, uses 196 (recorded) UIC devices to manage stormwater from public rights-of-way (ROW). The locations of the City's UICs are shown in Figure 1. The City's UICs provide benefit to the local watershed by maintaining aquifer recharge in the urban environment. In addition, they are protective of sensitive aquatic receptors by providing an alternative to direct discharge to surface water. UICs are regulated by the Oregon Department of Environmental Quality (DEQ). Because the City's UICs infiltrate only stormwater from public ROWs, DEQ considers them to be Class V injection systems under Oregon Administrative Rules (OAR) 340-044-0011(5)(d).

The City has retained Brown and Caldwell to update its 2004 Stormwater Master Plan (SMP). An objective of the SMP is to identify Capital Improvement Projects (CIP) to retrofit UICs or manage flow from UICs that are removed from service by decommissioning. UICs that require retrofit or decommissioning will be identified on the basis of conditions of a UIC Water Pollution Control Facilities (WPCF) permit that the City likely will receive in late 2013.

This technical memorandum presents an evaluation of whether City UICs will require retrofit or decommissioning based on conditions of the July 2012 draft *Water Pollution Control Facilities Permit for Class V Stormwater Underground Injection Control Systems* (DEQ, 2012a) (draft July 2012 UIC WPCF permit template). The first step in the evaluation is to conduct a system-wide assessment that identifies "at-risk" UICs that would potentially need retrofit or decommissioning because they either 1) discharge directly to groundwater or 2) are located within permit-specified setbacks of water wells. The second step of the evaluation is to conduct

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an unsaturated zone Groundwater Protectiveness Demonstration (GWPD). The GWPD is used to determine which of the "at-risk" UICs identified during the system-wide assessment would need to be decommissioned due to inadequate vertical separation distance from the bottom of the UIC to groundwater.

1.1 Objectives

The objectives of this technical memorandum are:

- Present the preliminary system-wide assessment based on water well location information, as provided by the City and UIC data from the City's 2005 UIC Stormwater Management Plan (HDR, 2005).
- Present a GWPD model, and document model applications to:
  - Address UICs that discharge directly to groundwater and/or were identified within setbacks to water wells as a part of the preliminary system-wide assessment (as described in Condition 6(b)(i) of Schedule A in the draft July 2012 UIC WPCF permit template).
  - Develop Alternate Action Levels to support stormwater discharge monitoring under the City's UIC WPCF permit.
- Based on the results of the GWPD, identify UICs for retrofit or decommissioning as a part of future CIPs.

The main text of the technical memorandum provides an overview of the UIC system-wide assessment and unsaturated zone GWPD model. Additional technical details are provided in Attachment A (UIC system-wide assessment), Attachment B (technical documentation for the unsaturated zone GWPD model), and Attachment C (the unsaturated zone GWPD model).

1.2 Technical Memorandum Organization

This technical memorandum is organized as follows:

- **Section 1: Introduction**. Discusses the City's UIC system and outlines the technical memorandum's objectives.
- **Section 2: UIC Conceptual Model.** Provides information about City UIC facilities and conceptual model for City UIC facilities.
- **Section 3: Preliminary System-Wide Assessment.** Identifies UICs within water well setbacks (Section 3.1), UICs that discharge directly to groundwater (Section 3.2), and actions required to address these UICs (Section 3.3).
- **Section 4: GWPD Application.** Provides background related to the different types of GWPDs and summarizes how they are used to demonstrate groundwater protectiveness.
- **Section 5: Unsaturated Zone GWPD Model**. Documents the unsaturated zone GWPD model used for the City, including model input parameters (Section 5.1) and model results (Section 5.2).
- **Section 6: Conclusions and Recommendations**

- **References.**

2. UIC Conceptual Model

A typical UIC facility in the City is comprised of a catch basin that collects stormwater runoff from the public ROW; piping that conveys the stormwater from the catch basin to the UIC; and the UIC itself that infiltrates stormwater to the subsurface. Occasionally, a sedimentation manhole (i.e., a solid concrete cylinder) is installed between the catch basin and UIC to allow for sediment in stormwater to settle before entering the UIC and to prevent floatables (e.g., trash and debris, oil and grease) from flowing into the UIC. UICs in the City are typically 15- to 30-foot-deep, 4-foot-diameter cylindrical structures constructed of concrete. Rectangular openings (perforations) in the concrete walls of a UIC allow stormwater to infiltrate from the sides of the UIC, and many of the UICs are completed with an open bottom to allow stormwater to infiltrate from the bottom of the UIC.

The conceptual site model for stormwater infiltration from a UIC and pollutant fate and transport after the water leaves the UIC is shown schematically in Figure 2. As shown in Figure 2, stormwater discharges into the UIC, infiltrates through the unsaturated zone, and recharges groundwater. Infiltration through the unsaturated zone likely occurs under near-saturated conditions because of the near-constant infiltration of water during the rainy season. Before entering the unsaturated zone, large-size particulate matter (which pollutants may be sorbed to) falls out of suspension into the bottom of the UIC. During transport through the unsaturated zone, pollutant concentrations attenuate because of degradation, dispersion, volatilization, and retardation. Therefore, pollutant concentrations in unsaturated zone porewater beneath the UIC decrease as the water filters downward through the unsaturated zone to the water table.

3. Preliminary System-Wide Assessment

This section presents a preliminary system-wide assessment of the City's UICs. A system-wide assessment is an inventory of the physical characteristics of a City's UICs. Condition 1 of Schedule B in the draft July 2012 UIC WPCF permit template stipulates that the system-wide assessment must include:

1. An inventory of all UICs that receive stormwater or other fluids and their locations by latitude and longitude in decimal degrees.
2. An estimate of vehicle trips per day for the area(s) drained by the UICs.
3. An inventory of all UICs that discharge directly to groundwater.
4. An inventory of all UICs within 500 feet of any water well and/or within the 2-year time-of-travel of a public water well.
5. An inventory of all UICs that are prohibited by OAR 340-044-0015(2).
6. An inventory of all industrial and commercial properties with activities that have the potential to discharge to UICs that the City owns or operates.

The City developed a summary of its UIC system in 2005 as a part of the City's UIC Stormwater Management Plan (HDR, 2005). The 2005 system summary contains most of the information required by the July 2012 draft permit template for a system-wide assessment, but prior to the City submitting their system-wide assessment (in conjunction with receipt of their permit) the following information would be needed:

(1) Identification of additional UICs within setbacks to water wells based on water well location information collected by the City since 2005 (Item 4 above), and

(2) Updates to the inventory to reflect new vertical separation distance requirements in the draft July 2012 UIC WPCF permit template (Item 3 above).

In this technical memorandum, the following sections provide updated information to the HDR (2005) system summary by identifying UICs within water well setbacks (Section 3.1) and UICs that discharge directly to groundwater (Section 3.2), and providing recommendations for corrective action (Section 3.3).

3.1 UICs Within Water Well Setbacks

This section discusses the methods used to identify UICs within permit-specified setbacks to water wells (i.e., 500 feet or the 2-year time-of-travel). As explained in the *Permit Template Evaluation Report – Class V UIC Municipal and Industrial/Commercial Stormwater Water Pollution Control Facilities Permit* (DEQ, 2012b) (which accompanies the draft July 2012 UIC WPCF permit template), water wells include domestic, irrigation, industrial, and public water wells used for water supply. If a jurisdiction can demonstrate that it is unlikely that irrigation or industrial wells will be used for domestic or municipal water supply, then they can be removed from consideration as water wells.

Irrigation, industrial, domestic, and municipal water wells within the City are identified in Table 1 and shown in the left panel of Figure 3.

Identification of UICs within water well setbacks is based on the following water well location information provided by the City:

- Locations of City municipal wells (Well Numbers 2 through 8) by latitude and longitude (personal communication, 2012a).
- Locations of water wells from the Oregon Water Resources Department (OWRD) water rights database (personal communication, 2012b). These wells were located to the nearest quarter quarter section (which has an accuracy of $^+/_-$ 1,320 feet) or using the legal description in the water right (if provided).
- Locations of private water wells provided by the City (personal communication, 2012c). The private wells are located using the address on driller logs from the online OWRD well log query, and are accurate to the property on which the well is located.

Note that the water well inventory in Table 1 and Figure 3 may be is incomplete because it likely omits several water well locations in the City that could not be accurately located. Additional data sources would need to be consulted to ensure a complete inventory of water well locations. Data sources would include the online OWRD well log query (i.e., for wells without addresses), DEQ well location studies related to the solvent plume that has impacted City municipal wells, and City water service connection records.

At this time, thirty-three UICs are either within 500 feet of a water well or within the 2-year time-of-travel of a public water well. These "at-risk" UICs are shown in the left panel of Figure 3 and are listed in Table 2 and Attachment A.

3.2 UICs That Discharge Directly to Groundwater

UICs that discharge directly to groundwater ("wet feet" UICs) were identified on the basis of the U.S. Geological Survey (USGS; USGS, 2008) depth to groundwater study for the Portland Basin and UIC depths measured as a part of the *UIC Stormwater Management Plan* (HDR, 2005). Wet feet UICs were identified by the following formula:

$$SD = \left(DTW_{USGS} - \frac{\Delta s_{USGS}}{2}\right) - d_{UIC} \quad (3.1)$$

Where:

SD	=	Vertical separation distance between the bottom of the UIC and seasonal high groundwater (feet)
DTW_{USGS}	=	Average depth to water beneath a UIC from USGS (2008) (feet)
Δs_{USGS}	=	Seasonal fluctuation in the water table from USGS (2008) (5.9 feet), based on a statistical analysis of seasonal groundwater level fluctuations in the Portland Basin for the Unconsolidated Sedimentary Aquifer (the hydrogeologic unit where most City UICs are located).
d_{UIC}	=	Depth of the UIC measured by HDR (2005) (feet)

UICs with a negative separation distance (*SD*) are considered to be wet feet UICs. Two wet feet UICs (UIC ID Nos. 24027 and 44003) were identified using Equation 3.1, and are shown in the right panel of Figure 3. Additional information about the wet feet UICs is provided in Attachment A (see highlighted rows).

3.3 Actions for UICs Within Water Well Setbacks and UICs That Discharge Directly to Groundwater

This section discusses actions for UICs that discharge directly to groundwater and for UICs within setbacks to water wells, based on the draft July 2012 UIC WPCF permit template.

Action for UICs That Discharge Directly to Groundwater

Direct discharge to groundwater is not prohibited in the draft July 2012 UIC WPCF permit template. However, additional action is required for UICs that discharge directly to groundwater if the UIC is within the setback to a water well (see Condition 3 of Schedule B of the permit template).

Neither of the two City UICs that discharge directly to groundwater is located within a setback to a water well in Table 1, so no action is required at this time. However, if additional water wells are identified when the system-wide assessment is finalized, and either of the two wet-feet UICs is located within setbacks to the newly identified wells, then the City will be required to show that the UICs will not affect groundwater users (by Condition 3 of Schedule B of the draft July 2012 UIC WPCF permit template). Alternatively, the permitee may decommission the UICs or structurally retrofit the UICs so that the direct discharge to groundwater is eliminated, thus eliminating the potential for required future action if additional wells are identified.

Action for UICs Within Water Well Setbacks

Under the draft July 2012 UIC WPCF permit template, it is not a permit violation for existing injection systems to be within the horizontal setbacks from water wells; however, the UICs must be addressed by one of the following actions within one year of discovery:

- Conduct a protectiveness demonstration to show that the existing UIC does not impair groundwater quality or supply (Condition 6(b)(i) of Schedule A).
- Retrofit or implement a passive, structural, and/or technological control to reduce or eliminate pollutants to the UIC (Condition 6(b)(ii) of Schedule A).
- Close the UIC (Condition 6(b)(iii) of Schedule A).

The GWPD summarized in this technical memorandum will satisfy Condition 6(b)(i) of Schedule A, thus eliminating the need to conduct any additional activities to address UICs within specified setbacks from identified wells at this time.

4. GWPD Application

There are two approaches for demonstrating groundwater protectiveness using a model. Both approaches simulate attenuation of stormwater pollutants in the subsurface (i.e., after infiltration from a UIC), but differ based on whether they simulate pollutant attenuation during vertical transport in unsaturated soils above the water table (unsaturated zone GWPD) or pollutant attenuation during horizontal transport in saturated soils below the water table (saturated zone GWPD). Additional detail related to the two types of GWPDs is provided below:

- **Unsaturated Zone GWPD**. Unsaturated zone GWPDs are based on modeling pollutant fate and transport *vertically* through the *unsaturated* soils beneath a UIC. Groundwater protectiveness is demonstrated by showing that the pollutants attenuate to below background levels before reaching the groundwater table, and, therefore, that the pollutants do not impair groundwater quality.

- **Saturated Zone GWPD.** A saturated zone GWPD consists of modeling *horizontal* pollutant fate and transport through *saturated* soils. The model is used to demonstrate that that the UIC does not adversely impact groundwater users by delineating the "area where waste or material that could become waste if released to the environment, is located or has been located" [OAR 340-040-0010(19)]. In the context of stormwater infiltration from a UIC, this area is the location where groundwater contains stormwater pollutants above background levels (i.e., which is considered to be the method reporting limit [MRL] for non-metals).

The City chose an unsaturated zone GWPD to demonstrate groundwater protectiveness because almost all City UICs have a significant thickness of unsaturated soils between the bottom of the UIC and groundwater table to attenuate pollutant concentrations.

5. Unsaturated Zone GWPD Model

This section summarizes the results of an unsaturated zone GWPD for UICs within water well setbacks that were identified as a part of the system-wide assessment (Section 3), and presents Alternate Action Levels for the City's UIC WPCF permit. The unsaturated zone GWPD model is based on a conservative, analytical pollutant fate and transport equation that simulates one-dimensional pollutant attenuation by dispersion, biodegradation, and retardation. The model output is pollutant concentrations over time and distance based on user-provided input parameters (soil properties, pollutant properties, and organic carbon content of the subsurface). The unsaturated zone GWPD model was used to demonstrate protectiveness and develop Alternate Action Levels:

- **Protectiveness Demonstration.** Protectiveness is demonstrated by showing the pollutant concentrations are attenuated to zero (i.e., below the MRL) before reaching the water table. Pollutant fate and transport are simulated for organic pollutants pentachlorophenol (PCP); di(2-ethylhexyl)phthalate (DEHP); and benzo(a)pyrene; and lead. These pollutants are among the most mobile, toxic, and environmentally persistent in their respective chemical classes (GSI, 2008). They will also be monitored under the City's UIC WPCF permit, and are the most likely pollutants in their respective chemical classes to exceed regulatory standards (Kennedy/Jenks, 2009).

- **Alternate Action Levels.** The draft July 2012 UIC WPCF permit template establishes Action Levels for pollutants in stormwater. Based on information from DEQ (B. Mason, personal communication, October 5, 2012), monitoring of the following pollutants will be required under municipal UIC WPCF permits: benzo(a)pyrene, DEHP, PCP, antimony, lead, zinc, and copper. Action Levels will be established for each pollutant in the City's UIC WPCF permit. Exceedance of an Action Level is not a permit violation. However, if a pollutant concentration exceeds an Action Level, then corrective action is required in accordance with Conditions 3 and 4 of Schedule A. The City is permitted to replace the Action Levels in the draft permit with Alternate Action Levels based on a GWPD model (Condition 2, Schedule A). Alternate Action Levels are developed for zinc, copper, antimony, and DEHP because the existing Action Levels in the draft July 2012 UIC WPCF permit template for these pollutants have not been adjusted on the basis of previous GWPDs (other Table 1 pollutants, lead, benzo(a)pyrene, and PCP, already have been adjusted upward based on other municipalities' unsaturated zone GWPDs).

The following section provides an overview of unsaturated zone GWPD model input parameters (Section 5.1) and results (Section 5.2). Detailed technical documentation for input parameters, the governing equations, and conservative assumptions in the unsaturated zone GWPD model are provided in Attachment B.

5.1 Input Parameters

Pollutant attenuation in subsurface soils depends on the following variables: (1) soil properties, (2) organic carbon content of the subsurface, and (3) pollutant properties. These variables are input parameters for the unsaturated zone GWPD model, and are based on local geologic conditions and stormwater chemistry in the City. The input parameters are varied to evaluate two scenarios for pollutant fate and transport: (1) the average scenario, which is represented by the central tendency or expected mean value of the input parameter, and (2) the reasonable maximum scenario, which is represented by the worst case, upper bound of the input parameter that potentially could occur. The following sections summarize the input parameters used in the unsaturated zone GWPD model for the average and reasonable maximum scenarios.

Soil Properties

Soil properties input into the unsaturated zone GWPD model are based on surficial geology in the Milwaukie vicinity. A surficial geology map of the City was obtained from the Oregon Department of Geology and Mineral Industries (DOGAMI), Oregon Geologic Data Compilation (DOGAMI, 2012), and is provided in Figure 4. Shallow geology in the City is composed of the catastrophic flood deposits of the Missoula Floods. All but one of the City's UICs (44003) are located in the fine-grained facies of the Missoula Flood Deposits (Qff), which are coarse sand to silt deposited by ponded floodwaters (Madin, 1990). The UIC that is not located in the fine-grained facies of the Qff discharges directly to groundwater, and is not included in the unsaturated zone GWPD model. Therefore, input parameters for the unsaturated zone GWPD model are based on soil properties in the Qff.

Soil properties used for the average and reasonable maximum scenarios of the unsaturated zone GWPD model are summarized in Table 3. Porosity, bulk density, and the dispersion coefficient were taken from literature references based on the properties of the Qff. Average linear pore water velocity was estimated from 11 infiltration tests conducted by the City at City UICs in the Qff. The City conducted infiltration tests at the locations shown in Figure 4. Technical documentation for using infiltration tests to calculate average linear pore water velocity is provided in Attachment B.

Organic Carbon Content of the Subsurface

The organic carbon content of the subsurface that is input into the unsaturated zone GWPD model (i.e., f_{oc}, a dimensionless measure of organic carbon content in a soil [grams of carbon per grams of soil]) is based on carbon loading of soil during stormwater infiltration. Organic carbon concentrations in stormwater vary during the year, reaching the highest levels in the fall during leaf drop and the lowest levels during the winter. The total organic carbon (TOC) concentration in stormwater was calculated from more than 100 stormwater samples collected at different times of the year in Milwaukie and nearby jurisdictions. Specifically, TOC data include samples from 61 UICs in Gresham (collected by the City of Gresham), 15 UICs in Clackamas County (collected by Clackamas County Water Environment Services), 12 UICs in Portland (collected by the City of Portland Bureau of Environmental Services), and 15 UICs in Milwaukie (collected by City staff). The unsaturated zone GWPD model uses an f_{oc} of 0.0208 g_{carbon}/g_{soil} for the average scenario (based on mean TOC concentration in stormwater) and an f_{oc} 0.0024 g_{carbon}/g_{soil} for the reasonable maximum scenario (based on minimum TOC concentrations observed in stormwater). Technical documentation for calculating f_{oc} based on filtering of particulate matter in stormwater is provided in Section 2.2 of Attachment B.

Pollutant Properties

Pollutant properties used for the average and reasonable maximum scenarios of the unsaturated zone GWPD model are summarized in Table 4. Pollutant properties for organic chemicals (i.e., PCP, DEHP and benzo(a)pyrene) are based on literature references, and pollutant properties for metals (i.e., antimony, zinc, copper, and lead) were calculated based on stormwater samples collected in the cities of Milwaukie and Portland. Note that half-lives (i.e., the time required for the pollutant concentration to decline to half of the initial concentration because of degradation) were not assigned to metals because they do not degrade in the subsurface, and organic partitioning coefficients were not assigned to metals because they do not sorb to organic carbon. Technical documentation for the pollutant properties is presented in Attachment B.

5.2 Model Results

This section presents the results of the unsaturated zone GWPD model, including the protectiveness demonstration and Alternate Action Levels. Results of the unsaturated zone GWPD model apply to stormwater with pollutant concentrations typical of stormwater runoff from urban ROWs, and do not apply to releases of pollutants to the environment (i.e., spills). The model results should be considered along with the City's internal risk management goals to develop policy for stormwater management that is protective of the groundwater resource.

Protectiveness Demonstration

Table 5 presents the minimum protective vertical separation distances under the average and reasonable maximum scenarios of the unsaturated zone GWPD model. The model calculations for these scenarios are presented in Table 1 of Attachment C.

The average scenario represents most reasonably likely conditions, and is used for regulatory compliance. Under the average scenario, the minimum protective vertical separation distances are less than 1 foot. The largest minimum protective separation distance is for PCP (0.47 foot protective separation distance is significantly smaller than the protective separation distances calculated by other jurisdictions' unsaturated zone GWPDs, reflecting the fact that Milwaukie's UICs are sited in relatively fine-grained sediments. When demonstrating groundwater protectiveness, we recommend using a protective separation distance of 1.0 foot for the minimum separation distance instead of 0.47 foot. Using 1.0 foot conservatively accounts for uncertainties in the USGS (2008) depth to groundwater study (which is the basis for calculating separation distance).

The reasonable maximum scenario represents the worst-case conditions, and is characterized by compounding conservatism of input variables. The purpose of the reasonable maximum scenario is to evaluate model sensitivity, and it is not used for regulatory compliance.

All of the UICs within water well setbacks identified in Table 2 have significantly more than the minimum protective vertical separation distance of 1.0 foot. Specifically, separation distances for UICs in Table 2 range from 31 feet to 92 feet. Therefore, the minimum vertical separation distances in Table 5 demonstrate that City UICs within water well setbacks do not impair groundwater quality or supply based on an unsaturated zone GWPD, in accordance with Schedule A, Condition 6(b)(i) of the draft July 2012 UIC WPCF permit template.

Alternate Action Levels

Alternate Action Levels are shown in Table 6, and calculations for the Alternate Action Levels are provided in Table 2 of Attachment C. Under the average and reasonable maximum scenarios, zinc, copper, antimony, and DEHP attenuate to below the MRL before reaching the water table when initial concentrations in influent stormwater are equal to the Alternate Action Level. The Alternate Action Levels were developed using the following assumptions:

- Alternate Action Levels are limited to maximum concentrations of 10 times the existing Action Levels (antimony, zinc, and copper) or 5 times the existing Action Levels (i.e., DEHP, to keep the Action Level within the published range for DEHP solubility in water).
- The separation distance between the bottom of the UICs and the seasonal high groundwater is 1.0 foot so that the Alternate Action Levels apply to all but three City UICs (24027 and 44003 that discharge directly to groundwater, and 24008, which has 0.16 foot of vertical separation distance). The remaining UICs with known depths have vertical separation distances of more than 5 feet.
- Pollutant concentrations at or below the Alternate Action Level measured at the end of the inlet pipe to the UIC are attenuated to the MRL at or above the water table.

6. Conclusions and Recommendations

We make the following conclusions based on the unsaturated zone GWPD model:

- The 33 UICs within permit-specified setbacks to water wells are protective of the groundwater resource, and, therefore, have been addressed in accordance with Schedule A, Condition 6(b)(i) of the draft July 2012 UIC WPCF permit template. <u>These 33 UICs do not need to be retrofitted or decommissioned as a part of future CIP projects, based on the conditions of the draft July 2012 UIC WPCF permit template.</u>
- Three City UICs (44003, 24008, and 24027) have less than the minimum protective separation distance. <u>These UICs are outside of currently identified water well setbacks and require no action. However, if these UICs become included within a water well setback because of identification of new water wells in the future, action will be required.</u> Actions potentially include a saturated zone GWPD, demonstration that the newly identified water well is not at risk from the UIC using hydrogeologic methods, structural retrofit (e.g., backfilling), passive control, or decommissioning.
- Action Levels for zinc, antimony, copper, and DEHP can be adjusted to the levels in Table 6 and still be protective of groundwater for UICs with at least 1.0 foot of vertical separation distance.

The conclusions of this unsaturated zone GWPD regarding UICs within water well setbacks are based on a preliminary inventory of water wells, and do not consider UICs with unknown depths. We make the following recommendations so that the results of the unsaturated GWPD can be applied to all City UICs as additional water wells are identified and/or all UIC depths are measured. The following additional activities are required prior to completion of the system wide assessment and to comply with conditions outlined in the draft July 2012 UIC WPCF permit template.

- The City will need to continue to identify water wells as a part of its system-wide assessment. As UICs are identified within setbacks to newly identified water wells, the vertical separation distance at each UIC (Attachment A) must be compared to the minimum protective separation distance of 1.0 foot (as calculated as part of this GWPD). UICs are protective of groundwater when the separation distance is more than 1.0 foot.
- The City operates 32 UICs where the depth is unknown because the UIC is buried (Attachment A). These UICs will have to be uncovered and depth measured as a part of the system-wide assessment, and the vertical separation distance to seasonal high groundwater should be calculated.
    - If any of the 32 UICs are identified as being within newly identified water well setbacks (1 of the 32 UICs with unknown depth [UIC No. 34142] currently is identified as within a water well setback), compare the vertical separation distance at each UIC to the minimum protective separation distance of 1.0 foot. UICs are protective of groundwater when the vertical separation distance is more than 1.0 foot.
    - Determine if the Alternate Action Levels can be applied to the UICs by comparing the vertical separation distance at each UIC to the minimum protective separation distance of 1.0 foot. Alternate Action Levels can be applied to the UICs when the vertical separation distance is more than 1.0 foot.

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FIGURES

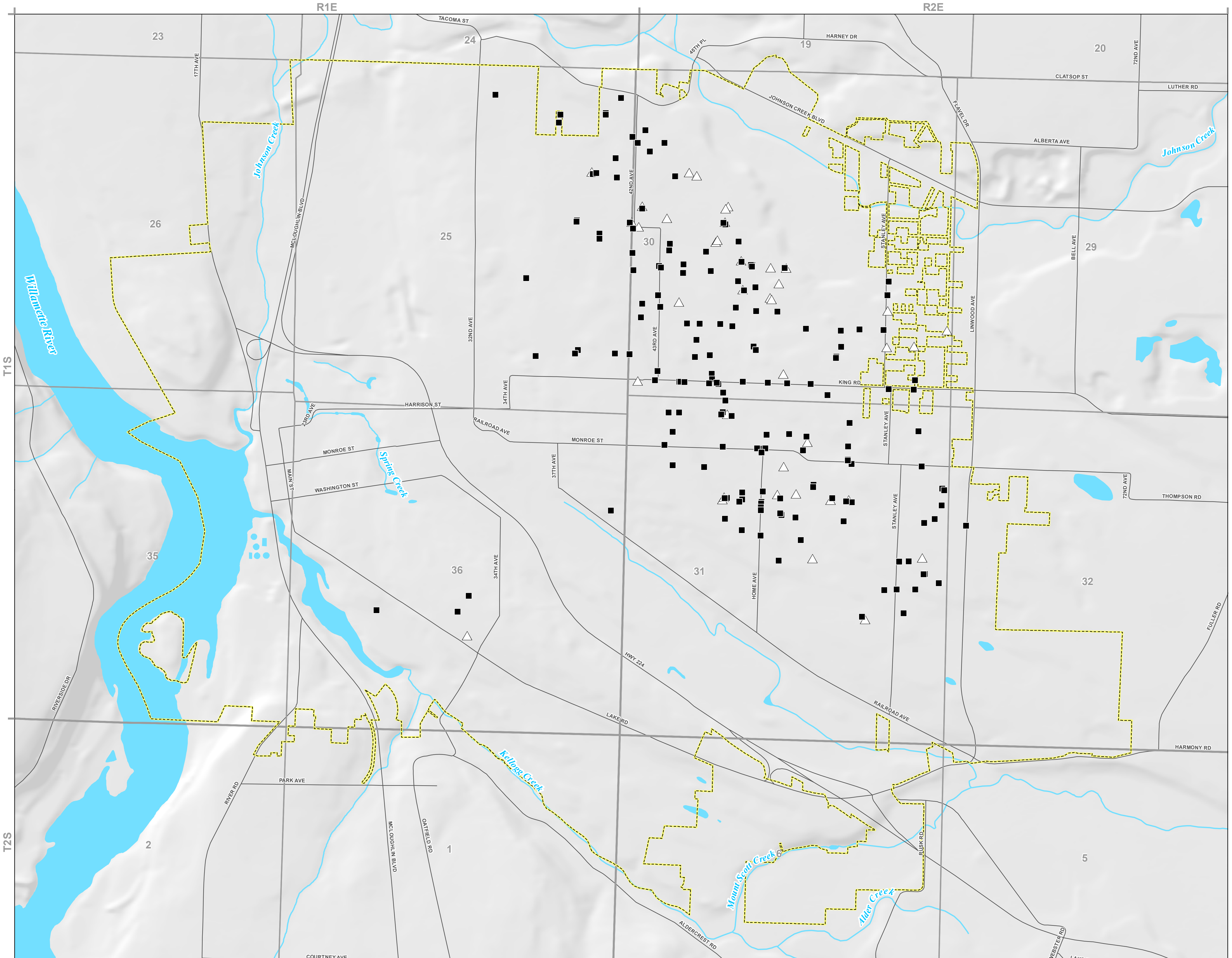


FIGURE 1
UIC Locations
City of Milwaukie

LEGEND

- UICs with Known Depth
- UICs with Unknown Depth

All Other Features

- Milwaukie City Limits
- Major Roads
- Watercourses
- Waterbodies

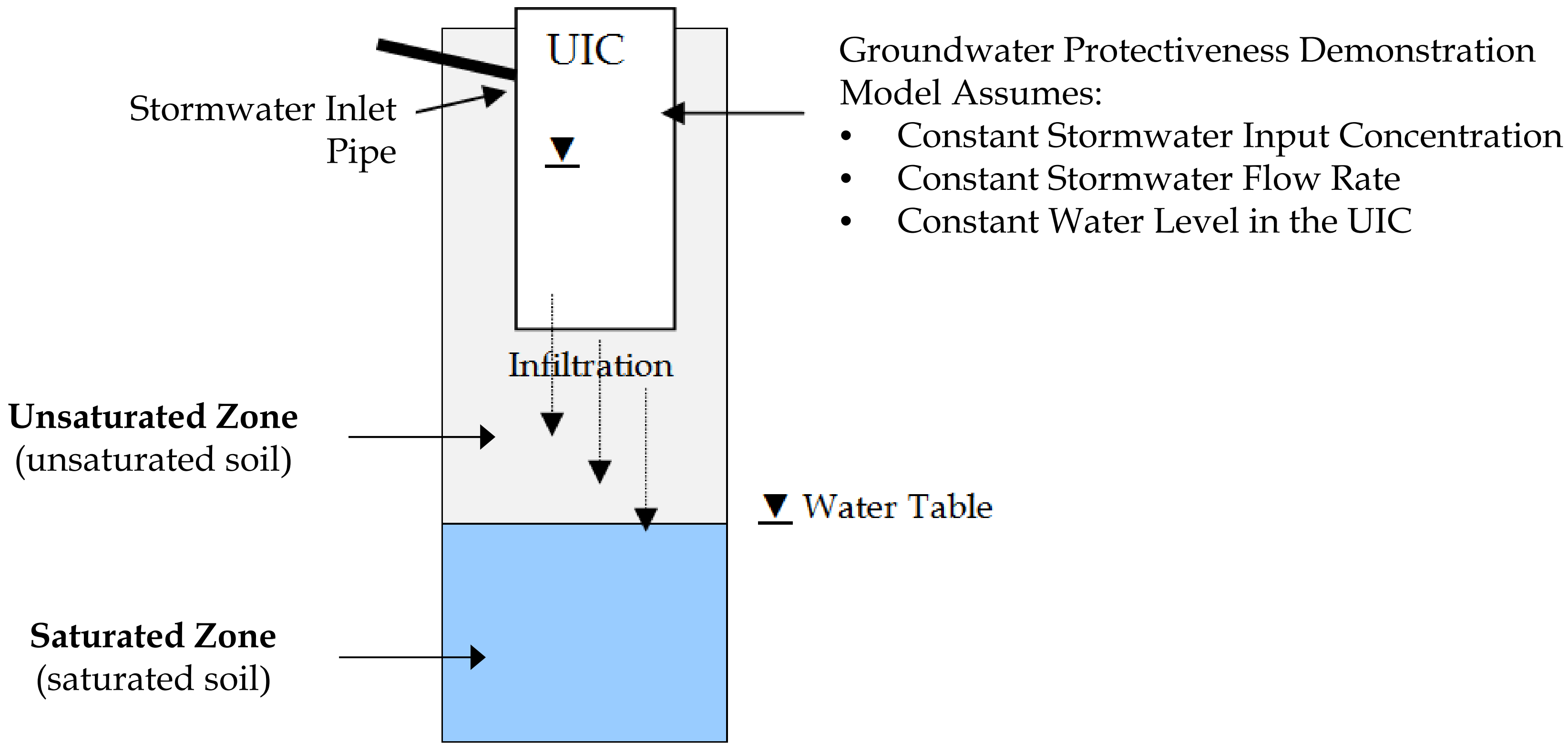
N

0 750 1,500 2,250
Feet

MAP NOTES:
Date: November 6, 2012
Data Sources: City of Milwaukie, DOGAMI, USGS, METRO RLIS

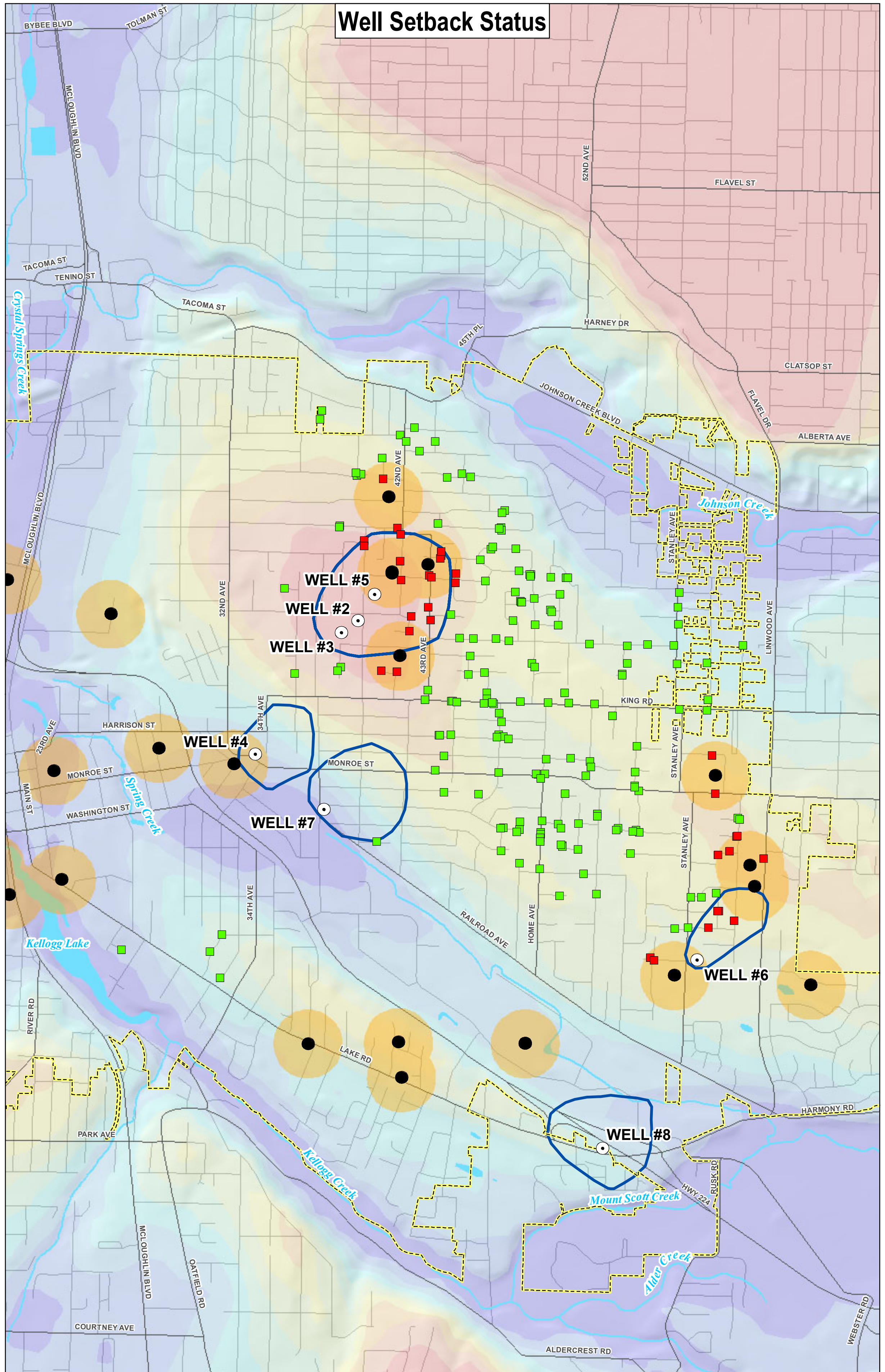
GSI Water Solutions, Inc.

File Path: P:\Portland\374 - Brown & Caldwell\003 - City of Milwaukie Risk Model\Project_GIS\Project_mxds\Final_Report\Figure1_UIC_Locations.mxd



GSI Water Solutions, Inc.

FIGURE 2
UIC Conceptual Model
City of Milwaukie



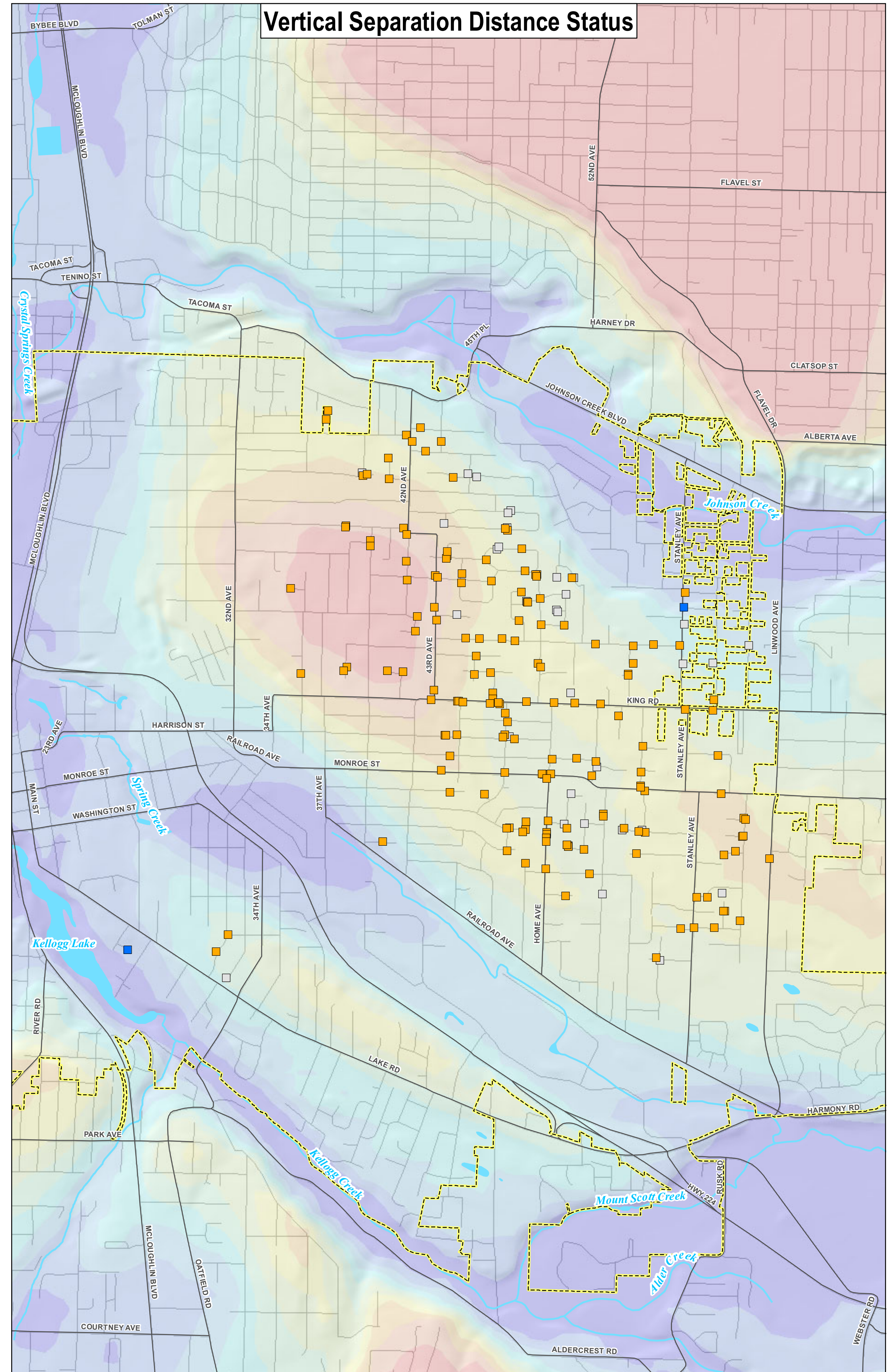


FIGURE 3

UIC Compliance Under July 2012 Permit Template

City of Milwaukie

LEGEND

UIC Locations

Well Setback Status

- Inside Well Setback - 33 Total
- Outside Well Setack - 163 Total

Vertical Separation Distance Status

- Wet Feet - 2 Total
- Dry Feet - 162 Total
- Dry/Wet Feet Unknown - 32 Total (Buried UIC)

Water Wells

- City of Milwaukie Water Supply Wells
- Private Wells

USGS (2008) Groundwater Depth

- 0 - 10 feet
- >10 - 20 feet
- >20 - 30 feet
- >30 - 40 feet
- >40 - 50 feet
- >50 - 60 feet
- >60 - 70 feet
- >70 - 80 feet
- >80 - 90 feet
- >90 - 100 feet

All Other Features

- 2 Year Time of Travel Zones
- 500 foot Setback from Private Wells
- Milwaukie City Limits
- Major Roads
- Minor Roads
- Watercourses
- Waterbodies

NOTE:
UICs inside well setbacks are within the 2 year time of travel zone of City of Milwaukie municipal wells or within 500 feet of private wells.

N

0 1,000 2,000 3,000
Feet

MAP NOTES:
Date: November 6, 2012
Data Sources: City of Milwaukie, OR DEQ, USGS, METRO RLIS

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File Path: P:\Portland\374 - Brown & Caldwell\003 - City of Milwaukie Risk Model\Project_GIS\Project_mxds\Final_Report\Figure3_July_2012_Permit_Template.mxd

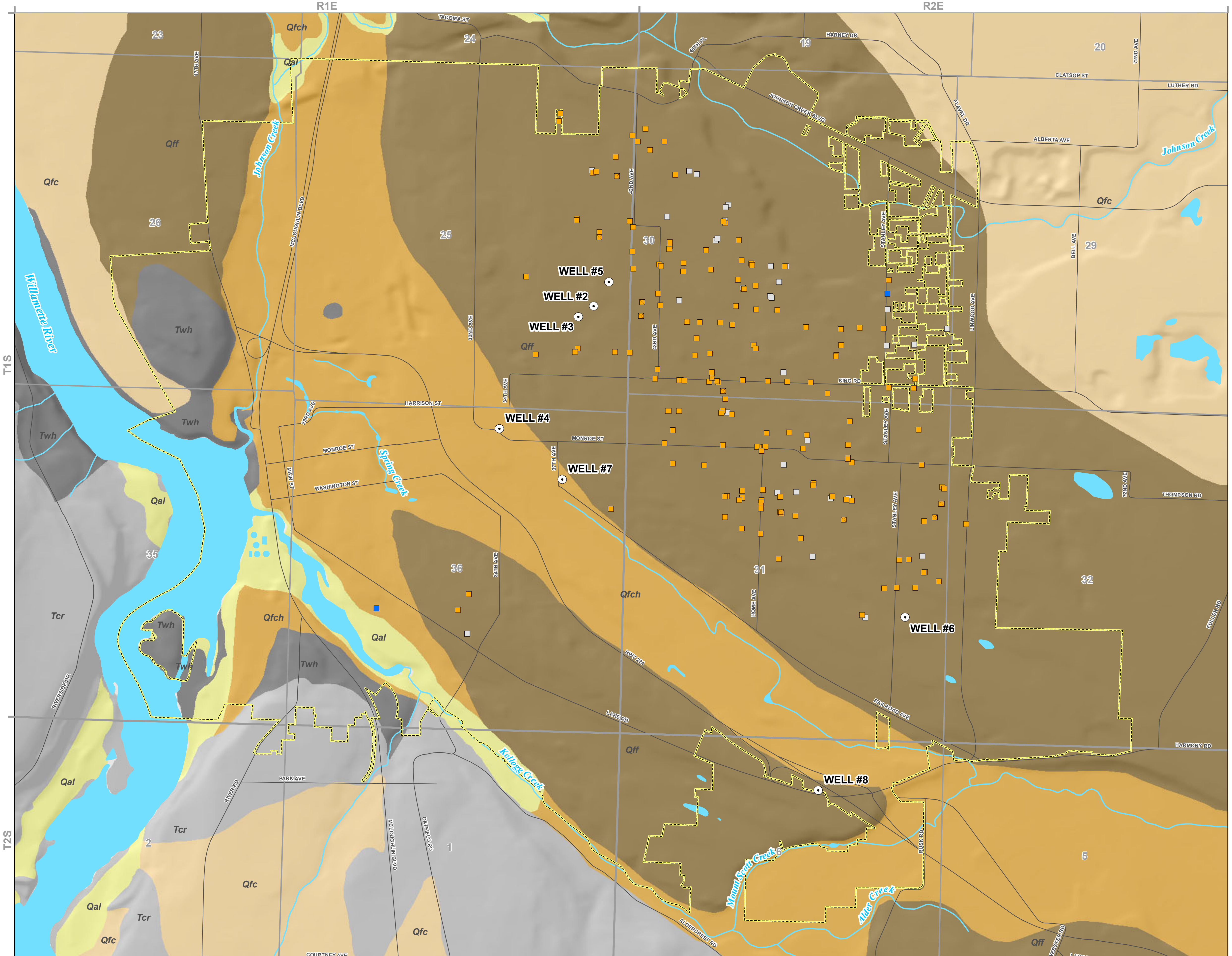


FIGURE 4

Surficial Geology Map

City of Milwaukie

LEGEND

- City of Milwaukie Water Supply Wells

UIC Locations

- UIC Where Infiltration Test Was Conducted

Vertical Separation Status

- Wet Feet - 2 Total
- Dry Feet - 162 Total
- Dry/Wet Feet Unknown - 32 Total (Buried UIC)

Surficial Geology from DOGAMI

Quaternary Sedimentary Units

- Qal - Alluvium
- Qfc - Catastrophic flood deposits, coarse grained facies
- Qfch - Catastrophic flood deposits, channel facies
- Qff - Catastrophic flood deposits, fine grained facies

Miocene Basalt

- Tcr - Columbia River Basalt Group

Eocene Units

- Twh - Basalt of Waverly Heights and associated undifferentiated sedimentary rocks

All Other Features

- Milwaukie City Limits
- Major Roads
- Watercourses
- Waterbodies

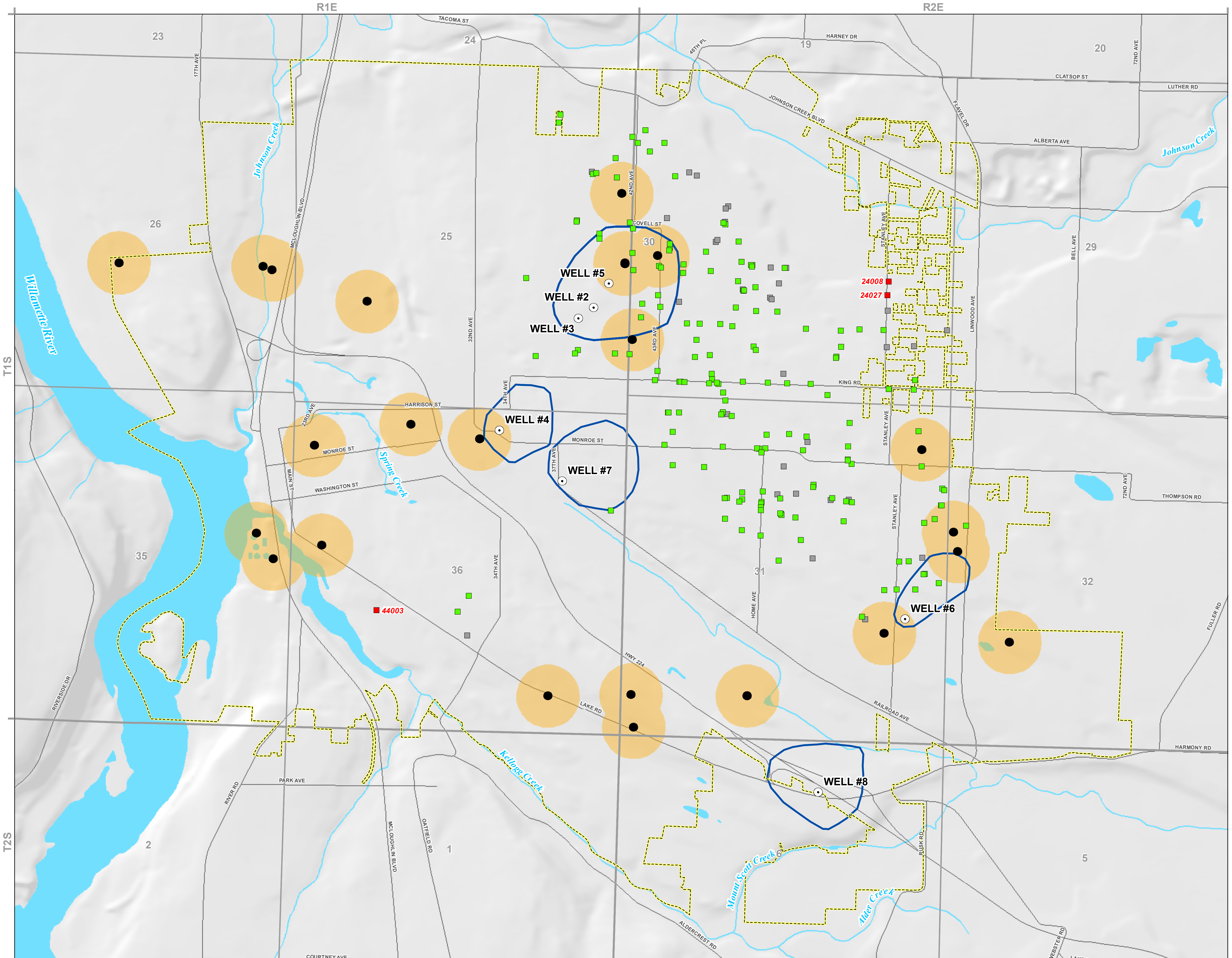
N

0 750 1,500 2,250
Feet

MAP NOTES:
Date: November 6, 2012
Data Sources: City of Milwaukie, DOGAMI, USGS, METRO RLIS

GSI Water Solutions, Inc.

File Path: P:\Portland\374 - Brown & Caldwell\003 - City of Milwaukie Risk Model\Project_GIS\Project_mxds\Final_Report\Figure4_Surficial_Geology_Map.mxd



File Path: P:\Portland\374 - Brown & Caldwell\003 - City of Milwaukie Risk Model\Project_GIS\Project_mxds\Final_Report\Figure5_July_2012_Permit_Template.mxd

FIGURE 5

UIC Compliance Under July 2012 Permit Template

City of Milwaukie

LEGEND

UIC Locations

- Compliant with Permit Conditions
- Separation Distance < 1.0 feet
- Depth Unknown

Water Wells

- City of Milwaukie Water Supply Wells
- Private Wells

All Other Features

- 2 Year Time of Travel Zones
- 500 foot Setback from Private Wells
- Milwaukie City Limits
- Major Roads
- Watercourses
- Waterbodies

N

0 750 1,500 2,250

Feet

MAP NOTES:

Date: November 6, 2012

Data Sources: City of Milwaukie, METRO RLIS, USGS

GSI Water Solutions, Inc.

TABLES

Table 1

Water Well Locations Within City of Milwaukie City Limits

City of Milwaukie, Oregon

OWRD Well ID	Water Right ID			Well Owner	Well Type	Data Source	Location Accuracy [4]
	Permit No.	Certificate No.	Claim No.				
CLAC 312				Robert Dwyer	Irrigation	City Private Well Database [1]	Property
CLAC 316				Dr. George Corti	Domestic	City Private Well Database [1]	Property
CLAC 317				Raymond Gitch	Domestic	City Private Well Database [1]	Property
CLAC 318				O. L. Wilson	Domestic	City Private Well Database [1]	Property
CLAC 354				Zon Wells	Domestic	City Private Well Database [1]	Property
CLAC 355				Ralph Elser	Domestic	City Private Well Database [1]	Property
CLAC 358				OMARK Properties	Domestic	City Private Well Database [1]	Property
CLAC 362				Donald Calderwood	Domestic	City Private Well Database [1]	Property
CLAC 364				Walter Freeman	Domestic	City Private Well Database [1]	Property
CLAC 366				J. E. Powers	Domestic	City Private Well Database [1]	Property
CLAC 367				Ambrose Calcagno	Domestic	City Private Well Database [1]	Property
CLAC 376						City Private Well Database [1]	Property
CLAC 378				Archie Timmons	Domestic	City Private Well Database [1]	Property
CLAC 3979				Union High School District	Irrigation	City Private Well Database [1]	Property
CLAC 3986				M. A. Warner	Domestic	City Private Well Database [1]	Property
CLAC 56001				Water Environmental Services	Irrigation	City Private Well Database [1]	Property
	G-13719			Clackamas County Service District 1		OWRD Water Rights Database [2]	Water Right
			GR-2877	OMARK Industries		OWRD Water Rights Database [2]	QQ Section
	G-776	24592		Ralph Elser		OWRD Water Rights Database [2]	QQ Section
	G-251	29069		Ambrose Calcagno		OWRD Water Rights Database [2]	Water Right
	G-3041	37507		OMARK Properties		OWRD Water Rights Database [2]	Water Right
	G-4276	37508		OMARK Properties		OWRD Water Rights Database [2]	Water Right
	G-2619	38040		Wilfred C. Wilhelm		OWRD Water Rights Database [2]	Water Right
	G-4855	38217		Clinton C. Warren		OWRD Water Rights Database [2]	Water Right
			GR-1478	City of Milwaukie Well No. 2 [5]	Municipal	City Municipal Well Database [3]	Lat/Long
			GR-1480	City of Milwaukie Well No. 3 [5]	Municipal	City Municipal Well Database [3]	Lat/Long
	G-1609	32158		City of Milwaukie Well No. 4 [5]	Municipal	City Municipal Well Database [3]	Lat/Long
	G-2542	34010		City of Milwaukie Well No. 5 [5]	Municipal	City Municipal Well Database [3]	Lat/Long
	G-9953	56403		City of Milwaukie Well No. 6 [5]	Municipal	City Municipal Well Database [3]	Lat/Long
	G-9954	56404		City of Milwaukie Well No. 7 [5]	Municipal	City Municipal Well Database [3]	Lat/Long
	G-10582	82571		City of Milwaukie Well No. 8 [5]	Municipal	City Municipal Well Database [3]	Lat/Long

Notes:

[1] Data provided by City in the "privatewell_pts" shapefile. CL19965 was excluded because the on-line OWRD well log search indicates that it is a monitoring well.

[2] Data provided by City in the "water_rights_within_Milwaukie" shapefile. Only groundwater rights were included.

[3] Data provided by the City in the "wells" shapefile.

[4] Location accuracy:

- Property: wells located by address, and therefore are accurate to the property on which the well is located
- QQ Section: wells located to the nearest quarter quarter section based on information from OWRD are accurate to +/- 1,320 feet
- Water Right: wells located using legal description in the water right, location is considered to be highly accurate
- Lat/Long: wells located by latitude and longitude coordinates

[5] Water Right ID from West Yost Associates (2011)

Table 2

Active UICs Within Water Well Setbacks

City of Milwaukie, Oregon

UIC ID	Address	Longitude	Latitude	ADT	UIC Depth (feet)	Average DTW (feet)	Seasonal High DTW (feet)	Vertical Separation Distance (feet)	Within 2 Year Time of Travel	Within 500 feet of Private Well
24018	5844 SE HARRISON ST	-122.602345	45.446119	<1000 ADT	23.30	57.32	54.32	31.02		X
34138	5866 SE LLOYD ST	-122.602303	45.439283	<1000 ADT	25.00	61.25	58.25	33.25	X	
34136	11576 SE 59TH AV	-122.601816	45.439943	<1000 ADT	21.00	65.02	62.02	34.02	X	
34141	5565 SE HARLOW ST	-122.605514	45.438041	<1000 ADT	18.00	58.26	55.26	37.26		X
24021	5838 SE MONROE ST	-122.602094	45.444602	>1000 ADT	29.50	69.81	66.81	37.31		X
34034	4341 SE ROCKWOOD ST	-122.617913	45.453768	<1000 ADT	35.50	77.52	74.52	39.02	X	X
34140	4341 SE ROCKWOOD ST	-122.617924	45.453945	<1000 ADT	32.60	74.81	71.81	39.21	X	X
34135	11496 SE 59TH AV	-122.601738	45.439957	<1000 ADT	22.00	64.77	61.77	39.77	X	
34013	4102 SE WAKE CT	-122.621291	45.456756	<1000 ADT	25.00	69.30	66.30	41.30		X
34137	11557 SE 60TH AV	-122.600868	45.439578	<1000 ADT	19.50	64.77	61.77	42.27	X	
34139	11221 SE LINWOOD AV	-122.599279	45.442087	<1000 ADT	25.92	71.60	68.60	42.68		X
34128	11114 SE 60TH AV	-122.600851	45.442936	<1000 ADT	24.00	70.90	67.90	43.90		X
34036	9656 SE 44TH AV	-122.617054	45.453077	<1000 ADT	26.08	73.99	70.99	44.91		X
34130	5965 SE DERDAN CT	-122.601224	45.442342	<1000 ADT	19.00	72.64	69.64	50.64		X
34037	4402 SE HOWE ST	-122.617067	45.452702	>1000 ADT	19.58	73.99	70.99	51.41		X
34027	9405 SE 42ND AV	-122.620217	45.454567	>1000 ADT	27.20	81.94	78.94	51.74	X	
34045	9665 SE 43RD AV	-122.618559	45.452972	>1000 ADT	33.50	88.64	85.64	52.14	X	X
34035	9616 SE 43RD AV	-122.617949	45.453664	>1000 ADT	21.80	77.52	74.52	52.72	X	X
34131	5922 SE DERDAN CT	-122.601853	45.442174	<1000 ADT	14.75	70.80	67.80	53.05		X
34129	11114 SE 60TH AV	-122.600810	45.442947	<1000 ADT	14.60	70.90	67.90	53.30		X
34142	5620 SE HARLOW ST	-122.605325	45.437930	<1000 ADT	0.00	57.88	54.88	54.88		X
34087	10205 SE 41ST CT	-122.621115	45.449139	<1000 ADT	34.00	94.83	91.83	57.83		X
34025	4145 SE OLSEN ST	-122.620413	45.454822	>1000 ADT	17.93	81.94	78.94	61.01		X
34088	10236 SE 41ST CT	-122.620227	45.449127	<1000 ADT	27.42	91.44	88.44	61.02		X
34029	9475 SE 40TH AV	-122.622262	45.454301	>1000 ADT	28.11	92.29	89.29	61.18	X	
34176	9918 SE 43RD AV	-122.618401	45.451205	>1000 ADT	22.00	86.44	83.44	61.44	X	
34030	9631 SE 42ND AV	-122.620212	45.453502	>1000 ADT	29.50	95.29	92.29	62.79	X	X
34147	9523 SE 40TH AV	-122.622262	45.454084	<1000 ADT	26.20	92.29	89.29	63.09	X	
34047	9839 SE 43RD AV	-122.618569	45.451708	>1000 ADT	20.00	86.44	83.44	63.44	X	
34033	4243 SE HARVEY ST	-122.619583	45.450734	<1000 ADT	24.00	91.88	88.88	64.88	X	X
34046	9660 SE 43RD AV	-122.618429	45.452911	>1000 ADT	22.00	88.64	85.64	65.84	X	X
34031	9738 SE 42ND AV	-122.620121	45.452766	>1000 ADT	23.30	94.32	91.32	68.02	X	X
34032	4207 SE HARVEY ST	-122.619517	45.451329	<1000 ADT	23.00	94.96	91.96	69.96	X	

Notes

UIC ID = Underground Injection Control Device Identification Number

ADT = Average Daily Traffic Volume in Trips per Day

W = Depth to Groundwater

Water Solutions, Inc.

Table 3

Model Input Parameters – Soil Properties

City of Milwaukie, Oregon

Input Parameter	Units	Average Scenario	Reasonable Maximum Scenario	Data Source and Location of Technical Documentation
Total Porosity (η)	-	0.375	0.375	Midrange porosity for a sand, Freeze and Cherry (1979) Table 2.4. Appendix B, Section 2.1.1.
Effective Porosity (η_e)	-	0.31	0.31	Effective porosity of the USA hydrogeologic unit (USGS, 2008). Appendix B, Sections 2.1.1 and 2.1.4.
Bulk Density (ρ_b)	g/cm^3	1.66	1.66	Calculated by equation 8.26 in Freeze and Cherry (1979). Appendix B, Section 2.1.2.
Dispersivity (α)	m/d	5% of transport distance	5% of transport distance	Calculated based on Gelhar (1985). Appendix B, Section 2.1.3.
Pore Water Velocity (v)	m/d	0.365	0.746	Based on 11 infiltration tests conducted by City staff. Average scenario uses the median velocity, reasonable maximum scenario uses the 95% UCL velocity. Appendix B, Section 2.1.4 and Section 4.0.

Notes

g/cm^3 = grams per cubic centimeter

m/d = meters per day

95% UCL = 95% Upper Confidence Limit on the mean

(-) = input parameter units are dimensionless

Table 4

Model Input Parameters – Pollutant Properties

City of Milwaukie, Oregon

Input Parameter	Units	Pollutant	Average Scenario	Reasonable Maximum Scenario	Data Source and Location of Technical Documentation
Initial Concentration	µg/L	PCP	10	10	Action Level in July 2012 permit template
		DEHP	60	60	Action Level in July 2012 permit template
		B(a)P	2	2	Action Level in July 2012 permit template
		Lead	500	500	Action Level in July 2012 permit template
Organic Carbon Partitioning Coefficient (K_{oc})	L/Kg	PCP	877	703	EPA (1996), assuming a pH of 6.4. Appendix B, Section 2.3.1.
		DEHP	12,200	12,200	Calculated based on equations in Roy and Griffin (1985). Appendix B, Section 2.3.1.
		B(a)P	282,185	282,185	
Distribution Coefficient (K_d)	L/Kg	PCP	18.3	1.7	Calculated based on Equation 5.12 in Watts (1998). Appendix B, Section 2.3.2.
		DEHP	254	29	Calculated based on Equation 5.12 in Watts (1998). Appendix B, Section 2.3.2.
		B(a)P	5,870	670	Calculated based on Equation 5.12 in Watts (1998). Appendix B, Section 2.3.2.
		Antimony	25,000	9,700	Calculated from City of Portland stormwater discharge monitoring data. Appendix B, Section 2.3.2.
		Zinc	53,000	22,500	
		Copper	159,000	25,000	Calculated from City of Milwaukie stormwater discharge monitoring data. Appendix B, Section 2.3.2.
		Lead	1,200,000	535,000	
Half Life (h)	d	PCP	31.4	49.9	Literature values. Appendix B, Section 2.3.3.
		DEHP	46.2	69.3	Literature values. Appendix B, Section 2.3.3.
		B(a)P	533	2,666	Literature values. Appendix B, Section 2.3.3.
Retardation Factor (R)	-	PCP	82	8.4	Calculated based on Equation (9.14) in Freeze and Cherry (1979). Appendix B, Section 2.3.4.
		DEHP	1,100	130	
		B(a)P	26,000	3,000	
		Antimony	25,000	9,700	
		Zinc	53,000	22,500	
		Copper	160,000	25,000	
		Lead	1,200,000	550,000	

Notes

d = days

L/Kg = Liters per Kilogram

µg/L = micrograms per liter

DEHP = di(2-ethylhexyl) phthalate

(-) = input parameter units are dimensionless

PCP = pentachlorophenol

B(a)P = benzo(a)pyrene

GSI Water Solutions, Inc.

Table 5

Protective Vertical Separation Distances

City of Milwaukie, Oregon

Pollutant	MRL (µg/L)	Minimum Protective Vertical Separation Distance (feet)	
		Average Scenario	Reasonable Maximum Scenario
Lead [1]	0.1	0.00929	0.043
Benzo(a)pyrene	0.01	0.00145	0.02586
PCP	0.04	0.47	9.34
DEHP	1	0.029	0.52

Notes:

MRL = method reporting limit

µg/L = micrograms per liter

PCP = pentachlorophenol

DEHP = di(2-ethylhexyl)phthalate

[1] Metals transport simulations are longer than 13.75 days because metals do not biodegrade over time. Metals transport simulations assume 1000 years of transport at 13.75 days per year = 13,750 days of transport.

[2] The vertical separation distance in the unsaturated zone that is necessary for pollutant concentrations to attenuate to below the method reporting limit.

Table 6

Proposed Alternate Action Levels (UICs $\geq$ 1 Feet Vertical Separation Distance)

City of Milwaukie, Oregon

Pollutant	MRL (μg/L) [1]	Existing Action Level (μg/L) [2]	Alternate Action Level (μg/L) [3]	Output Concentration (μg/L) [4]	
				Average Scenario	Reasonable Maximum Scenario
Antimony	0.1	6	60	0	0
Copper	0.1	1,000	10,000	0	0
Zinc	0.5	5,000	50,000	0	0
DEHP	1	60	300	0	0

Notes:

μg/L = micrograms per liter

UCL = upper confidence limit

MRL = method reporting limit

DEHP = di(2-ethylhexyl)phthalate

[1] Method Reporting Limit (MRL) based on typically achievable MRLs during the Gresham winter 2009 - 2010 stormwater monitoring event.

[2] Existing Action Levels from the draft July 2012 UIC WPCF permit template

[3] Alternate Action Levels are based on the "average transport scenario" of the GWPD model and the assumption that groundwater is protected when pollutant concentrations just above the water table are below the MRL. The Alternate Action Level is the input concentration of the pollutant entering the UIC in the unsaturated zone GWPD model.

[4] Output concentration is the concentration below the UIC after 1 foot of transport.

Attachments

Attachment A

UIC Preliminary System-Wide Assessment

City of Milwaukie, Oregon

UIC ID	Address	Owner	Type	Qualifier	Raised	Longitude	Latitude	ADT	Impervious Area (square feet)	UIC Depth	Average Depth to Water (feet)	Seasonal High DTW (feet)	Surface Elevation	Vertical Separation Distance	Within 2 Year Time of Travel	Within 500ft of Private Well
Active UICs																
24006	4725 SE FIELDCREST AV	MILW	TYP1	NOT RAISED LOCATED UNDER BROKEN DRIVEWAY APPROACH.	Not Rasied	-122.614392	45.455626	<1000 ADT	55370	UNKNOWN	51.15	48.15	157.36	48.15		
24007	4718 SE FIELDCREST AV	MILW	TYP1	NOT RAISED BEHIND CURB, NEAR JAPANESE MAPLE.	Not Rasied	-122.614553	45.455533	<1000 ADT	53370	UNKNOWN	51.15	48.15	158.80	48.15		
24009	3898 SE WAKE ST	MILW	TYP1	NOT RAISED IN STREET.	Not Rasied	-122.622829	45.456972	<1000 ADT	46214	UNKNOWN	70.19	67.19	158.55	67.19		
24031	9920 SE STANLEY AV	MILW	TYP2	WEEK 2 MORE ON MAPLE, SOUTH OF ADDRESS**READ COMMENTS**		-122.604428	45.451298	>1000 ADT	8129	UNKNOWN	30.74	27.74	0.00	27.74		
24032	10114 SE STANLEY AV	MILW	TYP2	WEEK 2		-122.604442	45.449723	>1000 ADT	7248	UNKNOWN	43.66	40.66	0.00	40.66		
24033	5907 SE HECTOR ST	MILW				-122.602761	45.449794	<1000 ADT	12351	UNKNOWN	38.91	35.91	0.00	35.91		
34015	4489 SE MASON HILL DR	MILW	TYP1	NOT RAISED	Not Rasied	-122.616848	45.457049	<1000 ADT	37483	UNKNOWN	50.94	47.94	155.52	47.94		
34016	4508 SE MASON HILL DR	MILW	TYP1	NOT RAISED UNDER SMALL RETAINING WALL(BLOCKS) BEHIND SIDEWALK.	Not Rasied	-122.616371	45.456929	<1000 ADT	37483	UNKNOWN	50.94	47.94	155.46	47.94		
34019	4302 SE FIELDCREST DR	MILW	TYP1	NOT RAISED 5' BEHIND WATER METER BOX IN YARD.	Not Rasied	-122.618132	45.455054	<1000 ADT	34400	UNKNOWN	72.88	69.88	161.85	69.88		
34020	4705 SE FIELDCREST DR	MILW	TYP1	NOT RAISED IN GRASS.	Not Rasied	-122.614566	45.454959	<1000 ADT	40200	UNKNOWN	55.17	52.17	158.01	52.17		
34043	4674 SE ARDEN ST	MILW	TYP1	NOT RAISED IN GRASS YARD BEHIND CATCH BASIN.	Not Rasied	-122.615106	45.454084	<1000 ADT	37010	UNKNOWN	58.50	55.50	159.40	55.50		
34053	4906 SE WINWORTH CT	MILW	TYP1	NOT RAISED	Not Rasied	-122.611684	45.453031	<1000 ADT	63057	UNKNOWN	51.86	48.86	167.75	48.86		
34055	5082 SE WINWORTH CT	MILW	TYP1	NOT RAISED	Not Rasied	-122.610735	45.453034	<1000 ADT	32385	UNKNOWN	49.57	46.57	171.04	46.57		
34057	4823 SE WILLOW ST	MILW	TYP1	NOT RAISED	Not Rasied	-122.613368	45.452050	<1000 ADT	9452	UNKNOWN	57.78	54.78	163.03	54.78		
34062	9802 SE 50TH AV	MILW	TYP1	NOT RAISED	Not Rasied	-122.611162	45.452356	<1000 ADT	26782	UNKNOWN	54.34	51.34	174.58	51.34		
34063	4906 SE LEONE LN	MILW	TYP1	NOT RAISED	Not Rasied	-122.611673	45.451733	<1000 ADT	12776	UNKNOWN	56.25	53.25	173.52	53.25		
34064	4928 SE LEONE LN	MILW	TYP1	NOT RAISED	Not Rasied	-122.611590	45.451662	<1000 ADT	13776	UNKNOWN	58.49	55.49	173.82	55.49		
34072	10276 SE 56TH AV	MILW	TYP1	NOT RAISED	Not Rasied	-122.610743	45.448454	<1000 ADT	28855	UNKNOWN	63.75	60.75	184.70	60.75		
34078	10594 SE 47TH AV	MILW	TYP1	NOT RAISED UNDER SIDEWALK	Not Rasied	-122.614132	45.446645	<1000 ADT	65818	UNKNOWN	53.37	50.37	153.61	50.37		
34096	5445 SE WOODHAVEN ST	MILW	TYP1	NOT RAISED	Not Rasied	-122.606523	45.443084	<1000 ADT	36475	UNKNOWN	64.52	61.52	172.94	61.52		
34100	11015 SE 54TH AV	MILW	TYP1	NOT RAISED UNDER DRIVEWAY.	Not Rasied	-122.607646	45.443058	<1000 ADT	32357	UNKNOWN	56.42	53.42	165.60	53.42		
34104	11400 SE WOOD AV	MILW	TYP1	NOT RAISED	Not Rasied	-122.608657	45.440504	<1000 ADT	133879	UNKNOWN	54.15	51.15	153.92	51.15		
34117	5151 SE ELK ST	MILW	TYP1	NOT RAISED.	Not Rasied	-122.610570	45.444452	<1000 ADT	23304	UNKNOWN	52.92	49.92	156.62	49.92		
34118	11107 SE 51ST AV	MILW	TYP1	NOT RAISED	Not Rasied	-122.610909	45.443233	<1000 ADT	27969	UNKNOWN	53.14	50.14	155.79	50.14		
34120	11021 SE 52ND AV	MILW	TYP1	NOT RAISED	Not Rasied	-122.609779	45.443284	<1000 ADT	67385	UNKNOWN	53.51	50.51	157.74	50.51		
34132	5918 SE SUNDIAL CT	MILW	TYP1			-122.601920	45.440655	<1000 ADT	41260	UNKNOWN	67.53	64.53	185.01	64.53		
34142	5620 SE HARLOW ST	MILW	TYP1	NOT RAISED	Not Rasied	-122.605325	45.437930	<1000 ADT	35647	UNKNOWN	57.88	54.88	158.57	54.88		Yes
34149	10706 SE 52ND AV	MILW	TYP1	NOT RAISED	Not Rasied	-122.609144	45.445537	<1000 ADT	9060	UNKNOWN	57.98	54.98	169.37	54.98		
34160	4409 SE MELODY LN	MILW	TYP1	NOT RAISED	Not Rasied	-122.617274	45.451452	<1000 ADT	11927	UNKNOWN	74.29	71.29	151.63	71.29		
34189	4661 SE ARDEN ST	MILW	TYP1	NOT RAISED	Not Rasied	-122.615012	45.454168	<1000 ADT	7269	UNKNOWN	58.50	55.50	0.00	55.50		
34190	10000 SE WICHITA AV	MILW				-122.600770	45.450520	<1000 ADT	30030	UNKNOWN	24.41	21.41	36.00	21.41		
44006	11973 SE 33RD AV	MILW	TYP1	NOT RAISED	Not Rasied	-122.629735	45.436785	<1000 ADT	8402	UNKNOWN	44.95	41.95	0.00	41.95		
34186	3667 SE ROSWELL ST	MILW	TYP1	ON SOUTH END OF FIELD- MIDDLE OF PARK CAN NOT ACCESS WITH VACTOR		-122.624930	45.459054	<1000 ADT	0	9.83	59.10	56.10	0.00	46.27		
24008	5662 SE WILLOW ST	MILW	TYP1			-122.604421	45.452565	<1000 ADT	18068	10.92	14.08	11.08	140.75	0.16		
34134	5804 SE SUNDIAL CT	MILW	TYP1			-122.603330	45.440474	<1000 ADT	34208	12.00	65.79	62.79	179.09	50.79		
34167	11630 SE STANLEY AV	MILW	TYP1			-122.603436	45.439258	<1000 ADT	18034	12.00	59.19	56.19	162.50	44.19		
34187	3667 SE ROSWELL ST	MILW	TYP1	NORTH EAST SIDE OF PARK CAN NOT ACCESS WITH VACTOR		-122.624861	45.459401	<1000 ADT	0	13.75	59.10	56.10	0.00	42.35		
24025	4351 SE JACKSON ST	MILW	TYP1	ACROSS FROM THIS ADDRESS, ACTUALLY ON THE CHURCH PROPERTY		-122.617450	45.445817	<1000 ADT	7099	14.00	73.86	70.86	186.75	56.86		
34129	11114 SE 60TH AV	MILW	TYP1			-122.600810	45.442947	<1000 ADT	27731	14.60	70.90	67.90	197.85	53.30		Yes
34131	5922 SE DERDAN CT	MILW	TYP1			-122.601853	45.442174	<1000 ADT	17368	14.75	70.80	67.80	195.36	53.05		Yes
34085	10317 SE 46TH AV	MILW	TYP1			-122.615124	45.448144	<1000 ADT	18090	15.60	56.41	53.41	150.71	37.81		
34021	4710 SE FIELDCREST DR	MILW	TYP1			-122.614542	45.454843	<1000 ADT	40200	16.08	55.17	52.17	158.94	36.09		
34175	5238 SE PARK ST	MILW	TYP1			-122.609403	45.441290	<1000 ADT	19138	16.08	54.72	51.72	155.18	35.64		
34154	4703 SE MONROE ST	MILW	TYP2	WEEK 3		-122.614349	45.445229	>1000 ADT	22823	16.18	56.20	53.20	164.86	37.02		
24027	9878 SE STANLEY AV	MILW	TYP1	USED TO BE CLACKAMAS COUNTY		-122.604486	45.451968	<1000 ADT	7037	16.80	19.74	16.74	154.71	-6.00		
24029	4335 SE MONROE ST	MILW	TYP2	WEEK 3 WEST CORNER OF THE PROPERTY, ACTUALLY CLOSER TO THE CHURCH		-122.617922	45.445251	>1000 ADT	2547	17.00	70.32	67.32	185.81	50.32		
34025	4145 SE OLSEN ST	MILW	TYP2			-122.620413	45.454822	>1000 ADT	48261	17.93	81.94	78.94	156.60	61.01		Yes
34141	5565 SE HARLOW ST	MILW	TYP1			-122.605514	45.438041	<1000 ADT	35647	18.00	58.26	55.26	158.78	37.26		Yes
34146	4318 SE JEFFERSON ST	MILW	TYP1	ON SHOULDER NEAR FENCE.		-122.617392	45.444387	<1000 ADT	52189	18.11	67.85	64.85	181.65	46.74		
64001	4097 SE RIO VISTA ST	MILW	TYP2	WEEK 4		-122.621124	45.442355	<1000 ADT	5047	18.17	26.97	23.97	114.05	5.80		
34010	4264 SE MEADOWCREST CT	MILW	TYP1			-122.619290	45.457908	<1000 ADT	45987	18.25	59.37	56.37	157.35	38.12		
34181	11192 SE 52ND CT	MILW	TYP1			-122.610719	45.442421	<1000 ADT	9590	18.50	54.53	51.53	153.47	33.03		
34133	5840 SE SUNDIAL CT	MILW	TYP1			-122.602745	45.440488	<1000 ADT	20705	18.83	67.53	64.53	181.29	45.70		
34056	4889 SE ROBERTA LN	MILW	TYP1			-122.613681	45.452406	<1000 ADT	40983	19.00	61.71	58.71	162.50	39.71		
34130	5965 SE DERDAN CT	MILW	TYP1			-122.601224	45.442342	<1000 ADT	17367	19.00	72.64	69.64	195.16	50.64		Yes
34158	4766 SE WASHINGTON PL	MILW	TYP1			-122.613078	45.442974	<1000 ADT	3175	19.00	58.77	55.77	169.67	36.77		
34161	5129 SE KING RD	MILW	TYP2	WEEK 3		-122.610491	45.448048	>1000 ADT	29000	19.00	63.56	60.56	182.45	41.56		
34162	5253 SE KING RD	MILW	TYP2	WEEK 3		-122.609041	45.448051	>1000 ADT	24970	19.00	64.97	61.97	192.13	42.97		
34157	11168 SE 52ND AV	MILW	TYP1			-122.609773	45.442253	<1000 ADT	19730	19.33	53.31	50.31	154.85	30.98		
34054	5082 SE WINWORTH CT	MILW	TYP1			-122.610838	45.453033	<1000 ADT	32357	19.50	49.57	46.57	171.23	27.07		
34073	5011 SE KING RD	MILW	TYP2	WEEK 3		-122.611677	45.448056	>1000 ADT	146899	19.50	61.50	58.50	175.95	39.00		

Attachment A
UIC Preliminary System-Wide Assessment
City of Milwaukie, Oregon

UIC ID	Address	Owner	Type	Qualifier	Raised	Longitude	Latitude	ADT	Impervious Area (square feet)	UIC Depth	Average Depth to Water (feet)	Seasonal High DTW (feet)	Surface Elevation	Vertical Separation Distance	Within 2 Year Time of Travel	Within 500ft of Private Well
34097	5502 SE WOODHAVEN ST	MILW	TYP1			-122.606329	45.442985	<1000 ADT	36475	19.50	64.52	61.52	174.59	42.02		
34137	11557 SE 60TH AV	MILW	TYP2	WEEK 4		-122.600868	45.439578	<1000 ADT	85446	19.50	64.77	61.77	174.07	42.27	Yes	
34037	4402 SE HOWE ST	MILW	TYP2	WEEK 1		-122.617067	45.452702	>1000 ADT	33457	19.58	73.99	70.99	155.90	51.41		Yes
34069	4543 SE LOGUS RD	MILW	TYP2	WEEK 2		-122.615970	45.450520	>1000 ADT	60284	19.60	67.93	64.93	152.59	45.33		
34152	9667 SE 49TH AV	MILW	TYP2	WEEK 1		-122.612841	45.453050	>1000 ADT	14151	19.60	55.53	52.53	164.35	32.93		
34066	9903 SE 49TH AV	MILW	TYP2	WEEK 1		-122.612521	45.451132	>1000 ADT	35520	19.67	59.59	56.59	168.49	36.92		
34081	4501 SE RHODESA ST	MILW	TYP1			-122.616130	45.449826	<1000 ADT	68068	19.83	65.81	62.81	151.88	42.98		
34093	5510 SE JACKSON ST	MILW	TYP1			-122.606652	45.445390	<1000 ADT	122825	19.92	61.64	58.64	182.99	38.72		
34014	4422 SE MASON HILL DR	MILW	TYP1	2" BELOW GRASS AND SIDEWALK BEHIND CATCH BASIN.		-122.617693	45.456879	<1000 ADT	19250	20.00	57.02	54.02	159.95	34.02		
34047	9839 SE 43RD AV	MILW	TYP2	WEEK 2		-122.618569	45.451708	>1000 ADT	139485	20.00	86.44	83.44	155.05	63.44	Yes	
34065	4994 SE HARVEY ST	MILW	TYP1			-122.611218	45.451132	<1000 ADT	19305	20.00	57.55	54.55	174.65	34.55		
34074	4813 SE KING RD	MILW	TYP2	WEEK 3		-122.613213	45.448065	>1000 ADT	76314	20.00	58.01	55.01	157.75	35.01		
34095	5510 SE MONROE ST	MILW	TYP2	WEEK 3		-122.606415	45.444635	>1000 ADT	26080	20.00	63.96	60.96	184.27	40.96		
34155	5732 SE LLOYD ST	MILW	TYP1			-122.604203	45.439218	<1000 ADT	20755	20.00	58.13	55.13	160.34	35.13		
34083	4585 SE WHITE LAKE RD	MILW	TYP1			-122.615290	45.449184	<1000 ADT	38490	20.60	61.85	58.85	150.61	38.25		
24024	10112 SE 54TH CT	MILW	TYP1			-122.607246	45.449690	<1000 ADT	7133	21.00	49.96	46.96	182.02	25.96		
34042	9626 SE 49TH AV	MILW	TYP2	WEEK 1		-122.612822	45.453124	>1000 ADT	14157	21.00	53.17	50.17	163.52	29.17		
34050	4345 SE KING RD	MILW	TYP2	WEEK 3		-122.617127	45.448000	>1000 ADT	21092	21.00	68.25	65.25	165.26	44.25		
34068	4479 SE LOGUS RD	MILW	TYP2	WEEK 2		-122.616752	45.450524	>1000 ADT	60284	21.00	71.08	68.08	152.71	47.08		
34136	11576 SE 59TH AV	MILW	TYP2	WEEK 4		-122.601816	45.439943	<1000 ADT	26180	21.00	65.02	62.02	174.27	34.02	Yes	
34168	4404 SE KING RD	MILW	TYP2	WEEK 3		-122.616805	45.447982	>1000 ADT	3978	21.00	68.25	65.25	162.48	44.25		
34125	5092 SE HUNTER CT	MILW	TYP1			-122.610738	45.440379	<1000 ADT	44510	21.30	60.42	57.42	163.27	36.12		
34071	10143 SE 49TH AV	MILW	TYP2	WEEK 2		-122.612623	45.449597	>1000 ADT	36113	21.33	62.05	59.05	173.46	59.05		
34159	4726 SE WASHINGTON PL	MILW	TYP1			-122.613242	45.442880	<1000 ADT	4888	21.33	58.77	55.77	171.37	34.44		
44004	10271 SE 54TH AV	MILW	TYP1			-122.607523	45.449255	<1000 ADT	2004	21.50	54.36	51.36	191.32	29.86		
44005	10271 SE 54TH AV	MILW	TYP1			-122.607526	45.449204	<1000 ADT	2004	21.50	54.36	51.36	192.74	29.86		
34182	5770 SE KING RD	MILW	TYP2	WEEK 3		-122.604260	45.447915	>1000 ADT	33796	21.58	53.36	50.36	186.74	28.78		
34035	9616 SE 43RD AV	MILW	TYP2	WEEK 1 ACTUALLY ON ROCKWOOD AT 44TH COURT, IN THE SIDE (NORTH) YARD OF THIS ADDRESS		-122.617949	45.453664	>1000 ADT	32632	21.80	77.52	74.52	157.42	52.72	Yes	Yes
34180	4314 SE HARRISON ST	MILW	TYP1	ACROSS THE STREET FROM THIS ADDRESS		-122.617728	45.446648	<1000 ADT	2782	21.92	74.68	71.68	184.73	50.57		
34046	9660 SE 43RD AV	MILW	TYP2	WEEK 1		-122.618429	45.452911	>1000 ADT	25062	22.00	88.64	85.64	157.63	65.84	Yes	Yes
34121	4745 SE WASHINGTON PL	MILW	TYP1			-122.613075	45.443283	<1000 ADT	8439	22.00	58.77	55.77	167.07	33.77		
34135	11496 SE 59TH AV	MILW	TYP2	WEEK 4		-122.601738	45.439957	<1000 ADT	18642	22.00	64.77	61.77	174.86	39.77	Yes	
34176	9918 SE 43RD AV	MILW	TYP2	WEEK 2		-122.618401	45.451205	>1000 ADT	3880	22.00	86.44	83.44	155.56	61.44	Yes	
34105	10708 SE HOME AV	MILW	TYP1			-122.611684	45.445803	<1000 ADT	64775	22.08	52.69	49.69	157.79	27.61		
34082	4526 SE WHITE LAKE RD	MILW	TYP1			-122.616210	45.449085	<1000 ADT	17152	22.60	64.31	61.31	152.85	38.71		
34124	4706 SE ADAMS ST	MILW	TYP1			-122.614096	45.442120	<1000 ADT	52161	22.63	64.61	61.61	177.53	39.01		
34179	4314 SE HARRISON ST	MILW	TYP1	ACROSS THE STREET FROM THIS ADDRESS		-122.617760	45.446647	<1000 ADT	2782	22.92	74.68	71.68	185.00	49.57		
34007	4205 SE ROSWELL ST	MILW	TYP1			-122.619615	45.458827	<1000 ADT	43509	23.00	45.37	42.37	150.37	23.04		
34032	4207 SE HARVEY ST	MILW	TYP2	WEEK 2		-122.619517	45.451329	<1000 ADT	80170	23.00	94.96	91.96	162.44	69.96	Yes	
34184	4572 SE KING RD	MILW	TYP2	WEEK 3		-122.615282	45.447952	>1000 ADT	7652	23.00	56.41	53.41	152.01	30.41		
34044	4802 SE ARDEN ST	MILW	TYP1			-122.613710	45.454118	<1000 ADT	58917	23.08	54.94	51.94	161.19	28.86		
34150	5486 SE HARLENE ST	MILW	TYP1			-122.606796	45.442150	<1000 ADT	54778	23.11	59.93	56.93	167.76	33.82		
44001	3206 SE WISTER ST	MILW	TYP1			-122.629706	45.438496	<1000 ADT	58127	23.17	46.38	43.38	0.00	20.21		
24018	5844 SE HARRISON ST	MILW	TYP1			-122.602345	45.446119	<1000 ADT	120923	23.30	57.32	54.32	183.86	31.02		Yes
34031	9738 SE 42ND AV	MILW	TYP2	WEEK 2		-122.620121	45.452766	>1000 ADT	90921	23.30	94.32	91.32	158.49	68.02	Yes	Yes
34058	5123 SE JACKSON ST	MILW	TYP1			-122.610304	45.445861	<1000 ADT	7440	23.50	56.14	53.14	165.31	29.64		
34119	11102 SE 51ST AV	MILW	TYP1			-122.610742	45.443069	<1000 ADT	27970	23.50	53.41	50.41	154.40	26.91		
34183	5880 SE KING RD	MILW	TYP2	WEEK 3		-122.602708	45.447910	>1000 ADT	12744	23.58	48.54	45.54	177.76	21.96		
34033	4243 SE HARVEY ST	MILW	TYP2	WEEK 2		-122.619583	45.450734	<1000 ADT	30834	24.00	91.88	88.88	169.02	64.88	Yes	Yes
34059	4828 SE WILLOW ST	MILW	TYP1			-122.613328	45.452006	<1000 ADT	9452	24.00	57.78	54.78	162.86	30.78		
34102	11003 SE WOOD AV	MILW	TYP1			-122.608715	45.443688	<1000 ADT	36908	24.00	56.03	53.03	164.79	29.03		
34128	11114 SE 60TH AV	MILW	TYP1			-122.600851	45.442936	<1000 ADT	27730	24.00	70.90	67.90	197.39	43.90		Yes
44003	2636 SE GINO LN	MILW	TYP1			-122.635349	45.437784	<1000 ADT	55412	24.00	150.00	9.33	0.00	-9.17		
34076	10508 SE 47TH AV	MILW	TYP1			-122.614255	45.447236	<1000 ADT	70070	24.30	53.07	50.07	151.24	26.07		
34012	8983 SE 41ST AV	MILW	TYP1			-122.621386	45.457590	<1000 ADT	5280	25.00	65.91	62.91	162.31	37.91		
34013	4102 SE WAKE CT	MILW	TYP1			-122.621291	45.456756	<1000 ADT	20956	25.00	69.30	66.30	158.72	41.30		Yes
34051	4345 SE KING RD	MILW	TYP2	WEEK 3		-122.617033	45.448000	>1000 ADT	21092	25.00	68.25	65.25	164.26	40.25		
34084	10317 SE 46TH AV	MILW	TYP1			-122.615136	45.448379	<1000 ADT	280915	25.00	59.16	56.16	149.90	43.96		
34086	3515 SE SHERRY LN	MILW	TYP1			-122.626687	45.452304	<1000 ADT	24206	25.00	92.85	89.85	168.77	64.85		
34138	5866 SE LLOYD ST	MILW	TYP2	WEEK 4		-122.602303	45.439283	<1000 ADT	16747	25.00	61.25	58.25	168.68	33.25	Yes	
34039	4629 SE ROCKWOOD ST	MILW	TYP2			-122.615682	45.453641	>1000 ADT	27331	25.25	67.08	64.08	160.01	38.83		

Attachment A

UIC Preliminary System-Wide Assessment

City of Milwaukie, Oregon

UIC ID	Address	Owner	Type	Qualifier	Raised	Longitude	Latitude	ADT	Impervious Area (square feet)	UIC Depth	Average Depth to Water (feet)	Seasonal High DTW (feet)	Surface Elevation	Vertical Separation Distance	Within 2 Year Time of Travel	Within 500ft of Private Well
34164	4201 SE MEADOWCREST CT	MILW	TYP1			-122.620048	45.458268	<1000 ADT	2398	25.40	52.15	49.15	155.46	23.75		
34185	4664 SE KING RD	MILW	TYP2	WEEK 3		-122.614809	45.447997	>1000 ADT	3481	25.42	56.41	53.41	4.00	27.99		
34079	10593 SE 47TH AV	MILW	TYP1			-122.614503	45.446623	<1000 ADT	65818	25.50	57.18	54.18	155.39	28.68		
34101	5181 SE MONROE ST	MILW	TYP2	WEEK 3		-122.609417	45.445179	>1000 ADT	41360	25.50	56.35	53.35	167.18	27.85		
34126	11016 SE 60TH AV	MILW	TYP1			-122.600801	45.443664	<1000 ADT	36296	25.58	73.27	70.27	196.78	44.69		
34139	11221 SE LINWOOD AV	MILW	TYP1			-122.599279	45.442087	<1000 ADT	10527	25.92	71.60	68.60	194.92	42.68		Yes
34052	4664 SE KING RD	MILW	TYP2	WEEK 3		-122.614727	45.447945	>1000 ADT	86826	26.00	56.41	53.41	151.23	27.30		
34191	10125 SE HOLLYWOOD AV	MILW		LOC AT SOUTHERN PROPERTY LINE OF ADDRESS, ON HOLLYWOOD		-122.602658	45.448322	<1000 ADT	1790	26.00	45.10	42.10	0.00	42.10		
34192	10144 SE 49TH AV	MILW	TYP2	WEEK 2		-122.612476	45.449444	>1000 ADT	4911	26.00	62.05	59.05	0.00	33.05		
34036	9656 SE 44TH AV	MILW	TYP1			-122.617054	45.453077	<1000 ADT	65144	26.08	73.99	70.99	155.71	44.91		Yes
34148	5225 SE JACKSON ST	MILW	TYP1			-122.609222	45.445762	<1000 ADT	35084	26.11	57.98	54.98	169.25	28.87		
24023	5404 SE LOGUS RD	MILW	TYP2	WEEK 2		-122.607280	45.450387	>1000 ADT	13628	26.20	45.43	42.43	178.84	16.23		
34147	9523 SE 40TH AV	MILW	TYP2			-122.622262	45.454084	<1000 ADT	42701	26.20	92.29	89.29	162.16	63.09	Yes	
34151	9667 SE 49TH AV	MILW	TYP2	WEEK 1		-122.612898	45.453114	>1000 ADT	14153	26.20	53.17	50.17	164.72	23.97		
34107	10750 SE HOME AV	MILW	TYP2	WEEK 3		-122.611737	45.445214	>1000 ADT	9742	26.30	52.80	49.80	156.23	23.50		
24011	9941 SE STANLEY AV	MILW	TYP2	WEEK 2		-122.604662	45.450459	>1000 ADT	80500	26.33	37.79	34.79	169.51	8.46		
34060	4828 SE WILLOW ST	MILW	TYP1			-122.613294	45.452012	<1000 ADT	9453	26.58	57.78	54.78	162.92	28.20		
34040	4813 SE ROCKWOOD ST	MILW	TYP2	WEEK 1		-122.613502	45.453246	>1000 ADT	18255	27.00	57.59	54.59	162.36	27.59		
34077	10593 SE 47TH AV	MILW	TYP1			-122.614407	45.446726	<1000 ADT	65818	27.00	57.18	54.18	153.10	27.18		
34110	10722 SE 55TH AV	MILW	TYP1			-122.606658	45.444787	<1000 ADT	25752	27.00	63.34	60.34	182.14	35.64		
34173	9712 SE 46TH AV	MILW	TYP1			-122.615370	45.452817	<1000 ADT	26926	27.00	68.78	65.78	161.20	38.78		
34027	9405 SE 42ND AV	MILW	TYP2	WEEK 1 NEED FLAGGERS FOR CLEANING		-122.620217	45.454567	>1000 ADT	150788	27.20	81.94	78.94	156.61	51.74	Yes	
34088	10236 SE 41ST CT	MILW	TYP1	CUP MEDALLION		-122.620227	45.449127	<1000 ADT	27720	27.42	91.44	88.44	186.77	61.02		Yes
34098	5464 SE WOODHAVEN ST	MILW	TYP1			-122.606691	45.443018	<1000 ADT	36177	27.67	59.03	56.03	171.15	28.36		
34075	10463 SE 47TH AV	MILW	TYP1			-122.614412	45.447576	<1000 ADT	70069	28.00	56.56	53.56	149.61	26.56		
34090	10527 SE 44TH AV	MILW	TYP1	ACTUALLY ON HARRISON, SOUTH EAST OF PROPERTY LISTED		-122.617093	45.446666	<1000 ADT	144511	28.00	69.80	66.80	179.34	38.80		
34029	9475 SE 40TH AV	MILW	TYP1	WEEK 1		-122.622262	45.454301	>1000 ADT	50464	28.11	92.29	89.29	161.16	61.18	Yes	
34023	3739 SE OLSEN ST	MILW	TYP2	WEEK 1		-122.623664	45.454860	>1000 ADT	39900	28.17	87.00	84.00	160.58	55.83		
34122	4705 SE WASHINGTON ST	MILW	TYP2	WEEK 4		-122.614004	45.443034	>1000 ADT	4142	28.30	62.34	59.34	174.26	31.04		
34106	4993 SE MONROE ST	MILW	TYP2			-122.612120	45.445195	>1000 ADT	11047	28.33	52.80	49.80	154.91	21.47		
34061	9827 SE 49TH AV	MILW	TYP2	WEEK 1		-122.612599	45.452162	>1000 ADT	58253	28.43	57.78	54.78	166.03	26.35		
34145	11192 SE 52ND CT	MILW	TYP1			-122.610641	45.442345	<1000 ADT	32823	29.00	54.53	51.53	153.17	22.53		
44002	11855 SE 32ND AV	MILW	TYP1	UNDER LOW HANGING POWER LINES, HARD TO CLEAN		-122.630365	45.437804	<1000 ADT	9070	29.00	43.07	40.07	0.00	11.07		
34112	11104 SE HOME AV	MILW	TYP2	WEEK 4		-122.611879	45.442887	>1000 ADT	25752	29.10	56.53	53.53	164.07	24.43		
34009	8954 SE 43RD AV	MILW	TYP1			-122.618415	45.458294	<1000 ADT	45987	29.20	50.71	47.71	158.31	18.51		
34022	4710 SE FIELDCREST DR	MILW	TYP1			-122.614666	45.454906	<1000 ADT	40200	29.42	55.17	52.17	157.83	22.75		
24021	5838 SE MONROE ST	MILW	TYP2	WEEK 3		-122.602094	45.444602	>1000 ADT	33809	29.50	69.81	66.81	201.98	37.31		Yes
34030	9631 SE 42ND AV	MILW	TYP2	WEEK 1		-122.620212	45.453502	>1000 ADT	24907	29.50	95.29	92.29	157.09	62.79	Yes	Yes
34070	4705 SE LOGUS RD	MILW	TYP2	WEEK 2 IN BARKDUST, BEHIND BUSHES		-122.614700	45.450534	>1000 ADT	60284	29.50	66.25	63.25	160.89	33.75		
34024	3739 SE OLSEN ST	MILW	TYP2	WEEK 1		-122.623687	45.454804	>1000 ADT	39900	29.58	87.00	84.00	161.01	54.42		
34008	8929 SE 42ND AV	MILW	TYP2	WEEK 1 ON ROSWELL		-122.620391	45.458527	>1000 ADT	127501	29.80	55.38	52.38	153.26	22.58		
34099	11015 SE 54TH AV	MILW	TYP1			-122.607545	45.443130	<1000 ADT	32356	29.92	59.03	56.03	165.84	26.11		
34067	9907 SE 48TH AV	MILW	TYP1	DRYWELL IS DEEPER THAN 30 FT, BUT ONLY HAVE ENOUGH TUBES ON VACTOR TO CLEAN TO 30 FT.		-122.613772	45.451270	<1000 ADT	41711	30.00	63.32	60.32	163.17	30.32		
34169	4545 SE GARRETT CR	MILW	TYP1			-122.615460	45.444339	<1000 ADT	19250	30.00	64.98	61.98	177.59	31.98		
34111	11017 SE HOME AV	MILW	TYP2	WEEK 4		-122.611828	45.443344	>1000 ADT	25752	30.30	56.53	53.53	161.08	23.23		
34127	11002 SE 60TH AV	MILW	TYP1			-122.600687	45.443603	<1000 ADT	36296	30.30	70.05	67.05	198.03	36.75		
34113	11104 SE HOME AV	MILW	TYP2	WEEK 4		-122.611889	45.442819	>1000 ADT	25751	30.67	56.53	53.53	164.45	22.86		
34011	4764 SE LOGUS RD	MILW	TYP2	WEEK 2		-122.613959	45.450456	>1000 ADT	45987	31.00	63.76	60.76	164.81	29.76		
34143	11262 SE 48TH CT	MILW	TYP1			-122.613042	45.441649	<1000 ADT	9282	31.20	62.36	59.36	170.98	28.16		
34156	4645 SE WASHINGTON ST	MILW	TYP2	WEEK 4		-122.614146	45.443012	>1000 ADT	9522	31.20	62.34	59.34	173.74	28.14		
34103	11003 SE WOOD AV	MILW	TYP1			-122.608724	45.443595	<1000 ADT	36911	31.42	56.03	53.03	164.46	21.61		
24014	10294 SE 36TH AV	MILW	TYP1			-122.625985	45.448940	<1000 ADT	76621	31.90	77.49	74.49	165.06	46.91		
34114	11112 SE HOME AV	MILW	TYP2	WEEK 4		-122.611908	45.442662	>1000 ADT	25751	32.00	58.52	55.52	164.73	23.52		
34116	5001 SE PARK ST	MILW	TYP2	WEEK 4 AT INTERSECTION; ON HOME AVE		-122.611876	45.441437	>1000 ADT	31706	32.00	61.14	58.14	168.30	26.14		
34080	4751 SE HARRISON ST	MILW	TYP1			-122.613844	45.446570	<1000 ADT	65818	32.08	53.37	50.37	152.29	18.29		
34140	4341 SE ROCKWOOD ST	MILW	TYP1	DRYWELL IS ACTUALLY IN 44TH CT TO THE WEST OF ADDRESS		-122.617924	45.453945	<1000 ADT	9957	32.60	74.81	71.81	155.43	39.21	Yes	Yes
34144	11192 SE 52ND CT	MILW	TYP1			-122.610651	45.442388	<1000 ADT	32818	32.60	54.53	51.53	153.04	18.93		
24013	5206 SE LOGUS RD	MILW	TYP2	WEEK 2		-122.609425	45.450420	>1000 ADT	28338	33.30	51.73	48.73	177.33	15.43		
24003	3898 SE WAKE ST	MILW	TYP1	BUIRED		-122.622767	45.456873	<1000 ADT	34442	33.50	70.19	67.19	158.22	33.69		
34045	9665 SE 43RD AV	MILW	TYP2	WEEK 1		-122.618559	45.452972	>1000 ADT	26500	33.50	88.64	85.64	157.32	52.14	Yes	Yes
34115	11134 SE HOME AV	MILW	TYP2	WEEK 4		-122.611900	45.442533	>1000 ADT	25751	33.60	58.52	55.52	165.37	21.92		

UIC ID	Address	Owner	Type	Qualifier	Raised	Longitude	Latitude	ADT	Impervious Area (square feet)	UIC Depth	Average Depth to Water (feet)	Seasonal High DTW (feet)	Surface Elevation	Vertical Separation Distance	Within 2 Year Time of Travel	Within 500ft of Private Well
24010	10256 SE 38TH AV	MILW	TYP1			-122.623405	45.449253	<1000 ADT	46214	33.70	88.81	85.81	176.37	52.11		
34049	4215 SE KING RD	MILW	TYP2	WEEK 3		-122.618615	45.448037	>1000 ADT	5250	33.83	81.83	78.83	183.37	44.83		
24004	9040 SE 39TH AV	MILW	TYP1	BEHIND CURB IN DIRT		-122.622550	45.456916	<1000 ADT	34442	34.00	70.19	67.19	159.16	33.19		
34087	10205 SE 41ST CT	MILW	TYP1	CUP MEDALLION		-122.621115	45.449139	<1000 ADT	27719	34.00	94.83	91.83	187.93	57.83		Yes
34091	10477 SE 53RD PL	MILW	TYP1			-122.608009	45.447590	<1000 ADT	19673	34.00	63.94	60.94	192.18	26.94		
34092	10592 SE 55TH AV	MILW	TYP1			-122.606600	45.446406	>1000 ADT	29467	34.30	68.46	65.46	193.15	31.16		
34048	10360 SE 43RD AV	MILW	TYP2	WEEK 3		-122.618476	45.448429	>1000 ADT	9227	34.70	83.03	80.03	175.48	45.33		
24015	10229 SE 38TH AV	MILW	TYP1			-122.623579	45.449099	<1000 ADT	93384	35.00	88.81	85.81	176.37	50.81		
34108	4993 SE MONROE ST	MILW	TYP2	WEEK 3		-122.612229	45.445201	>1000 ADT	21816	35.00	52.80	49.80	154.78	14.80		
34034	4341 SE ROCKWOOD ST	MILW	TYP2	WEEK 1		-122.617913	45.453768	<1000 ADT	32632	35.50	77.52	74.52	156.02	39.02	Yes	Yes
34109	4972 SE MONROE ST	MILW	TYP2	WEEK 3 APPROX. 15' SOUTH OF PHONE POLE ON EAST SIDE OF FENCE		-122.611966	45.445032	>1000 ADT	25751	35.50	52.80	49.80	154.90	14.30		
24012	5621 SE LOGUS RD	MILW	TYP2	WEEK 2		-122.606137	45.450463	>1000 ADT	12094	36.00	42.18	39.18	174.07	3.18		
34094	10722 SE 55TH AV	MILW	TYP1			-122.606657	45.444829	<1000 ADT	13853	36.50	63.34	60.34	182.02	36.24		
Inactive UICs																
34028	4200 SE COVELL ST	MILW	TYP1	DECOMMISSIONED		-122.619851	45.454648	<1000 ADT	21105	0.00	80.24	77.24	155.78	77.24		
34153	11800 SE STANLEY AV	MILW		WAS A WEEK 4 THIS IS NOW A SEDIMENTATION MANHOLE. DRYWELL RECORDS SAVED. 31055 IS CURRENT MANHOLE NUMBER		-122.602973	45.438233		60571	5.67	58.33	2.00	159.65	0.00	Yes	Yes
34041	4813 SE ROCKWOOD ST	MILW	TYP2	NOT RAISED. UNDER DRIVEWAY BEHIND CATCH BASIN.	Not Rasied	-122.613509	45.453297	>1000 ADT	18255	0.00	57.59	54.59	162.64	54.59		
24028	10425 SE 42ND AV	MILW	TYP2	DISCONNECTED BUT NOT DECOM'D		-122.619663	45.447985	>1000 ADT	0	0.00	86.33	83.33	189.25	83.33		
34017	4207 SE FIELDCREST AV	MILW	TYP1	NOT RAISED DISCONNECTED BUT NOT DECOM'D	Not Rasied	-122.619674	45.455548	<1000 ADT	15340	0.00	75.06	72.06	159.01	72.06		Yes
34026	9393 SE 42ND AV	MILW	TYP2	NOT RAISED UNDER CONCRETE DRIVEWAY, DISCONNECTED	Not Rasied	-122.620296	45.454856	>1000 ADT	46261	0.00	81.94	78.94	156.59	78.94		Yes
34123	11121 SE 47TH AV	MILW	TYP2	NOT RAISED DISCONNECTED BUT NOT DECOM'D	Not Rasied	-122.614276	45.442962	>1000 ADT	63181	0.00	62.34	59.34	173.63	59.34		
34174	4645 SE WASHINGTON ST	MILW	TYP2	NOT RAISED DISCONNECTED FROM SYSTEM	Not Rasied	-122.614186	45.443072	>1000 ADT	22406	0.00	62.34	59.34	172.83	59.34		
24026	3305 SE MARY CT	MILW	TYP1	DISCONNECTED BUT NOT DECOMMISSIONED (HOME OWNER SOMETIMES BURRIES)		-122.628875	45.460196	<1000 ADT	24273	13.40	54.36	51.36	145.49	37.96		
34018	4212 SE FIELDCREST	MILW	TYP1	RAISED AND DISCONNECTED, NOT DECOM'D		-122.619679	45.455437	<1000 ADT	15340	22.00	75.06	72.06	159.06	50.06		Yes
34005	8731 SE 40TH AV	MILW	TYP2	DISCONNECTED BUT NOT DECOM'D		-122.622076	45.459456	>1000 ADT	29601	23.00	46.39	43.39	150.96	20.39		
34006	8685 SE 41ST AV	MILW	TYP1	DISCONNECTED BUT NOT DECOM'D		-122.621149	45.460202	<1000 ADT	78921	24.50	43.25	40.25	148.93	15.75		
34004	8731 SE 40TH AV	MILW	TYP2	DISCONNECTED BUT NOT DECOM'D		-122.622073	45.459526	>1000 ADT	29599	30.60	46.39	43.39	151.18	12.79		
34003	8731 SE 40TH AV	MILW	TYP2	DISCONNECTED BUT NOT DECOM'D		-122.622077	45.459506	>1000 ADT	29599	33.50	46.39	43.39	151.11	9.89		

Notes

WET FEET UICs
DRY FEET UICs WITH < 1.0 FEET SEPARATION DISTANCE

ADT = Average Daily Trips
UIC = Underground Injection Control
DTW = Depth to Water

Attachment B – Technical Documentation for the Unsaturated Zone GWPD

1 Pollutant Fate and Transport Processes

An Underground Injection Control (UIC) device allows stormwater to infiltrate into the unsaturated zone (i.e., variably saturated soils above the water table). The stormwater is transported downward by matric forces that hold the water close to mineral grain surfaces. During transport, pollutant concentrations are attenuated by the following processes:

- **Volatilization.** Volatilization is pollutant attenuation by transfer from the dissolved phase to the vapor phase. Because soil pores in the unsaturated zone are only partially filled with water, chemicals with a high vapor pressure volatilize into the vapor phase. The propensity of a pollutant to volatilize is described by the Henry's constant. Because volatilization is not significant at depths below most UIC bottoms (USEPA, 2001), volatilization is not included in the unsaturated zone Groundwater Protectiveness Demonstration (GWPD).

- **Adsorption.** Adsorption is pollutant attenuation by partitioning of substances in the liquid phase onto the surface of a solid substrate. Physical adsorption is caused mainly by Van der Waals forces and electrostatic forces between the pollutant molecule and the ions of the solid substrate molecule's surface. For organic pollutants, the unsaturated zone GWPD simulates adsorption is a function of f_{oc} (fraction organic compound) and K_{oc} (organic carbon partitioning coefficient). For metals, the unsaturated zone GWPD uses stormwater analytical data to estimate adsorption.

- **Degradation.** Degradation is pollutant attenuation by biotic and abiotic processes. Abiotic degradation includes hydrolysis, oxidation-reduction, and photolysis. Biotic degradation involves microorganisms metabolizing pollutants through biochemical reactions.

- **Dispersion.** Dispersion describes pollutant attenuation from pore water mixing, which occurs because of differences in subsurface permeability.

2 Pollutant Fate and Transport Input Parameters

The unsaturated zone GWPD consists of an analytical model that simulates the effects of adsorption, degradation, and dispersion based on user-specified input parameters from selected references and available regulatory guidance. Input parameters to the unsaturated zone GWPD model include soil properties, organic carbon content in the subsurface, and pollutant properties, as described in the following sections:

- Soil properties
    - Total porosity and effective porosity (Section 2.1.1)
    - Soil bulk density (Section 2.1.2)
    - Dispersion coefficient and dispersivity (Section 2.1.3)
    - Average linear pore water velocity (Section 2.1.4)
- Organic carbon content of the subsurface
    - Fraction organic carbon (Section 2.2.1)
- Pollutant properties
    - Organic carbon partitioning coefficient (Section 2.3.1)
    - Distribution coefficient (Section 2.3.2)
    - Degradation rate constant and half life (Section 2.3.3)
    - Retardation factor (Section 2.3.4)

2.1 Soil Properties

Soil properties include total porosity, effective porosity, soil bulk density, dispersivity/dispersion coefficient, and average linear pore water velocity.

2.1.1 Total Porosity (η) and Effective Porosity (η_e)

Total porosity is the percent of pore space in a material. Porosities are correlated with soil type (e.g., sand, silt, gravel), and were estimated from Table 2.4 of Freeze and Cherry (1979). Specifically, the midrage porosity was used. Effective porosity is the percent of pore space through which flow occurs, as was estimated as 0.31 for the USA hydrogeologic unit from USGS (2008)

2.1.2 Soil Bulk Density (ρ_b)

Bulk density is the density of a soil, including soil particles and pore space. According to Freeze and Cherry (1979), bulk density is calculated from total porosity by the following formula:

$$\rho_b = 2.65(1-\eta) \tag{B.1}$$

2.1.3 Dispersion Coefficient (D) and Dispersivity (α)

Dispersion is the spreading of a pollutant plume caused by differential advection. The dispersion coefficient, D, is defined as:

$$D = \alpha\ v \tag{B.2}$$

where:

v is average linear pore water velocity (L/T), and
α is longitudinal dispersivity (L).

The dispersivity (and therefore the dispersion coefficient) is a scale-dependent parameter. According to a review of tracer tests conducted under saturated conditions, dispersivity is estimated as (Gelhar et al., 1992):

$$\alpha \leq \frac{L}{10} \tag{B.3}$$

where:

L is the length scale of transport (i.e., separation distance) (L).

However, according to a review of tracer tests conducted in the unsaturated zone, dispersivity can be significantly less than would be estimated by Equation (B.3) (Gehlar et al., 1985):

$$\frac{L}{10} \leq \alpha \leq \frac{L}{100} \tag{B.4}$$

Because the unsaturated zone under the UICs is at near-saturated conditions, this technical memorandum assumes that $\alpha_L = \frac{L}{20}$, which is less than saturated dispersivity, but is on the high end of the reported range in unsaturated dispersivity.

2.1.4 Average Linear Pore Water Velocity (v)

Average linear pore water velocity is the rate that water moves vertically through the unsaturated zone, and is directly proportional to soil moisture content (i.e., pore water velocity increases as soil moisture content increases). Soil moisture content is the percent of water in soil, and is equal to or less than porosity. The unsaturated zone GWPD conservatively assumes that soils are fully saturated, which is likely representative of actual conditions because of the near-constant infiltration of water during the rainy season.

Darcy's Law is (Stephens, 1996):

$$v = -K_u\left(\frac{\partial\psi}{\partial y} + \frac{\partial y}{\partial y}\right) \tag{B.5}$$

where:

v is specific discharge (L/T),

K_u is unsaturated hydraulic conductivity (L/T), estimated from infiltration tests,

$\left(\frac{\partial\psi}{\partial y}\right)$ is the pressure gradient (L/L), and

$\left(\frac{\partial y}{\partial y}\right)$ is the head gradient (L/L).

In the unsaturated zone, $\left(\frac{\partial y}{\partial y}\right) = 1$. When the unsaturated zone is stratified and pressure head is averaged over many layers (which is the case in Portland Basin sediments), $\left(\frac{\partial\psi}{\partial y}\right) = 0$. Under these conditions, equation (B.5) reduces to (Stephens, 1996):

$$v = -K_u \tag{B.6}$$

Average linear pore water velocity is calculated by dividing Equation B.6 by 0.31, the effective porosity of the USA hydrogeologic unit (USGS, 2008).

2.2 Organic Carbon Content in the Subsurface

The organic carbon content in the subsurface is parameterized by fraction organic carbon, a dimensionless measure of the quantity of organic carbon in soil (i.e., g_{carbon} / g_{soil}). Carbon in unsaturated soil beneath a UIC is derived from two sources:

- Organic carbon incorporated into sediments during deposition
- Particulate matter (e.g., degraded leaves, pine needles, pollen, etc.) that is filtered out of stormwater and accumulates in unsaturated soil adjacent to UICs as stormwater discharges from the UIC

Organic carbon incorporated into the Portland Basin sediments (i.e., Missoula Flood Deposits) during deposition is relatively low; therefore, the unsaturated zone GWPD only considers organic carbon that accumulates in the unsaturated zone soils due to filtering of particulate matter in stormwater.

2.2.1 Fraction Organic Carbon (f_{oc})

Stormwater contains organic carbon from degraded leaves, pine needles, pollen, etc. As stormwater infiltrates into the unsaturated zone surrounding the UIC, the organic carbon is filtered out of solution and the f_{oc} in soil increases over time because of the ongoing addition of organic carbon. An estimate of f_{oc} based on the accumulation of carbon in unsaturated soil was derived by calculating the grams of organic carbon added to unsaturated materials surrounding the UIC during a 10-year period. A 10-year accumulation period was selected because literature evaluating the longevity of organic material in bioretention cells indicates that it lasts about 20 years before it begins to degrade (Weiss et al, 2008). The following equations were used in the analysis:

$$I = (A)(p)(1-e) \tag{B.7}$$

$$CL = (I)(C)(t)\left(\frac{1\,\text{liter}}{1{,}000\,\text{cm}^3}\right)\left(\frac{1\,\text{gram}}{1{,}000\ \text{milligrams}}\right) \tag{B.8}$$

$$\rho_{oc} = \frac{CL}{SV} \tag{B.9}$$

$$f_{oc} = \frac{\rho_{oc}}{\rho_b + \rho_{oc}} \tag{B.10}$$

where:

- I = Average annual stormwater infiltration volume (cubic feet per year)
- A = Area of a typical UIC catchment (square feet)
- p = Precipitation (feet per year)
- e = Evaporative loss fraction (dimensionless)
- CL = Organic carbon loaded into the unsaturated zone beneath a UIC during a 10-year period (grams)

C = TOC concentration in stormwater (milligrams per liter)
t = Time of carbon loading (years)
ρ_{oc} = Organic carbon weight per unit unsaturated zone material volume (grams per cubic centimeter)
SV = Material volume into which the organic carbon would accumulate because of filtration and adsorption (assumed to be the volume of soil from 3 feet above the UIC bottom to 5 feet below the base of the UIC, extending 1 foot from the radius of the UIC) (cubic centimeters)
f_{oc} = Fraction organic carbon (dimensionless)
ρ_b = Bulk density (grams per cubic centimeter)

Calculations of f_{oc}, based on the filtering of TOC for the average and reasonable maximum scenarios, are shown in Tables B-1 through B-4. First, the average annual precipitation was calculated from rain gages (Table B-1) and used to calculate the volume of stormwater that infiltrates into a UIC (Table B-2) by Equation (B.7). Next, a time-weighted average total organic carbon concentration in stormwater was calculated (Table B-3) and was used to calculate the grams of carbon added to the unsaturated zone surrounding the UIC during a 10-year period by Equation (B.8), mass of organic carbon per unit volume of material surrounding the UIC (ρ_{oc}) by Equation (B.9), and convert ρ_{oc} to f_{oc} by Equation (B.10) (Table B-4).

2.3 Pollutant Properties

Pollutant properties include the organic carbon partitioning coefficient, distribution coefficient, degradation rate constant/half life, and retardation factor.

2.3.1 Organic Carbon Partitioning Coefficient (K_{oc})

The organic carbon partitioning coefficient (K_{oc}) is pollutant specific, and governs the degree to which the pollutant will partition between the organic carbon and water phases. Higher K_{oc} values indicate that the pollutant has a higher tendency to partition in the organic carbon phase, and lower K_{oc} values indicate that the pollutant will have a higher tendency to partition in the water phase.

K_{oc} was assigned differently for PCP and other organic pollutants, according to the following criteria:

- **PCP.** The K_{oc} for PCP is pH dependent, so K_{oc}s for the average and reasonable maximum scenarios were estimated on the basis of the range of groundwater pH of shallow groundwater.

- **All Organic Pollutants except PCP.** For the average scenario, K_{oc} was estimated from empirical regression equations relating K_{oc} to the octanol water partitioning coefficient (K_{ow}) and/or pollutant solubility. For the reasonable maximum scenario, K_{oc} was assumed to be either the lowest-reported literature value or the K_{oc} calculated by empirical equations, which ever was lower (i.e., more conservative).

2.3.2 Distribution Coefficient (K_d)

For organic pollutants, the distribution coefficient, K_d, was estimated from the following equation (e.g., Watts, 1998):

$$K_d = f_{oc}K_{oc} \tag{B.11}$$

For metals, K_d was estimated from equations in Bricker (1998). The most important solid phases for sorption of metals in environmental porous media are clays, organic matter, and iron/manganese oxyhydroxides (Langmuir et al., 2004). The distribution of a trace metal between dissolved and sorbed phases is described by the following equation:

$$K_d = \frac{C_s}{C_w} \tag{B.12}$$

where:

C_s is the concentration of the metal adsorbed on the solid phase (M/L^3), and
C_w is the dissolved concentration (M/L^3).

The value of K_d for metals can depend on a number of environmental factors, including the nature and abundance of the sorbing solid phases, dissolved metal concentration, pH, redox conditions, and water chemistry. Measured K_d values for a given metal range over several orders of magnitude depending on the environmental conditions (Allison and Allison, 2005). Therefore, site-specific K_d values are preferred for metals over literature-reported K_ds. K_d values can be determined empirically for a particular situation from Equation (B.12) (Bricker, 1998). The partitioning coefficients were estimated from total and dissolved metals concentrations and total suspended solids (TSS) data. Sorbed concentrations were calculated by normalizing the particulate metals concentrations to the concentration of TSS. For each sample, an apparent K_d value was calculated for each metal from the following equation:

$$K_d = \frac{\left([Me]_t - [Me]_d\right)}{[Me]_d \times TSS} \times 10^6 \tag{B.13}$$

where:

$[Me]_t$ is total metals concentration (M/L^3), and
$[Me]_d$ is dissolved metal concentration (M/L^3)

Note that in Equation (B.13), metals concentrations are in micrograms per liter, and TSS are in units of milligrams per liter.

Although the K_ds are determined from systems containing lower concentrations of sorbing particle surfaces than is typical of stormwater infiltrating through a soil column, this is considered to be conservative because (1) the low levels of suspended solids in the stormwater may result in nonlinear sorption regime, in which case calculated K_d values may be significantly lower than would be expected in a higher surface area environment (i.e., the unsaturated zone), and (2) site-specific K_ds calculated in the stormwater already account for the effect of dissolved organic carbon, which could lower apparent K_d values by complexing with trace metals, and thereby shifting the partitioning to the solution.

2.3.3 Degradation Rate Constant (*k*) and Half Life (*h*)

Degradation rate is a chemical-specific, first-order rate constant, and depends on whether the unsaturated zone is aerobic or anaerobic. The organic pollutants evaluated in the unsaturated zone GWPD are biodegradable under aerobic conditions (Aronson et al., 1999; MacKay, 2006); therefore, it is expected that these compounds will biodegrade to some extent within the unsaturated zone after discharging from the UIC. Metals are not included in this section because they do not undergo biodegradation.

Aerobic biodegradation rate constants were compiled from a review of the scientific literature, including general reference guides as well as compound-specific studies. The review included degradation in soils, surface water, groundwater, and sediment. Soil aerobic degradation rates were considered to be most representative of UIC field conditions and these are summarized for each of the compounds of interest. First-order rate constants are generally appropriate for describing biodegradation under conditions where the substrate is limited and there is no growth of the microbial population (reaction rate is dependent on substrate concentration rather than microbial growth). Because of the low concentrations of the organic pollutants detected in stormwater, it is appropriate to consider biodegradation as a pseudo-first-order rate process for the UIC unsaturated zone scenario.

The ranges of biodegradation rates representative of conditions expected to be encountered in the unsaturated zone beneath UICs are summarized in Table B-5. Summary statistics provided in Table B-5 include number of measurements, minimum, maximum, mean, 25th, and 50th percentile (median) values. For the average scenario, the median biodegradation rate was used. For the reasonable maximum, the 25th percentile biodegradation rate was used.

The half-life of a pollutant is the time required for pollutant concentration decline to one half of its initial value. Half-life is calculated by the following formula:

$$h = \frac{\ln(2)}{k} \tag{B.14}$$

where:

k is the first-order rate constant (T^{-1}), and
h is the half-life (T)

2.3.4 Retardation Factor (*R*)

The retardation factor, *R*, is the ratio between the rate of pollutant movement and the rate of pore water movement. For example, a retardation factor of 2 indicates that pollutants move twice as slow as pore water. The retardation factor is estimated by equation 9.14 of Freeze and Cherry (1979):

$$R = 1 + \frac{(\rho_b)(K_d)}{\eta} \tag{B.15}$$

where:

ρ_b is soil bulk density (M/L^3),
K_{oc} is the organic carbon partitioning coefficient (L^3/M),
f_{oc} is fraction organic carbon (dimensionless), and
η is total porosity (dimensionless).

3 Governing Equation for Unsaturated Zone GWPD

A one-dimensional pollutant fate and transport equation was used to estimate the magnitude of pollutant attenuation during transport through the unsaturated zone. This constant source Advection-Dispersion Equation (ADE) incorporates adsorption, degradation (biotic and abiotic), and dispersion to estimate pollutant concentration at the water table (e.g., Watts, 1998). This equation is provided below:

$$\frac{C(y,t)}{C_0} = \frac{1}{2}\left[\left(e^{A_1}\right)erfc\left(A_2\right) + \left(e^{B_1}\right)erfc\left(B_2\right)\right] \tag{B.16}$$

where:

$$A_1 = \left(\frac{y}{2D'}\right)\left(v' - \sqrt{(v')^2 + 4D'k'}\right)$$

$$A_2 = \frac{y - t\sqrt{(v')^2 + 4D'k'}}{2\sqrt{D't}}$$

$$B_1 = \left(\frac{y}{2D'}\right)\left(v' + \sqrt{(v')^2 + 4D'k'}\right)$$

$$B_2 = \frac{y + t\sqrt{(v')^2 + 4D'k'}}{2\sqrt{D't}}$$

$$v' = \frac{v}{R}$$

$$D' = \frac{D}{R}$$

$$k' = \frac{k}{R}$$

and:

- *y* is distance in the vertical direction (L),
- *v* is average linear pore water velocity (L/T),
- *D* is the dispersion coefficient (L^2/T),
- *R* is the retardation factor (dimensionless),
- *k* is the first-order degradation constant (T^{-1}),
- *t* is average infiltration time (T),
- C_0 is initial pollutant concentration (M/L^3),
- *C(y, t)* is pollutant concentration at depth *y* and time *t* (M/L^3), and
- *erfc* is complementary error function used in partial differential equations

Equation (1) is an exact solution to the one-dimensional ADE. The exact solution can be used for both short (i.e., less than 3.5 meters) and long transport distances (greater than 35 meters; Neville and Vlassopoulos, 2008). An approximate solution to the 1-dimensional ADE has also been developed, and can only be used for long transport distances. The unsaturated zone GWPD uses the exact solution to the ADE.

With the exception of infiltration time (t), the input parameters were described in Section 2. Infiltration time is the length of time during the year that stormwater discharges into a UIC and, therefore, migrates downward through the unsaturated zone. For modeling purposes, the duration of the rainy season is estimated to be 7 months. Because stormwater discharges into UICs only when the precipitation rate exceeds a threshold value, the infiltration time is dependent on the occurrence of rain events equal to or greater than this amount. The DEQ (2005) permit fact sheet for the City of Portland assigns a threshold precipitation rate of 0.08 inch/hour for stormwater to discharge into UICs. The unsaturated zone GWPD conservatively assumes that stormwater discharges into UICs at one-half of the threshold precipitation rate (i.e., 0.04 inch/hour). Precipitation and infiltration times from 1999 to 2011 in the City are shown in Table B-1.

The key assumptions in applying this equation include:

- Transport is one-dimensional vertically downward from the bottom of the UIC to the water table (Note: water typically exfiltrates from holes in the side of the UIC, as well as from the bottom).

- The stormwater discharge rate into the UIC is constant and maintains a constant head within the UIC to drive the water into the unsaturated soil. (Note: stormwater flows are highly variable, short duration, and result in varying water levels within the UIC dependent on the infiltration capacity of the formation.)

- Pollutant concentrations in water discharging into the UIC are uniform and constant throughout the period of infiltration (Note: concentrations are variable seasonally and throughout storm events).

- The pollutant undergoes equilibrium sorption (instantaneous and reversible) following a linear sorption isotherm.

- The pollutant is assumed to undergo a first-order transformation reaction involving biotic degradation.

- The pollutant does not undergo transformation reactions in the sorbed phase (i.e., no abiotic or biotic degradation).

- There is no portioning of the pollutant to the gas phase in the unsaturated zone.

- The soil is initially devoid of the pollutant.

The unsaturated zone GWPD provides a conservative simulation of pollutant fate and transport for the following reasons:

- Modern UICs are constructed with a solid concrete bottom so stormwater is discharged horizontally through the sides of the UIC at up to 20 feet above the bottom of the UIC and then migrates vertically downward. Thus, the assumption that stormwater flows vertically downward from the base of the UIC underestimates the travel distance of stormwater in the unsaturated zone.

- Stormwater flow from the UIC is assumed to be constant with a uniform flow through the unsaturated zone, while in reality stormwater flows are highly variable and short in duration resulting in varying water levels within the UIC depending on the infiltration capacity of the formation. Thus, the UIC periodically will fill with water and then drain. This will cause variable flow from the UIC. It is not feasible to simulate complex cycles of filling and drainage for each UIC. Thus, the simplified approach is implemented in which the analytical solution is used to predict concentrations at a time corresponding to the period over which the UIC likely contains water. This approach is conservative because it predicts the maximum infiltration that would be expected at the water table sustained for the period during which the UIC contains water.

- Pollutant concentrations are assumed to be constant, while in reality they are variable throughout storm events. This likely over-predicts the concentration throughout the duration of a storm event. In addition, the unsaturated zone GWPD does not take into account pollutant attenuation that occurs while in the UIC (i.e. through adsorption to sediment or organic matter in the UIC) before entering the surrounding soil.

4 Infiltration Tests for Calculating Average Linear Pore Water Velocity

Infiltration tests are conducted to estimate hydraulic conductivity (a proportionality constant that, under unsaturated conditions, is equivalent to specific discharge [see Equation B.5]). Pump-in tests consist of injecting water into a UIC at a known rate until the water level in the UIC stabilizes. Figure B-1 shows a conceptual diagram of a UIC during a pump-in test.

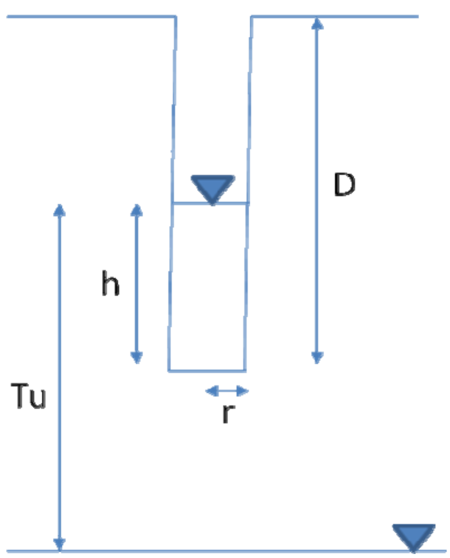


Figure B-1. Pump-in test conceptual model.

According to USDI (1993), horizontal hydraulic conductivity in the unsaturated zone is calculated from a pump-in test by the following formulae:

$K_s =$

$$\frac{\left[\ln\left(\frac{h}{r}+\sqrt{\left(\frac{h}{r}\right)^2+1}\right)-1\right]Q}{2\pi h^2} \quad \text{if } T_u \geq 3h \tag{B.17}$$

$$\left[\frac{3\ln\left(\frac{h}{r}\right)}{\pi h\left(h+2T_U\right)}\right]Q \quad \text{if } 3h \geq T_u \geq h \tag{B.18}$$

where:

K_s is saturated hydraulic conductivity (L/T),

h is the height of the stable water level above the UIC bottom (L),

D is the depth of the UIC from ground surface to bottom (L)

T_u is the separation distance between the water table and stable water level in the UIC (L),

Q is the rate water enters the UIC when the water level is stable (L^3/T), and

r is the radius of the UIC (L).

In the unsaturated zone beneath UICs, specific discharge is equivalent to unsaturated hydraulic conductivity (K_u). However, the fate and transport analysis uses saturated hydraulic conductivity (K_s) in Equation (B.5) to calculate groundwater velocity. Because of the tortuosity of unsaturated flow paths, K_u is always smaller than K_s (usually by several orders of magnitude); therefore, using K_s in Equation (B.5) is conservative. Because water is transported vertically through the unsaturated zone, the horizontal hydraulic conductivity calculated by the pump-in test must be converted to a vertical hydraulic conductivity.

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Table B-1

Precipitation, 1999 - 2011

City of Milwaukie, Oregon

Year	Precipitation (inches)	Precipitation (feet)	Hours With ≥ 0.04 inches/hr intensity (hours)	Days with ≥ 0.04 inches/hr intensity (days)
2011	47.40	4.0	441	18.4
2010	53.73	4.5	482	20.1
2009	33.14	2.8	303	12.6
2008	32.12	2.7	283	11.8
2007	38.89	3.2	389	16.2
2006	44.40	3.7	417	17.4
2005	33.55	2.8	291	12.1
2004	28.32	2.4	249	10.4
2003	38.96	3.2	378	15.8
2002	30.55	2.5	284	11.8
2001	31.24	2.6	299	12.5
2000	24.06	2.0	227	9.5
1999	36.72	3.1	352	14.7
Maximum	*53.73*	*4.48*	*482*	*20.1*
Minimum	*24.06*	*2.01*	*227*	*9.5*
Average	*36.39*	*3.03*	*338*	*14.1*
Median	*33.55*	*2.80*	*303*	*12.6*
Geomean	*35.57*	*2.96*	*330*	*13.7*

Notes

Data from Harney Street Rain Gage at 2033 SE Harney Street, available online at the City of Portland HYDRA Rainfall Network: http://or.water.usgs.gov/non-usgs/bes/

Table B-2

Stormwater Infiltration Volume

City of Milwaukie, Oregon

Impervious Area, *A* (ft^2)	**Annual Precipitation, *P*** (Geometric Mean, 1999 - 2011) (ft/yr)	**Evaporative Loss Factor, *e*** (-)	**Infiltration Volume, *I*** (ft^3/year)	**Infiltration Volume, *I*** (cm^3/yr)
36,225 (1)	2.96	0.26 (2)	79,468 (3)	2.25E+09 (3)

Notes

(1) Average impervious area based on delineations for 194 UIC drainage basins in the City of Milwaukie.

(2) Evaporation Loss Factor from Snyder and otehrs (1994)

(3) Calculated by the following equation: $I = (A)(P)(1\text{-}e)$

ft = feet

cm = centimeters

Table B-3

Total Organic Carbon in Stormwater

City of Milwaukie, Oregon

Time Period	Months	N	Min (mg/L)	Max (mg/L)	Mean (mg/L)	Average Scenario (calculated using mean TOC) Weighting		Weighted Mean TOC (mg/L)	Reasonable Maximum Scenario (calculated using minimum TOC) Weighting		Weighted Mean TOC (mg/L)
			TOC Concentrations								
Fall	Oct, Nov (1)	15	3.1	55.4	20.5	2 / 9	22%	8.19	2 / 9	22%	1.44
Winter	Dec, Jan, Feb, Mar (2)	61	0.25	9.7	2.5	4 / 9	44%		4 / 9	44%	
Spring	Apr, May, June (3)	27	1.9	23.8	7.6	3 / 9	33%		3 / 9	33%	

Notes

(1) Data from Clackamas County WES

(2) Data from City of Gresham

(3) Data from City of Portland and City of Milwaukie

mg/L = milligrams per liter

Water Solutions, Inc.

Table B-4
Fraction Organic Carbon
City of Milwaukie, Oregon

	CL Calculation					*SV Calculation*					ρ_{oc} *Calculation*	f_{oc} Calculation	
	Infiltration Volume (cm^3/yr)	**Carbon Concentration** (mg TOC/1000 cm^3)	**Time** (years)	**Conversion Factor for ug to g**	**CL**	**UIC radius** (cm)	**UIC radius + 1 foot** (cm)	**3' Above base volume** (cm^3)	**5' Below base volume** (cm^3)	**Total Volume** (cm^3)	ρ_{oc} (g TOC per cm^3 soil)	**Bulk Density** (g/cm^3)	f_{oc}
Average Scenario	2.25E+09	8.19	10	1,000,000	184,195	60.96	91.44	1,333,723	4001170.42	5,334,894	0.034526425	1.66	0.020375
Reasonable Maximum Scenario	2.25E+09	1.44	10	1,000,000	32,404	60.96	91.44	1,333,723	4001170.42	5,334,894	0.006073976	1.66	0.003646

Notes
cm = centimeters
mg = milligrams
ug = micrograms
g = grams
yr = year

Equations:

$$CL = (I)(C)(t)\left(\frac{1\text{ liter}}{1{,}000\text{ cm}^3}\right)\left(\frac{1\text{ gram}}{1{,}000\text{ milligrams}}\right)$$

$$\rho_{oc} = \frac{CL}{SV}$$

$$f_{oc} = \frac{\rho_{oc}}{\rho_b + \rho_{oc}}$$

CL = Organic carbon loaded into the unsaturated zone beneath a UIC during a 10-year period
I = Average annual stormwater infiltration volume
C = TOC concentration in stormwater
t = time of carbon loading
ρ_{oc} = Organic carbon weight per unit unsaturated zone material volume
SV = material volume into which the organic carbon would accumulate because of filtration and adsorption (assumed to be the soil from three feet above the UIC bottom to five feet below the base of the UIC, extending 1 foot from the radius of the UIC (equation not shown)
f_{oc} = fraction organic carbon
ρ_b = bulk density

Table B-5

Biodegradation Rates

City of Milwaukie, Oregon

Compound	First-Order Biodegradation Rate (day^{-1})					
	N	*Median*	*Mean*	*Maximum*	*25 th percentile*	*Minimum*
Benzo(a)pyrene [1]	38	0.0013	0.0021	0.015	0.00026	ND
Di-(2-ethylhexyl)phthalate [2]	34	0.015	0.021	0.082	0.01	0.004
PCP [3]	10	0.206	0.221	0.361	0.1695	0.139

Notes:

[1] Rate constants under aerobic conditions in soil were compiled from Aronson et al. (1999) Ashok et al. (1995); Bossart and Bartha (1986); Carmichael and Pfaender (1997); Coover and Sims (1987); Deschenes et al. (1996); Grosser et al. (1991); Grosser et al. (1995); Howard et al. (1991); Keck et al. (1989); Mackay et al. (2006); Mueller et al. (1991); Park et al. (1990); and Wild and Jones (1993).

[2] From Dorfler et al. (1996); Efroymson and Alexander (1994); Fairbanks et al. (1985); Fogel et al. (1995); Maag and Loekke (1990); Mayer and Sanders (1973); Ruedel et al. (1993); Schmitzer et al. (1988); Scheunert et al. (1987) and Shanker et al. (1985).

[3] From Schmidt et al. (1999) and D'Angelo and Reddy (2000)

Attachment C

Table C-1. Pollutant Fate and Transport

Groundwater Protectiveness Demonstration

	Parameter	Symbol	Units	Metals		PAHs		SVOCs			
				Lead		Benzo(a)pyrene		PCP		di-(2-ethylhexyl) phthalate	
				Average Scenario	Reasonable Maximum Scenario	Average Scenario	Reasonable Maximum Scenario	Average Scenario	Reasonable Maximum Scenario	Average Scenario	Reasonable Maximum Scenario
UIC Properties	Distance Needed to Reach MRLs	y	m	0.00283	0.0130	0.00044	0.0079	0.14	2.85	0.0090	0.1589
		y	ft	0.00929	0.043	0.00145	0.02586	0.47	9.34	0.029	0.52
	Concentration	C_0	mg/L	0.50 [1]	0.50 [1]	0.002 [1]	0.002 [1]	0.01 [1]	0.01 [1]	0.06 [1]	0.06 [1]
	Infiltration Time	t	d	13,750 [2]	13,750 [2]	13.75 [3]	13.75 [3]	13.75 [3]	13.75 [3]	13.75 [3]	13.75 [3]
Pollutant Properties	First-Order Rate Constant	k	d^{-1}			1.30E-03 [4]	2.60E-04 [5]	2.21E-02 [6]	1.39E-02 [7]	1.50E-02 [4]	1.00E-02 [5]
	Half-Life	h	d			533.2 [8]	2666.0 [8]	31.4 [8]	49.9 [8]	46.2 [8]	69.3 [8]
Physical and Chemical Soil Properties	Soil Porosity	η	-	0.375 [9]	0.375 [9]	0.375 [9]	0.375 [9]	0.375 [9]	0.375 [9]	0.375 [9]	0.375 [9]
	Soil Bulk density	ρ_b	g/cm^3	1.66 [10]	1.66 [10]	1.66 [10]	1.66 [10]	1.66 [10]	1.66 [10]	1.66 [10]	1.66 [10]
	Fraction Organic Carbon	f_{oc}	-			0.0208 [11]	0.0024 [11]	0.0208 [11]	0.0024 [11]	0.0208 [11]	0.0024 [11]
	Organic Carbon Partition Coefficient	K_{oc}	L/kg			282,185 [12]	282,185 [12, 13]	877 [14]	703 [14]	12,200 [12]	12,200 [12, 13]
	Distribution Coefficient	K_d	L/kg	1,203,704 [15]	535,040 [16]	5,872 [17]	674 [17]	18.3 [17]	1.7 [17]	253.9 [17]	29.2 [17]
	Pore Water Velocity	v	m/d	0.37 [18]	0.75 [19]	0.37 [18]	0.75 [19]	0.37 [18]	0.75 [19]	0.37 [18]	0.75 [19]
Calculations	Retardation Factor	R	-	5,316,360	2,363,094	25,937	2,980	81.6	8.4	1,122	130
	Dispersion Coefficient	D	m^2/d	5.16E-05	4.85E-04	8.09E-06	2.94E-04	2.63E-03	1.06E-01	1.64E-04	5.93E-03
	Normalized Dispersion	D'	m^2/d	9.71E-12	2.05E-10	3.12E-10	9.87E-08	3.22E-05	1.26E-02	1.46E-07	4.57E-05
	Normalized Velocity	v'	m/d	6.87E-08	3.16E-07	1.41E-05	2.50E-04	4.47E-03	8.86E-02	3.25E-04	5.75E-03
	Normalized Degradation	k'	d^{-1}	0.00E+00	0.00E+00	5.01E-08	8.73E-08	2.71E-04	1.65E-03	1.34E-05	7.71E-05
	A_1	-	-	0.00E+00	0.00E+00	-1.58E-06	-2.75E-06	-8.71E-03	-5.29E-02	-3.69E-04	-2.13E-03
	A_2	-	-	2.58E+00	2.58E+00	1.91E+00	1.91E+00	1.96E+00	1.95E+00	1.59E+00	1.59E+00
	e^{A1}	-	-	1.00E+00	1.00E+00	1.00E+00	1.00E+00	9.91E-01	9.48E-01	1.00E+00	9.98E-01
	$erfc(A_2)$	-	-	2.63E-04	2.63E-04	7.03E-03	7.04E-03	5.62E-03	5.89E-03	2.42E-02	2.43E-02
	B_1	-	-	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.01E+01	2.00E+01	2.00E+01
	B_2	-	-	5.16E+00	5.16E+00	4.86E+00	4.86E+00	4.88E+00	4.89E+00	4.75E+00	4.75E+00
	e^{B1}	-	-	4.85E+08	4.85E+08	4.85E+08	4.85E+08	4.89E+08	5.12E+08	4.85E+08	4.86E+08
	$erfc(B_2)$	-	-	2.84E-13	2.84E-13	6.20E-12	6.20E-12	4.96E-12	4.73E-12	1.89E-11	1.89E-11
	Concentration Immediately Above Water Table	C	mg/L	1.00E-04	1.00E-04	1.00E-05	1.00E-05	4.00E-05	4.00E-05	1.00E-03	1.00E-03
MRL		C	mg/L	1.00E-04	1.00E-04	1.00E-05	1.00E-05	4.00E-05	4.00E-05	1.00E-03	1.00E-03
Action Level		C	mg/L	5.00E-01 [20]		2.00E-03 [20]		1.00E-02 [20]		6.00E-02 [20]	

NOTES *(SEE APPENDIX B FOR CITATIONS)*

[1] Equal to the action level in Table 1 or Table 2 of the July 2012 draft UIC WPCF permit template

[2] Infiltration time for lead is 1,000 years (1,000 years at 13.75 days per year = 13,750 days)

[3] Infiltration time is the number of hours (converted to days) during the year that stormwater infiltrates into the UIC. Stormwater infiltration is conservatively assumed to occur when the precipitation rate is $\geq$ 0.04 inches/hour. Precipitation data source is the Harney Street rain gage at 2033 SE Harney Street (HYDRA, 2012). Annual precipitation from 1999 to 2011 were used in the analysis, and were averaged using the geometric mean.

[4] Median biodegradation rate from a review of scientific literature (see Table B-5 for references).

[5] 25th percentile biodegradation rate from a review of scientific literature (seeTable B-5 for references).

[6] 10 percent of the average biodegradation rate of PCP under aerobic conditions (see Table B-5 for references).

[7] 10 percent of the minimum biodegradation rate of PCP under aerobic conditions (see Table B-5 for references).

[8] Calculated from the following formula: $C_t = C_0e^{-kt}$, where C_t is concentration at time t, C_0 is initial concentration, t is time, and k is biodegradation rate.

[9] Madin (1990) identifies the Qff as a coarse sand to silt. Therefore, the midrange porosity of a sand from Freeze and Cherry (1979), page 37, Table 2.4 is used in this analysis (range = 0.25 to 0.50).

[10] Calculated by formula 8.26 in Freeze and Cherry (1979): $\rho_b = 2.65(1-\eta)$.

[11] Estimate of f_{oc} based on loading of TOC in stormwater; see Appendix B for details.

[12] Calculated from the equation of Roy and Griffin (1985), which relates K_{oc} (soil organic carbon-water partitioning coefficient) to water solubility and K_{ow} (octanol-water partitioning coefficient) as presented in Fetter (1994).

[13] Because the K_{oc}s reported in field studies were all higher than K_{oc}s calculated from K_{ow} (i.e., field-study K_{oc}s were less conservative), the reasonable maximum scenario uses the K_{oc} calculated by Roy and Griffin (1985)

[14] The K_{oc} for Pentachlorophenol is pH-dependent. Soil and groundwater pH are in equilibrium; therefore, soil pH can be estimated from groundwater pH. Ph has been measured at twelve USGS wells screened at or near the water table in Portland on the east side of the Willamette River from 1997 to 2007. The average groundwater pH at the wells is 6.4, and was used for the "Average Scenario". This pH is consistent with shallow soil pH in Multnomah County (Green, 1983). The PCP organic carbon partitioning coefficient when pH = 6.4 is 877 L/kg [EPA (1996) – Appendix L: Koc Values for Ionizing Organics as a Function of pH]. Because PCP is more mobile at higher pH, Koc for the "Reasonable Maximum Scenario" is based on the average maximum groundwater pH at the USGS wells (i.e., 6.6). This pH is consistent with shallow soil pH in Multnomah County (Green, 1983). The PCP organic carbon partitioning coefficient when pH = 6.6 is 704 L/kg.

[15] Median K_d for lead, calculated using stormwater analytical data collected by the City of Milwaukie in spring of 2012 and an equation from Brickner (1998)

[16] 10th percentile K_d for lead, calculated using stormwater analytical data collected by the City of Milwaukie in spring of 2012 and an equation from Brickner (1998)

[17] K_d calculated from the following equation: Kd = $(f_{oc})(K_{oc})$ (e.g., Watts, pg. 279, 1998).

[18] The median average linear velocity calculated using the pump-in method at11 City of Milwaukie UICs. The pump-in method is outlined in USDI (pgs. 83 - 95, 1993).

[19] The 95% UCL on the mean of average linear velocity based on 11 pump-in tests at City of Milwaukie UICs. The pump-in method is outlined in USDI (pgs. 83 - 95, 1993). 95% UCL was calculated using ProUCL Software Version 4.00.05 and the 95% Student's-t UCL.

[20] Action Levels from Table 1 and Table 2 of the July 2012 draft UIC WPCF permit template.

ABBREVIATIONS

PAHs = Polynuclear Aromatic Hydrocarbons
SVOCs = Semi-Volatile Organic Compounds
VOCs = Volatile Organic Compounds
PCP = Pentachlorophenol
USGS = United States Geological Survey
UCL = Upper Confidence Level
MRL = Method Reporting Limit
UIC = Underground Injection Control
WPCF = Water Pollution Control Facilities
Qmf = Quaternary Missoula Flood Deposits
EPA = Environmental Protection Agency
TOC = Total Organic Carbon
d = days
g/cm^3 = grams per cubic centimeter
ft = feet
L = Liters per kilogram
m = meters
m/d = meters per day
m^2/d = square meters per day
mg/L = milligrams per liter

Attachment C
Table C-2. Pollutant Fate and Transport
Alternate Action Levels

	Parameter	Symbol	Units	Metals						SVOCs	
				Zinc		Copper		Antimony		di-(2-ethylhexyl) phthalate	
				Average Scenario	Reasonable Maximum Scenario	Average Scenario	Reasonable Maximum Scenario	Average Scenario	Reasonable Maximum Scenario	Average Scenario	Reasonable Maximum Scenario
UIC Properties	Transport Distance	y	m	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31
		y	ft	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Concentration	C_0	mg/L	50.0 [1]	50.0 [1]	10.0 [1]	10.0 [1]	0.060 [1]	0.060 [1]	0.30 [1]	0.30 [1]
	Infiltration Time	t	d	13,750 [2]	13,750 [2]	13,750 [2]	13,750 [2]	13,750 [2]	13,750 [2]	13.75 [3]	13.75 [3]
Pollutant Properties	First-Order Rate Constant	k	d^{-1}							1.50E-02 [4]	1.00E-02 [5]
	Half-Life	h	d							46.2 [6]	69.3 [6]
Physical and Chemical Soil Properties	Soil Porosity	η	-	0.375 [7]	0.375 [7]	0.375 [7]	0.375 [7]	0.375 [7]	0.375 [7]	0.375 [7]	0.375 [7]
	Soil Bulk density	ρ_b	g/cm^3	1.66 [8]	1.66 [8]	1.66 [8]	1.66 [8]	1.66 [8]	1.66 [8]	1.66 [8]	1.66 [8]
	Fraction Organic Carbon	f_{oc}	-							0.0208 [9]	0.0024 [9]
	Organic Carbon Partition Coefficient	K_{oc}	L/kg							12,200 [10]	12,200 [10,11]
	Distribution Coefficient	K_d	L/kg	53,263 [12]	22,542 [13]	159,310 [14]	24,801 [15]	24,927 [12]	9,675 [13]	253.9 [16]	29.2 [16]
	Pore Water Velocity	v	m/d	0.37 [17]	0.75 [18]	0.37 [17]	0.75 [18]	0.37 [17]	0.75 [18]	0.37 [17]	0.75 [18]
Calculations	Retardation Factor	R	-	235,246	99,562	703,620	109,539	110,095	42,732	1,122	130
	Dispersion Coefficient	D	m^2/d	5.57E-03	1.14E-02	5.57E-03	1.14E-02	5.57E-03	1.14E-02	5.57E-03	1.14E-02
	Normalized Dispersion	D'	m^2/d	2.37E-08	1.14E-07	7.91E-09	1.04E-07	5.06E-08	2.66E-07	4.96E-06	8.77E-05
	Normalized Velocity	v'	m/d	1.55E-06	7.49E-06	5.19E-07	6.81E-06	3.32E-06	1.75E-05	3.25E-04	5.75E-03
	Normalized Degradation	k'	d^{-1}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.34E-05	7.71E-05
	A_1	-	-	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-1.25E-02	-4.09E-03
	A_2	-	-	7.86E+00	2.55E+00	1.43E+01	2.80E+00	4.92E+00	5.37E-01	1.82E+01	3.25E+00
	e^{A1}	-	-	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	9.88E-01	9.96E-01
	$erfc(A_2)$	-	-	9.98E-29	3.15E-04	1.08E-90	7.66E-05	3.47E-12	4.48E-01	5.03E-146	4.19E-06
	B_1	-	-	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01	2.00E+01
	B_2	-	-	9.05E+00	5.15E+00	1.50E+01	5.27E+00	6.65E+00	4.50E+00	1.87E+01	5.53E+00
	e^{B1}	-	-	4.85E+08	4.85E+08	4.85E+08	4.85E+08	4.85E+08	4.85E+08	4.91E+08	4.87E+08
	$erfc(B_2)$	-	-	1.79E-37	3.37E-13	2.13E-99	8.70E-14	5.34E-21	1.89E-10	9.82E-155	5.18E-15
	Concentration Immediately Above Water Table	C	mg/L	4.67E-27	1.19E-02	1.06E-89	5.94E-04	1.82E-13	1.62E-02	1.47E-146	1.00E-06
MRL		C	mg/L	5.00E-04	5.00E-04	1.00E-04	1.00E-04	1.00E-04	1.00E-04	1.00E-03	1.00E-03
Action Level		C	mg/L	5.00E+00 [19]		5.00E-03 [19]		6.00E-03 [19]		6.00E-02 [19]	

NOTES *(SEE APPENDIX B FOR CITATIONS)*

[1] Equal to the 10X the action level in Table 1 of the July 2012 draft UIC WPCF permit template for zinc, antimony, copper, and cadmium; equal to 5X the action level in Table 1 for DEHP.

[2] Infiltration time for metals is for 1,000 years (1,000 years at 13.75 days per year = 13,750 days)

[3] Infiltration time is the number of hours during the year (converted to days) that stormwater infiltrates into the UIC. Stormwater infiltration is conservatively assumed to occur when the precipitation rate is $\geq$ 0.04 inches/hour. Precipitation data source is the Harney Street rain gage at 2033 SE Harney Street (HYDRA, 2012). Annual precipitation from 1999 to 2011 were used in the analysis, and were averaged using the geometric mean.

[4] Median biodegradation rate from a review of scientific literature (see Table B-5 for references).

[5] 25th percentile biodegradation rate from a review of scientific literature (see Table B-5 for references).

[6] Calculated from the following formula: $C_t = C_0e^{-kt}$, where C_t is concentration at time t, C_0 is initial concentration, t is time, and k is biodegradation rate.

[7] Madin (1990) identifies the Qff as a coarse sand to silt. Therefore, the midrange porosity of a sand from Freeze and Cherry (1979), page 37, Table 2.4 is used in this analysis (range = 0.25 to 0.50).

[8] Calculated by formula 8.26 in Freeze and Cherry (1979): $\rho_b = 2.65(1-\eta)$.

[9] Estimate of f_{oc} based on loading of TOC in stormwater; see Appendix B for details.

[10] Calculated from the equation of Roy and Griffin (1985), which relates K_{oc} (soil organic carbon-water partitioning coefficient) to water solubility and K_{ow} (octanol-water partitioning coefficient) as presented in Fetter (1994).

[11] Because the K_{oc}s reported in field studies were all higher than K_{oc}s calculated from K_{ow} (i.e., field-study K_{oc}s were less conservative), the reasonable maximum scenario uses the K_{oc} calculated by Roy and Griffin (1985)

[12] Median K_d, calculated using stormwater discharge monitoring data from the City of Portland and an equation from Brickner (1998)

[13] 10th percentile K_d, calculated using stormwater discharge monitoring data from the City of Portland and an equation from Brickner (1998)

[14] Median K_d for copper, calculated using stormwater analytical data collected by the City of Milwaukie in spring of 2012 and an equation from Brickner (1998)

[15] 10th percentile K_d for copper, calculated using stormwater analytical data collected by the City of Milwaukie in spring of 2012 and an equation from Brickner (1998)

[16] K_d calculated from the following equation: $Kd = (f_{oc})(K_{oc})$ (e.g., Watts, pg. 279, 1998).

[17] The median average linear velocity calculated using the pump-in method at 11 City of Milwaukie UICs. The pump-in method is outlined in USDI (pgs. 83 - 95, 1993).

[18] The 95% UCL on the mean of average linear velocity based on 11 pump-in tests at City of Milwaukie UICs. The pump-in method is outlined in USDI (pgs. 83 - 95, 1993). 95% UCL was calculated using ProUCL Software Version 4.00.05 and the 95% Student's-t UCL.

[19] Action Levels from Table 1 and Table 2 of the July 2012 draft UIC WPCF permit template.

ABBREVIATIONS

PAHs = Polynuclear Aromatic Hydrocarbons
SVOCs = Semi-Volatile Organic Compounds
VOCs = Volatile Organic Compounds
PCP = Pentachlorophenol
USGS = United States Geological Survey
UCL = Upper Confidence Level
MRL = Method Reporting Limit
UIC = Underground Injection Control
WPCF = Water Pollution Control Facilities
Qmf = Quaternary Missoula Flood Deposits
EPA = Environmental Protection Agency
TOC = Total Organic Carbon
d = days
g/cm^3 = grams per cubic centimeter
ft = feet
L = Liters per kilogram
m = meters
m/d = meters per day
m^2/d = square meters per day
mg/L = milligrams per liter

Appendix C: CIP Fact Sheets

Capital Project Fact Sheet Priority Ranking No. 10
Project Name: Willow Detention Pond Retrofit

Project Name	Willow Detention Pond Retrofit
Project ID	1-1
Modeled System No.	1
Associated Subbasins	JCD80, JCD90, JCD91
Associated Modeled Pipes/Conduits	
Objective(s) Addressed	Water Quality Retrofit

Project Description

The existing Willow Detention Pond is located at the end of 55th Avenue, south of Firwood Street. By topography, the pond appears to drain approximately 15 acres of residential area in subbasin JCD80, located in the northeastern portion of the City. As-built information on the pond inlet and outlet structure was not available at the time of this study; however, it is assumed that the pond was designed for flood control and was not constructed with water quality features. During design, the extent and feasibility of this CIP should be evaluated based on survey information.

This CIP includes amendment of the pond bottom with drain rock, and amended soil and vegetation to enhance the existing pond treatment capabilities.

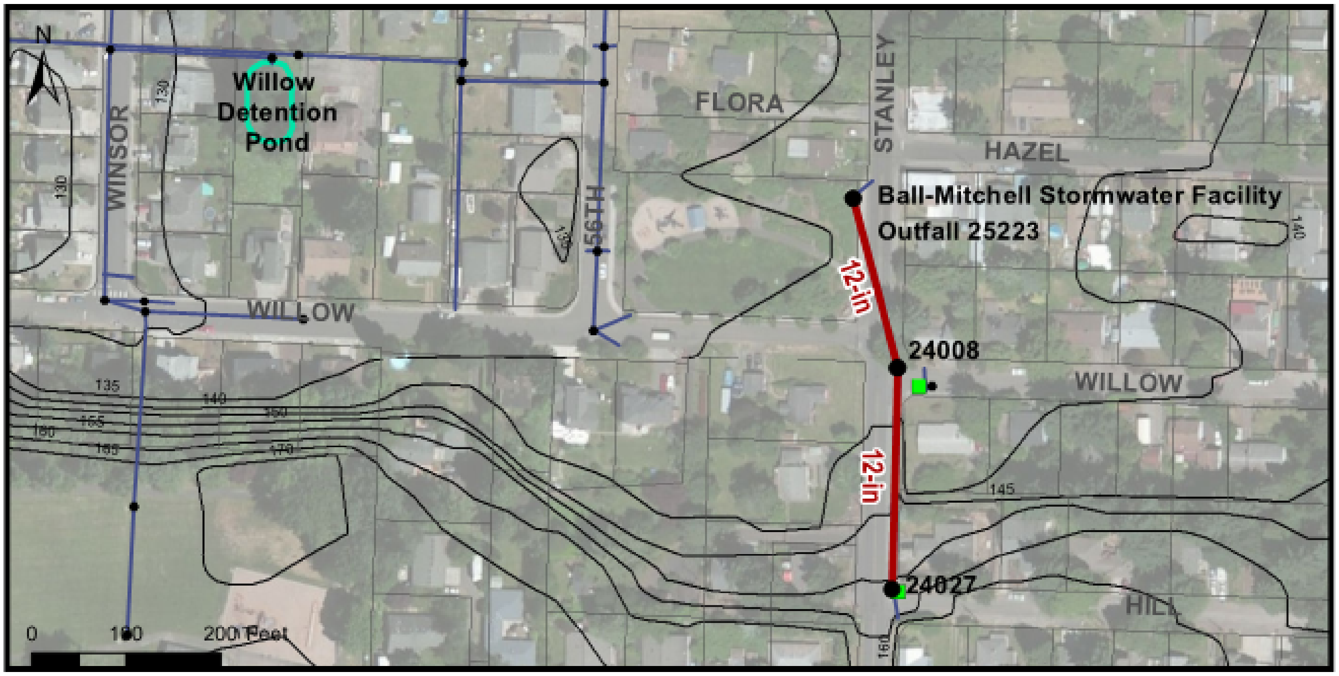
Estimated Planning Cost (2012 dollars)	
Construction Cost Sub-total (See Appendix X for details)	$36,400
Construction Contingency (30%)	$10,900
Sub-total	$47,300
Engineering and Permitting (40%)	$18,900
Construction Administration (5%)	$2,400
Capital Project Implementation Cost Total	**$68,600**
Existing to Future % Flow Increase[1]	Not Applicable

Design Assumptions

- This cost estimate does not include piping modifications to collect and convey runoff to and from the facility or upsizing to provide additional storage volume.

1. *Existing to future percent flow increase is based on the 25-year percent flow increase from the contributing drainage area between the existing and future land use scenarios. This value is used to assign a dollar value to the portion of this CIP which can be attributed to growth.*

Capital Project Fact Sheet Priority Ranking No. 12
Project Name: Stanley-Willow UIC Decommissioning



Project Name	Stanley-Willow UIC Decommissioning
Project ID	1-2
Modeled System No.	1
Associated Subbasins	JCD90, JCD91 (developed for CIP)
Associated Modeled Pipes/Conduits	JCD90 (24008_25223) JCD91 (24027_24008)
Objective(s) Addressed	Water Quality – UIC Decommissioning

Project Description

The risk that UICs pose to known drinking water sources within the City was evaluated as a part of this project. It was found that UICs with less than 3 feet of vertical seperation between the bottom of the UIC and the ground water table may pose a risk of PCP contamination if located within the 2-year time of travel from a drinking water well. UIC 24027 has less than 3 feet of vertical seperation between the ground water table and the bottom of the UIC. UIC 24008 has less than 5 feet of vertical seperation between the ground water table and the bottom of the UIC. Though UIC 24027 is not known to be within the 2-year time of travel of a drinking water well, it would require decommissioning in the future if a new well was installed or if it is found to be within a drinking water well that is not currently identified.

This CIP includes replacement of UICs 24027 and 24008 and the associated four catch basins with three new 48 inch manholes and four new catch basins to convey drainage captured by the existing catch basins along Hill Street and Willow Street from Stanley Avenue to Hollywood Avenue. The flow will be conveyed in 425 feet of new 12 inch HDPE pipe to outfall 25223, which enters the Ball-Mitchell Stormwater Facility at Ball-Mitchell Park.

This CIP also includes planting native vegetation on the bottom of the stormwater facility at Ball-Mitchell Park to promote infiltration and improve water quality benefit. Cost to plant 2,000 square feet of native water quality facility plants is included. Appendix F4 of the City of Portland Stormwater Management Manual provides templates and facility plant lists that provide guidance on appropriate plant types for stormwater facilities.

Project Name: Stanley-Willow UIC Decommissioning

Estimated Planning Cost (2012 dollars)	
Construction Cost Sub-total (See Appendix X for details)	$56,300
Construction Contingency (30%)	$16,900
Sub-total	$73,200
Engineering and Permitting (25%)	$18,300
Construction Administration (5%)	$3,700
UIC Closure Report	$5,000
Capital Project Implementation Cost Total	**$100,200**
Site Acquisition	$0
Annual Maintenance Costs	
Existing to Future % Flow Increase[1]	Not Applicable

Design Assumptions

- The drainage area captured by this project is 3.92 acres, of which 35% is assumed to be impervious. The peak 25-year flow in JCD90 associated with runoff from the 3.92 acres is 0.9 cfs.
- The Ball-Mitchell Stormwater Facility has sufficient capacity to accept additional drainage as a result of this CIP.
- All UICs must be closed in a manner that complies with the federal prohibition of fluid movement, as outlined in 40 CFR 144.12 and 144.82a. Current guidelines for UIC decommissioning can be found on the Oregon DEQ website.

1. *Existing to future percent flow increase is based on the 25-year percent flow increase from the contributing drainage area between the existing and future land use scenarios. This value is used to assign a dollar value to the portion of this CIP which can be attributed to growth.*

Project Name	Main Street at Milport Road
Project ID	4-1
Modeled System No.	4
Associated Subbasins	JCB10
Associated Modeled Pipes/Conduits	JCB10d (21265-21059) JCB10c (21059-ODMH017)
Objective(s) Addressed	Flood Control – Pipe Capacity Deficiency

Project Description

The 12-in x 24-in elliptical CMP associated with modeled conduit JCB10d (21265-21059) and the 18-in concrete pipe associated with modeled conduit JCB10c (21059-ODMH017) are under capacity, causing predicted flooding along JCB10d between SE Main and SE Omark and in the parking lot between an industrial building and SE Main St. Flooding is predicted during the 10 and 25-yr existing and future land use scenarios.

This CIP includes replacement of JCB10d and JCB10c from manhole 21265 to manhole ODMH017 with 380-ft of 30-in concrete pipe using the same upstream and downstream invert elevations. Replacement of model conduits JCB10d and JCB10c (defined by the upstream node to downstream node number) includes replacement of 7 manholes.

This pipe is aligned in private property. Ownership of the pipe is listed as City of Milwaukie in the City's GIS, however the easment for this pipe is unknown in GIS.

Estimated Planning Cost (2012 dollars)	
Construction Cost Sub-total (See Appendix X for details)	$142,700
Construction Contingency (30%)	$42,800
Sub-total	$185,500
Engineering and Permitting (25%)	$46,400
Construction Administration (5%)	$9,300
Capital Project Implementation Cost Total	$241,200
Existing to Future % Flow Increase[1]	43%

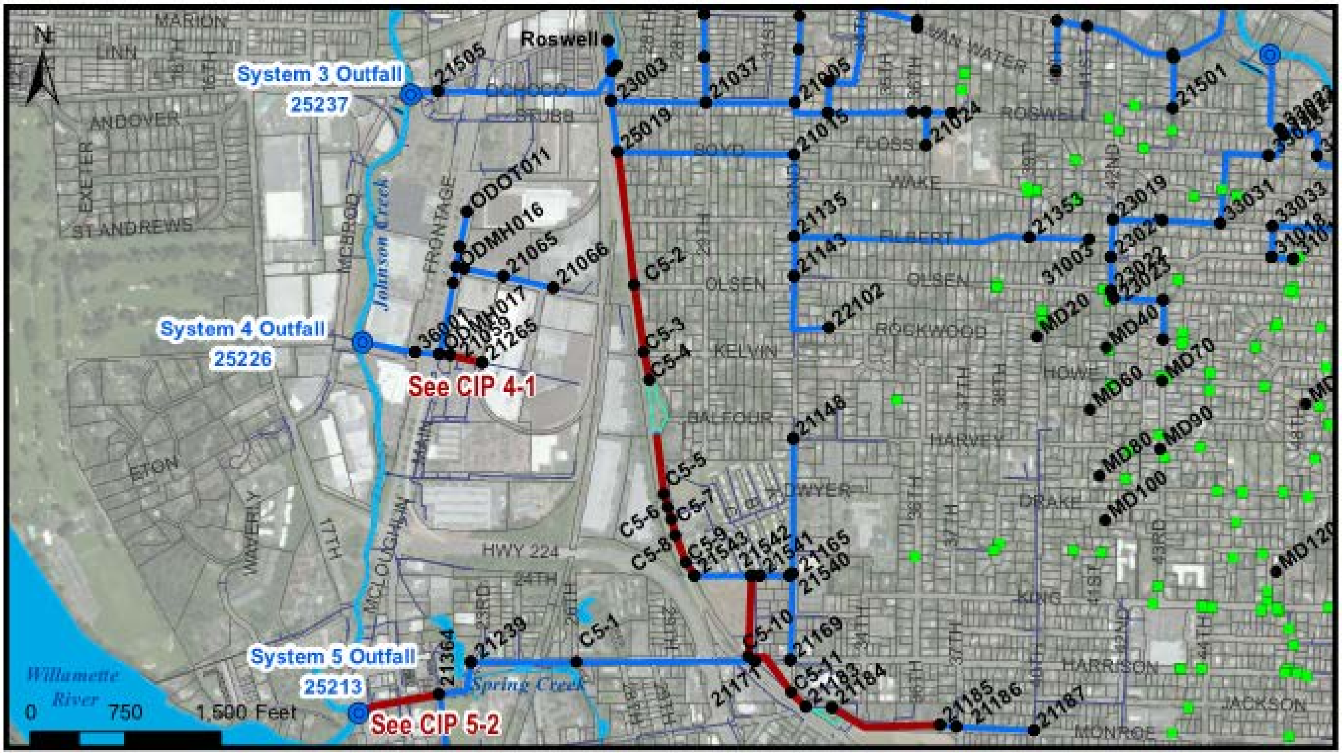
Design Assumptions

- Site acquisition is not included in the cost for this project.
- ODMH017 is owned by the Oregon Department of Transportation (ODOTM017). It is assumed that this manhole will need to be replaced as a part of this project. Installation of manhole ODMH017 will require closure of one northbound lane of McLoughlin Boulevard. Traffic control was increased from 2% to 5% of the capital expense total for this project.

1. *Existing to future percent flow increase is based on the 25-year percent flow increase from the contributing drainage area between the existing and future land use scenarios. This value is used to assign a dollar value to the portion of this CIP which can be attributed to growth.*

Capital Project Fact Sheet — Priority Ranking No. 4

Project Name: Meek Street



Project Name	Meek Street
Project ID	5-1
Modeled System No.	5
Associated Subbasins	JCC94, JCC93, JCC92, JCC91, JCA60, JCA52, JCA51, JCA50, JCA41
Associated Modeled Pipes/Conduits	Multiple
Objective(s) Addressed	Flood Control – Pipe Capacity Deficiency

Project Description

System wide flooding is predicted during the existing and future 10 and 25-year events. CIP 5-1 addresses the majority of the flooding via the Meek Street bypass, which re-routes flows from subbasins JCA41, JCA50, JCA51, JCA52 and JCA60 away from the Harrison Street system to the north.

A similar CIP to address flooding in System 5 was proposed in the 2004 plan. Since completion of the 2004 plan, the City completed design for a 36-in pipeline to convey flow from 32nd Ave, along Meek Street and north along the railroad tracks to the west end of Balfour Street. In 2005, the portion of this pipeline along Meek Street, west of 32nd Avenue was constructed. However, the Meek Street pipe system was constructed with inadequate slope to maintain the existing concept per CIP-2 from the 2004 MP. This CIP proposes to incorporate the recently constructed pipeline along Meek Street into the design.

The portion of this CIP along Monroe Street includes replacement of the existing 12-in concrete pipe with 18-in HDPE from manhole 21185 to 21184. This pipe discharges into a new detention facility between Oak and Railroad, which is necessary to maintain use of the recently constructed 36-in pipeline on Meek Street. The detention facility is proposed on tax lot 11E36AB03000, which is currently undeveloped private property.

1,560-ft of new 36-in HDPE pipe is proposed from the discharge of the Oak and Railroad detention facility at 21183 to Meek Street at manhole 21542. Approximately 630-ft of the pipeline is aligned on private property along an existing 12-in pipe owned by the City.

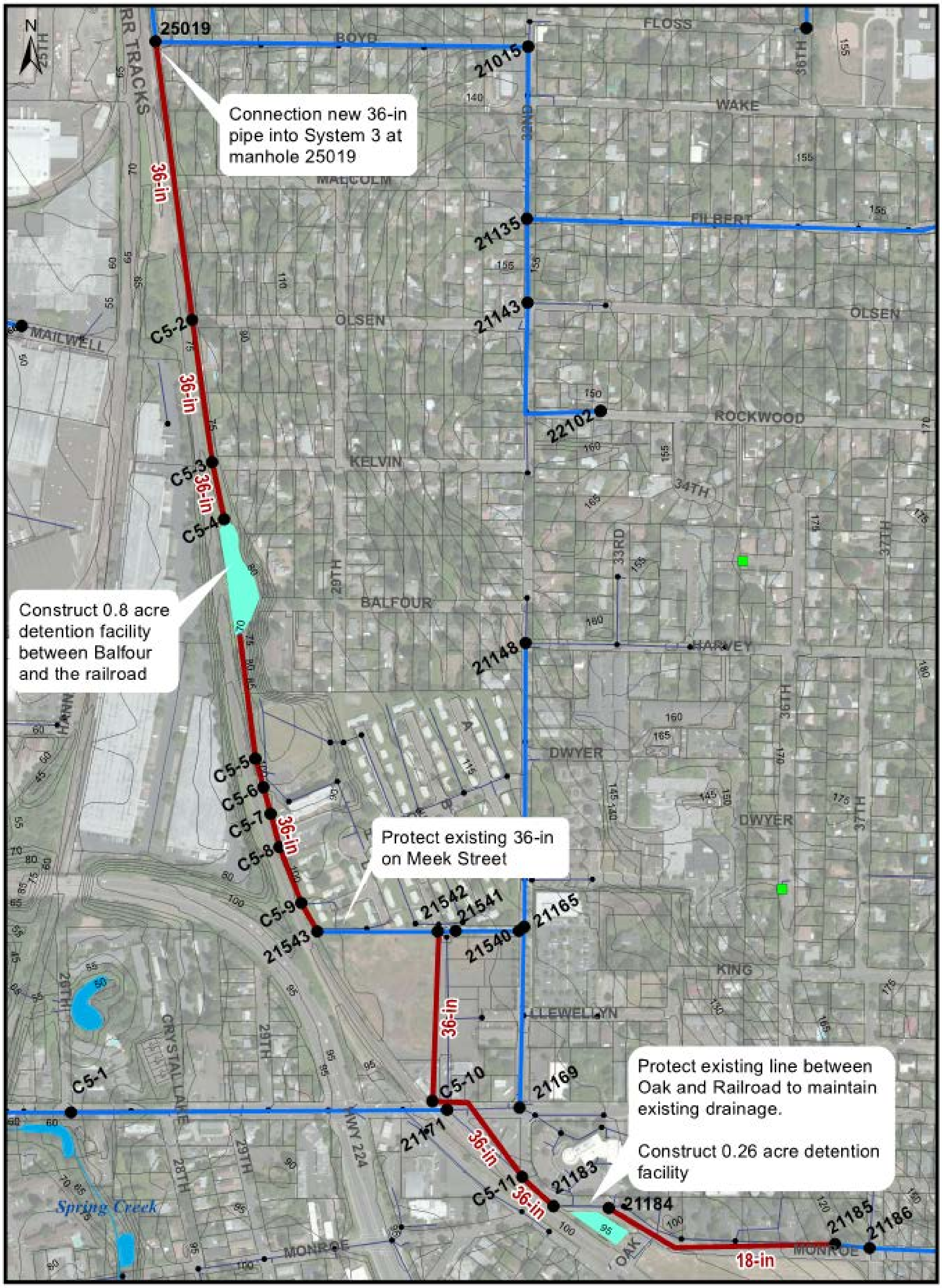
The existing 36-in pipe on Meek Street from manhole 21542 to manhole 21543 will be protected in place. At manhole 21543, 985-ft of new HDPE is proposed per the 2006 Meek Street Storm Improvements Phase II design, completed by Century West Engineering Coorporation. This pipeline is aligned on the east side of the railroad tracks. The new 36-in pipeline will discharge to a detention facility at Balfour, which is sized to utilize the available open space and provide necessary storage to maintain capacity in System 3, downstream of manhole 25019.

From the Balfour detention facility, 1,800-ft of 36-in HDPE is proposed to the connection at manhole 25019. Open channel flow may be an option for this reach, but this CIP was estimating using pipe because information on the available width between the railroad tracks and the toe of the existing slope was unknown.

Estimated Planning Cost (2012 dollars)	
Construction Cost Sub-total (See Appendix X for details)	$1,827,300
Construction Contingency (30%)	$548,200
Sub-total	$2,375,500
Engineering and Permitting (25%)	$593,900
Construction Administration (5%)	$118,800
Capital Project Implementation Cost Total	**$3,088,200**
Existing to Future % Flow Increase	56%

Design Assumptions

- Site acquisition is not included in the cost of this project. The proposed Oak and Railroad detention facility has been sited on private property.
- The City has an existing easement for use of the Balfour site.
- Cost of asphalt surface restoration was removed on pipe unit costs from Meek Street to manhole 25019.
- 1,000 cubic yards of excavation and 1,000 cubic yards of embankment was assumed to estimate earthwork costs for the Balfour facility. Detailed design with survey information should be completed to estimate actual earthwork quantities and evaluate slope stability in this area. The eastern portion of the Balfour facility is located near the toe of a steep slope.
- The vertical datum on the Meek Street Storm Improvements Phase II design, completed in 2006 by Century West Engineering Coorporation does not match NGVD29, which was the datum used for this master plan. Elevations were adjusted relatively to the NGVD29 datum for modeling and reporting purposes.


Connection new 36-in pipe into System 3 at manhole 25019
Construct 0.8 acre detention facility between Balfour and the railroad
Protect existing 36-in on Meek Street
Protect existing line between Oak and Railroad to maintain existing drainage.
Construct 0.26 acre detention facility
25019
21015
21135
21143
22102
21148
21543
21542
21541
21540
21165
21169
21171
21183
21184
21185
21186
C5-1
C5-2
C5-3
C5-4
C5-5
C5-6
C5-7
C5-8
C5-9
C5-10
C5-11
36-in
18-in
RR TRACKS
BOYD
FLOSS
WAKE
MALCOLM
FILBERT
OLSEN
MAILWELL
ROCKWOOD
KELVIN
34TH
BALFOUR
HARVEY
DWYER
KING
LLEWELLYN
MONROE
OAK
HWY 224
CRYSTAL LAKE
29TH
28TH
20TH
33RD
36TH
37TH
Spring Creek

Project Name	Harrison Street Outfall
Project ID	5-2
Modeled System No.	5
Associated Subbasins	JCA10, JCA20, JCA30, JCA40
Associated Modeled Pipes/Conduits	JCA10a (21364_25213)
Objective(s) Addressed	Flood Control – Pipe Capacity Deficiency

Project Description

System wide flooding is predicted during the existing and future 10 and 25-year events. CIP 5-2 addresses the predicted flooding down Harrison Street not addressed with installation of CIP 5-1. Following installation of CIP 5-1 in the model, flooding is predicted on 21st Street along modeled conduit JCA20 (21094_21364) and along Harrison Street along modeled conduits JCA30a (21239_21364) and JCA30b (C5-2_21239). JCA30b represents recent improvements from 23rd Street to 26th Street along Harrison Street, which were completed as a part of the Trimet Light Rail Project (and not included in this cost estimate). The predicted flooding is due to a constriction in the outfall conduit JCA10 (21364_25213).

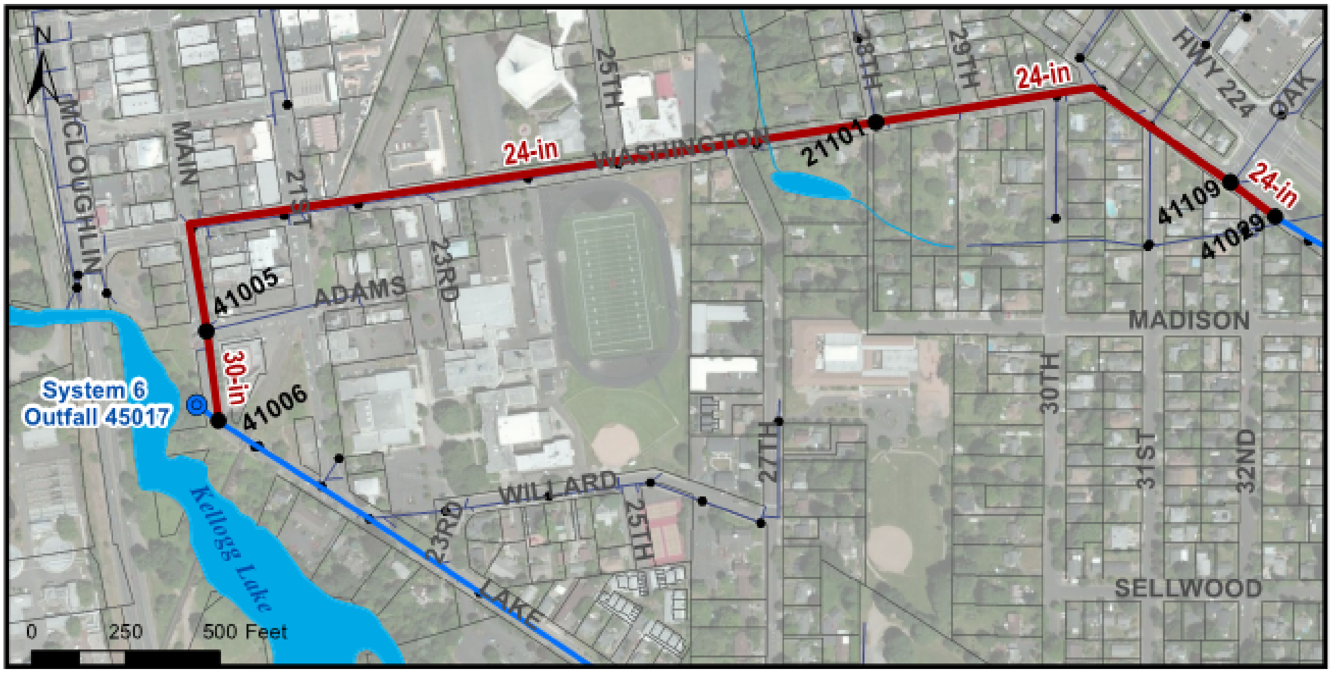
This CIP includes replacement of 696-feet of existing 24-in concrete pipe with 696-feet of 36-in along JCA10, from manhole 21364 to the outfall at Johnson Creek, which extends 40-feet from manhole 25213.

Estimated Planning Cost (2012 dollars)	
Construction Cost Sub-total (See Appendix X for details)	$366,500
Construction Contingency (30%)	$110,000
Sub-total	$476,500
Engineering and Permitting (25%)	$119,100
Construction Administration (5%)	$23,800
Capital Project Implementation Cost Total	**$619,400**
Existing to Future % Flow Increase[1]	45%

Design Assumptions

- If the outfall is located within the ordinary high water mark, additional permitting may be required.

1. *Existing to future percent flow increase is based on the 25-year percent flow increase from the contributing drainage area between the existing and future land use scenarios. This value is used to assign a dollar value to the portion of this CIP which can be attributed to growth.*



Project Name	Washington Street
Project ID	6-1
Modeled System No.	6
Associated Subbasins	KC10, KC30, KC40, KC50, KC60
Associated Modeled Pipes/Conduits	KC30b (41029_41109), KC30a (41109_21101) KC10b (21101_41005), KC10a (41105_41006)
Objective(s) Addressed	Flood Control – Pipe Capacity Deficiency

Project Description

The 21-in pipe KC10a on Main Street near Kellogg Lake and the 18-in pipes KC10b and KC30a along Washington Street are under capacity, which is causing predicted flooding along Washington Street between Main Street and Hwy 224 during the 10 and 25-yr existing and future land use scenarios.

This CIP includes replacement of 239-ft of existing 21-in concrete pipe with 30-in pipe along KC10a from manhole 41005 to 41006. This CIP also includes replacement of 3,312 feet of existing 18-in concrete pipe with 24-in concrete pipe along KC10b from manhole 41109 to 41005 and KC30a from manhole 41029 to 41005.

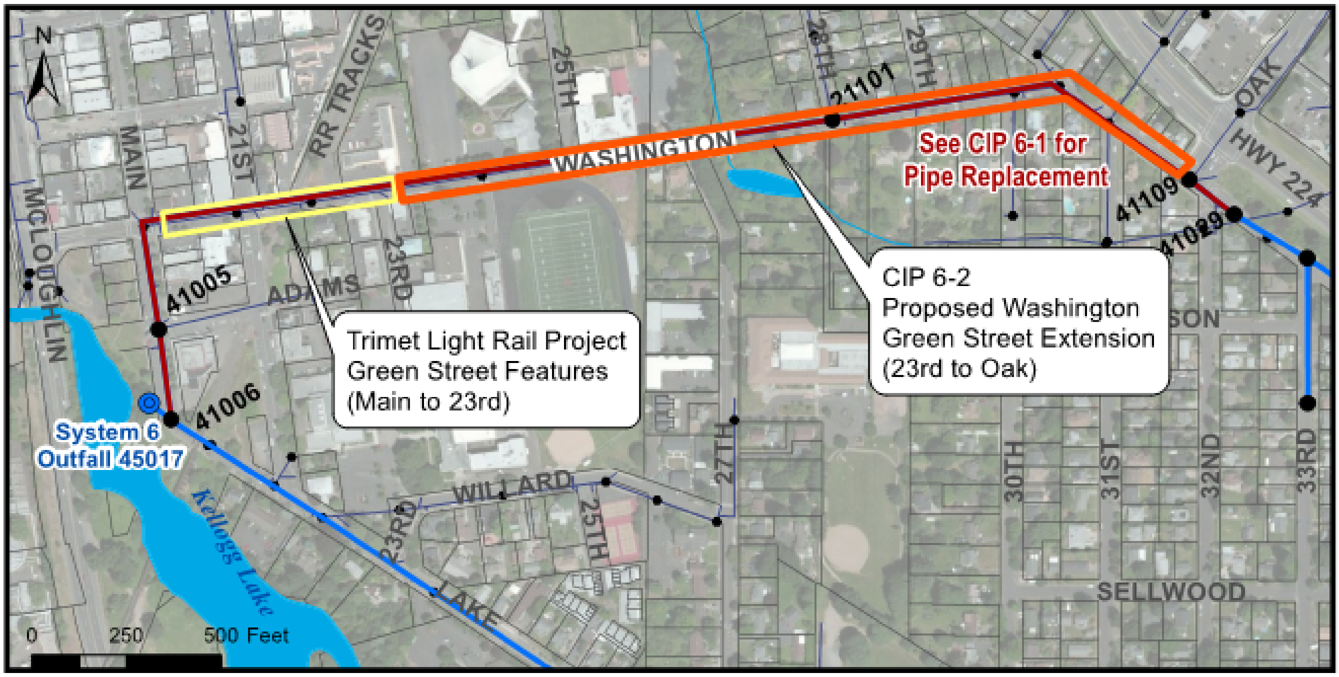
Estimated Planning Cost (2012 dollars)	
Construction Cost Sub-total (See Appendix X for details)	$1,156,400
Construction Contingency (30%)	$347,000
Sub-total	$1,503,400
Engineering and Permitting (15%)	$225,500
Construction Administration (5%)	$75,200
Capital Project Implementation Cost Total	$1,804,100
Existing to Future % Flow Increase[1]	17%

Design Assumptions

- A segment of this CIP will be installed by Trimet during the construction of the max light rail line between 21st and 25th along Washington Street. However, funding of this segment is still in progress and was included in the cost estimate for this CIP.

1. *Existing to future percent flow increase is based on the 25-year percent flow increase from the contributing drainage area between the existing and future land use scenarios. This value is used to assign a dollar value to the portion of this CIP which can be attributed to growth.*

Capital Project Fact Sheet Priority Ranking No. 12
Project Name: Washington Green Streets



Project Name	Washington Green Streets
Project ID	6-2
Modeled System No.	6
Associated Subbasins	KC30, KC40, KC50, KC60
Associated Modeled Pipes/Conduits	KC30b (41029_41109), KC30a (41109_21101) KC10b (21101_41005), KC10a (41105_41006)
Objective(s) Addressed	Water Quality

Project Description

The contributing area from Washington Street is a high pollutant load generating area. Currently, the Trimet Light Rail Project is installing green street features to provide water quality treatment from Main to 23rd along Washington Street.

This CIP includes an extension of the green street features being installed by Trimet, from 23rd to Oak along Washington Street. The installation of CIP 6-1 will involve pipe replacement and repaving a portion of Washington Street, which provides an opportunity to complete green street features while the pipe replacement construction is occuring.

Estimated Planning Cost (2012 dollars)	
Construction Cost Sub-total (See Appendix X for details)	$271,200
Construction Contingency (30%)	$81,400
Sub-total	$352,600
Engineering and Permitting (40%)	$141,100
Construction Administration (5%)	$17,600
Capital Project Implementation Cost Total	**$511,300**
Existing to Future % Flow Increase[1]	Not applicable

Design Assumptions

- The cost of this CIP may be reduced if construction is completed in conjunction with CIP 6-1. Potential efficiencies include mobilization/ demobilization, traffic control, pipe connections, and erosion control costs.

1. *Existing to future percent flow increase is based on the 25-year percent flow increase from the contributing drainage area between the existing and future land use scenarios. This value is used to assign a dollar value to the portion of this CIP which can be attributed to growth.*

Project Name	International Way and Wister
Project ID	12-1
Modeled System No.	12
Associated Subbasins	MSB20, MSB21
Associated Modeled Pipes/Conduits	MSB20d (61010_61028)
Objective(s) Addressed	A Flood Control

Project Description

The 24-in MSB20d at International Way is negatively sloped and MSB20e and MSB20d is under capacity, resulting in predicted flooding along MSB20e. According to elevations in the model, the invert elevations of nodes 61105 and 61028 are 80.8-ft.

This CIP includes replacement of 80-ft of existing 24-in pipe with 48-in pipe along MSB20d from manhole 61010 to manhole 61028 to reduce expected flooding. Flooding of 0.28 cfs is still predicted in the model at the 25-year future scenario following the installation of this CIP.

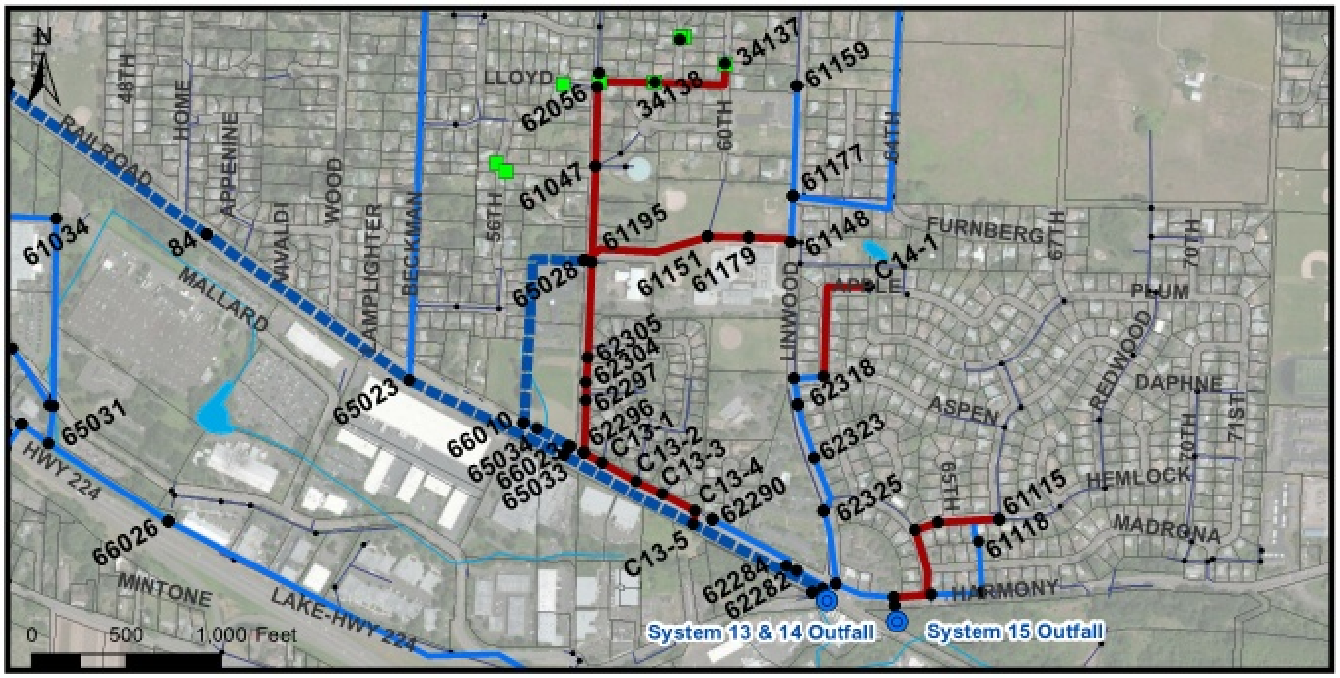
Estimated Planning Cost (2012 dollars)	
Construction Cost Sub-total (See Appendix X for details)	$57,700
Construction Contingency (30%)	$17,300
Sub-total	$75,000
Engineering and Permitting (25%)	$11,300
Construction Administration (5%)	$3,700
Capital Project Implementation Cost Total	**$90,000**
Existing to Future % Flow Increase	74%

Design Assumptions

- Invert elevations were unable to be verified during this study at this location. Verification of the inverted slope is recommended prior to moving forward with this CIP.

Capital Project Fact Sheet Priority Ranking No. 1

Project Name: UIC Decommissioning on Lloyd



Project Name	UIC Decommissioning on Lloyd
Project ID	13-1
Modeled System No.	13
Associated Subbasins	MSA22, MSA23, MSA24, MSA25, MSA26, MSA27
Associated Modeled Pipes/Conduits	MSA23a (34137_34138), MSA22a (34138_62056), MSA25b (62056_61047), MSA25a (61047_61195), MSA27d (61195_62305), MSA27c (62305_62304), MSA27b (62304_62297), MSA27a (62297_62296)
Objective(s) Addressed	Water Quality - UIC Decommissioning – Flood Control

Project Description

UIC 34155 (west of Stanley Avenue) and UIC 34137 (intersection of 60th Avenue and Lloyd Street), are not operational, as reported by City maintenance staff. The City has attempted to retrofit these UICs, however, the UICs are still not functioning properly and flooding has been reported at the intersection of Lloyd Street and Stanley Avenue. UICs 34167 and 34138 are also included in this CIP due to their location along Lloyd Street.

This CIP includes decommissioning of the four UICs described above and installation of 787 feet of new 12-in HDPE pipe along Lloyd Street from 60th Avenue to Stanley Avenue. Along Stanley Ave. (from Lloyd St. to Railroad Ave.) this CIP also includes replacement of existing concrete pipe with 1,314 feet of new 12-in HDPE pipe and 499 feet of 18-in HDPE pipe.

To address water quality of new contributing area previously captured by UICs, this CIP includes installation of a bypass manhole at the Stanley Avenue entrance to Linwood Elementary School, which would divert flow associated with the water quality storm to a newly constructed rain garden. The rain garden would be installed in the existing channel. The channel currently runs east-west along the school driveway from the an existing rain garden located on the school grounds to Stanley Avenue. The existing rain garden was sized to treat runoff associated with a building expansion at the school.

CIP 13-2 includes pipe improvements and a planning study for the conveyance system on Linwood Elementary School grounds.

CIP 13-3 addresses the conveyance system downstream of CIP 13-1, starting at Railroad Avenue and extending to the system outfall at the Railroad Avenue channel. Construction of CIP 13-3 should be scheduled in accordance with CIP 13-1.

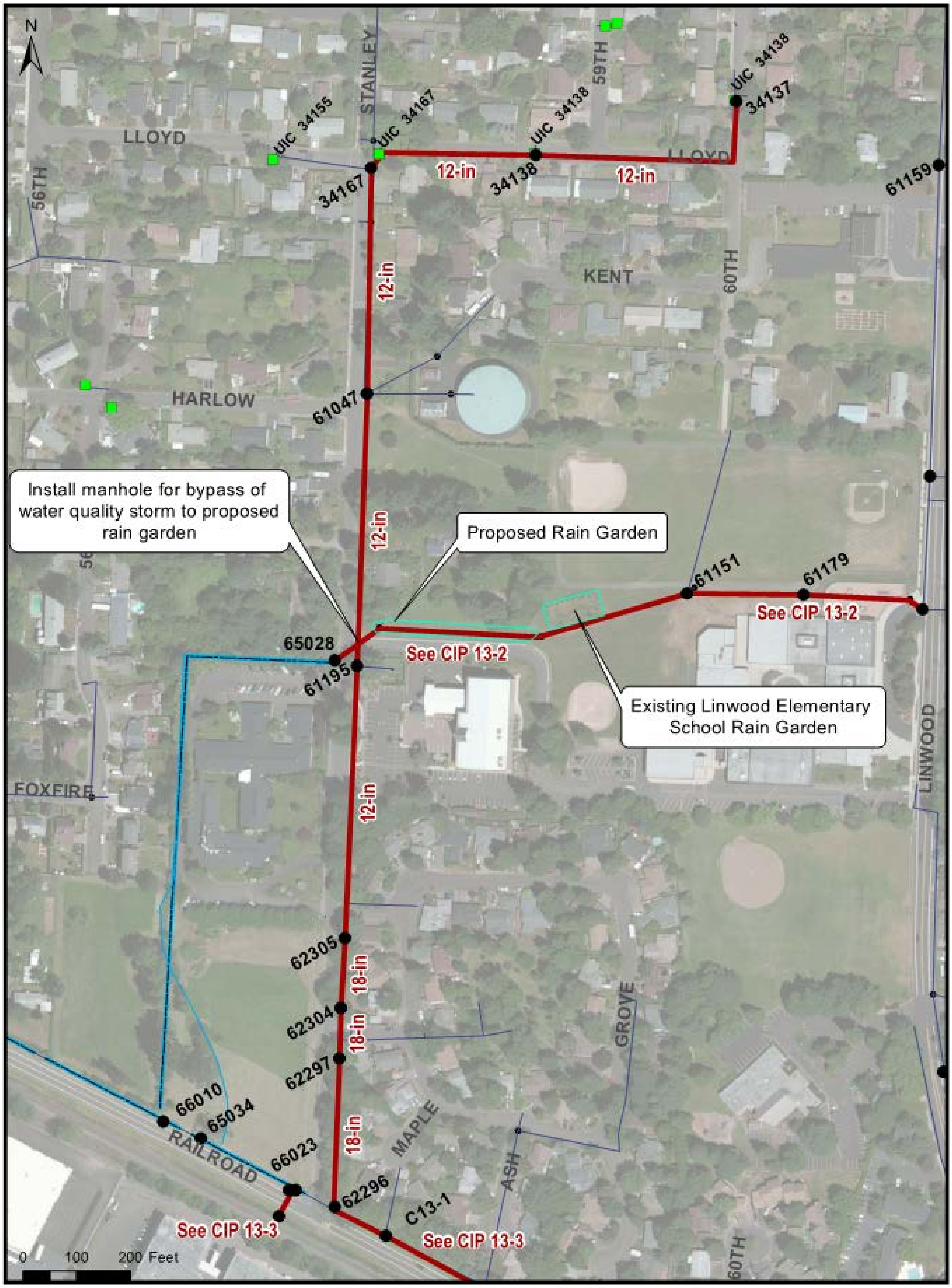
Project Name: UIC Decommissioning on Lloyd

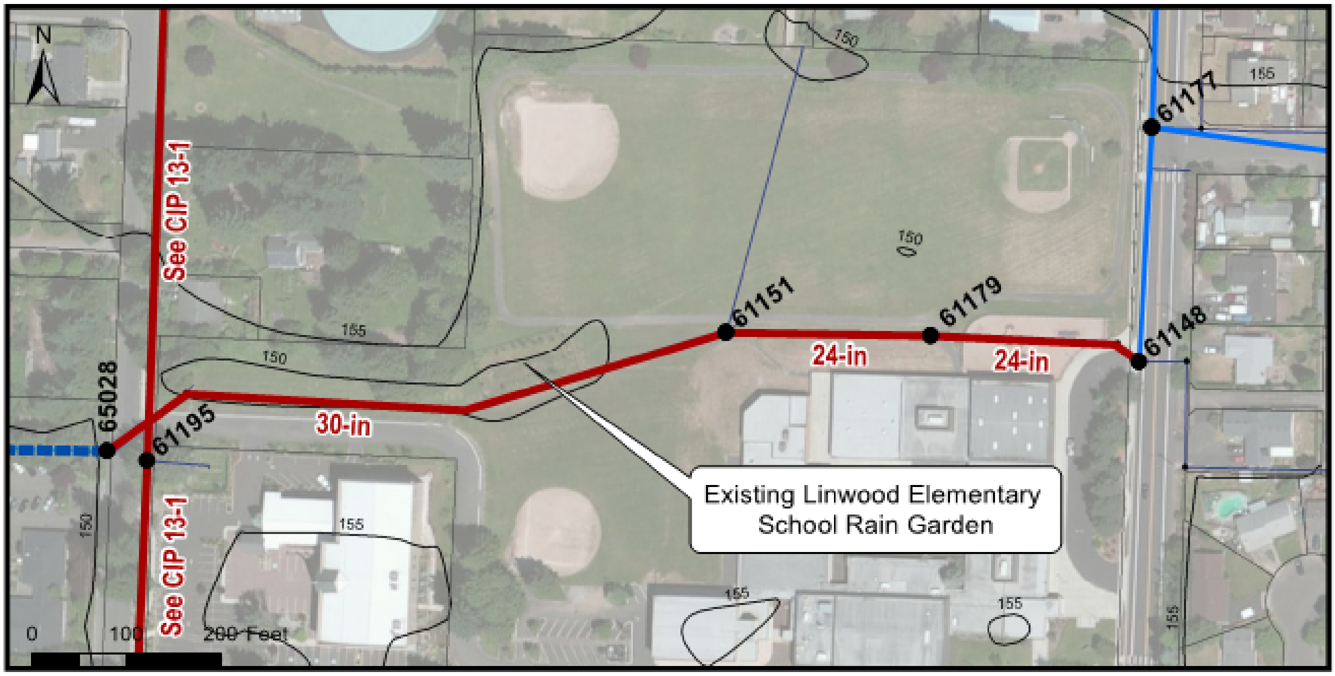
Estimated Planning Cost (2012 dollars)	
Construction Cost Sub-total (See Appendix X for details)	$463,800
Construction Contingency (30%)	$139,100
Sub-total	$602,900
Engineering and Permitting (25%)	$150,700
Construction Administration (5%)	$30,100
UIC Closure Report	$10,000
Capital Project Implementation Cost Total	**$793,700**
Existing to Future % Flow Increase[1]	**55%**

Design Assumptions

- This CIP introduces additional flow to the pipeline along Stanley Avenue. CIP 13-3 should be completed prior to or in conjunction with this CIP.
- It is assumed that the City would not acquire additional property for the water quality portion of this CIP; coordination with the school district will be conducted to ensure construction and maintenance easements on the school grounds. An alternative water quality facility may be considered on the southwest side of the City's well and storage tank site which is south of Kent Street.
- All UICs must be closed in a manner that complies with the federal prohibition of fluid movement, as outlined in 40 CFR 144.12 and 144.82a. Current guidelines for UIC decommissioning can be found on the Oregon DEQ website.

1. *Existing to future percent flow increase is based on the 25-year percent flow increase from the contributing drainage area between the existing and future land use scenarios. This value is used to assign a dollar value to the portion of this CIP which can be attributed to growth.*


N
LLOYD
STANLEY
59TH
UIC 34155
UIC 34167
UIC 34138
UIC 34138
34137
12-in
12-in
34167
34138
LLOYD
61159
56TH
KENT
60TH
12-in
HARLOW
61047
Install manhole for bypass of water quality storm to proposed rain garden
12-in
Proposed Rain Garden
61151
61179
See CIP 13-2
65028
See CIP 13-2
61195
Existing Linwood Elementary School Rain Garden
FOXFIRE
12-in
LINWOOD
62305
18-in
62304
GROVE
18-in
62297
66010
65034
RAILROAD
66023
18-in
MAPLE
62296
C13-1
ASH
See CIP 13-3
See CIP 13-3
60TH
0
100
200 Feet



Project Name	Linwood Elementary
Project ID	13-2
Modeled System No.	13
Associated Subbasins	MSA90, MSA80, MSA70
Associated Modeled Pipes/Conduits	MSA80b (61148_61179), MSA80a (61179_61151), MSA70d (61151_65028)
Objective(s) Addressed	Flood Control

Project Description

The 15-in concrete pipe associated with modeled conduit MSA80b (61148_61179) and the 18-in concrete pipes associated with modeled conduits MSA80a (61179_61151) and MSA70d (61151_65028) are under capacity. Flooding is predicted along this reach, which is located between Linwood Avenue and Stanley Ave on the Linwood Elementary School grounds. Capacity limitations are caused by undersized piping along MSA80b , MSA80a and MSA70d.

The cost for this CIP was developed as a pipe replacement with the option to conduct a planning level study to evaluate additional options for flood mitigation.

The pipe replacement includes replacement of 243-ft existing 15-in pipe with 24-in pipe along MSA80b, 186-ft of existing 18-in pipe with 24-in pipe along MSA80a, and 683-ft of existing 18-in pipe with 30-in pipe along MSA70d. There is also a backslope on MSA80c (61177_61148) along Linwood Avenue, however with improvements made to downstream piping from 61148 to 65028, the model does not predict flooding during the future 25-year event along Linwood Avenue. Modeled conduit MSA80c is associated with approximately 250-ft of 24-in concrete pipe.

The planning level study would consider partial pipe replacement from Linwood Avenue to the west side of the school rain garden. At this point, the feasibility of daylighting the existing pipe to a channel for water quality and flood control would be evaluated. This option would be an alternative to full pipe replacement. The rain garden proposed at for CIP 13-1 would be considered as a part of the pipe replacement option for CIP 13-2. The planning study would also include an evaluation of grant funding opportunities for the school district to expand existing raingardens.

See CIP 13-1 for pipe and water quality improvements on Stanley Avenue.

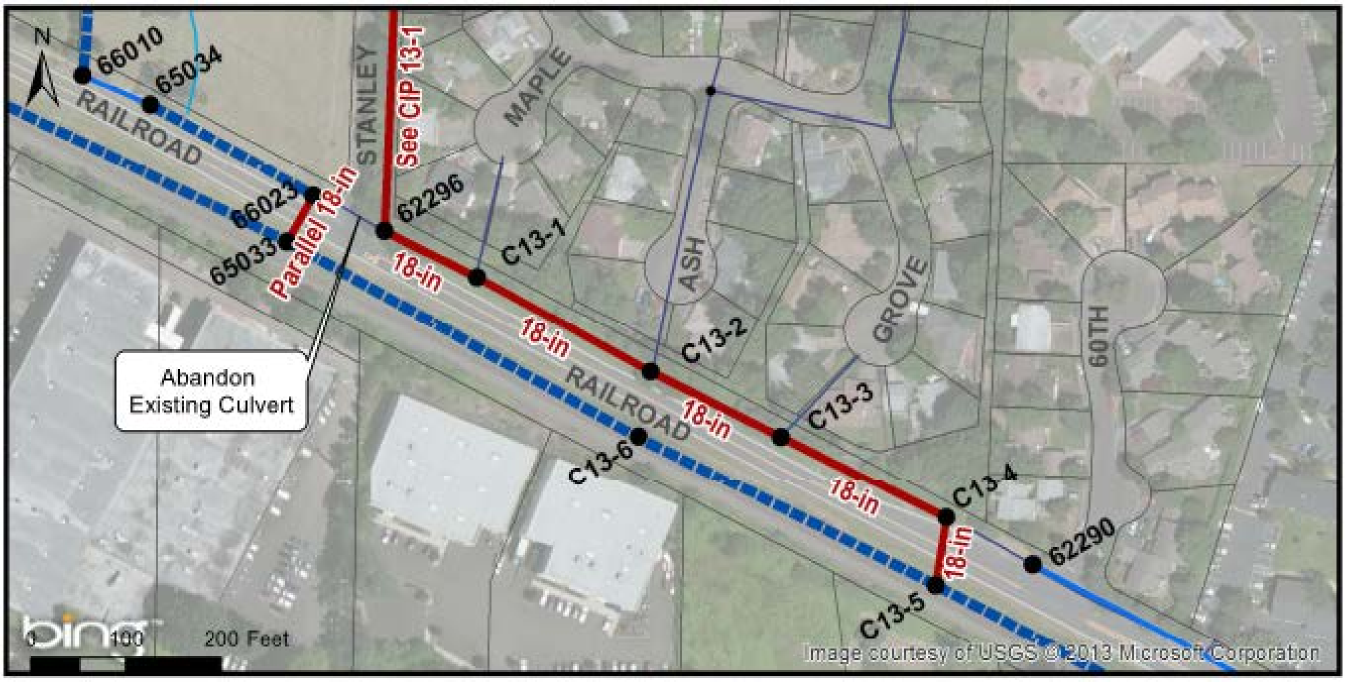
Project Name: Linwood Elementary

Estimated Planning Cost (2012 dollars)	
Construction Cost Sub-total (See Appendix X for details)	$248,400
Construction Contingency (30%)	$74,500
Sub-total	$322,900
Planning Level Study	$50,000
Engineering and Permitting (25%)	$80,700
Construction Administration (5%)	$16,100
Capital Project Implementation Cost Total	**$469,700**
Existing to Future % Flow Increase[1]	**23%**

Design Assumptions

- It is assumed that the City currently has an easement for the stormwater pipe on the Linwood Elementary School property.

1. *Existing to future percent flow increase is based on the 25-year percent flow increase from the contributing drainage area between the existing and future land use scenarios. This value is used to assign a dollar value to the portion of this CIP which can be attributed to growth.*



Project Name	Railroad Avenue at Stanley
Project ID	13-3
Modeled System No.	13
Associated Subbasins	MSA22, MSA23, MSA24, MSA25, MSA26, MSA27, MSA31, MSA70, MSA71, MSA72, MSA80, MSA90
Associated Modeled Pipes/Conduits	MSA31a (C13-4_C13-5), MSA31b (C13-3_C13-4), MSA31a (C13-2_CIP13-3), MSA31d (C13-1_C13-2), MSA31e (62296_C13-1)
Objective(s) Addressed	Flood Control

Project Description

The 18-in culvert associated with modeled conduit MSA20a (66023_65033) is under capacity, causing predicted flooding along MSA20a over Railroad Avenue. Flooding is predicted during the 25-yr existing and 10 and 25-year future land use scenarios and was also observed during a storm event on November 19th and 20th, 2012.

This CIP includes abandoning the existing culvert under Stanley Avenue at Railroad Avenue, which is associated with modeled conduit MSA20c (62296_65011). Flow from the channel on the west side of Stanley is routed through two new 18-in 60-ft parallel reinforced concrete culverts under Railroad Avenue on the west side of Stanley. Cover depth at this location limits pipe height to 18-in. Flow from Stanley as described in CIP 13-1 is routed through a new 670-ft 18-in HDPE pipeline on the north side of Railroad Avenue from a new manhole at 62296 to a new manhole at C13-4. Intermediate manholes are placed to accept flows from Maple Street, Ash Street, and Grove Loop. At new manhole C13-4, flow is routed through a new 60-ft 18-in reinforced concrete culvert, where this CIP outfalls to the channel located to the south of Railroad Avenue, associated with modeled conduit MSA110a (C13-5_61107).

There is currently no information available regarding an existing pipe from Stanley Avenue to 60th Court, along the north side of Railroad Avenue, however given the location of pipes which appear to accept drainage from Maple, Ash and Grove, it is assumed that there is an existing pipe at this location. This CIP replaces that pipe segment and creates a new outfall at C13-5.

Capital Project Fact Sheet Priority Ranking No. 2

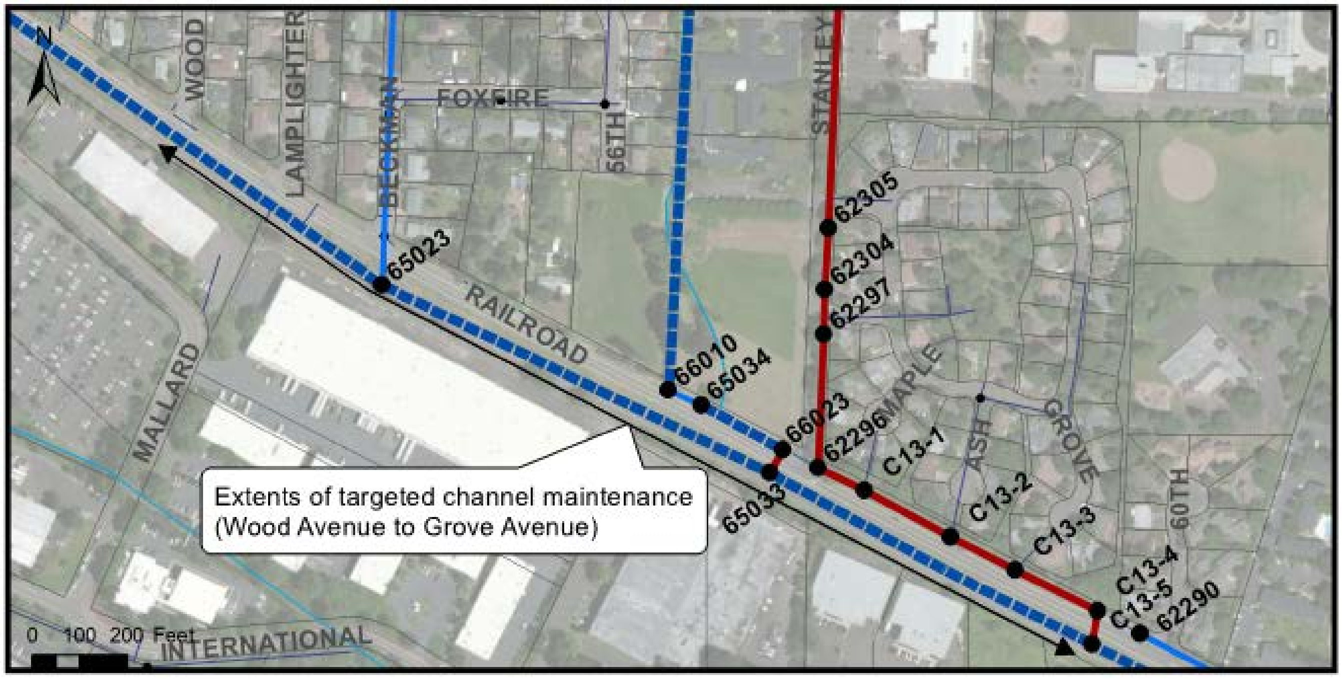
Project Name: Railroad Avenue at Stanley

Estimated Planning Cost (2012 dollars)	
Construction Cost Sub-total (See Appendix X for details)	$211,400
Construction Contingency (30%)	$63,400
Sub-total	$274,900
Engineering and Permitting (25%)	$68,700
Construction Administration (5%)	$13,700
Capital Project Implementation Cost Total	$357,300
Existing to Future % Flow Increase[1]	33%

Design Assumptions

- This CIP alleviates existing flooding and also re-routes flows from Stanley Avenue, and should be constructed prior to installation of CIP 13-1.

1. *Existing to future percent flow increase is based on the 25-year percent flow increase from the contributing drainage area between the existing and future land use scenarios. This value is used to assign a dollar value to the portion of this CIP which can be attributed to growth.*



Project Name	Railroad Avenue Channel
Project ID	13-4
Modeled System No.	13
Associated Subbasins	MSA250, MSA230, MSA220, MSA215. MSA210
Associated Modeled Pipes/Conduits	MSA110d, MSA110c
Objective(s) Addressed	Water Quality - Targeted Maintenance

Project Description

The existing channel along the north side of Railroad Avenue receives drainage from a large portion of the City. Limited maintenance appears to be conducted, which is limiting the ability of the channel to convey stormwater and provide water quality benefit.

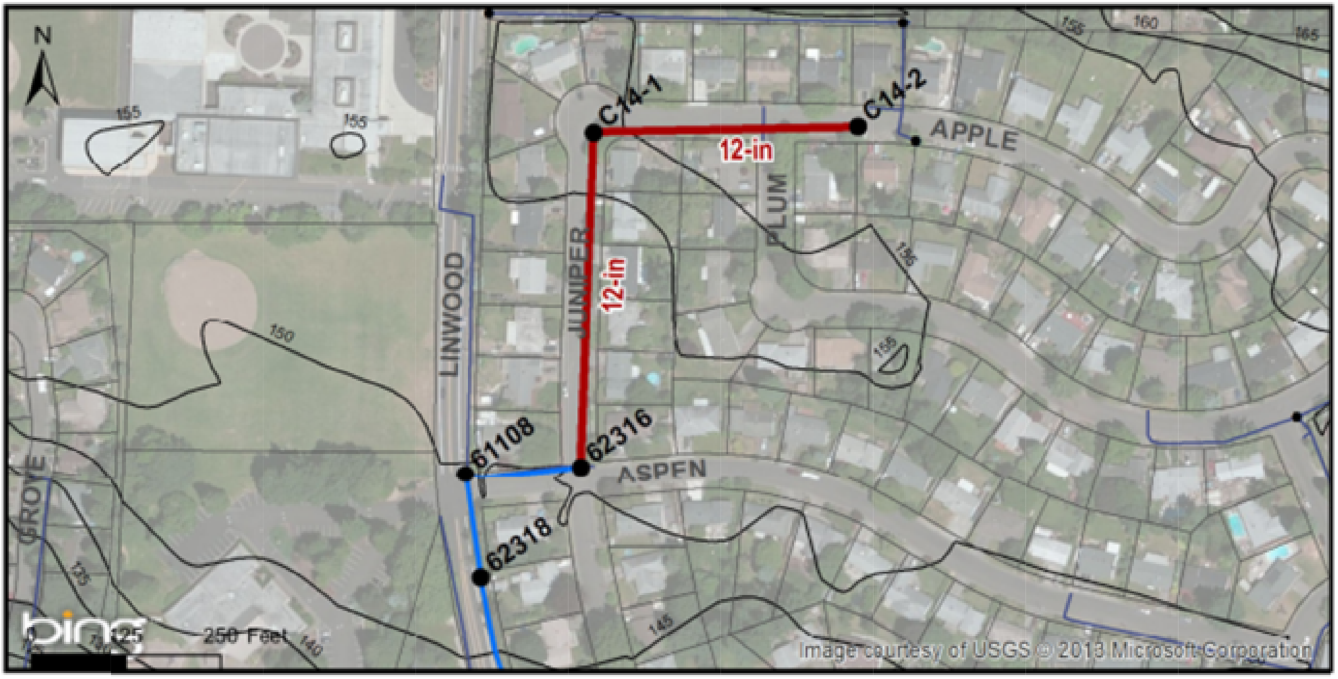
Conduct targeted maintenance activities including hand removal of non-native vegetation, sediment removal, and replanting activities. Maintenance activities to focus on approximately 2,000 linear feet of channel between Wood Avenue and Grove Loop.

Estimated Planning Cost (2012 dollars)	
Construction Cost Sub-total (See Appendix X for details)	$33,900
Construction Contingency (30%)	$10,200
Sub-total	$44,100
Engineering and Permitting (15%)	$6,600
Construction Administration (5%)	$2,200
Capital Project Implementation Cost Total	$52,900
Existing to Future % Flow Increase	Not Applicable

Design Assumptions

- This CIP alleviates existing flooding and also re-routes flows from Stanley Avenue, and should be constructed prior to installation of CIP 13-1.

Project Name: Plum and Apple Street



Project Name	Plum and Apple Street
Project ID	14-1
Modeled System No.	14
Associated Subbasins	MSA61
Associated Modeled Pipes/Conduits	MSA61c (C14-2_62316)
Objective(s) Addressed	Flood Control – Pipe Capacity Deficiency

Project Description

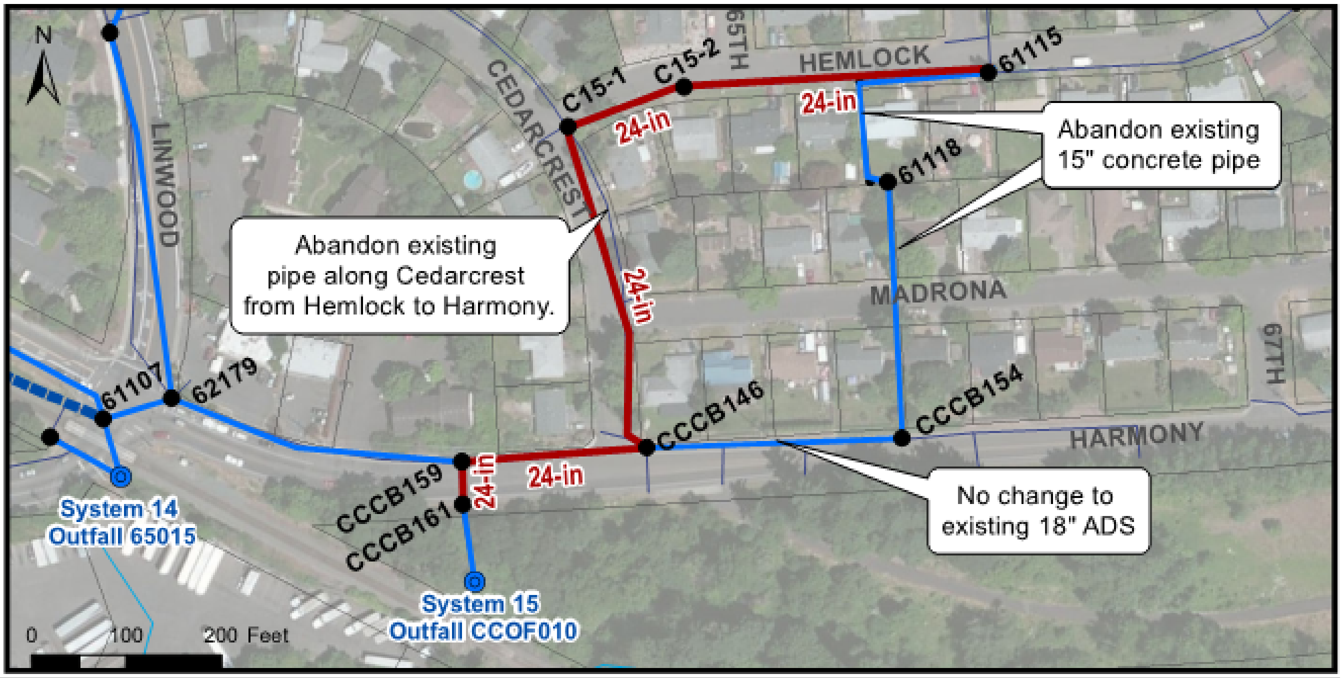
This capital project will provide increased capacity to alleviated observed local flooding problems, as reported by City maintenance staff.

This CIP includes 780 feet of new 12 inch HDPE pipe from new manhole C14-2 to manhole 62316, at the intersection of Juniper and Aspen Street.

Estimated Planning Cost (2012 dollars)	
Construction Cost Sub-total (See Appendix X for details)	$106,600
Construction Contingency (30%)	$32,000
Sub-total	$138,600
Engineering and Permitting (25%)	$34,600
Construction Administration (5%)	$6,900
Capital Project Implementation Cost Total	$180,100
Existing to Future % Flow Increase	43%

Design Assumptions

- CIP sizing and design is based on assumptions contained in the 2004 Master Plan and per communication with City staff. No downstream flooding is predicted as a result of this CIP.



Project Name	Hemlock Street
Project ID	15-1
Modeled System No.	15
Associated Subbasins	MSA100, MSA110
Associated Modeled Pipes/Conduits	Model Conduits Realigned from Existing Condition Model MSA100f (61115_CIP15-2), MSA100e (CIP15-2_CIP15-1), MSA100d (CIP15-1_CCCB146), MSA100c (CCCB146_CCCB159), MSA100b (CCCB159_CCCB161)
Objective(s) Addressed	Flood Control – Pipe Capacity Deficiency

Project Description

The 15-in pipe segments associated with model conduits MSA100f (61115_61118), MSA100e (61118_CCCB154), and the 18-in pipe segments associated with model conduits MSA100d (CCCB154_CCCB146), MSA100c (CCCB146_CCCB159), and MSA100b (CCCB159_CCCB161) are under capacity, causing predicted flooding during existing and future land use scenarios from Hemlock Street, through private property to Harmony Way.

This CIP includes replacement and realignment of this pipeline, which is currently located in private residential backyards from from Hemlock Street to Harmony Way. When constructed, this pipeline will replace a portion of the pipeline along Cedarcrest Drive, from Hemlock Street to Harmony Way. The diameter and elevation of this pipe is currently unknown, and should be identified in the design stage.

Estimated Planning Cost (2012 dollars)	
Construction Cost Sub-total (See Appendix X for details)	$331,700
Construction Contingency (30%)	$99,500
Sub-total	$431,200
Engineering and Permitting (25%)	$107,800
Construction Administration (5%)	$21,600
Capital Project Implementation Cost Total	$560,600
Existing to Future % Flow Increase	16%

Design Assumptions

- Currently, 17.5 acres of subbasin MSA100 and 39.6 acres of subbasin MSA110 are undeveloped and outside of the City limits. This CIP is sized to capture drainage from this area if developed into low density residential land use (assuming 35% impervious coverage).

Capital Project Fact Sheet Priority Ranking No. 10

Project Name: 47th and Llewellyn

Project Name	47th and Llewellyn
Project ID	G1
Modeled System No.	Not Applicable
Associated Subbasins	Subbasin delineated for CIP
Associated Modeled Pipes/Conduits	Not Applicable
Objective(s) Addressed	Flood Control – UIC Deficiency

Project Description

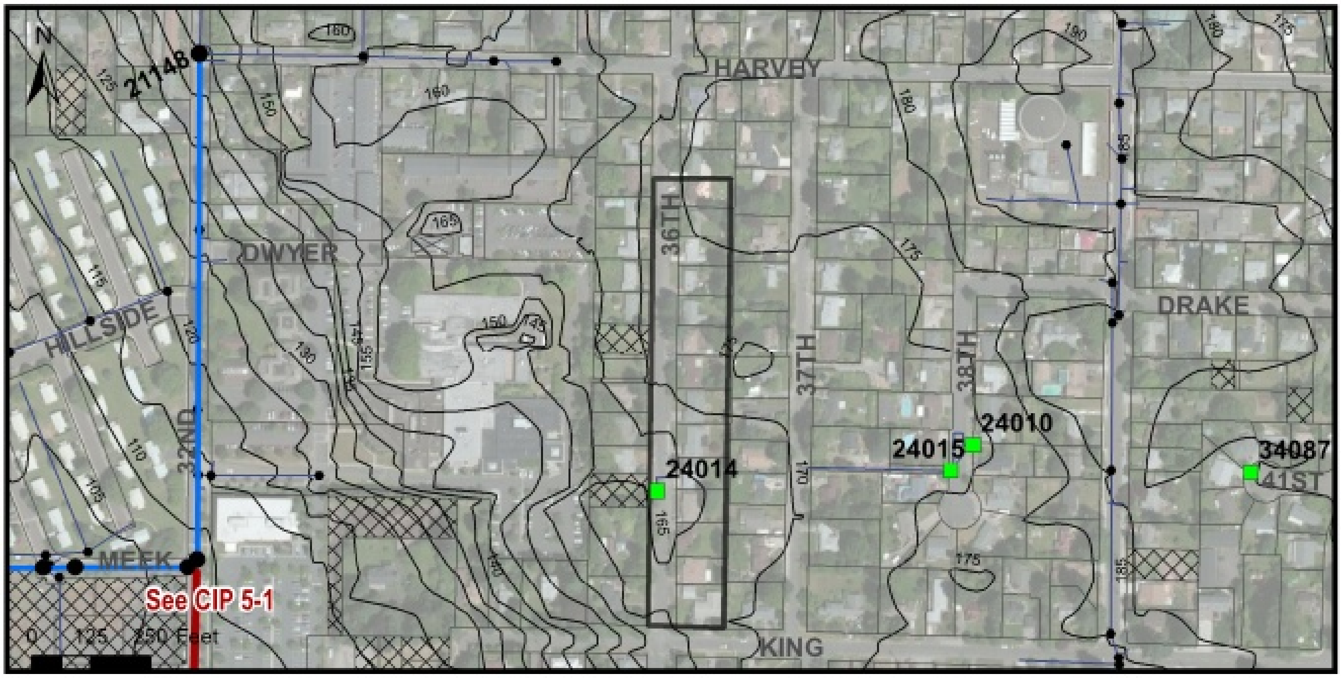
The City reports flooding at the intersection of 47th and Llewellyn, near UIC 34076. The existing UIC is functioning, but is undersized for the contributing drainage area. The total contributing area estimated in ArcGIS is approximatley 8.0 acres. According to the City's UIC database, 70,070 square feet of impervious surface contribute to this UIC.

Due to the existing grade and lack of a nearby piped drainage system, this CIP includes the installation of additional UICs and associated inlets and inlet lead lines to alleviate flooding at 47th and Llewellyn. According to Exhibit 2-31 in the 2010 City of Portland Stormwater Management Manual, an additional 5 UICs are required to accommodate the 70,070 square feet of impervious surface.

Estimated Planning Cost (2012 dollars)	
Construction Cost Sub-total (See Appendix X for details)	$81,200
Construction Contingency (30%)	$27,600
Sub-total	$119,700
Engineering and Permitting (25%)	$29,900
Construction Administration (5%)	$6,000
Capital Project Implementation Cost Total	**$155,600**
Existing to Future % Flow Increase	Not Modeled

Design Assumptions

- The drainage area captured by this project was estimated to be 8.0 acres, which is based on aerial photography, ArcGIS contour lines, taxlots and existing stormwater infrastructure.
- Additional UICs are assumed to be 48-in in diameter and 20-ft deep.
- The cost for registration of new UICs with DEQ is included in the engineering and permitting estimate. The current fee for UIC registration with DEQ is $300 per UIC.



Project Name	36th near King
Project ID	G2
Modeled System No.	Not Applicable
Associated Subbasins	Not Applicable
Associated Modeled Pipes/Conduits	Not Applicable
Objective(s) Addressed	Water Quality - Flood Control – UIC Deficiency

Project Description

The City reports flooding between King Road and Harvey Street, at UIC 24014. This UIC is located at a low point in elevation along 36th Avenue, between Harvey and King.

Due to the existing grade and lack of a nearby piped drainage system, this CIP includes installation of a raingarden or other stormwater feature to minimize flow into the UIC and provide water quality treatment of contributing impervious area within the ROW. This CIP includes installation of 4 new catchbasins will capture drainage from 26th and direct flow to the rain garden until has reached capacity. Overflow enters UIC 24014. This configuration will ensure that the stormwater planter recieves stormwater first, which will help with survival of the facility plants.

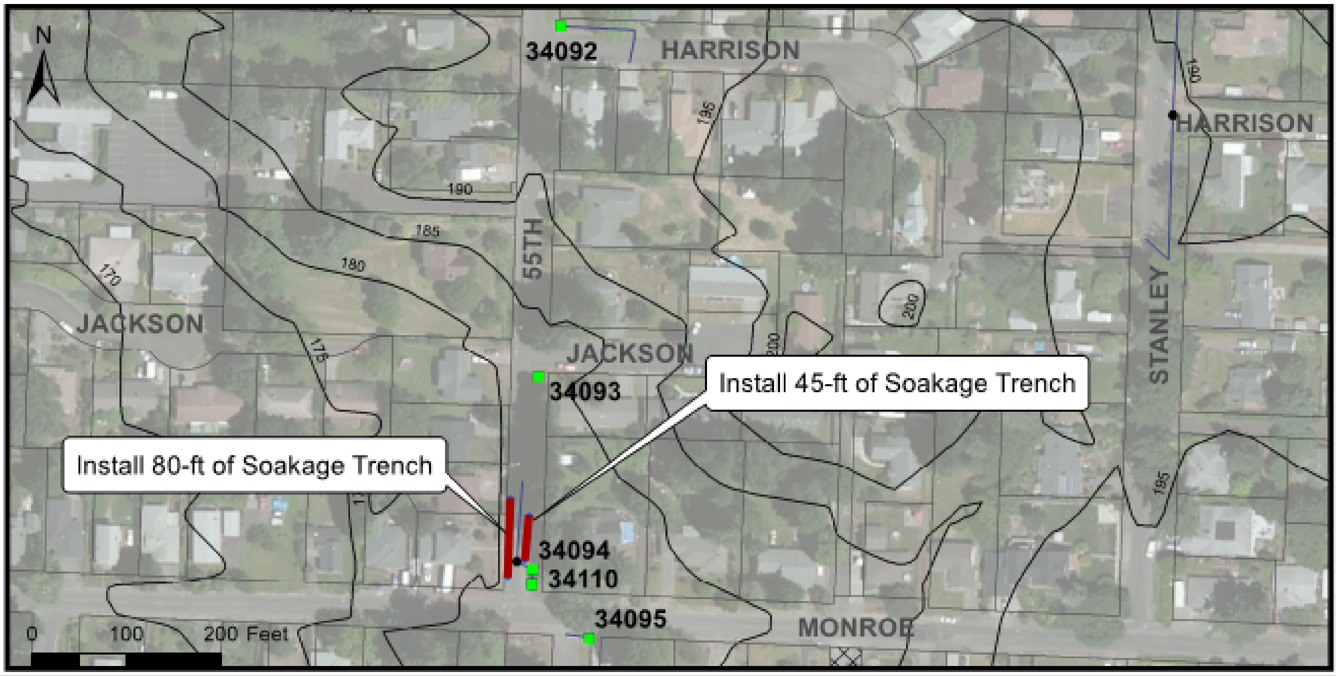
This facility is located on the existing vacant parcel to the west of UIC 24014. As an alternative to purchasing the vacant parcel, the City could also locate multiple small stormwater planters along SE 36th to capture roadway drainage prior to discharge to the UIC.

Project Name: 36th near King

Estimated Planning Cost (2012 dollars)	
Construction Cost Sub-total (See Appendix X for details)	$61,900
Construction Contingency (30%)	$18,600
Sub-total	$80,500
Engineering and Permitting (25%)	$20,100
Construction Administration (5%)	$4,000
Capital Project Implementation Cost Total	**$104,600**
Existing to Future % Flow Increase	Not Applicable

Design Assumptions

- The total contributing area for this UIC was estimated to be 3.5 acres (152,460 square feet), using topographical information in GIS. The contributing impervious area from ROW was estimated to be 28,500 square feet. To size the stormwater facility, a 6% sizing factor was applied to the contributing area, which results in a 1,710 square foot facility.
- The vacant parcel to the west of UIC 24012 has a tax lot ID of 11E25DC04900, is 0.19 acres in size, and is valued at $73,272 according to the current METRO tax lot GIS database. The above cost does not include property acquisition.



Project Name	55th near Monroe
Project ID	G3
Modeled System No.	Not Applicable
Associated Subbasins	Subbasin delineated for CIP
Associated Modeled Pipes/Conduits	Not Applicable
Objective(s) Addressed	Flood Control – UIC Deficiency

Project Description

The City reports flooding onto private property near the corner of 55th Avenue and Monroe Street. According to the City's GIS, UICs 34094 and 34110 are providing drainage to this area. UIC 34094 serves an impervious area of 13,853 square feet and UIC 34110 serves an impervious area of 25,752 square feet. These UICs are not providing adequate capacity and therefore, the City is proposing an additional 125-ft of soakage trench to be installed at the catch basins which convey drainage to the UICs. The soakage trench provides additional surface area for infiltration without being designated as a UIC as long as they maintain a depth of less than 5-ft.

Estimated Planning Cost (2012 dollars)	
Construction Cost Sub-total (See Appendix X for details)	$14,200
Construction Contingency (30%)	$4,200
Sub-total	$18,400
Engineering and Permitting (25%)	$3,700
Construction Administration (5%)	$900
Capital Project Implementation Cost Total	**$23,000**
Existing to Future % Flow Increase	Not Applicable

Design Assumptions

- The City of Portland Stormwater Management Manual was referenced for design criteria.

Appendix D: CIP Hydraulic Results Tables

Table D-1. Hydraulic Evaluation of the CIP Scenario for the Milwaukie Storm Drainage System

	Node Name						Invert Elevation (ft)		Ground Elevation (ft)		Future CIP 10 yr Max Water Surface Elevation (ft)		Future CIP 25 yr Max Water Surface Elevation (ft)		Future CIP Max Flow (cfs)		
Structure Name	US	DS	Length (ft)	Structure Size/Type	Capacity (cfs)	Slope (%)	US	DS	US	DS	US	DS	US	DS	10 yr	25 yr	CIP Number
SYSTEM #1																	
CJCD91	24027	24008	240	12-in Dia	8.6	5.82%	150.71	136.75	154.7	140.8	150.8	137.0	150.8	137.1	0.1	0.2	1-2
CJCD90	24008	25223	185	12-in Dia	1.9	0.30%	136.55	136.00	140.8	137.0	137.0	136.3	137.1	136.4	0.6	0.9	1-2
JCD62c	23026	23024	303	36-in Dia	29.4	0.19%	149.79	149.20	157.6	157.9	150.5	150.5	150.6	150.6	1.0	1.5	
JCD62b	23024	23023	388	36-in Dia	10.7	0.03%	149.90	149.80	157.9	155.6	150.5	150.1	150.6	150.2	1.0	1.5	
JCD62c	23026	23024	303	36-in Dia	29.4	0.19%	149.79	149.20	157.6	157.9	150.5	150.5	150.6	150.6	1.0	1.5	
JCD62b	23024	23023	388	36-in Dia	10.7	0.03%	149.90	149.80	157.9	155.6	150.5	150.1	150.6	150.2	1.0	1.5	
JCD62a	23023	23022	70	36-in Dia	35.4	0.29%	149.30	149.10	155.6	155.9	149.8	149.8	149.9	149.9	1.0	1.5	
JCD61b	23022	23021	250	36-in Dia	13.4	0.04%	149.00	148.90	155.9	159.9	149.8	149.7	149.9	149.8	1.0	1.5	
JCD61a	23021	23019	303	36-in Dia	57.0	0.53%	149.30	147.70	159.9	163.3	149.7	149.4	149.8	149.6	2.5	3.7	
JCD60c	23019	23016	318	36-in Dia	10.6	0.03%	147.08	147.00	163.3	169.2	149.4	149.4	149.6	149.6	2.4	3.6	
JCD60b	23016	33031	461	36-in Dia	36.9	0.30%	148.90	147.50	169.2	160.1	149.4	148.0	149.6	148.1	2.2	3.6	
JCD60a	33031	33025	908	36-in Dia	20.9	0.07%	144.14	143.50	160.1	154.0	145.3	143.8	145.5	143.8	3.8	5.4	
JCD50e	33025	33024	263	24-in Dia	103.1	14.79%	143.50	104.62	154.0	110.0	143.8	105.5	143.8	105.7	3.8	5.4	
JCD50d	33024	33023	51	24-in Dia	16.7	0.39%	104.62	104.42	110.0	111.0	105.5	105.5	105.7	105.6	3.8	5.4	
JCD80b.1	31024	22673	287	15-in Dia	3.4	0.20%	119.33	118.76	124.0	120.7	122.8	119.7	124.1	120.7	7.2	9.0	
JCD80b-rd	31024	22673	287	12-in Roadway		1.17%	124.00	120.65	124.0	120.7			124.1	120.7	0.0	2.9	
JCD80a.1	22673	33039	774	18-in Dia	10.4	1.14%	118.76	109.90	120.7	114.3	119.7	111.5	120.7	112.1	7.2	10.1	
JCD80a-rd	22673	33039	774	12-in Roadway		0.82%	120.65	114.30	120.7	114.3			120.7	114.3	0.0	0.4	
JCD70d.1	31019	31018	177	18-in Dia	8.7	0.80%	152.92	151.50	156.0	156.0	153.7	152.8	153.9	153.2	4.2	6.0	
JCD70d-rd	31019	31018	177	12-in Roadway		0.00%	156.00	156.00	156.0	156.0	152.8	152.8	153.2	153.2	0.0	0.0	
JCD70c	31018	33033	242	18-in Dia	2.3	0.03%	151.50	151.42	156.0	156.0	152.8	152.2	153.2	152.4	4.2	6.0	
JCD70b	33033	33039	924	24-in Dia	56.5	4.43%	151.08	110.13	156.0	114.3	151.4	111.5	151.5	112.1	4.2	6.0	
JCD70a.1	33039	33040	370	24-in Dia	7.6	0.08%	109.72	109.42	114.3	114.0	111.5	110.5	112.1	110.7	9.5	13.5	
JCD70a-rd	33039	33040	370	12-in Roadway		0.08%	114.30	114.00	114.3	114.0					0.0	0.0	
JCD50c	33040	33043	494	24-in Dia	16.8	0.64%	109.17	106.00	114.0	113.5	110.4	107.0	110.7	107.2	9.5	13.5	
JCD50b	33043	33023	476	36-in Dia	45.3	0.33%	106.00	104.42	113.5	111.0	107.0	105.5	107.2	105.6	9.5	13.4	
JCD50a	33023	25262	663	48-in Dia	116.8	0.47%	104.42	101.29	111.0	107.0	105.5	105.3	105.6	105.3	16.6	23.7	
SYSTEM #2 - No CIPs planned																	
JCD20	21290	21516	413	18-in Dia	9.8	0.63%	142.89	140.30	150.0	151.5	143.2	140.6	143.3	140.6	0.8	1.2	
JCD30b	21516	21515	253	21-in Dia	15.5	1.11%	140.30	137.50	151.5	149.0	140.6	137.9	140.6	138.0	0.8	1.2	
JCD30a	21515	21519	726	24-in Dia	33.1	2.47%	137.50	119.60	149.0	128.0	137.9	120.3	138.0	120.4	3.0	4.5	
JCD40b	21501	21504	398	18-in Dia	27.9	5.05%	139.70	119.60	148.0	130.0	140.0	120.5	140.1	120.7	3.2	4.6	
JCD40a	21504	21519	31	24-in Dia	1.0	0.00%	119.60	119.60	130.0	128.0	120.5	120.3	120.7	120.4	3.2	4.6	
JCD10c	21519	POMH010	967	24-in Dia	33.9	2.62%	119.60	94.27	128.0	104.5	120.3	95.0	120.4	95.0	7.6	11.0	
JCD10b	POMH010	POOF005	24	24-in Dia	46.9	6.25%	94.30	92.80	104.5	104.5	95.0	94.8	95.0	94.8	7.6	11.0	
SYSTEM #3 - No CIPs planned																	
JCC60c	21035	21043	46	18-in Dia	-7.2	-0.54%	141.83	142.08	148.0	148.0	142.8	142.6	143.0	142.8	-2.6	-4.0	
JCC60b	21043	21025	1402	24-in Dia	16.3	0.60%	142.08	133.70	148.0	142.0	142.6	134.3	142.8	134.4	2.6	4.0	
JCC60a	21025	21013	243	30-in Dia	23.1	0.37%	133.70	132.80	142.0	139.5	134.3	133.8	134.4	134.0	2.6	3.9	
JCC70	21021	21023	206	15-in Dia	7.9	1.75%	147.30	143.70	154.0	152.5	147.8	144.8	147.9	145.2	2.3	3.3	
JCC80	21024	21023	257	15-in Dia	5.0	0.70%	145.50	143.70	151.7	152.5	145.8	144.8	145.9	145.2	0.6	0.9	
JCC60e	21023	21022	104	15-in Dia	1.9	0.10%	143.70	143.60	152.5	152.0	144.8	144.1	145.2	144.2	2.9	4.1	
JCC60d	21022	21013	676	18-in Dia	12.3	1.60%	143.60	132.80	152.0	139.5	144.1	133.8	144.2	134.0	2.9	4.1	
JCC50c	21013	21005	337	36-in Dia	33.8	0.30%	132.80	131.80	139.5	142.5	133.8	132.3	134.0	132.4	5.5	8.1	

Table D-1. Hydraulic Evaluation of the CIP Scenario for the Milwaukie Storm Drainage System																	
	Node Name						Invert Elevation (ft)		Ground Elevation (ft)		Future CIP 10 yr Max Water Surface Elevation (ft)		Future CIP 25 yr Max Water Surface Elevation (ft)		Future CIP Max Flow (cfs)		
Structure Name	US	DS	Length (ft)	Structure Size/Type	Capacity (cfs)	Slope (%)	US	DS	US	DS	US	DS	US	DS	10 yr	25 yr	CIP Number
JCC50b	21002	21003	257	15-in Dia	3.5	0.35%	138.90	138.00	143.0	144.0	139.5	138.3	139.6	138.4	1.0	1.6	
JCC50a	21003	21005	415	15-in Dia	9.3	1.49%	138.00	131.80	144.0	142.5	138.3	132.3	138.4	132.4	1.0	1.6	
JCC40	21005	21037	699	36-in Dia	115.0	3.44%	131.80	107.80	142.5	117.0	132.3	108.3	132.4	108.4	6.5	9.7	
JCC30a	21038	21037	354	24-in Dia	27.4	1.69%	113.80	107.80	125.3	117.0	114.1	108.3	114.2	108.4	1.7	2.6	
JCC30b	21039	21038	342	21-in Dia	18.9	1.67%	119.50	113.80	131.0	125.3	119.9	114.1	120.0	114.2	1.7	2.6	
JCC20c	21037	23003	745	36-in Dia	161.6	6.84%	107.80	56.90	117.0	65.0	108.3	59.7	108.4	61.1	8.7	12.9	
JCC110b	22102	21143	672	18-in Dia	10.2	1.09%	146.50	139.20	149.0	152.6	147.0	139.8	147.1	139.9	2.3	3.6	
JCC110a	21143	21135	325	24-in Dia	13.3	0.40%	139.20	137.90	152.6	145.8	139.8	138.5	139.9	138.6	2.3	3.6	
JCC120.1	31003	21353	467	15-in Dia	8.3	1.18%	152.00	146.50	155.8	154.4	152.6	147.2	152.8	147.3	4.0	5.7	
JCC120-rd	31003	21353	467	12-in Roadway		0.30%	155.80	154.40	155.8	154.4					0.0	0.0	
JCC100b	21353	21135	1867	24-in Dia	18.1	0.46%	146.50	137.90	154.4	145.8	147.2	138.5	147.3	138.6	4.0	5.7	
JCC100a.1	21135	21015	651	30-in Dia	50.4	1.75%	137.90	126.50	144.8	136.0	138.5	127.2	138.6	127.3	6.2	9.3	
JCC100a-rd	21135	21015	651	12-in Roadway		1.35%	144.80	136.00	144.8	136.0					0.0	0.0	
JCC90b.1	21015	25019	1404	24-in Dia	43.3	4.24%	126.50	67.00	136.0	70.0	127.2	68.0	127.3	68.2	10.2	15.1	
JCC90b-rd	21015	25019	1404	12-in Roadway		4.70%	136.00	70.00	136.0	70.0					0.0	0.0	
JCC90a	25019	23003	409	36-in Channel	334.4	2.47%	67.00	56.90	70.0	65.0	68.0	59.7	68.2	61.1	27.8	45.8	
JCC20b	23003	Roswell	279	48-in Dia	44.2	0.32%	56.90	56.00	65.0	60.0	59.7	57.7	61.1	58.3	33.7	56.9	
JCC20a	25245	21267	55	30-in Dia	61.6	2.62%	52.50	51.05	60.0	61.5	54.1	52.5	54.7	52.9	31.5	48.4	
JCC10b.1	21267	21505	1324	42-in Dia	92.4	0.98%	51.05	38.08	59.0	46.0	52.5	39.8	52.9	40.1	32.9	50.5	
JCC10b-rd	21267	21505	1324	30-in Roadway		0.98%	59.00	46.00	59.0	46.0					0.0	0.0	
JCC10a.1	21505	25237	242	48-in Dia	132.3	0.98%	38.08	35.70	46.0	40.0	39.8	39.7	40.1	39.7	37.2	56.5	
JCC10a-rd	21505	25237	242	30-in Roadway		2.48%	46.00	40.00	46.0	40.0	39.7	39.7	39.7	39.7	0.0	0.0	
SYSTEM #4																	
CJCB10d.1	**21265**	**21059**	**307**	**24-in Elliptical**	**18.9**	**0.65%**	**37.00**	**35.00**	**40.0**	**41.0**	**38.5**	**36.4**	**40.0**	**36.6**	**20.9**	**24.7**	**4-1**
CJCB10d-rd	**21265**	**21059**	**307**	**24-in Roadway**		**-0.33%**	**40.00**	**41.00**	**40.0**	**41.0**			**40.0**	**40.0**	**0.0**	**0.0**	
CJCB10c.1	**21059**	**ODMH017**	**73**	**30-in Dia**	**34.1**	**0.69%**	**35.00**	**34.50**	**41.0**	**41.0**	**36.4**	**35.8**	**36.6**	**35.9**	**20.9**	**24.7**	**4-1**
CJCB10c-rd	**21059**	**ODMH017**	**73**	**24-in Roadway**		**0.00%**	**41.00**	**41.00**	**41.0**	**41.0**	**35.8**	**35.8**	**35.9**	**35.9**	**0.0**	**0.0**	
JCB30b.1	ODOT011	ODMH015	302	24-in Dia	15.0	0.51%	41.82	40.28	45.7	44.2	42.9	41.2	43.0	41.3	7.6	9.4	
JCB30b-rd	ODOT011	ODMH015	302	12-in Roadway		0.50%	45.72	44.20	45.7	44.2					0.0	0.0	
JCB30a	ODMH015	ODMH016	160	24-in Dia	22.7	1.16%	40.36	38.50	45.2	43.5	41.2	40.0	41.3	40.3	7.6	9.4	
JCB20c	21066	21065	402	18-in Dia	9.6	0.97%	45.10	41.20	51.0	45.6	46.0	42.5	46.2	42.7	6.6	8.2	
JCB20b	21065	21064	318	21-in Dia	9.0	0.38%	41.20	40.00	45.6	44.0	42.5	40.7	42.7	40.9	6.6	8.2	
JCB20a	21064	ODMH016	69	18-in Dia	13.9	2.04%	40.00	38.60	44.0	43.5	40.7	40.0	40.9	40.3	6.6	8.3	
JCB10f	ODMH016	ODMH031	140	30-in Dia	24.9	0.43%	38.60	38.00	43.5	43.0	40.0	39.2	40.3	39.4	13.3	16.5	
JCB10e	ODMH031	ODMH017	556	36-in Dia	47.3	0.59%	37.75	34.50	43.0	41.0	38.8	35.8	39.0	35.9	13.2	16.5	
JCB10b	ODMH017	36001	161	42-in Dia	118.4	1.61%	34.50	31.90	41.0	41.8	35.8	33.4	35.9	33.5	33.3	41.0	
JCB10a	36001	25226	425	36-in Dia	73.3	1.40%	31.94	26.00	41.8	38.8	33.4	29.0	33.5	29.0	33.3	41.0	

Table D-1. Hydraulic Evaluation of the CIP Scenario for the Milwaukie Storm Drainage System

Structure Name	Node Name US	Node Name DS	Length (ft)	Structure Size/Type	Capacity (cfs)	Slope (%)	Invert Elevation (ft) US	Invert Elevation (ft) DS	Ground Elevation (ft) US	Ground Elevation (ft) DS	Future CIP 10 yr Max Water Surface Elevation (ft) US	Future CIP 10 yr Max Water Surface Elevation (ft) DS	Future CIP 25 yr Max Water Surface Elevation (ft) US	Future CIP 25 yr Max Water Surface Elevation (ft) DS	Future CIP Max Flow (cfs) 10 yr	Future CIP Max Flow (cfs) 25 yr	CIP Number
SYSTEM #5																	
JCA50c.1	21148	21165	1212	15-in Dia	13.4	3.08%	137.40	100.01	144.0	107.0	138.2	100.8	138.7	101.0	10.0	13.2	
JCA50c-rd	21148	21165	1212	24-in Roadway		3.05%	144.00	107.00	144.0	107.0					0.0	0.0	
JCA50b	21169	21540	670	36-in Dia	29.4	0.19%	95.05	93.75	102.0	106.5	96.5	94.9	96.8	96.4	12.3	16.5	
JCC94c	21540	21541	216	36-in Dia	66.1	0.98%	93.75	91.63	106.5	101.1	94.9	94.1	96.4	96.1	21.8	27.3	
JCC94b	21541	21542	78	36-in Dia	64.9	0.95%	91.63	90.89	101.1	100.3	94.1	94.1	96.1	96.0	21.3	27.3	
JCA60.1	21187	21186	738	18-in Dia	23.3	5.69%	162.70	120.70	166.0	124.0	163.4	121.2	163.6	121.3	8.4	12.4	
JCA60-rd	21187	21186	738	24-in Roadway		5.69%	166.00	124.00	166.0	124.0					0.0	0.0	
JCA41c.1	21186	21185	148	18-in Dia	33.0	7.09%	120.70	110.20	124.0	116.0	121.2	111.0	121.3	111.3	8.4	12.4	
JCA41c-rd	21186	21185	148	24-in Roadway		5.40%	124.00	116.00	124.0	116.0					0.0	0.0	
CJCA41b.1	21185	21184	826	18-in Dia	14.1	1.81%	110.20	95.25	116.0	98.7	111.0	98.4	111.3	98.8	8.4	12.3	5-1
CJCA41b-rd	21185	21184	826	24-in Roadway		2.10%	116.00	98.68	116.0	98.7			111.3	98.8	0.0	0.0	
CJCA41a	21184	C5-1_Det1	30	30-in Dia	58.0	2.00%	94.75	94.15	100.7	100.0	98.4	98.3	98.8	98.7	17.1	23.5	5-1
CJCA40b	21183	C5-11	180	36-in Dia	24.8	0.14%	93.57	93.32	100.0	100.0	95.0	94.7	97.5	97.3	11.7	20.7	5-1
CJCA40a	C5-11	C5-10	460	36-in Dia	29.8	0.20%	93.32	92.40	100.0	100.0	94.7	94.4	97.3	96.9	11.7	20.7	5-1
CJCC94e	C5-10	21542	920	36-in Dia	27.0	0.16%	92.40	90.89	100.0	100.3	94.4	94.1	96.9	96.0	12.4	20.7	5-1
JCC94a	21542	21543	451	36-in Dia	23.3	0.12%	90.89	90.34	100.3	98.0	94.1	91.8	96.0	92.3	35.0	54.0	5-1
CJCC93e	21543	C5-9	150	36-in Dia	71.0	1.13%	90.34	88.64	98.0	95.4	91.8	90.1	92.3	90.6	35.0	54.1	5-1
CJCC93d	C5-9	C5-8	209	36-in Dia	66.8	1.00%	88.54	86.44	95.4	95.4	90.1	88.0	90.6	88.5	35.0	54.1	5-1
CJCC93c	C5-8	C5-7	113	36-in Dia	114.1	2.92%	86.34	83.04	95.4	90.9	87.5	84.2	87.8	84.5	35.0	54.1	5-1
CJCC93b	C5-7	C5-6	67	36-in Dia	257.5	14.93%	82.94	72.94	90.9	85.4	83.7	73.7	83.9	74.7	35.0	54.1	5-1
CJCC93a	C5-6	C5-5	112	36-in Dia	101.7	2.32%	72.44	69.84	85.4	79.4	73.7	73.1	74.7	74.3	35.0	53.9	5-1
CJCC92	C5-5	C5-1_Det2	394	36-in Dia	61.1	0.84%	69.74	66.44	79.4	74.0	73.1	72.8	74.3	73.4	39.8	60.6	5-1
CJCC91c	C5-4	C5-3	170	36-in Dia	27.7	0.20%	71.00	70.66	75.0	75.0	72.7	72.4	73.3	73.0	17.3	27.3	5-1
CJCC91b	C5-3	C5-2	550	36-in Dia	29.8	0.20%	70.66	69.56	75.0	75.0	72.4	71.1	73.0	71.5	17.8	28.1	5-1
CJCC91a	C5-2	25019	570	36-in Dia	44.7	0.45%	69.56	67.00	75.0	71.0	71.1	68.0	71.5	68.2	17.8	28.1	5-1
JCA30b.1	C5-1	21239	994	24-in Dia	38.4	2.87%	55.85	27.33	67.5	39.5	56.3	33.5	56.3	36.5	4.3	5.2	
JCA30b-rd	C5-1	21239	994	24-in Roadway		2.82%	67.50	39.50	67.5	39.5					0.0	0.0	
JCA30a.1	21239	21364	440	24-in Dia	6.7	0.10%	27.02	26.57	39.5	40.5	33.5	29.8	36.5	30.9	18.4	22.7	
JCA30a-rd	21239	21364	440	24-in Roadway		-0.23%	39.50	40.50	39.5	40.5					0.0	0.0	
JCA20.1	21094	21364	785	15-in Dia	5.5	0.53%	34.14	30.00	42.0	40.5	39.7	31.1	42.0	31.2	8.1	9.2	
JCA20-rd	21094	21364	785	24-in Roadway		0.19%	42.00	40.50	42.0	40.5					0.0	0.2	
CJCA10.1	21364	25213	696	36-in Dia	19.8	0.10%	26.57	25.86	40.5	44.0	29.8	27.9	30.9	27.9	27.2	34.6	5-2
CJCA10-rd	21364	25213	696	24-in Roadway		-0.50%	40.50	44.00	40.5	44.0					0.0	0.0	
SYSTEM #6																	
KC60b.1	41069	41068	466	15-in Dia	5.9	0.60%	96.30	93.50	100.0	102.0	97.0	94.1	97.1	94.2	2.9	4.2	
KC60b-rd	41069	41068	466	12-in Roadway		-0.43%	100.00	102.00	100.0	102.0					0.0	0.0	
KC60a.1	41068	41064	325	18-in Dia	9.5	0.58%	93.50	91.60	102.0	102.0	94.1	92.3	94.2	92.4	2.9	4.2	
KC60a-rd	41068	41064	325	12-in Roadway		0.00%	102.00	102.00	102.0	102.0	92.3	92.3	92.4	92.4	0.0	0.0	
KC50b.1	41065	41064	420	18-in Dia	11.8	0.90%	95.40	91.60	98.0	102.0	95.8	92.3	95.9	92.4	1.9	2.8	
KC50b-rd	41065	41064	420	12-in Roadway		-0.95%	98.00	102.00	98.0	102.0					0.0	0.0	
KC50a.1	41064	41031	319	24-in Dia	20.6	0.60%	91.60	89.70	102.0	100.5	92.3	90.6	92.4	92.1	4.8	6.9	
KC50a-rd	41064	41031	319	12-in Roadway		0.47%	102.00	100.50	102.0	100.5					0.0	0.0	
KC40b.1	41032	41031	384	18-in Dia	12.0	0.94%	93.30	89.70	96.0	100.5	93.7	90.6	93.8	92.1	1.7	2.5	
KC40b-rd	41032	41031	384	12-in Roadway		-1.17%	96.00	100.50	96.0	100.5					0.0	0.0	
KC40a.1	41031	41029	234	24-in Dia	16.6	0.39%	89.70	88.80	100.5	98.0	90.6	89.6	92.1	91.7	6.6	9.5	
KC40a-rd	41031	41029	234	12-in Roadway		1.07%	100.50	98.00	100.5	98.0					0.0	0.0	

Table D-1. Hydraulic Evaluation of the CIP Scenario for the Milwaukie Storm Drainage System

	Node Name						Invert Elevation (ft)		Ground Elevation (ft)		Future CIP 10 yr Max Water Surface Elevation (ft)		Future CIP 25 yr Max Water Surface Elevation (ft)		Future CIP Max Flow (cfs)		
Structure Name	**US**	**DS**	**Length (ft)**	**Structure Size/Type**	**Capacity (cfs)**	**Slope (%)**	**US**	**DS**	**US**	**DS**	**US**	**DS**	**US**	**DS**	**10 yr**	**25 yr**	**CIP Number**
CKC30b.1	41029	41109	164	24-in Dia	21.3	1.02%	88.80	87.12	98.0	98.0	89.6	88.8	91.7	91.4	6.6	10.3	6-1
CKC30b-rd	41029	41109	164	12-in Roadway		0.00%	98.00	98.00	98.0	98.0	88.8	88.8	91.4	91.4	0.0	0.0	
CKC30a.1	41109	21101	1029	24-in Dia	17.5	0.43%	87.12	82.72	98.0	92.1	88.8	84.1	91.4	85.4	15.8	20.6	6-1
CKC30a-rd	41109	21101	1029	12-in Roadway		0.57%	98.00	92.10	98.0	92.1					0.0	0.0	
CKC10b.1	21101	41005	2119	24-in Dia	38.2	2.04%	82.72	39.41	92.1	46.0	84.1	40.9	85.4	41.1	31.2	38.5	6-1
CKC10b-rd	21101	41005	2119	12-in Roadway		2.18%	92.10	46.00	92.1	46.0					0.0	0.0	
CKC10a.1	41005	41006	239	30-in Dia	49.5	1.04%	39.41	36.92	46.0	44.0	40.9	38.4	41.1	38.6	31.2	38.5	6-1
CKC10a-rd	41005	41006	239	12-in Roadway		0.84%	46.00	44.00	46.0	44.0					0.0	0.0	
KC21a.1	41020	41011	1470	18-in Dia	16.9	1.85%	67.00	39.80	72.0	52.0	67.5	40.8	67.6	41.0	4.0	5.2	
KC21a-rd	41020	41011	1470	12-in Roadway		1.36%	72.00	52.00	24.0	39.8					0.0	0.0	
KC20b	41011	41006	321	18-in Dia	16.9	1.86%	39.80	33.84	52.0	44.0	40.8	35.0	41.0	35.2	13.0	16.6	
KC20a.1	41006	45017	64	24-in Dia	104.9	15.38%	33.84	24.00	44.0	40.0	35.0	24.9	35.2	25.0	44.0	55.0	
KC20a-rd	41006	45017	64	12-in Roadway		6.25%	44.00	40.00	44.0	40.0					0.0	0.0	
SYSTEM #7 - No CIPS planned																	
WRA30e.1	11003	15009	883	18-in Dia	7.9	0.40%	54.00	50.45	60.0	56.0	60.1	50.8	60.1	50.8	6.6	7.0	
WRA30e-rd	11003	15009	883	12-in Roadway		0.45%	60.00	56.00	60.0	56.0	60.1	56.0	60.1	56.1	1.1	3.2	
WRA30d	15009	12055	70	36-in Channel	856.4	16.86%	50.45	38.65	56.0	54.0	50.8	40.1	50.8	41.6	7.7	10.3	
WRA30c	12055	15000	287	18-in Dia	8.8	0.50%	38.65	37.21	54.0	41.0	40.1	37.9	41.6	38.0	7.7	10.2	
WRA30b	15000	CCIN002	677	36-in Channel	243.0	1.43%	37.21	27.50	41.0	32.0	37.9	28.1	38.0	28.2	7.7	10.2	
WRA30a	CCIN002	15005	169	36-in Dia	98.1	7.41%	27.50	15.00	32.0	33.0	28.1	18.0	28.2	18.0	7.7	10.2	
SYSTEM #8 - No CIPs planned																	
MSC10d	41153	41154	128	15-in Dia	7.9	1.08%	92.72	91.34	99.5	100.0	93.2	91.9	93.4	92.0	2.8	4.2	
MSC10c	41159	41154	689	15-in Dia	9.9	1.69%	103.00	91.34	110.7	100.0	103.5	91.8	103.6	91.9	3.3	4.7	
MSC10b	41154	41151	405	18-in Dia	14.8	2.30%	90.77	81.46	100.0	87.2	91.5	82.1	91.6	82.3	6.0	8.9	
MSC10a	41151	45009	678	24-in Dia	56.5	7.22%	80.96	32.00	87.2	55.0	81.4	32.4	81.5	32.5	6.0	8.9	
SYSTEM #9 - No CIPs planned																	
MSC40i	41119	41149	631	15-in Dia	6.1	0.63%	121.20	117.20	125.0	122.9	121.8	117.7	122.0	117.9	2.4	4.1	
MSC40h	41149	41145	167	15-in Dia	8.3	1.19%	116.20	114.20	122.9	121.2	116.7	114.7	116.8	114.8	2.4	4.1	
MSC40g	41145	41164	43	15-in Dia	11.0	2.09%	114.00	113.10	121.2	121.0	114.4	113.5	114.5	113.6	2.4	4.1	
MSC40f	41164	41163	109	15-in Dia	6.4	0.70%	112.60	111.84	121.0	119.3	113.1	112.4	113.3	112.6	2.4	4.1	
MSC40e	41163	41162	223	18-in Dia	14.8	1.42%	111.64	108.47	119.3	116.5	112.1	108.9	112.2	109.0	2.4	4.1	
MSC40d	41162	41161	183	18-in Dia	16.5	1.76%	108.22	105.00	116.5	113.3	108.6	105.4	108.8	105.5	2.4	4.1	
MSC40c	41161	41165	465	18-in Dia	20.6	4.45%	104.00	83.30	113.3	88.6	104.3	83.6	104.5	83.8	2.4	4.1	
MSC40b	41165	41166	104	24-in Dia	18.9	0.50%	82.80	82.28	88.6	92.1	83.3	82.8	83.4	82.9	2.4	4.1	
MSC40a	41166	41044	245	24-in Dia	16.9	0.64%	82.08	80.50	92.1	90.5	82.6	81.0	82.8	81.2	2.4	4.1	
MSC30	41045	41044	148	18-in Dia	-2.5	-0.07%	80.40	80.50	86.2	90.5	80.9	80.7	81.0	80.8	-0.4	-0.6	
MSC20c	41044	41048	447	30-in Dia	49.3	1.68%	80.20	72.70	90.5	78.0	80.6	73.3	80.7	73.4	2.8	4.7	
MSC60b	41055	41054	103	18-in Dia	0.4	0.00%	77.90	77.90	82.0	83.0	78.9	78.9	79.2	79.1	2.3	3.3	
MSC60a	41054	41053	121	18-in Dia	-2.8	-0.08%	77.90	78.00	83.0	86.0	78.9	78.4	79.1	78.5	-2.3	-3.3	
MSC50c	41079	41076	1210	15-in Dia	5.6	0.53%	79.70	73.30	84.0	80.0	80.0	78.4	80.1	78.5	0.8	1.2	
MSC50b	41076	41075	90	18-in Dia	-20.6	-2.77%	73.30	75.80	80.0	80.0	78.4	78.4	78.5	78.5	-0.8	-1.2	
MSC50a	41075	41053	119	24-in Dia	-28.7	-1.86%	75.80	78.00	80.0	86.0	78.4	78.4	78.5	78.5	-0.8	-1.2	
MSC20b	41053	41048	229	24-in Dia	32.0	2.32%	78.00	72.70	86.0	78.0	78.4	73.3	78.5	73.4	2.8	4.1	
MSC20a	41048	45010	1300	30-in Dia	64.8	2.90%	72.70	35.00	78.0	45.0	73.3	35.6	73.4	35.7	7.0	10.9	

Table D-1. Hydraulic Evaluation of the CIP Scenario for the Milwaukie Storm Drainage System

	Node Name						Invert Elevation (ft)		Ground Elevation (ft)		Future CIP 10 yr Max Water Surface Elevation (ft)		Future CIP 25 yr Max Water Surface Elevation (ft)		Future CIP Max Flow (cfs)		
Structure Name	US	DS	Length (ft)	Structure Size/Type	Capacity (cfs)	Slope (%)	US	DS	US	DS	US	DS	US	DS	10 yr	25 yr	CIP Number
SYSTEM #10 - No CIPs planned																	
MSC80	41063	43000	652	21-in Dia	14.7	1.00%	86.80	80.30	92.0	87.0	87.2	81.1	87.3	81.2	1.5	2.3	
MSC70b	43000	41074	231	21-in Dia	9.7	0.43%	80.30	79.30	87.0	89.0	81.1	79.6	81.2	79.7	2.7	3.9	
MSC70a	41074	45013	429	21-in Dia	35.1	5.67%	79.30	55.00	89.0	60.0	79.6	55.3	79.7	55.4	2.7	3.9	
SYSTEM #11 - No CIPs planned																	
MSC110b	41099	41100	619	15-in Dia	7.9	1.73%	96.80	86.10	103.5	91.0	97.1	86.4	97.2	86.5	1.1	1.7	
MSC110a	41100	41101	47	18-in Dia	12.6	1.69%	86.10	85.30	91.0	91.8	86.4	85.9	86.5	86.1	1.1	1.7	
MSC100	42201	41101	483	15-in Dia	8.4	1.97%	94.80	85.30	98.0	91.8	95.1	85.9	95.1	86.1	0.8	1.1	
MSC90b	41101	41103	461	21-in Dia	16.4	1.24%	85.30	79.60	91.8	86.0	85.9	80.3	86.1	80.5	4.3	6.3	
MSC90a	41103	45014	711	24-in Dia	16.9	0.65%	79.60	75.00	86.0	80.0	80.3	75.7	80.5	75.8	4.3	6.3	
SYSTEM #12																	
MSB20e.1	61105	61010	889	24-in Dia	0.7	0.00%	80.80	80.80	90.0	86.0	87.4	82.4	90.0	82.6	15.5	19.8	
MSB20e-rd	61105	61010	889	12-in Roadway		0.45%	90.00	86.00	90.0	86.0			90.0	86.0	0.0	0.3	
CMSB20d	**61010**	**61028**	**79**	**48-in Dia**	**4.2**	**0.00%**	**80.80**	**80.80**	**86.0**	**86.0**	**82.4**	**82.1**	**82.6**	**82.3**	**15.4**	**20.0**	**12-1**
MSB20c	61028	61032	1135	48-in Dia	67.4	0.26%	80.80	77.90	86.0	87.0	82.1	79.8	82.3	80.1	15.4	20.0	
MSB20b	61032	65029	358	54-in Dia	39.9	0.14%	77.90	77.40	87.0	84.0	79.8	78.4	80.1	78.8	15.4	20.0	
MSB20a	65029	65032	42	72-in Channel	604.1	0.22%	77.40	77.31	84.0	89.0	78.4	78.3	78.8	78.7	15.2	19.9	
MSB30d.1	66003	61027	2226	48-in Dia	12.6	0.03%	80.00	79.42	88.0	86.0	84.2	81.4	85.9	81.7	20.2	26.3	
MSB30d-rd	66003	61027	2226	12-in Roadway		0.09%	88.00	86.00	88.0	86.0					0.0	0.0	
MSB30c.1	61027	61036	430	48-in Dia	46.4	0.12%	79.42	78.90	86.0	86.0	81.4	80.7	81.7	81.0	19.5	25.5	
MSB30c-rd	61027	61036	430	12-in Roadway		0.00%	86.00	86.00	86.0	86.0	80.7	80.7	81.0	81.0	0.0	0.0	
MSB30b.1	61036	61034	760	48-in Dia	45.9	0.12%	78.90	78.00	86.0	86.0	80.7	79.6	81.0	79.8	19.5	25.4	
MSB30b-rd	61036	61034	760	12-in Roadway		0.00%	86.00	86.00	86.0	86.0	79.6	79.6	79.8	79.8	0.0	0.0	
MSB30a	61034	65032	382	48-in Dia	60.4	0.60%	78.00	75.70	87.0	89.0	79.6	78.3	79.8	78.7	19.4	25.2	
MSB10c	65032	65031	119	72-in Channel	360.1	0.08%	75.70	75.61	89.0	86.0	78.3	78.3	78.7	78.7	33.7	42.8	
MSC120c.1	ODMH005	62355	162	15-in Dia	6.7	1.24%	96.75	94.75	100.0	98.0	97.5	95.2	97.6	95.2	3.0	4.2	
MSC120c-rd	ODMH005	62355	162	12-in Roadway		1.24%	100.00	98.00	100.0	98.0					0.0	0.0	
MSC120b	62355	ODMH004	124	18-in Dia	18.8	10.82%	94.75	81.30	98.0	91.5	95.2	84.5	95.2	84.8	3.0	4.2	
MSC120a	ODMH004	65031	146	24-in Dia	-15.1	-1.51%	81.30	83.50	91.5	86.0	84.5	84.1	84.8	84.2	-3.0	-4.2	
MSB10b	65031	66026	777	72-in Channel	47.1	0.00%	75.61	75.60	86.0	88.0	78.3	78.0	78.7	78.5	34.2	42.4	
MSB10a	66026	65027	3076	48-in Dia	88.6	0.44%	75.60	62.00	88.0	90.0	78.0	64.2	78.5	64.5	54.9	68.5	
SYSTEM #13																	
MSA90.1	61160	61177	2523	24-in Dia	20.2	0.93%	171.10	147.67	179.0	153.5	172.0	149.2	172.2	150.5	9.1	12.2	
MSA90-rd	61160	61177	2523	12-in Roadway		1.01%	179.00	153.50	179.0	153.5					0.0	0.0	
MSA80d	61159	61177	583	15-in Dia	13.2	4.85%	174.90	146.60	178.8	153.5	175.2	149.2	175.3	150.5	1.4	2.4	
MSA80c.1	61177	61148	253	24-in Dia	-7.3	-0.12%	146.60	146.91	153.5	152.0	149.2	148.4	150.5	149.2	-10.4	-14.4	
MSA80c-rd	61177	61148	253	12-in Roadway		0.59%	153.50	152.00	153.5	152.0					0.0	0.0	
CMSA80b.1	**61148**	**61179**	**243**	**24-in Dia**	**13.3**	**0.25%**	**146.90**	**146.30**	**152.0**	**152.0**	**148.4**	**147.8**	**149.2**	**148.4**	**10.4**	**14.4**	**13-2**
CMSA80b-rd	**61148**	**61179**	**243**	**12-in Roadway**		**0.00%**	**152.00**	**152.00**	**152.0**	**152.0**	**147.8**	**147.8**	**148.4**	**148.4**	**0.0**	**0.0**	
CMSA80A.1	**61179**	**61151**	**186**	**24-in Dia**	**10.6**	**0.25%**	**146.30**	**145.83**	**152.0**	**152.0**	**147.8**	**147.0**	**148.4**	**147.4**	**10.4**	**14.4**	**13-2**
CMSA80A-rd	**61179**	**61151**	**186**	**12-in Roadway**		**0.00%**	**152.00**	**152.00**	**152.0**	**152.0**	**146.9**	**146.9**	**147.4**	**147.4**	**0.0**	**0.0**	
CMSA70d.1	**61151**	**65028**	**684**	**30-in Dia**	**29.5**	**0.37%**	**145.33**	**142.79**	**152.0**	**149.0**	**146.9**	**143.5**	**147.4**	**143.6**	**14.5**	**20.5**	**13-2**
CMSA70d-rd	**61151**	**65028**	**684**	**12-in Roadway**		**0.44%**	**152.00**	**149.00**	**152.0**	**149.0**					**0.0**	**0.0**	
MSA70c	65028	66010	1111	36-in Channel	365.7	3.31%	142.79	106.00	149.0	109.0	143.5	106.8	143.6	107.0	14.5	20.5	

Table D-1. Hydraulic Evaluation of the CIP Scenario for the Milwaukie Storm Drainage System																	
	Node Name						Invert Elevation (ft)		Ground Elevation (ft)		Future CIP 10 yr Max Water Surface Elevation (ft)		Future CIP 25 yr Max Water Surface Elevation (ft)		Future CIP Max Flow (cfs)		
Structure Name	US	DS	Length (ft)	Structure Size/Type	Capacity (cfs)	Slope (%)	US	DS	US	DS	US	DS	US	DS	10 yr	25 yr	CIP Number
MSA70b	66010	65034	55	30-in Dia	92.7	3.64%	106.00	104.00	109.0	107.0	106.8	104.8	107.0	104.9	14.5	20.5	
MSA70a	65034	66023	174	24-in Channel	109.9	1.72%	104.00	101.00	107.0	104.0	104.8	101.9	104.9	102.5	15.1	21.3	
CMSA23a	34137	34138	482	12-in Dia		0.90%	164.82	160.50	172.0	167.5	165.0	160.6	165.0	160.7	0.1	0.3	13-1
CMSA22a	34138	62056	305	12-in Dia		1.40%	160.45	156.17	167.5	160.0	160.6	156.9	160.7	159.1	0.4	0.6	13-1
CMSA25b	62056	61047	407	12-in Dia		0.33%	156.05	154.70	160.0	159.0	156.9	155.3	159.1	155.8	1.9	3.3	13-1
CMSA25a	61047	61195	496	12-in Dia		1.54%	154.65	147.00	159.0	151.0	155.2	147.6	155.8	147.9	2.8	4.7	13-1
CMSA27d	61195	62305	406	12-in Dia		4.91%	146.95	127.00	151.0	131.0	147.4	127.5	147.6	127.6	3.3	5.8	13-1
CMSA27c	62305	62304	127	18-in Dia		7.06%	126.50	117.50	131.0	122.5	126.9	117.9	127.0	118.0	4.4	7.6	13-1
CMSA27b	62304	62297	100	18-in Dia		5.95%	117.45	111.50	122.5	116.5	117.9	111.9	118.0	112.1	4.4	7.6	13-1
CMSA27a	62297	62296	272	18-in Dia		3.84%	111.45	101.00	116.5	105.0	111.9	101.8	112.1	102.2	4.4	7.6	13-1
CMSA20a.1	66023	65033	59	18-in Dia	17.5	2.79%	101.00	99.35	104.0	102.0	101.9	101.4	102.5	101.9	7.1	9.6	13-3
CMSA20a.2	66023	65033	59	18-in Dia		2.79%	101.00	99.35	104.0	102.0	101.9	101.4	102.5	101.9	8.0	11.6	13-3
CMSA31e	62296	C13-1	110	18-in Dia		0.32%	100.90	100.55	105.0	104.3	101.8	101.2	102.2	101.5	4.4	7.6	13-3
CMSA31d	C13-1	C13-2	205	18-in Dia		1.50%	100.55	97.47	104.3	103.0	101.2	98.1	101.5	98.4	5.1	8.8	13-3
CMSA31c	C13-2	C13-3	155	18-in Dia		1.50%	97.47	95.14	103.0	102.0	98.1	95.8	98.4	96.1	5.1	8.8	13-3
CMSA31b	C13-3	C13-4	200	18-in Dia		1.47%	95.14	92.20	102.0	100.0	95.8	93.3	96.1	93.7	5.1	8.8	13-3
CMSA31a	C13-4	C13-5	60	18-in Dia		2.00%	92.20	91.00	100.0	95.0	93.3	93.3	93.7	93.5	5.1	8.8	13-3
MSA110g	80-81	82-83	976	36-in Channel	58.3	0.15%	107.00	105.50	110.0	106.0	108.9	107.8	109.3	108.2	21.6	30.9	
MSA110f	82-83	84	1309	36-in Channel	43.4	0.11%	105.50	104.00	108.5	104.0	107.8	106.1	108.2	106.5	23.3	33.6	
MSA110e	84	65023	1320	36-in Channel	47.0	0.28%	104.00	100.27	107.0	101.0	106.1	102.6	106.5	103.2	22.9	33.2	
MSA110d	65023	65033	918	24-in Channel	18.6	0.10%	100.27	99.35	103.3	99.4	102.6	101.4	103.2	101.9	25.9	38.2	
MSA110c	65033	C13_6	400	24-in Channel	40.9	0.98%	99.35	95.42	102.0	99.4	101.4	97.3	101.9	97.7	39.9	58.2	
MSA110b	C13_6	C13-5	350	24-in Roadway	46.3	1.26%	95.42	91.00	97.8	95.0	97.3	93.3	97.7	93.5	39.9	58.2	
MSA110a.1	C13-5	66018	783	48-in Channel	165.0	1.66%	91.00	78.00	95.0	82.0	93.3	80.6	93.5	81.9	51.0	64.0	
MSA110a.2	66018	61107	45	24-in Channel	58.6	7.78%	78.00	74.50	82.0	84.7	80.6	78.7	81.9	79.5	43.4	48.0	
MSA110a.3	66018	65039	35	20.04-in Channel	12.8	2.86%	80.00	79.00	82.0	82.0	80.6	79.6	81.9	80.5	3.4	15.9	
SYSTEM #14																	
CMSA61d	C14-2	C14-1	340	12-in Dia	2.5	0.50%	150.00	148.30	155.0	155.0	150.5	148.7	150.6	148.9	1.0	1.7	14-1
CMSA61c	C14-1	62316	440	12-in Dia	2.3	0.42%	148.10	146.25	155.0	151.0	148.7	146.5	148.9	146.6	1.0	1.7	14-1
MSA60b	62318	62323	301	15-in Dia	11.4	3.65%	142.08	131.08	146.0	134.0	142.4	131.4	142.5	131.5	1.8	3.0	
MSA60a	62323	62325	323	18-in Dia	24.5	6.31%	129.67	109.33	134.0	112.0	130.0	109.6	130.0	109.7	1.8	3.0	
MSA50c.1	62325	62179	397	18-in Dia	26.0	7.11%	108.42	80.17	112.0	83.0	108.7	80.5	108.8	80.6	2.0	3.6	
MSA50c-rd	62325	62179	397	30-in Roadway		7.30%	112.00	83.00	112.0	83.0					0.0	0.0	
MSA50a.1	62179	61107	59	18-in Dia	26.0	7.09%	80.17	76.00	83.0	82.2	80.5	78.7	80.6	79.5	3.3	5.4	
MSA50a-rd	62179	61107	59	30-in Roadway		1.36%	83.00	82.20	83.0	82.2					0.0	0.0	
MSA50c.1	62325	62179	397	18-in Dia	26.0	7.11%	108.42	80.17	114.5	85.5	108.7	80.5	108.8	80.6	2.0	3.6	
MSA50c-rd	62325	62179	397	30-in Roadway		7.30%	112.00	83.00	114.5	85.5					0.0	0.0	
MSA50b.1	CCCCB159	62179	329	18-in Dia	15.5	2.53%	88.50	80.17	92.0	83.0	87.8	80.5	88.4	80.6	0.0	0.0	
MSA50b-rd	CCCCB159	62179	329	30-in Roadway		2.74%	92.00	83.00	92.0	83.0					0.0	0.0	
MSA30c	62290	62284	490	15-in Dia	8.0	1.78%	89.50	80.75	93.0	82.5	90.1	81.1	90.2	81.2	2.5	3.5	
MSA30b.1	62284	62282	47	18-in Dia	20.4	4.39%	80.75	78.67	82.5	82.0	81.1	79.1	81.2	79.6	2.5	3.5	
MSA30b-rd	62284	62282	47	30-in Roadway		1.05%	82.50	82.00	82.5	82.0					0.0	0.0	
MSA30a.1	62282	61107	195	24-in Dia	24.6	1.37%	78.67	76.00	82.0	82.2	79.1	78.7	79.6	79.5	2.5	3.5	
MSA30a-rd	62282	61107	195	30-in Roadway		-0.10%	82.00	82.20	82.0	82.2					0.0	0.0	
MSA240b	65039	66016	30	72-in Box Culvert	706.7	2.00%	73.00	72.40	82.0	82.0	73.7	73.5	74.0	73.7	40.3	59.4	
MSA240a	66016	65015	53	72-in Box Culvert	721.9	2.08%	72.40	71.30	82.0	79.0	73.5	72.4	73.7	72.6	85.9	111.2	
MSA40	61107	66016	45	24-in Dia	33.7	2.22%	74.50	73.50	82.2	82.0	78.7	75.5	79.5	75.5	47.5	53.5	

Table D-1. Hydraulic Evaluation of the CIP Scenario for the Milwaukie Storm Drainage System

	Node Name						Invert Elevation (ft)		Ground Elevation (ft)		Future CIP 10 yr Max Water Surface Elevation (ft)		Future CIP 25 yr Max Water Surface Elevation (ft)		Future CIP Max Flow (cfs)		
Structure Name	US	DS	Length (ft)	Structure Size/Type	Capacity (cfs)	Slope (%)	US	DS	US	DS	US	DS	US	DS	10 yr	25 yr	CIP Number
SYSTEM #15																	
CMSA100f.1	61115	61118	234	24-in Dia	14.5	0.41%	112.83	111.87	124.5	123.2	120.0	113.8	120.0	113.8	32.2	32.2	15-1
CMSA100e.1	61118	CCCB154	287	24-in Dia	39.2	3.00%	111.78	103.17	123.2	108.0	113.5	104.4	113.5	104.4	32.2	32.2	15-1
CMSA100d.1	CCCB154	CCCB146	271	24-in Dia	45.5	4.06%	103.17	92.20	108.0	97.0	104.4	93.8	104.4	93.8	32.2	32.2	15-1
CMSA100c.1	CCCB146	CCCCB159	188	24-in Dia	33.8	2.23%	92.20	88.00	96.0	92.0	93.5	89.2	93.8	89.6	24.1	32.2	15-1
CMSA100c-rd	CCCB146	CCCCB159	188	12-in Roadway		2.13%	96.00	92.00	96.0	92.0					0.0	0.0	
CMSA100b.1	CCCCB159	CCCB161	38	24-in Dia	68.9	10.73%	87.00	82.88	92.0	92.8	87.8	84.9	88.4	86.0	24.1	32.2	15-1
CMSA100b-rd	CCCCB159	CCCB161	38	12-in Roadway		-2.08%	92.00	92.80	92.0	92.8					0.0	0.0	
MSA100a	CCCB161	CCOF010	87	24-in Dia	21.1	1.01%	82.88	82.00	92.8	91.0	84.9	83.7	86.0	83.9	24.1	32.2	

Appendix E: CIP Detailed Cost Estimates

City of Milwaukie - Stormwater Master Plan
Capital Improvement Project
Preliminary Engineering Unit Cost
Table E-1

ITEM	UNIT	UNIT COST ($)
Water Quality Facility Installation		
General Earthwork/ Excavation	CY	$12
Embankment	CY	$8
Clearing Brush	AC	$1,850
Clear and Grub brush including stumps	AC	$6,500
Amended Soils and Mulch	CY	$26
Jute Matting, Biodegradeable	SY	$2
Geomembrane	SY	$25
Energy dissapation pad - Rip-Rap, Class 50	CY	$60
Rock Weir - Rip-Rap, Class 50	CY	$60
Drain Rock	CY	$31
Pond Outflow Control Structure	EA	$5,100
Pond Inlet Structure	EA	$4,100
Emergency Overflow Weir	LF	$21
Water Quality Facility Plantings	SF	$3
Rain Garden	SF	$25
Stormwater Planter	SF	$37
Structure Installation		
Precast Concrete Manhole (48", 0-8' deep)	EA	$2,100
Precast Concrete Manhole (48", 9-12' deep)	EA	$5,800
Precast Concrete Manhole (48", 13-20' deep)	EA	$8,900
Precast Concrete Manhole (60", 0-8' deep)	EA	$4,300
Precast Concrete Manhole (60", 9-12' deep)	EA	$8,200
Precast Concrete Manhole (72", 0-8' deep)	EA	$5,500
Drywell (48", 20-25' deep)	EA	$10,000
Curb Inlet	EA	$1,900
Concrete Inlet, Type D (0-8' deep)	EA	$2,000
Concrete Inlet, Type G-1	EA	$2,300
Concrete Inlet, Type G-2	EA	$1,900
Concrete Fill - UIC Decomissioning	CY	$140
Connection to Existing Structure	EA	$1,000
Abandon Existing Manhole	EA	$254
Plug Existing Pipe	EA	$500
Remove Existing Pipe (15-18")	FT	$27
Restoration/ Resurfacing		
Non-Water Quality Facility Landscaping	AC	$20,600
4-foot Chain Link Fence	LF	$21
Hydroseed	AC	$2,300
Project Totals		
Project Sub-Total		
Mobilization/Demobilization (10%)	LS	10%
Erosion Control (2%)	LS	2%
Construction Contingency (30%)	LS	30%
Construction Cost Estimate		
Engineering and Permitting (%)	LS	Varies by project (25-40%)
Construction Administration (%)	LS	5%
Total Project Engineering and Construction Cost		

City of Milwaukie - Stormwater Master Plan Costs
PIPE INSTALLATION with Asphalt
Table E-2

Storm Drain Pipe Construction Cost per Linear Foot											
	Diameter (inches)										
Cover Depth (feet)	**12**	**18-Reinf Conc**	18	24	30	**30-Reinf Conc**	36	42	48	54	60
2-5	$78	$144	$122	$161	$209	$271	$259	$316	$370	$470	$556
5-10	$107	$184	$162	$213	$273	$335	$336	$404	$470	$582	$680
10-15	$135	$224	$202	$265	$337	$400	$412	$492	$571	$695	$805
15-20	$163	$264	$242	$317	$401	$464	$488	$580	$671	$807	$929

Breakdown of Linear Foot Cost											
Depth of Cover (ft)	**12**	**18**	**18**	24	30	30	36	42	48	54	60
Sub Task											
Pipe + Bed (ft)	2	2.0	2.0	2.5	3.0	3.0	3.5	4.0	4.5	5.0	5.5
Width (ft)	2	3	3	4	5	5	6	7	8	9	10
Bedding (ft)	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.3	0.4
Shoring (lf)	$ 4.0	$ 4.0	$ 4.0	$ 4.0	$ 4.0	$ 4.0	$ 4.0	$ 4.0	$ 4.0	$ 4.0	$ 4.0
Sawcutting and Asphalt Removal (lf)	$ 17.0	$ 24.0	$ 24.0	$ 31.0	$ 38.0	$ 38.0	$ 45.0	$ 52.0	$ 59.0	$ 66.0	$ 73.0
Trench Excavation (CY)	$ 25.0	$ 25.0	$ 25.0	$ 25.0	$ 25.0	$ 25.0	$ 25.0	$ 25.0	$ 25.0	$ 25.0	$ 25.0
Trench Backfill (CY)	$ 40.0	$ 40.0	$ 40.0	$ 40.0	$ 40.0	$ 40.0	$ 40.0	$ 40.0	$ 40.0	$ 40.0	$ 40.0
HDPE Piping unless noted concrete (lf)	$ 12.8	$ 45.5	$ 23.0	$ 27.0	$ 37.0	$ 99.5	$ 47.5	$ 61.0	$ 70.5	$ 123.0	$ 159.0
Asphalt Restoration (lf)	$ 13.4	$ 20.1	$ 20.1	$ 26.8	$ 33.5	$ 33.5	$ 40.2	$ 46.9	$ 53.6	$ 60.3	$ 67.0
Cover (CY)											
2-5	0.5	0.8	0.8	1.1	1.5	1.5	1.9	2.3	2.8	3.3	3.9
5-10	0.9	1.3	1.3	1.9	2.4	2.4	3.0	3.6	4.3	5.0	5.7
10-15	1.2	1.9	1.9	2.6	3.3	3.3	4.1	4.9	5.8	6.7	7.6
15-20	1.6	2.4	2.4	3.3	4.3	4.3	5.2	6.2	7.3	8.3	9.4
Cost ($/LF)											
2-5	$78	$144	$122	$161	$209	$271	$259	$316	$370	$470	$556
5-10	$107	$184	$162	$213	$273	$335	$336	$404	$470	$582	$680
10-15	$135	$224	$202	$265	$337	$400	$412	$492	$571	$695	$805
15-20	$163	$264	$242	$317	$401	$464	$488	$580	$671	$807	$929

CIP 1-1: Willow Detention Pond Retrofit

Description	Quantity	Unit	Unit Cost (2012)	2012 Cost
Capital Expenses				
Excavation	442	CY	$ 12	$ 5,307
18" Amended Soils and Mulch	221	CY	$ 26	$ 5,749
18" Drain Rock	221	CY	$ 31	$ 6,854
Water Quality Facility Plantings	3,980	SF	$ 3	$ 11,940
Capital Expense Sub-Total				$ 29,850
Mobilization/Demobilization	10%	LS		$ 2,985
Traffic Control/Utility Relocation	2%	LS		$ 597
Erosion Control	10%	LS		$ 2,985
Construction Cost Sub-Total				$ 36,417
Construction Contingency	30%	LS		$ 10,925
Capital Expense Total				$ 47,342
Administrative Expenses				
Engineering and Permitting	40%	LS		$ 18,937
Construction Administration	5%	LS		$ 2,367
Administrative Expense Total				$ 21,304
Capital Implementation Cost Total				**$ 68,646**

CIP 1-2: Stanley - Willow UIC Decommissioning						
Description	Quantity	Unit		Unit Cost (2012)		2012 Cost
Capital Expenses						
Concrete Fill - UIC Decommissioning	8.4	CY		140		1173
Remove Remainder of UIC	2	EA		500		1000
Precast Concrete Manhole (48", 0-8' deep)	3	EA	$	2,100	$	6,300
Concrete Inlet, Type G-2	4	EA	$	1,900	$	7,600
HDPE Pipeline (12", 0-5' deep)	425	FT	$	78	$	33,340
Water Quality Facility Plantings	2,000	SF	$	3	$	6,000
Capital Expense Sub-Total					$	49,413
Mobilization/Demobilization	10%	LS			$	4,941
Traffic Control/Utility Relocation	2%	LS			$	988
Erosion Control	2%	LS			$	988
Construction Cost Sub-Total					$	56,330
Construction Contingency	30%	LS			$	16,899
Capital Expense Total					$	73,229
Administrative Expenses						
Engineering and Permitting	25%	LS			$	18,307
Construction Administration	5%	LS			$	3,661
UIC Closure Report		LS			$	5,000
Administrative Expense Total					$	26,969
Capital Implementation Cost Total					**$**	**100,198**

CIP 4-1: Main Street at Milport Road				
Description	Quantity	Unit	Unit Cost (2012)	2012 Cost
Capital Expenses				
Precast Concrete Manhole (48", 0-8' deep)	6	EA	$ 2,100	$ 12,600
Precast Concrete Manhole (60", 0-8' deep)	1	EA	$ 4,300	$ 4,300
Connection to Existing Structures	2	EA	1,000	$ 2,000
Reinforced Concrete Pipeline (30", 2-5' deep)	380	FT	$ 271	$ 103,093
Capital Expense Sub-Total				$ 121,993
Mobilization/Demobilization	10%	LS		$ 12,199
Traffic Control/Utility Relocation	5%	LS		$ 6,100
Erosion Control	2%	LS		$ 2,440
Construction Cost Sub-Total				$ 142,731
Construction Contingency	30%	LS		$ 42,819
Capital Expense Total				$ 185,551
Administrative Expenses				
Engineering and Permitting	25%	LS		$ 46,388
Construction Administration	5%	LS		$ 9,278
Administrative Expense Total				$ 55,665
Capital Implementation Cost Total				**$ 241,216**

CIP 5-1: Meek Street				
Description	Quantity	Unit	Unit Cost (2012)	2012 Cost
Capital Expenses				
Monroe to Meek Pipe Improvements				
Precast Concrete Manhole (48", 0-8' deep)	5	EA	$ 2,100	$ 10,500
Precast Concrete Manhole (60", 0-8' deep)	4	EA	$ 4,300	$ 17,200
Precast Concrete Manhole (72", 0-8' deep)	2	EA	$ 5,500	$ 11,000
Plug Existing Pipe	2	EA	$ 500	$ 1,000
Connection to Existing Structures	2	EA	$ 1,000	$ 2,000
HDPE Pipeline (18", 5-10' deep)	826	FT	$ 162	$ 133,619
HDPE Pipeline (36", 5-10' deep)	1,560	FT	$ 336	$ 523,692
Monroe to Meek Pipe Improvements Sub-total				$ 699,011
Oak and Railroad Detention				
Pond Inlet Structure	1	EA	$ 4,100	$ 4,100
Pond Outflow Control Structure	1	EA	$ 5,100	$ 5,100
General Earthwork/ Excavation	1,588	CY	$ 12	$ 19,060
Amended Soils and Mulch	331	CY	$ 26	$ 8,610
Energy dissapation pad - Rip-Rap, Class 50	4	CY	$ 60	$ 222
Hydroseed	0.26	AC	$ 2,300	$ 598
Non-Water Quality Facility Landscaping	0.11	AC	$ 20,600	$ 2,365
Oak and Railroad Detention Sub-total				$ 40,056
Meek to Balfour Pipe Improvements				
Precast Concrete Manhole (60", 0-8' deep)	3	EA	$ 4,300	$ 12,900
Precast Concrete Manhole (60", 9-12' deep)	2	EA	$ 8,200	$ 16,400
Connection to Existing Structures	1	EA	$ 1,000	$ 1,000
HDPE Pipeline (36", 5-10' deep)	985	FT	$ 219	$ 215,989
Meek to Balfour Pipe Improvements Sub-total				$ 246,289
Balfour Detention Pond				
Pond Inlet Structure	1	EA	$ 4,100	$ 4,100
Pond Outflow Control Structure	1	EA	$ 5,100	$ 5,100
Clearing Brush	1	AC	$ 6,500	$ 6,500
General Earthwork/ Excavation	1,000	CY	$ 12	$ 12,000
Embankment	1,000	CY	$ 8	$ 8,000
Amended Soils and Mulch	1,128	CY	$ 26	$ 29,335
Energy dissapation pad - Rip-Rap, Class 50	20	CY	$ 60	$ 1,200
Hydroseed	0.69	AC	$ 2,300	$ 1,576

CIP 5-1: Meek Street				
Description	Quantity	Unit	Unit Cost (2012)	2012 Cost
Non-Water Quality Facility Landscaping	0.11	AC	$ 20,600	$ 2,365
Balfour Detention Pond Sub-total				$ 70,176
Balfour to MH 25019 Pipe Improvements				
Precast Concrete Manhole (60", 0-8' deep)	4	EA	$ 4,300	$ 17,200
HDPE Pipeline (36", 2-5' deep)	1,800	FT	$ 213	$ 382,640
Connection to Existing Structures	1	EA	$ 1,000	$ 1,000
Precast Concrete Manhole (72", 0-8' deep)	1	EA	$ 5,500	$ 5,500
Balfour to MH 25019 Pipe Improvements Sub-total				$ 406,340
Capital Expense Sub-Total				$ 1,461,871
Mobilization/Demobilization	10%	LS		$ 146,187
Traffic Control/Utility Relocation	10%	LS		$ 146,187
Erosion Control	5%	LS		$ 73,094
Construction Cost Sub-Total				$ 1,827,339
Construction Contingency	30%	LS		$ 548,202
Capital Expense Total				$ 2,375,541
Administrative Expenses				
Engineering and Permitting	25%	LS		$ 593,885
Construction Administration	5%	LS		$ 118,777
Administrative Expense Total				$ 712,662
Capital Implementation Cost Total				**$ 3,088,203**

CIP 5-2: Harrison Street				
Description	Quantity	Unit	Unit Cost (2012)	2012 Cost
Capital Expenses				
Precast Concrete Manhole (48", 9-12' deep)	3	EA	$ 5,800	$ 17,400
Precast Concrete Manhole (60", 9-12' deep)	2	EA	$ 8,200	$ 16,400
Connection to Existing Structures	1	EA	$ 1,000	$ 1,000
HDPE Pipeline (36", 10-15' deep)	696	FT	$ 412	$ 286,698
Capital Expense Sub-Total				$ 321,498
Mobilization/Demobilization	10%	LS		$ 32,150
Traffic Control/Utility Relocation	2%	LS		$ 6,430
Erosion Control	2%	LS		$ 6,430
Construction Cost Sub-Total				$ 366,508
Construction Contingency	30%	LS		$ 109,952
Capital Expense Total				$ 476,460
Administrative Expenses				
Engineering and Permitting	25%	LS		$ 119,115
Construction Administration	5%	LS		$ 23,823
Administrative Expense Total				$ 142,938
Capital Implementation Cost Total				**$ 619,398**

CIP 6-1: Washington Street				
Description	Quantity	Unit	Unit Cost (2012)	2012 Cost
Capital Expenses				
Precast Concrete Manhole (48", 0-8' deep)	4	EA	$ 2,100	$ 8,400
Precast Concrete Manhole (48", 9-12' deep)	10	EA	$ 5,800	$ 58,000
Connection to Existing Structures	4	EA	$ 1,000	$ 4,000
HDPE Pipeline (24", 10-15' deep)	3,312	FT	$ 265	$ 878,735
HDPE Pipeline (30", 5-10' deep)	239	FT	$ 273	$ 65,243
Capital Expense Sub-Total				$ 1,014,378
Mobilization/Demobilization	10%	LS		$ 101,438
Traffic Control/Utility Relocation	2%	LS		$ 20,288
Erosion Control	2%	LS		$ 20,288
Construction Cost Sub-Total				$ 1,156,390
Construction Contingency	30%	LS		$ 346,917
Capital Expense Total				$ 1,503,307
Administrative Expenses				
Engineering and Permitting	15%	LS		$ 225,496
Construction Administration	5%	LS		$ 75,165
Administrative Expense Total				$ 300,661
Capital Implementation Cost Total				**$ 1,803,969**

CIP 6-2: Washington Green Streets				
Description	Quantity	Unit	Unit Cost (2012)	2012 Cost
Capital Expenses				
Stormwater Planter	4,540	SF	$ 37	$ 167,980
Concrete Inlet, Type G-2	20	EA	$ 1,900	$ 38,000
HDPE Pipeline (10", 5-10' deep)	300	FT	$ 107	$ 31,956
Capital Expense Sub-Total				$ 237,936
Mobilization/Demobilization	10%	LS		$ 23,794
Traffic Control/Utility Relocation	2%	LS		$ 4,759
Erosion Control	2%	LS		$ 4,759
Construction Cost Sub-Total				$ 271,247
Construction Contingency	30%	LS		$ 81,374
Capital Expense Total				$ 352,621
Administrative Expenses				
Engineering and Permitting	40%	LS		$ 141,049
Construction Administration	5%	LS		$ 17,631
Administrative Expense Total				$ 158,680
Capital Implementation Cost Total				**$ 511,301**

CIP 12-1: International Way and Wister				
Description	Quantity	Unit	Unit Cost (2012)	2012 Cost
Capital Expenses				
Precast Concrete Manhole (72", 0-8' deep)	2	EA	$ 5,500	$ 11,000
Connection to Existing Structures	2	EA	$ 1,000	$ 2,000
HDPE Pipeline (48", 5-10' deep)	80	FT	$ 470	$ 37,629
Capital Expense Sub-Total				$ 50,629
Mobilization/Demobilization	10%	LS		$ 5,063
Traffic Control/Utility Relocation	2%	LS		$ 1,013
Erosion Control	2%	LS		$ 1,013
Construction Cost Sub-Total				$ 57,717
Construction Contingency	30%	LS		$ 17,315
Capital Expense Total				$ 75,032
Administrative Expenses				
Engineering and Permitting	15%	LS		$ 11,255
Construction Administration	5%	LS		$ 3,752
Administrative Expense Total				$ 15,006
Capital Implementation Cost Total				**$ 90,038**

CIP 13-1: UIC Decommissioning on Lloyd						
Description	Quantity	Unit		Unit Cost (2012)		2012 Cost
Capital Expenses						
Pipe Improvements						
Concrete Fill - UIC Decommissioning	20.7	CY		140		2900
Remove Remainder of UIC	4	EA		500		2000
Precast Concrete Manhole (48", 0-8' deep)	8	EA	$	2,100	$	16,800
Precast Concrete Manhole (48", 9-12' deep)	4	EA	$	5,800	$	23,200
Concrete Inlet, Type G-2	20	EA	$	1,900	$	38,000
Connection to Existing Structures	3	EA	$	1,000	$	3,000
HDPE Pipeline (10", 2-5' deep)	300	FT	$	78	$	23,534
HDPE Pipeline (12", 2-5' deep)	1,309	FT	$	78	$	102,686
HDPE Pipeline (12", 5-10' deep)	787	FT	$	107	$	83,832
HDPE Pipeline (18", 2-5' deep)	499	FT	$	122	$	60,755
Rain Garden						
General Earthwork/Excavation	500	CY	$	12	$	6,000
Amended Soils/Mulch	500	CY	$	26	$	13,000
Water Quality Facility Plantings	9,000	SF	$	3	$	27,000
Precast Concrete Bypass Manhole (48", 0-8' deep)	1	EA	$	2,100	$	2,100
Ditch Inlet	1	EA	$	2,000	$	2,000
Capital Expense Sub-Total					$	406,806
Mobilization/Demobilization	10%	LS			$	40,681
Traffic Control/Utility Relocation	2%	LS			$	8,136
Erosion Control	2%	LS			$	8,136
Construction Cost Sub-Total					$	463,759
Construction Contingency	30%	LS			$	139,128
Capital Expense Total					$	602,886
Administrative Expenses						
Engineering and Permitting	25%	LS			$	150,722
Construction Administration	5%	LS			$	30,144
UIC Closure Report		LS			$	10,000
Administrative Expense Total					$	190,866
Capital Implementation Cost Total					**$**	**793,752**

CIP 13-2: Linwood Elementary						
Description	Quantity	Unit		Unit Cost (2012)		2012 Cost
Capital Expenses						
Pipe Improvements						
Precast Concrete Manhole (48", 0-8' deep)	6	EA	$	2,100	$	12,600
Connection to Existing Structure	1	EA	$	1,000	$	1,000
HDPE Pipeline (24", 5-10' deep, no pavement)	429	FT	$	155	$	66,654
HDPE Pipeline (30", 5-10' deep, no pavement)	683	FT	$	201	$	137,612
Capital Expense Sub-Total					$	217,866
Mobilization/Demobilization	10%	LS			$	21,787
Traffic Control/Utility Relocation	2%	LS			$	4,357
Erosion Control	2%	LS			$	4,357
Construction Cost Sub-Total					$	248,367
Construction Contingency	30%	LS			$	74,510
Capital Expense Total					$	322,877
Administrative Expenses						
Planning Level Study		LS			$	50,000
Engineering and Permitting	25%	LS			$	80,719
Construction Administration	5%	LS			$	16,144
Administrative Expense Total					$	146,863
Capital Implementation Cost Total					**$**	**469,740**

CIP 13-3: Railroad Avenue at Stanley				
Description	Quantity	Unit	Unit Cost (2012)	2012 Cost
Capital Expenses				
Precast Concrete Manhole (48", 0-8' deep)	5	EA	$ 2,100	$ 10,500
Concrete Inlet, Type D (0-8')	1	EA	$ 2,000	$ 2,000
Connection to Existing Structure	3	EA	$ 1,000	$ 3,000
Remove Existing Pipe (15-18")	56	FT	$ 27	$ 1,512
Reinforced Concrete Pipeline (18", 0-5' deep)	180	FT	$ 144	$ 25,948
HDPE Pipeline (18", 5-10' deep)	660	FT	$ 202	$ 133,239
Capital Expense Sub-Total				$ 176,199
Mobilization/Demobilization	10%	LS		$ 17,620
Traffic Control/Utility Relocation	8%	LS		$ 14,096
Erosion Control	2%	LS		$ 3,524
Construction Cost Sub-Total				$ 211,439
Construction Contingency	30%	LS		$ 63,432
Capital Expense Total				$ 274,871
Administrative Expenses				
Engineering and Permitting	25%	LS		$ 68,718
Construction Administration	5%	LS		$ 13,744
Administrative Expense Total				$ 82,461
Capital Implementation Cost Total				**$ 357,332**

CIP 13-4: Railroad Avenue Channel				
Description	Quantity	Unit	Unit Cost (2012)	2012 Cost
Capital Expenses				
General Earthwork/Excavation	296	CY	$ 12	$ 3,556
Clearing Brush	0.2	AC	$ 1,850	$ 340
Energy dissapation pad - Rip-Rap, Class 50	6	CY	$ 60	$ 360
Water Quality Facility Plantings	8,000	SF	$ 3	$ 24,000
Capital Expense Sub-Total				$ 28,255
Mobilization/Demobilization	10%	LS		$ 2,826
Traffic Control/Utility Relocation	8%	LS		$ 2,260
Erosion Control	2%	LS		$ 565
Construction Cost Sub-Total				$ 33,906
Construction Contingency	30%	LS		$ 10,172
Capital Expense Total				$ 44,078
Administrative Expenses				
Engineering and Permitting	15%	LS		$ 6,612
Construction Administration	5%	LS		$ 2,204
Administrative Expense Total				$ 8,816
Capital Implementation Cost Total				**$ 52,894**

CIP 14-1: Plum Street				
Description	Quantity	Unit	Unit Cost (2012)	2012 Cost
Capital Expenses				
Precast Concrete Manhole (48", 0-8' deep)	4	EA	$ 2,100	$ 8,400
Connection to Existing Structure	2	EA	$ 1,000	$ 2,000
HDPE Pipeline (12", 5-10' deep)	780	FT	$ 107	$ 83,086
Capital Expense Sub-Total				$ 93,486
Mobilization/Demobilization	10%	LS		$ 9,349
Traffic Control/Utility Relocation	2%	LS		$ 1,870
Erosion Control	2%	LS		$ 1,870
Construction Cost Sub-Total				$ 106,574
Construction Contingency	30%	LS		$ 31,972
Capital Expense Total				$ 138,546
Administrative Expenses				
Engineering and Permitting	25%	LS		$ 34,637
Construction Administration	5%	LS		$ 6,927
Administrative Expense Total				$ 41,564
Capital Implementation Cost Total				**$ 180,110**

CIP 15-1: Hemlock Street				
Description	Quantity	Unit	Unit Cost (2012)	2012 Cost
Capital Expenses				
Precast Concrete Manhole (48", 0-8' deep)	2	EA	$ 2,100	$ 4,200
Precast Concrete Manhole (48", 9-12' deep)	3	EA	$ 5,800	$ 17,400
Precast Concrete Manhole (60", 0-8' deep)	2	EA	$ 4,300	$ 8,600
Connection to Existing Structure	4	EA	$ 1,000	$ 4,000
Abandon Existing Manhole	2	EA	$ 254	$ 508
Plug Existing Pipe	2	EA	$ 500	$ 1,000
HDPE Pipeline (24", 2-5' deep)	188	FT	$ 161	$ 30,272
HDPE Pipeline (24", 5-10' deep)	38	FT	$ 265	$ 10,082
HDPE Pipeline (24", 10-15' deep)	810	FT	$ 265	$ 214,908
Capital Expense Sub-Total				$ 290,970
Mobilization/Demobilization	10%	LS		$ 29,097
Traffic Control/Utility Relocation	2%	LS		$ 5,819
Erosion Control	2%	LS		$ 5,819
Construction Cost Sub-Total				$ 331,706
Construction Contingency	30%	LS		$ 99,512
Capital Expense Total				$ 431,218
Administrative Expenses				
Engineering and Permitting	25%	LS		$ 107,804
Construction Administration	5%	LS		$ 21,561
Administrative Expense Total				$ 129,365
Capital Implementation Cost Total				**$ 560,583**

CIP G1: UICs on Llewellyn						
Description	Quantity	Unit	Unit Cost (2012)		2012 Cost	
Capital Expenses						
Drywell (UIC) (48", 20-25' deep)	5	EA	$	10,000	$	50,000
Concrete Inlet, Type G-2	10	EA	$	1,900	$	19,000
HDPE Pipeline (10", 0-5' deep)	150	FT	$	78	$	11,767
Capital Expense Sub-Total					$	80,767
Mobilization/Demobilization	10%	LS			$	8,077
Traffic Control/Utility Relocation	2%	LS			$	1,615
Erosion Control	2%	LS			$	1,615
Construction Cost Sub-Total					$	92,074
Construction Contingency	30%	LS			$	27,622
Capital Expense Total					$	119,697
Administrative Expenses						
Engineering and Permitting	25%	LS			$	29,924
Construction Administration	5%	LS			$	5,985
Administrative Expense Total					$	35,909
Capital Implementation Cost Total					**$**	**155,606**

CIP G2: 36th near King						
Description	Quantity	Unit		Unit Cost (2012)		2012 Cost
Capital Expenses						
Concrete Inlet, Type G-2	4	EA	$	1,900	$	7,600
HDPE Pipeline (10", 0-5' deep)	50	FT	$	78	$	3,922
Stormwater Planter	1,710	SF	$	25	$	42,750
Capital Expense Sub-Total					$	54,272
Mobilization/Demobilization	10%	LS			$	5,427
Traffic Control/Utility Relocation	2%	LS			$	1,085
Erosion Control	2%	LS			$	1,085
Construction Cost Sub-Total					$	61,870
Construction Contingency	30%	LS			$	18,561
Capital Expense Total					$	80,432
Administrative Expenses						
Engineering and Permitting	25%	LS			$	20,108
Construction Administration	5%	LS			$	4,022
Administrative Expense Total					$	24,129
Capital Implementation Cost Total					**$**	**104,561**

CIP G3: 55th near Monroe						
Description	Quantity	Unit		Unit Cost (2012)		2012 Cost
Capital Expenses						
HDPE Pipeline (10", 0-5' deep)	125	EA	$	78	$	9,806
General Earthwork/Excavation	29	CY	$	12	$	347
Drain Rock	17	CY	$	31	$	538
Geomembrane	69	SY	$	25	$	1,736
Capital Expense Sub-Total					$	12,427
Mobilization/Demobilization	10%	LS			$	1,243
Traffic Control/Utility Relocation	2%	LS			$	249
Erosion Control	2%	LS			$	249
Construction Cost Sub-Total					$	14,167
Construction Contingency	30%	LS			$	4,250
Capital Expense Total					$	18,417
Administrative Expenses						
Engineering and Permitting	20%	LS			$	3,683
Construction Administration	5%	LS			$	921
Administrative Expense Total					$	4,604
Capital Implementation Cost Total					**$**	**23,022**

Appendix F: Staffing Analysis Tables

Table F-1: City of Milwaukie Maintenance Staffing Assessment														
Cost tracking activity	Stormwater program implementation (post-2012)							Pre-2012 activities	Maintenance staff cost schedule (annual)[2] (FTE)					Maintenance staff cost schedule (annual)[2] (hr)
	BMP category[a]	BMP/CIP name	Description	Increase in effort from pre-2012 activities (Y/N)	Cost assumptions	Implementation (staff or consultant)	Material costs (Y/N)	Activity description	2013	2014	2015	2016	2017	Annual average
NPDES Program Activities (per 2012 SWMP)	IDDE	Implement the illicit discharges elimination program	Develop and update an IDDE SOP	Y	IDDE SOP developed in November 2012. Assume 10 hrs/year for updating.	staff	N	Track updates/modifications to inspection procedures	0.005	0.005	0.005	0.005	0.005	10
			Conduct source identification tracking, testing, and follow up during the dry weather field screening activities (per the IDDE SOP)	Y	Assume 50% of inspected priority outfalls (~9 outfalls) require some type of investigation and follow up. Assume 8 hrs/outfall follow up.	staff	Y - lab costs	Conduct outfall inspections annually and record results of investigation results	0.04	0.04	0.04	0.04	0.04	72
	IDDE	Conduct annual dry weather field screening	Conduct annual inspections of priority outfalls	N	Eighteen priority outfalls identified per 2012 IDDE SOP.	staff	N	Conduct annual inspections of priority outfalls						
			Annually maintain a map of priority outfalls	Y	Map developed in November 2012. Assume 10 hrs/ year for updating.	staff	N	NA	0.005	0.005	0.005	0.005	0.005	10
	IDDE	Implement the spill response program	Respond to all non-hazardous material spills	N	No change in activities.	staff	Y	Respond to all spills reported to Public Works						
			Document sources, causes, and resulting water quality problems from spills	N	No change in activities.	staff	Y	Document results						
	ICD	Screen new and existing industrial facilities	Document facilities requiring 1200Z permits for DEQ once over the permit term	Y	Conduct review during 2014. Assume 40 hrs for review.	staff	N	NA		0.02				8
	ICD	Conduct industrial and commercial inspections	Inspect all facilities with 1200Z permits twice over the permit term	Y	Assumes five 1200Z permittees. One inspection effort conducted in 2012 (reflected in current staffing); one additional inspection effort to be conducted in 2015 (for the 2012-2017 permit term). Assume 8 hrs per permittee (40 hrs total for inspection effort).	staff	N	Track, inspect, and report results of inspections of the 1200-Z facilities			0.02			8
			Inspect all commercial and industrial food service industry facilities semi-annually	Y	Per 2011-2012, a total of 352 inspections conducted. However, effort is funded out of wastewater, not stormwater. No cost assumed for this activity.	staff	N	NA						
			Inspect other high priority facilities	Y	Assume a total of 10 high priority facilities to be inspected and documented annually and 8 hrs/inspection.	staff	N	NA	0.04	0.04	0.04	0.04	0.04	80
	CON	Implement erosion control	Require erosion control for development > 500 sf	N	No change in activities.	staff	N	Require erosion control for development > 500 sf						
			Conduct site plan review for applicable developments	Y	Assume 10% increase in erosion control plan review activities annually with increase in development. Per 2011-2012, there were 15 erosion control plan reviews conducted (reflected with current staffing). Assume 4 hrs/plan review.	staff	N	Conduct erosion control plan review	0.003	0.003	0.004	0.004	0.004	8
	CON	Provide education to construction site operators	Provide erosion control certification programs	N	No change in activities.	staff	N	Provide Erosion Control Certification Programs						
	CON	Conduct erosion control inspections	Inspect all sites with > 500 sf impervious area a minimum of twice	Y	Assume increased effort associated with 2 inspections instead of just one. Per 2011-2012, a total of 80 hrs spent on erosion control inspections. Assume an additional 80 hrs/yr + 10% increase with increase in development.	staff	N	Conduct initial erosion control inspections for all new and redevelopment sites	0.04	0.05	0.05	0.06	0.06	100
	PE	Provide public education and outreach materials	Promote public awareness through pamphlets, newsletter, and handouts	N	No change in activities.	staff	Y - printing	Promote public awareness through pamphlets, newsletters, and handouts						
			Conduct annual catch basin stenciling/marking	Y	Assume 10% increase in effort annually to continue implementation and ensure coverage of all catch basins in the City. Per 2011-2012, approximately 100 hrs was spent on stenciling activities (reflected in current staffing).	staff	Y - buttons	Continue stenciling catch basins	0.005	0.006	0.006	0.007	0.007	12
	PE	Participate in a public education effectiveness evaluation	Coordinate on a public education effectiveness evaluation, to be completed by July 1, 2015	Y	Assumes cost share with ACWA and Clackamas co-permittees. Cost not reflected in staffing assessment but staff time may be needed to participate in the project.	staff/ consultant	N	NA						
	PE	Conduct annual staff training	Provide City storm crews with 40 hrs of training annually	Y	Assume an additional 32 hrs of training for each existing staff (5.25 FTE).	staff	N	Provide spill response training to staff once per year	0.08	0.08	0.08	0.08	0.08	168
			Conduct regular stormwater staff meetings one to four times per year	Y	Assume 2 staff meetings annually at 2 hrs/meeting for existing staff (5.25 FTE)	staff	N		0.01	0.01	0.01	0.01	0.01	20
	PP	Conduct street sweeping and roadway repair activities	Sweep curbed streets once per month	Y	Street sweeping funded out of road/ transportation fund. Cost not reflected in stormwater staffing assessment.	Staff	Y - sweeper	Conduct ongoing street sweeping activities						
	PP	Minimize water quality impacts from landscape maintenance	Use the Portland IPM as a guide for pesticide/fertilizer application and landscape maintenance	Y	Assume increase (double) in effort associated with use of IPM over standard practice. Per 2011-2012, approximately 40 hrs spent on shoulder maintenance.	staff	N	Conduct pest management at public properties	0.02	0.02	0.02	0.02	0.02	40

Table F-1: City of Milwaukie Maintenance Staffing Assessment														
Cost tracking activity	Stormwater program implementation (post-2012)							Pre-2012 activities	Maintenance staff cost schedule (annual)[2] (FTE)					Maintenance staff cost schedule (annual)[2] (hr)
	BMP category[a]	BMP/CIP name	Description	Increase in effort from pre-2012 activities (Y/N)	Cost assumptions	Implementation (staff or consultant)	Material costs (Y/N)	Activity description	2013	2014	2015	2016	2017	Annual average
NPDES Program Activities (per 2012 SWMP) (continued)	PP	Reduce stormwater impacts from municipal facilities	Develop procedure for storage/disposal of street wastes in conjunction with operation of covered, on-site Decant Facility	Y	Procedure developed in 2012 (under current staffing). Assume 10 hrs/ year to inspect facility and update procedure.	staff	N	NA	0.005	0.005	0.005	0.005	0.005	10
	PP	Control infiltration and cross connections	Investigate sanitary lines for damage approximately every 5-6 years	Y	Cost reflected in City's Wastewater Program, not separately under the stormwater program	staff	N	Track cross connections through the illicit discharge program						
	PP	Implement Master Plan CIP projects	Annually contribute to the reserve fund for CIP design and construction; track location and drainage area of CIPs	Y	See cost tracking activity "Stormwater Master Plan Implementation" for associated staff cost estimates.	staff	N	Map location and drainage area of CIPs						
	OM	Conduct stormwater system cleaning and maintenance	Inspect stormwater conveyance system components every two years and perform maintenance	Y	City's current assets include: 123 sediment manholes, 549 manholes, 8,859' of ditches, and 875' of culverts. Not all assets inventoried yet. Assume current inspection and maintenance frequency is once per permit term. Revised frequency is two times per permit term. Therefore, one additional inspection and maintenance rotation for all recorded assets once over the permit term. Assume inspection/ maintenance requires 1 hr/sediment manhole (additional 0.14 FTE over 5-year term or 0.03 FTE annually); 0.5 hr/ manhole (.02 FTE over the 5-year permit term or 0.004 FTE annually); 20'/hr for culvert/ ditch maintenance (0.24 FTE over the 5-year permit term or 0.05 FTE annually); and 191'/hr for culvert/ ditch inspections (0.03 FTE over the 5-year permit term or 0.01 FTE annually).	staff	Y - vactor	Inspect the stormwater conveyance system as needed	0.09	0.09	0.09	0.09	0.09	188
	OM	Conduct catch basin cleaning	Clean 50% of catch basins annually	N	No change in activities.	staff	Y-vactor	Clean 50% of catch basins annually						
	OM	Private water quality facility maintenance program	Conduct annual inspections of ten private facilities	Y	Assume inspections and documentation require 8 hrs/facility with ten facilities requiring inspection annually.	staff	N	NA	0.04	0.04	0.04	0.04	0.04	80
	OM	Public structural control maintenance	Inspect and maintain public water quality facilities	Y	Traditional BMPs maintained prior to 2012. In 2011-2012, 260 hrs of rain garden maintenance conducted (not reflected in current staffing). City currently has a total of 40 public rain garden facilities. Assume 10% increase in facility installations with increased development plus 4 hrs per facility for inspection.	staff	Y - vactor	Inspect and maintain public facilities (storm filters, ponds, swales)	0.21	0.23	0.25	0.28	0.31	500
								Subtotal NPDES program costs	0.60	0.64	0.67	0.68	0.72	1314
UIC WPCF Permit Issuance and Compliance	OM	Complete system-wide assessment	Determine depths to covered UICs	Y	Assume permit issuance in 2014. System-wide assessment to be completed in 2015. 32 UICs to be uncovered. Assume 16 hrs/UIC.	staff	Y - excavator	NA			0.26			256
			Identify additional wells	Y	Assume permit issuance in 2014. System-wide assessment to be completed in 2015. Assume 40 hrs to research additional well locations.	staff	N	NA			0.02			40
			Evaluate depth to groundwater for uncovered UICs and any UICs within new well setbacks and document findings	Y	Assume permit issuance in 2014. System-wide assessment to be completed in 2015. Assume 40 hrs to complete assessment and document.	staff	N	NA			0.02			40
	OM	Update UICMP	Refine current UICMP per requirements of the new UIC WPCF permit	Y	Assume permit issuance in 2014 and submittal of UICMP to DEQ in 2014. Assume 80 hrs to update (in 2014) and 10 hrs/year to refine.	staff/consultant	N	NA		0.04	0.005	0.005	0.005	30
	OM	Update UIC stormwater monitoring plan	Refine current monitoring plan per requirements of the new UIC WPCF permit	Y	Assume permit issuance in 2014 and submittal of monitoring plan to DEQ in 2014. Assume 40 hrs to update (in 2014) and 10 hrs/year to refine.	staff/consultant	N	NA		0.02	0.005	0.005	0.005	24
	OM	Prepare annual reports	Prepare annual reports per requirements of the new UIC WPCF permit	Y	Assume permit issuance in 2014 and submittal of annual reports to DEQ starting in 2014. Assume 40 hrs/year to prepare.	Staff	N	NA		0.02	0.02	0.02	0.02	40
								Subtotal WPCF permit implementation costs	0.00	0.08	0.33	0.03	0.03	930
Stormwater Master Plan Implementation	OM	CIP 1-1: Willow detention pond retrofit	Retrofit existing detention pond for water quality enhancement	Y	Existing Willow Lake Pond not currently maintained under current staffing. Assume 16 hrs/year for inspection and maintenance.	staff	Y - vactor	NA						16
	OM	CIP 1-2: Stanley-Willow UIC decommissioning	Retrofit existing Ball-Mitchell Pond for water quality enhancement	Y	Existing Ball-Mitchell Pond not currently maintained under current staffing. Assume 16 hrs/year for pond inspection and maintenance.	staff	Y - vactor	NA						24
			Install four new catch basins	Y	Assume 0.5 hr/catch basin for maintenance.	staff	Y - vactor	NA						
			Install 425' of new pipe	Y	Assume 60'/hr for pipe cleaning and 191'/hr for TV inspections. Inspection and maintenance occurs biannually. Total average annual maintenance time for new pipe = 4.5 hrs.	staff	Y - vactor	NA						

Table F-1: City of Milwaukie Maintenance Staffing Assessment														
Cost tracking activity	Stormwater program implementation (post-2012)							Pre-2012 activities	Maintenance staff cost schedule (annual)[2] (FTE)					Maintenance staff cost schedule (annual)[2] (hr)
	BMP category[a]	BMP/CIP name	Description	Increase in effort from pre-2012 activities (Y/N)	Cost assumptions	Implementation (staff or consultant)	Material costs (Y/N)	Activity description	2013	2014	2015	2016	2017	Annual average
Stormwater Master Plan Implementation (continued)	OM	CIP 5-1: Meek Street	Install two new detention facilities.	Y	Assume 16 hrs/year for pond inspection and maintenance.	staff	Y - vactor	NA						66
			Install 10 new manholes.	Y	Assume 0.5 hr/manhole for maintenance.	staff	Y - vactor	NA						
			Install a total of 3,940' of new pipe.	Y	Assume 60'/hr for pipe cleaning and 191'/hr for TV inspections. Inspection and maintenance occurs biannually. Total average annual maintenance time for new pipe = 45 hrs.	staff	Y - vactor	NA						
	OM	CIP 6-2: Washington Green Streets	Install 4,540 sf of rain garden.	Y	Assume 50 sf/hr for maintenance + 4 hrs for vegetation inspection. Total annual maintenance time for rain gardens = 94 hrs.	staff	Y - vactor	NA						104
			Install 20 new catch basins.	Y	Assume 0.5 hr/catch basin for maintenance.	staff	Y - vactor	NA						
	OM	CIP 13-1: UIC Decommissioning on Lloyd	Install 9,000 sf of rain garden.	Y	Assume 50 sf/hr for maintenance + 4 hrs for vegetation inspection. Total annual maintenance time for rain gardens=184 hrs.	staff	Y - vactor	NA						204
			Install one new bypass manhole.	Y	Assume 0.5 hr/manhole for maintenance.	staff	Y - vactor	NA						
			Install 20 new catch basins.	Y	Assume 0.5 hr/catch basin for maintenance.	staff	Y - vactor	NA						
			Install 787' of new pipe.	Y	Assume 60'/hr for pipe cleaning and 191'/hr for TV inspections. Inspection and maintenance occurs biannually. Total annual maintenance time for new pipe= 9 hrs.	staff	Y - vactor	NA						
	OM	CIP 13-3: Railroad Avenue at Stanley	Install five new manholes.	Y	Assume 0.5 hr/manhole for maintenance.	staff	Y - vactor	NA						16
			Install a total of 850' of new pipe.	Y	Assume 60'/hr for pipe cleaning and 191'/hr for TV inspections. Inspection and maintenance occurs biannually. Total annual maintenance time for new pipe=13 hrs.	staff	Y - vactor	NA						
	OM	CIP 13-4: Railroad Avenue Channel	Maintain 2000' of open channel.	Y	Assumes 20'/hr for ditch maintenance. Assumes maintenance required once every 5 years. Total annual maintenance time for channel is 20 hrs.	staff	Y - vactor	NA						20
	OM	CIP 14-1: Apple Street	Install 650' of new pipe	Y	Assume 60'/hr for pipe cleaning and 191'/hr for TV inspections. Inspection and maintenance occurs biannually. Total annual maintenance time for new pipe=8 hrs.	staff	Y-vactor	NA						8
	OM	CIP 15-1: Hemlock Street	Install two new manholes.	Y	Assume 0.5 hr/manhole for maintenance.	staff	Y - vactor	NA						12
			Install a total of 986' of new pipe.	Y	Assume 60'/hr for pipe cleaning and 191'/hr for TV inspections. Inspection and maintenance occurs biannually. Total annual maintenance time for new pipe=11 hrs.	staff	Y - vactor	NA						
	OM	CIP G1: 47th and Llewellyn	Install five new UICs.	Y	Assume 1.5 hrs/drywell for inspection and maintenance	staff	Y-vactor	NA						8
	OM	CIP G2: 36th near King	Install 1,710 sf of rain garden.	Y	Assume 50 sf/hr for maintenance + 4 hrs for vegetation inspection. Total annual maintenance time for rain gardens = 38 hrs.	staff	Y-vactor	NA						40
			Install four new catch basins.	Y	Assume 0.5 hr/catch basin for maintenance.	staff	Y-vactor	NA						
			Install 50' of new pipe.	Y	Assume 60'/hr for pipe cleaning and 191'/hr for TV inspections. Inspection and maintenance occurs biannually. Total annual maintenance time for new pipe= 0.5 hr.	staff	Y-vactor	NA						
	OM	CIP G3: 55th and Monroe	Install 125' of soakage trench.	Y	Assume 60'/hr for cleaning and 191'/hr for inspections (consistent with pipe cleaning requirements). Inspection and maintenance occurs biannually. Total annual maintenance time for soakage trench= 0.5 hr.	staff	Y-vactor	NA						0
Subtotal Master Plan implementation costs (average annual staff time) (FTE/hrs)									0.25					518
Total maintenance staffing	NPDES maintenance staff cost (by implementation year)								0.60	0.64	0.67	0.68	0.72	1314
	UIC WPCF maintenance staff cost (by implementation year)								0.00	0.08	0.33	0.03	0.03	430
	Master Plan implementation staff cost								0.25	0.25	0.25	0.25	0.25	518
	Staffing contingency (estimated at 40% to account unscheduled maintenance and response)								0.56	0.65	0.83	0.64	0.66	1508
	Total staff cost (FTE and hourly)								1.41	1.62	2.08	1.60	1.66	3770

[a]BMP Categories are documented in the City 2012 Stormwater Management Plan.

[b]FTE is 2080 hrs; 0.02 FTE is 40 hrs; NPDES and WPCF program cost schedule based on implementation over a 5-year permit term (2012-2017); Stormwater Master Plan Implementation projected on an annual basis and assumes a 10-year CIP.

Abbreviations:

IDDE = Illicit Discharge Detection and Elimination PE = Public Education PP = Pollution Prevention ICD = Industrial/Commercial Development PC = Post Construction Site Runoff Control OM = Operation and Maintenance CON = Construction/Erosion Control

Table F-2: City of Milwaukie Engineering Staffing Assessment													
Cost tracking activity	Stormwater program implementation (post-2012)						Cost calculations[b]	Engineering staff cost schedule (annual)[c] (FTE by year or lump sum)					Engineering staff cost schedule (annual)[c] (hr)
	BMP category[a]	BMP/CIP name	Description	Increase in effort from pre-2012 activities (Y/N)	Cost assumptions	Implementation (staff or consultant)	Description	2013	2014	2015	2016	2017	Annual average
NPDES Program Activities (per 2012 SWMP)	ICD	Conduct industrial and commercial inspections	Develop a high priority pollutant facility inspection program (SOP).	Y	Assume 40 hrs for development. Twenty hrs/year for updating.	staff	NA	0.02	0.01	0.01	0.01	0.01	28
	PC	Implement municipal development codes	Review new and redevelopment applications for stormwater controls and standards.	Y	Assume 10% increase in plan review activities annually with increased development.	staff	Per 2011-2012, four applications were reviewed (with current staffing). Assume 10% annual increase in effort at 20 hrs per application.	0.004	0.004	0.005	0.005	0.006	16
			Review and revise design storm and design manual to comply with permit conditions by November 1, 2014.	Y	• Assume update conducted in-house. Update conducted in 2014. • Assume update requires 120 hrs of staff time.	staff	NA		0.06				24
	PP	Reduce stormwater impacts from municipal facilities	Develop procedure for storage/disposal of street wastes in conjunction with operation of covered, on-site Decant Facility.	Y	• Procedure developed in 2012 (under current staffing). • Assume 10 hrs/year to inspect facility and update procedure.	staff	NA	0.005	0.005	0.005	0.005	0.005	10
	OM	Private water quality facility maintenance program	Develop private water quality facility SOP by July 1, 2013.	Y	• SOP developed in 2012. • Assume 20 hrs/year for updating.	staff	NA	0.01	0.01	0.01	0.01	0.01	20
							Subtotal NPDES program costs (FTE)	0.04	0.09	0.03	0.03	0.03	98
Stormwater Master Plan Implementation	CIP	CIP 1-1: Willow detention pond retrofit	Retrofit existing detention pond for water quality enhancement.	Y	• Engineering and permitting costs estimated at 40% of the construction cost. Construction administration estimated at 5% of the construction cost. • Assume engineering and permitting costs for consultant and 100% of the construction administration cost would be required for internal staff.	staff/consultant	• Engineering and permitting cost (total): $18,900 • Construction administration (total): $2,400 • Total (City cost): $2,400 (or 0.02 FTE)						4
	CIP	CIP 1-2: Stanley-Willow UIC decommissioning	Decommission two UICs. Retrofit existing Ball-Mitchell Pond for water quality enhancement. Install four new catch basins and 425' of new pipe.	Y	• Engineering and permitting costs estimated at 25% of the construction cost. Construction administration estimated at 5% of the construction cost. • Assume engineering and permitting cost for consultant and 100% of the construction administration cost would be required for internal staff.	staff/consultant	• Engineering and permitting cost (total): $18,300 • Construction administration (total): $3,700 • Total (City cost): $3,700 (or 0.04 FTE)						8
	CIP	CIP 4-1: Main Street at Milport Road	Replace 380' of pipe and 7 manholes.	Y	• Engineering and permitting costs estimated at 25% of the construction cost. Construction administration estimated at 5% of the construction cost. • Assume engineering and permitting cost for consultant and 100% of the construction administration cost would be required for internal staff.	staff/consultant	• Engineering and permitting cost (total): $46,400 • Construction administration (total): $9,300 • Total (City cost): $9,300 (or 0.09 FTE)						19
	CIP	CIP 5-1: Meek Street	Install two new detention facilities, ten manholes, and 3,940' of new pipe.	Y	• Engineering and permitting costs estimated at 25% of the construction cost. Construction administration estimated at 5% of the construction cost. • Assume engineering and permitting cost for consultant and 100% of the construction administration cost would be required for internal staff.	staff/consultant	• Engineering and permitting cost (total): $593,900 • Construction administration (total): $118,800 • Total (City cost): $118,800 (or 1.19 FTE)						248
	CIP	CIP 5-2: Harrison Street Outfall	Replace 696' of pipe.	Y	• Engineering and permitting costs estimated at 25% of the construction cost. Construction administration estimated at 5% of the construction cost. • Assume engineering and permitting cost for consultant and 100% of the construction administration cost would be required for internal staff.	staff/consultant	• Engineering and permitting cost (total): $119,100 • Construction administration (total): $23,800 • Total (City cost): $23,800 (or 0.24 FTE)						50
	CIP	CIP 6-1: Washington Street	Replace 3,551' of pipe.	Y	• Engineering and permitting costs estimated at 15% of the construction cost. Construction administration estimated at 5% of the construction cost. • Assume engineering and permitting cost for consultant and 100% of the construction administration cost would be required for internal staff.	staff/consultant	• Engineering and permitting cost (total): $225,500 • Construction administration (total): $75,200 • otal (City cost): $75,200 (or 0.75 FTE)						156
	CIP	CIP 6-2: Washington Green Streets	Install 4,540 sf of rain garden and 20 new catch basins.	Y	• Engineering and permitting costs estimated at 40% of the construction cost. Construction administration estimated at 5% of the construction cost. • Assume engineering and permitting cost for consultant and 100% of the construction administration cost would be required for internal staff.	staff/consultant	• Engineering and permitting cost (total): $141,100 • Construction administration (total): $17,600 • Total (City cost): $17,600 (or 0.18 FTE)						37
	CIP	CIP 12-1: International Way and Wister	Replace 80' of pipe.	Y	• Engineering and permitting costs estimated at 25% of the construction cost. Construction administration estimated at 5% of the construction cost. • Assume engineering and permitting cost for consultant and 100% of the construction administration cost would be required for internal staff.	staff/consultant	• Engineering and permitting cost (total): $11,300 • Construction administration (total): $3,700 • Total (City cost): $3,700 (or 0.04 FTE)						8

Table F-2: City of Milwaukie Engineering Staffing Assessment

Cost tracking activity	Stormwater program implementation (post-2012)						Cost calculations[b]	Engineering staff cost schedule (annual)[c] (FTE by year or lump sum)					Engineering staff cost schedule (annual)[c] (hr)
	BMP category[a]	BMP/CIP name	Description	Increase in effort from pre-2012 activities (Y/N)	Cost assumptions	Implementation (staff or consultant)	Description	2013	2014	2015	2016	2017	Annual average
Stormwater Master Plan Implementation (continued)	CIP	CIP 13-1: UIC decommissioning on Lloyd	Decommission four UICs. Install 9,000 sf of rain garden, one bypass manhole, 20 new catch basins, and 787' of pipe. Replace 1,813' of pipe.	Y	• Engineering and permitting costs estimated at 25% of the construction cost. Construction administration estimated at 5% of the construction cost. • Assume engineering and permitting cost for consultant and 100% of the construction administration cost would be required for internal staff.	staff/consultant	• Engineering and permitting cost (total): $150,700 • Construction administration (total): $30,100 • Total (City cost): $30,100 (or 0.30 FTE)						62
	CIP	CIP 13-2: Linwood Elementary	Replace 1,112' of pipe and conduct a planning study.	Y	• Engineering and permitting costs estimated at 25% of the construction cost. Construction administration estimated at 5% of the construction cost. • Assume engineering and permitting cost for consultant and 100% of the construction administration cost would be required for internal staff.	staff/consultant	• Engineering and permitting cost (total): $80,700 • Construction administration (total): $16,100 • Total (City cost): $16,100 (or 0.16 FTE)						33
	OM	CIP 13-3: Railroad Avenue at Stanley	Install five new manholes and 850' of new pipe.	Y	• Engineering and permitting costs estimated at 25% of the construction cost. Construction administration estimated at 5% of the construction cost. • Assume engineering and permitting cost for consultant and 100% of the construction administration cost would be required for internal staff.	staff/consultant	• Engineering and permitting cost (total): $68,700 • Construction administration (total): $13,700 • Total (City cost): $13,700 (or 0.14 FTE)						29
	OM	CIP 13-4: Railroad Avenue Channel	Maintain 2000' of open channel.	Y	• Engineering and permitting costs estimated at 15% of the construction cost. Construction administration estimated at 5% of the construction cost. • Assume engineering and permitting conducted internally. 100% of engineering/ permitting and the construction administration cost would be required for internal staff.	staff	• Engineering and permitting cost (total): $6,600 • Construction administration (total): $2,200 • Total (City cost): $8,800 (or 0.09 FTE)						19
	OM	CIP 14-1: Apple Street	Install 650' of new pipe.	Y	• Engineering and permitting costs estimated at 25% of the construction cost. Construction administration estimated at 5% of the construction cost. • Assume engineering and permitting cost for consultant and 100% of the construction administration cost would be required for internal staff.	staff/consultant	• Engineering and permitting cost (total): $28,400 • Construction administration (total): $5,700 • Total (City cost): $5,700 (or 0.06 FTE)						12
	OM	CIP 15-1: Hemlock Street	Install two new manholes and 986' of new pipe.	Y	• Engineering and permitting costs estimated at 25% of the construction cost. Construction administration estimated at 5% of the construction cost. • Assume engineering and permitting cost for consultant and 100% of the construction administration cost would be required for internal staff.	staff/consultant	• Engineering and permitting cost (total): $107,800 • Construction administration (total): $21,600 • Total (City cost): $21,600 (or 0.22 FTE)						46
	OM	CIP G1: 47th and Llewellyn	Install five new UICs.	Y	• Engineering and permitting costs estimated at 25% of the construction cost. Construction administration estimated at 5% of the construction cost. • Assume engineering and permitting conducted internally. 100% of the engineering/permitting and construction administration cost would be required for internal staff.	staff	• Engineering and permitting cost (total): $29,900 • Construction administration (total): $6,000 • Total (City cost): $35,900 (or 0.36 FTE)						75
	OM	CIP G2: 36th near King	Install 1,710 sf of rain garden, four new catch basins, and 50' of new pipe.	Y	• Engineering and permitting costs estimated at 25% of the construction cost. Construction administration estimated at 5% of the construction cost. • Assume engineering and permitting cost for consultant and 100% of the construction administration cost would be required for internal staff.	staff/consultant	• Engineering and permitting cost (total): $20,100 • Construction administration (total): $4,000 • Total (City cost): $4,000 (or 0.04 FTE)						8
	OM	CIP G3: 55th and Monroe	Install 125' of soakage trench.	Y	• Engineering and permitting costs estimated at 25% of the construction cost. Construction administration estimated at 5% of the construction cost. • Assume engineering and permitting conducted internally. 100% of the engineering/permitting and construction administration cost would be required for internal staff.	staff	• Engineering and permitting cost (total): $3,700 • Construction administration (total): $900 • Total (City cost): $4,600 (or 0.05 FTE)						10
Subtotal Master Plan implementation costs (total staff time over 10-year CIP) (FTE/ hrs)								3.97					8258
Subtotal Master Plan implementation costs (average staff time over 10-year CIP) (FTE/ hrs)								0.40					822
Total engineering staffing							NPDES engineering staff cost (by implementation year)	0.04	0.09	0.03	0.03	0.03	98
							Master Plan Implementation staff cost (total)	0.40	0.40	0.40	0.40	0.40	822
							Staffing Contingency (to account for project overrun or internal design)	0.25	0.25	0.25	0.25	0.25	520
							Total staff cost (FTE and hourly)	0.69	0.74	0.68	0.68	0.68	1440

[a]*BMP Categories are documented in the City 2012 Stormwater Management Plan.*

[b]*For purposes of calculating an equivalent FTE per cost estimate, an annual FTE salary was assumed at $100,000/year.*

[c]*FTE is 2080 hrs; 0.02 FTE is 40 hrs; NPDES and WPCF program cost schedule based on implementation over a 5-year permit term (2012-2017); Stormwater Master Plan Implementation based on implementation over a 10-year CIP.*

Abbreviations: IDDE = Illicit Discharge Detection and Elimination PE = Public Education PP = Pollution Prevention ICD = Industrial/Commercial Development PC = Post Construction Site Runoff Control OM = Operation and Maintenance CON = Construction/Erosion Control

Appendix G: Financial Evaluation

STORMWATER FINANCIAL PLAN

CITY OF MILWAUKIE

Introduction

This technical memorandum provides a financial plan that will allow the City to implement its capital improvement program while meeting its other financial obligations, including policy objectives. The two main components of this plan (1) the computation of a system development charge (SDC) and (2) a revenue requirement analysis. However, since these components include analysis of multiple levels of service, we begin with defining each level of service used in this plan.

Levels of Service

In collaboration with Brown and Caldwell and City staff, we developed four levels of service that represent different trade-offs between the service that a stormwater program can provide and the cost of that service. **Exhibit 1** summarizes the key features of each level of service:

Levels of Service **Exhibit 1**

Level	Staffing	Capital Projects	Maintenance	TMDL/NPDES	System Replacement	Vehicle Replacement
Current	Meet historic programmatic needs. No additional staff.	Implement capital projects 13-1 and 5-1 per new CIP.	Maintain conventional system components	Meet historic permit needs.	System replacement when failure occurs.	Replace existing vactor truck with dedicated funds. Continue allocating $50,000/ yr for vehicle replacement (assumes 12- year replacement cycle).
Minimum	Meet programmatic needs per newly issued permits. Address capital projects 13-1, 13-3, 13-4 and 5-1 per new CIP.	Implement capital projects 13-1, 13-3, 13-4 and 5-1 per new CIP.	Maintain conventional and vegetated system components (i.e., raingardens)	Meet new permit requirements related to system evaluation and monitoring. Conduct water quality retrofits in accordance with permit requirements.	System replacement when failure occurs.	Replace existing vactor truck with dedicated funds. Continue allocating $50,000/ yr for vehicle replacement (assumes 12- year replacement cycle).
Recommended	Meet new programmatic needs per newly issued permits. Address higher priority capital projects.	Construct higher priority capital projects over a 10-year planning horizon. Construct all capital projects in the future.	Maintain conventional and vegetated system components (i.e., raingardens)	Meet new permit requirements related to system evaluation and monitoring. Conduct water quality retrofits in accordance with permit requirements.	Replace 50% of the system over a 75-year period. Assume $390,000/ yr for replacement activities starting in FY 2017/18.	Replace existing vactor truck with dedicated funds. Continue allocating $50,000/ yr for vehicle replacement (assumes 12- year replacement cycle).
Proactive	Meet new programmatic needs per newly issued permits Address all capital projects.	Construct all capital projects over a 10-year planning horizon.	Maintain conventional and vegetated system components (i.e., raingardens)	Meet new permit requirements related to system evaluation and monitoring. Conduct water quality retrofits in accordance with permit requirements.	Replace 100% of the system over a 75-year period. Assumes $780,000/yr for replacement activities starting in FY 2017/ 18.	Replace existing vactor truck with dedicated funds. Allocate $85,714/yr for vehicle replacement (assumes 7-year rotating cycle).

Source: Brown and Caldwell

For three of the four levels of service, we present two scenarios. One scenario finances capital improvements with a combination of debt and rate revenues. The other scenario finances capital improvements with rate revenue alone. Rate increases are naturally higher for those scenarios that rely exclusively on rate revenue. For the current level of service, we do not present a scenario that includes debt. SDCs differ for some levels of service, because some levels of service require a different set of capacity-increasing projects.

System Development Charges

SDCs are one-time fees imposed on new and increased development to recover the cost of system facilities needed to serve that growth. This section provides the rationale and calculations for a proposed stormwater SDC.

Method of Calculation

An SDC can include two components: a reimbursement fee and an improvement fee.

The reimbursement fee is the cost of available capacity per unit of growth that such available capacity will serve. In order for a reimbursement fee to be calculated, unused capacity must be available to serve future growth. For facility types that do not have available capacity, no reimbursement fee may be charged.

The improvement fee is the cost of capacity-increasing capital projects per unit of growth that those projects will serve. In reality, the capacity added by many projects serves a dual purpose of both meeting existing demand and serving future growth. To compute a compliant improvement fee, growth-related costs must be isolated, and costs related to current demand must be excluded.

We have used the "capacity approach" to allocate costs to the improvement fee basis. Under this approach, the cost of a given project is allocated to growth in proportion to the growth-related capacity that projects of a similar type will create.

Growth should be measured in units that most directly reflect the source of demand. For the City's stormwater utility, growth is measured in equivalent service units (ESUs). One ESU represents the stormwater service needs of an average single-family residence.

ORS 223.307(5) authorizes the expenditure of SDCs on "the costs of complying with the provisions of ORS 223.297 to 223.314, including the costs of developing system development charge methodologies and providing an annual accounting of system development charge expenditures." To avoid spending monies for compliance that might otherwise have been spent on growth-related projects, the City should include an estimate of compliance costs in its SDC rates.

Growth

The City's current stormwater customer base is 14,269 ESUs. Brown and Caldwell estimates that the amount of impervious area discharging to the City's stormwater collection system will increase by 30 percent between the present and buildout. Half of the increase in discharge will be attributable to increased connectivity of the stormwater system from redevelopment. The other half of the increase in discharge will be attributable to new impervious area added as a result of new development. Only the latter half will result in an increase to the customer base. We therefore estimate that the City's stormwater customer base will be 16,457 ESUs at buildout. This estimate implies growth of 2,188 ESUs between the present and buildout.

Eligible Costs

Having determined the anticipated growth that constitutes the denominator of the SDC calculation, we turn to the eligible costs that constitute the numerator.

Because the City's stormwater infrastructure has no excess capacity that is available to serve growth, the City cannot charge a reimbursement fee as part of its stormwater SDC.

Based on the capital improvement plan developed by Brown and Caldwell for the recommended and proactive levels of service, the City will construct the complete list of stormwater facilities with an estimated cost of $9,220,500 between the present and buildout. However, none of these projects will serve growth of the City's stormwater customer base exclusively. We have identified those projects that will serve development (increased impervious area). Of those, only the growth-related portion of each project can be collected as the improvement fee component of an SDC. **Exhibit 2** shows the growth-related portion of the planned stormwater projects for the recommended and proactive levels of service:

Improvement Fee — **Exhibit 2**

	Project	Total Cost	Development-Related Portion	Growth Portion of Development	Improvement Fee Cost Basis
1-1	Willow Detention Pond Retrofit	$ 68,600	0.00%	50.00%	$ -
1-2	Stanley-Willow UIC Decommissioning	100,200	0.00%	50.00%	-
4-1	Main Street at Milport Road	241,200	43.00%	50.00%	51,858
5-1A	Meek Street Phase 1	593,900	56.00%	50.00%	166,292
5-1B	Meek Street Phase 2	1,233,300	56.00%	50.00%	345,324
5-1C	Meek Street Phase 3	1,261,000	56.00%	50.00%	353,080
5-2	Harrison Street Outfall	619,400	45.00%	50.00%	139,365
6-1A	Washington Street Phase 1	225,500	17.00%	50.00%	19,168
6-2B	Washington Street Phase 2	1,578,600	17.00%	50.00%	134,181
6-2	Washington Green Streets	511,300	0.00%	50.00%	-
12-1	International Way and Wister Street	90,000	74.00%	50.00%	33,300
13-1	UIC decommissioning on Lloyd	793,700	55.00%	50.00%	218,268
13-2	Linwood Avenue	469,700	23.00%	50.00%	54,016
13-3	Railroad Avenue at Stanley	357,300	33.00%	50.00%	58,955
13-4	Railroad Avenue Channel	52,900	0.00%	50.00%	-
14-1	Plum and Apple Street	180,100	43.00%	50.00%	38,722
15-1	Hemlock Street to Harmony Road	560,600	16.00%	50.00%	44,848
G1	47th and Llewelyn	155,600	0.00%	50.00%	-
G2	36th near King	104,600	0.00%	50.00%	-
G3	Flooding on 55th Ave between King Street and Monroe Street	23,000	0.00%	50.00%	-
		$ 9,220,500			$ 1,657,375
	Growth in ESUs				2,188
	Improvement fee per ESU				**$ 758**

Source: Brown and Caldwell

When the SDC-eligible cost of $1,657,375 is divided by the expected growth of 2,188 ESUs, the resulting improvement fee is $758 per ESU.

Adjustments

Based on our experience with cities of similar size, we estimate that recoverable costs of compliance will be 0.96 percent of the improvement cost basis. Including these costs in the SDC adds $7 per ESU.

SDC Components

Exhibit 3 summarizes the components of the proposed stormwater SDC of $765 per ESU for the recommended and proactive levels of service. The proposed SDC represents a decrease from the current SDC of $1,184 per ESU.

SDC Components — **Exhibit 3**

Description	Amount
Reimbursement fee	$ -
Improvement fee	758
Adjustment	7
Total fee per ESU	**765**

Source: Previous exhibits

Other Levels of Service

Although the growth assumption of 2,188 new ESUs is valid for all levels of service, the current and minimum levels of service use shorter project lists than the recommended and proactive levels of service. Lower eligible costs result in lower SDCs. For the current level of service, the proposed SDC is $502 per ESU. For the minimum level of service, the proposed SDC is $529.

Indexing

ORS 223.304 allows for the periodic indexing of system development charges for inflation, as long as the index used is:

> (A) A relevant measurement of the average change in prices or costs over an identified time period for materials, labor, real property or a combination of the three;
>
> (B) Published by a recognized organization or agency that produces the index or data source for reasons that are independent of the system development charge methodology; and
>
> (C) Incorporated as part of the established methodology or identified and adopted in a separate ordinance, resolution or order.

We recommend that the City index its charges to the *Engineering News Record* Construction Cost Index for the City of Seattle and adjust its charges annually. There is no comparable Oregon-specific index.

Revenue Requirement Analysis

This section presents a financial analysis that reveals how much rate revenue would be required to meet operational and capital needs within contractual and policy constraints over the next ten years.

Criteria

At least two separate conditions must be satisfied in order for rates to be sufficient. First, the stormwater utility must generate revenues adequate to meet cash needs. Second, revenues must satisfy bond coverage requirements (if any).

Revenues should be sufficient to satisfy both tests. If revenues are found to be deficient by one or more of the tests, then the greater deficiency drives the rate increase.

The cash flow test identifies all cash requirements as projected in each given year. Cash requirements include operations and maintenance expenses, debt service payments, policy-driven additions to working capital, and capital improvement costs. If the stormwater service collected replacement funding, it would also be included in the test as an expense. These expenses are compared to the total projected annual revenues, including interest on fund balances. Shortfalls are then used to estimate the necessary rate increases.

The bond coverage test measures the ability of rate revenues to meet contractual obligations. For those scenarios that include the issuance of debt, we have based the bond coverage test on the common requirement that net revenues must equal or exceed 125 percent of annual bond debt service over the life of the bonds.

Projections

We created a spreadsheet model to forecast cash flows for the City's stormwater utility over a period of ten years. We used that model to determine the timing and magnitude of required rate increases under seven scenarios covering the four levels of service defined above:

- **Exhibit 4** summarizes the model's output for a ten-year period under the current level of service. Although this scenario represents the least ambitious level of service, the utility still requires six years of rate increase of four percent per year or more.
- **Exhibit 5** summarizes the model's output for a ten-year period under the minimum level of service with no debt. This scenario requires six years of rate increases at or near 7.7 percent per year.
- **Exhibit 6** also reflects the minimum level of service, but this scenario includes $2.5 million in revenue bonds to be issued in fiscal year 2017-18. This change cuts the required rate increases nearly in half.
- **Exhibit 7** summarizes the model's output for a ten-year period under the recommended level of service with no debt. This scenario requires seven years of rate increases above ten percent per year.
- **Exhibit 8** also reflects the recommended level of service, but this scenario includes $3.5 million in revenue bonds to be issued in fiscal year 2017-18. This debt does mitigate the required rate increases. However, more debt means higher coverage requirements. Therefore, the drop in required rate increases is not as dramatic as under the minimum level of service.
- **Exhibit 9** summarizes the model's output for a ten-year period under the proactive level of service with no debt. This scenario requires seven years of rate increases at or above 14 percent per year with additional double-digit increases after that.
- **Exhibit 10** also reflects the proactive level of service, but this scenario includes $4.0 million in revenue bonds to be issued in fiscal year 2017-18. This debt does mitigate the required rate increases. However, more debt means higher coverage requirements. Therefore, the drop in required rate increases is not as dramatic as under the minimum level of service.

Current Level of Service with No Debt | **Exhibit 4**

Description	FY 2012-13	FY 2013-14	FY 2014-15	FY 2015-16	FY 2016-17	FY 2017-18	FY 2018-19	FY 2019-20	FY 2020-21	FY 2021-22
Revenues:										
Stormwater rates	$1,970,000	$2,057,091	$2,148,033	$2,242,995	$2,339,911	$ 2,441,016	$ 2,539,164	$ 2,539,672	$ 2,540,180	$2,540,688
Other revenues	323,454	717,829	15,102	13,500	13,676	13,823	13,975	13,982	14,304	14,479
Bond proceeds	-	-	-	-	-	-	-	-	-	-
Total revenues	$2,293,454	$2,774,920	$2,163,135	$2,256,495	$2,353,588	$ 2,454,838	$ 2,553,139	$ 2,553,654	$ 2,554,484	$2,555,167
Expenditures:										
Personnel services	$ 433,000	$ 471,000	$ 488,000	$ 520,000	$ 539,000	$ 558,000	$ 587,295	$ 618,128	$ 650,580	$ 684,735
Materials and services	129,000	183,000	188,000	194,000	200,000	206,000	212,180	218,545	225,102	231,855
Capital outlay	350,000	754,000	900,231	50,000	744,779	1,550,498	1,647,067	53,045	54,636	56,275
Transfers	770,000	790,000	822,000	855,000	889,000	925,000	952,750	981,333	1,010,772	1,041,096
Debt service	-	-	-	-	-	-	-	-	-	-
Franchise fee	157,600	164,567	171,843	179,440	187,193	195,281	203,133	203,174	203,214	203,255
Total expenditures	$1,839,600	$2,362,567	$2,570,074	$1,798,440	$2,559,972	$ 3,434,779	$ 3,602,425	$ 2,074,225	$ 2,144,305	$2,217,216
Increase (decrease) in fund balance	$ 453,854	$ 412,353	$ (406,939)	$ 458,055	$ (206,384)	$ (979,941)	$ (1,049,286)	$ 479,429	$ 410,180	$ 337,951
Stormwater rate	$ 11.44	$ 11.94	$ 12.47	$ 13.02	$ 13.58	$ 14.16	$ 14.73	$ 14.73	$ 14.73	$ 14.73
Annual change in stormwater rate	0.00%	4.40%	4.40%	4.40%	4.30%	4.30%	4.00%	0.00%	0.00%	0.00%
System development charge per ESU	$ 502	$ 502	$ 502	$ 502	$ 502	$ 502	$ 502	$ 502	$ 502	$ 502

Source: FCS GROUP

Minimum Level of Service with No Debt | **Exhibit 5**

Description	FY 2012-13	FY 2013-14	FY 2014-15	FY 2015-16	FY 2016-17	FY 2017-18	FY 2018-19	FY 2019-20	FY 2020-21	FY 2021-22
Revenues:										
Stormwater rates	$1,970,000	$2,122,114	$2,285,974	$2,462,487	$2,652,629	$2,857,452	$3,075,234	$3,075,849	$3,076,464	$3,077,079
Other revenues	323,454	717,829	15,102	13,984	14,185	14,358	14,539	14,591	14,929	15,136
Bond proceeds	-	-	-	-	-	-	-	-	-	-
Total revenues	$2,293,454	$2,839,943	$2,301,076	$2,476,470	$2,666,814	$2,871,811	$3,089,772	$3,090,440	$3,091,393	$3,092,216
Expenditures:										
Personnel services	$ 433,000	$ 471,000	$ 684,121	$ 726,417	$ 756,254	$ 786,660	$ 827,959	$ 871,427	$ 917,177	$ 965,329
Materials and services	129,000	183,000	188,000	194,000	200,000	206,000	212,180	218,545	225,102	231,855
Capital outlay	350,000	754,000	900,231	446,145	744,779	1,550,498	1,647,067	53,045	127,034	56,275
Transfers	770,000	790,000	822,000	855,000	889,000	925,000	952,750	981,333	1,010,772	1,041,096
Debt service	-	-	-	-	-	-	-	-	-	-
Franchise fee	157,600	169,769	182,878	196,999	212,210	228,596	246,019	246,068	246,117	246,166
Total expenditures	$1,839,600	$2,367,769	$2,777,230	$2,418,561	$2,802,243	$3,696,754	$3,885,975	$2,370,418	$2,526,202	$2,540,721
Increase (decrease) in fund balance	$ 453,854	$ 472,174	$ (476,154)	$ 57,910	$ (135,430)	$ (824,943)	$ (796,203)	$ 720,022	$ 565,191	$ 551,494
Stormwater rate	$ 11.44	$ 12.32	$ 13.27	$ 14.29	$ 15.39	$ 16.58	$ 17.84	$ 17.84	$ 17.84	$ 17.84
Annual change in stormwater rate	0.00%	7.70%	7.70%	7.70%	7.70%	7.70%	7.60%	0.00%	0.00%	0.00%
System development charge per ESU	$ 529	$ 529	$ 529	$ 529	$ 529	$ 529	$ 529	$ 529	$ 529	$ 529

Source: FCS GROUP

Minimum Level of Service with Revenue Bonds — **Exhibit 6**

Description	FY 2012-13	FY 2013-14	FY 2014-15	FY 2015-16	FY 2016-17	FY 2017-18	FY 2018-19	FY 2019-20	FY 2020-21	FY 2021-22
Revenues:										
Stormwater rates	$1,970,000	$2,047,239	$2,127,507	$2,210,922	$2,297,607	$2,387,692	$ 2,474,143	$2,561,250	$2,651,424	$2,744,773
Other revenues	323,454	717,829	15,102	13,984	14,185	14,358	16,568	16,759	16,958	17,166
Bond proceeds	-	-	-	-	-	2,500,000	-	-	-	-
Total revenues	$2,293,454	$2,765,068	$2,142,609	$2,224,906	$2,311,793	$4,902,050	$ 2,490,711	$2,578,010	$2,668,383	$2,761,939
Expenditures:										
Personnel services	$ 433,000	$ 471,000	$ 684,121	$ 726,417	$ 756,254	$ 786,660	$ 827,959	$ 871,427	$ 917,177	$ 965,329
Materials and services	129,000	183,000	188,000	194,000	200,000	206,000	212,180	218,545	225,102	231,855
Capital outlay	350,000	754,000	900,231	446,145	744,779	1,550,498	1,647,067	53,045	127,034	56,275
Transfers	770,000	790,000	822,000	855,000	889,000	925,000	952,750	981,333	1,010,772	1,041,096
Debt service	-	-	-	-	-	202,946	202,946	202,946	202,946	202,946
Franchise fee	157,600	163,779	170,201	176,874	183,809	174,780	181,696	188,664	195,878	203,346
Total expenditures	$1,839,600	$2,361,779	$2,764,553	$2,398,436	$2,773,842	$3,845,884	$ 4,024,599	$2,515,961	$2,678,910	$2,700,848
Increase (decrease) in fund balance	$ 453,854	$ 403,289	$ (621,944)	$ (173,530)	$ (462,049)	$1,056,166	$(1,533,888)	$ 62,049	$ (10,527)	$ 61,091
Stormwater rate	$ 11.44	$ 11.89	$ 12.35	$ 12.83	$ 13.33	$ 13.85	$ 14.35	$ 14.85	$ 15.37	$ 15.91
Annual change in stormwater rate	0.00%	3.90%	3.90%	3.90%	3.90%	3.90%	3.60%	3.50%	3.50%	3.50%
System development charge per ESU	$ 529	$ 529	$ 529	$ 529	$ 529	$ 529	$ 529	$ 529	$ 529	$ 529

Source: FCS GROUP

Recommended Level of Service with No Debt — **Exhibit 7**

Description	FY 2012-13	FY 2013-14	FY 2014-15	FY 2015-16	FY 2016-17	FY 2017-18	FY 2018-19	FY 2019-20	FY 2020-21	FY 2021-22
Revenues:										
Stormwater rates	$1,970,000	$2,171,374	$2,393,333	$2,637,980	$2,904,997	$3,199,042	$3,522,849	$3,879,433	$4,035,417	$4,193,637
Other revenues	323,454	717,829	15,102	14,013	14,216	14,391	15,535	15,728	15,759	16,138
Bond proceeds	-	-	-	-	-	-	-	-	-	-
Total revenues	$2,293,454	$2,889,203	$2,408,435	$2,651,994	$2,919,213	$3,213,433	$3,538,384	$3,895,161	$4,051,176	$4,209,775
Expenditures:										
Personnel services	$ 433,000	$ 471,000	$ 696,091	$ 739,015	$ 769,514	$ 800,616	$ 842,648	$ 886,887	$ 933,448	$ 982,455
Materials and services	129,000	183,000	188,000	194,000	200,000	206,000	212,180	218,545	225,102	231,855
Capital outlay	350,000	754,000	900,231	446,145	744,779	1,940,498	2,037,067	1,495,132	517,034	1,615,526
Transfers	770,000	790,000	822,000	855,000	889,000	925,000	952,750	981,333	1,010,772	1,041,096
Debt service	-	-	-	-	-	-	-	-	-	-
Franchise fee	157,600	173,710	191,467	211,038	232,400	255,923	281,828	310,355	322,833	335,491
Total expenditures	$1,839,600	$2,371,710	$2,797,788	$2,445,199	$2,835,692	$4,128,037	$4,326,473	$3,892,252	$3,009,190	$4,206,422
Increase (decrease) in fund balance	$ 453,854	$ 517,493	$ (389,354)	$ 206,795	$ 83,521	$ (914,604)	$ (788,089)	$ 2,909	$1,041,986	$ 3,353
Stormwater rate	$ 11.44	$ 12.61	$ 13.89	$ 15.31	$ 16.86	$ 18.56	$ 20.43	$ 22.50	$ 23.40	$ 24.31
Annual change in stormwater rate	0.00%	10.20%	10.20%	10.20%	10.10%	10.10%	10.10%	10.10%	4.00%	3.90%
System development charge per ESU	$ 765	$ 765	$ 765	$ 765	$ 765	$ 765	$ 765	$ 765	$ 765	$ 765

Source: FCS GROUP

Recommended Level of Service with Revenue Bonds — Exhibit 8

Description	FY 2012-13	FY 2013-14	FY 2014-15	FY 2015-16	FY 2016-17	FY 2017-18	FY 2018-19	FY 2019-20	FY 2020-21	FY 2021-22
Revenues:										
Stormwater rates	$1,970,000	$2,133,937	$2,311,516	$2,501,560	$2,707,229	$2,929,808	$ 3,015,375	$3,103,442	$3,194,080	$ 3,287,366
Other revenues	323,454	717,829	15,102	14,013	14,216	14,391	18,002	18,569	18,770	18,979
Bond proceeds	-	-	-	-	-	3,500,000	-	-	-	-
Total revenues	$2,293,454	$2,851,765	$2,326,618	$2,515,573	$2,721,446	$6,444,199	$ 3,033,378	$3,122,011	$3,212,850	$ 3,306,346
Expenditures:										
Personnel services	$ 433,000	$ 471,000	$ 696,091	$ 739,015	$ 769,514	$ 800,616	$ 842,648	$ 886,887	$ 933,448	$ 982,455
Materials and services	129,000	183,000	188,000	194,000	200,000	206,000	212,180	218,545	225,102	231,855
Capital outlay	350,000	754,000	900,231	446,145	744,779	1,940,498	2,037,067	1,495,132	517,034	1,615,526
Transfers	770,000	790,000	822,000	855,000	889,000	925,000	952,750	981,333	1,010,772	1,041,096
Debt service	-	-	-	-	-	284,125	284,125	284,125	284,125	284,125
Franchise fee	157,600	170,715	184,921	200,125	216,578	211,655	218,500	225,545	232,796	240,259
Total expenditures	$1,839,600	$2,368,715	$2,791,243	$2,434,285	$2,819,871	$4,367,893	$ 4,547,270	$4,091,568	$3,203,278	$ 4,395,315
Increase (decrease) in fund balance	$ 453,854	$ 483,050	$ (464,625)	$ 81,288	$ (98,425)	$2,076,306	$(1,513,893)	$ (969,557)	$ 9,573	$(1,088,970)
Stormwater rate	$ 11.44	$ 12.39	$ 13.42	$ 14.52	$ 15.71	$ 17.00	$ 17.49	$ 18.00	$ 18.52	$ 19.06
Annual change in stormwater rate	0.00%	8.30%	8.30%	8.20%	8.20%	8.20%	2.90%	2.90%	2.90%	2.90%
System development charge per ESU	$ 765	$ 765	$ 765	$ 765	$ 765	$ 765	$ 765	$ 765	$ 765	$ 765

Source: FCS GROUP

Proactive Level of Service with No Debt — Exhibit 9

Description	FY 2012-13	FY 2013-14	FY 2014-15	FY 2015-16	FY 2016-17	FY 2017-18	FY 2018-19	FY 2019-20	FY 2020-21	FY 2021-22
Revenues:										
Stormwater rates	$1,970,000	$2,248,220	$2,565,732	$2,928,085	$3,341,613	$3,810,201	$4,344,498	$4,953,718	$5,638,459	$6,243,022
Other revenues	323,454	717,829	15,190	14,162	14,375	14,559	16,675	16,874	17,082	17,129
Bond proceeds	-	-	-	-	-	-	-	-	-	-
Total revenues	$2,293,454	$2,966,048	$2,580,922	$2,942,247	$3,355,988	$3,824,760	$4,361,173	$4,970,593	$5,655,541	$6,260,151
Expenditures:										
Personnel services	$ 433,000	$ 471,000	$ 718,189	$ 762,274	$ 793,993	$ 826,380	$ 869,765	$ 915,428	$ 963,488	$1,014,071
Materials and services	129,000	183,000	188,000	194,000	200,000	206,000	212,180	218,545	225,102	231,855
Capital outlay	350,000	789,714	938,517	487,079	788,441	2,376,970	2,474,934	2,904,013	3,118,238	3,469,756
Transfers	770,000	790,000	822,000	855,000	889,000	925,000	952,750	981,333	1,010,772	1,041,096
Debt service	-	-	-	-	-	-	-	-	-	-
Franchise fee	157,600	179,858	205,259	234,247	267,329	304,816	347,560	396,297	451,077	499,442
Total expenditures	$1,839,600	$2,413,572	$2,871,964	$2,532,600	$2,938,763	$4,639,166	$4,857,189	$5,415,616	$5,768,677	$6,256,219
Increase (decrease) in fund balance	$ 453,854	$ 552,476	$ (291,043)	$ 409,648	$ 417,225	$ (814,406)	$ (496,016)	$ (445,024)	$ (113,135)	$ 3,932
Stormwater rate	$ 11.44	$ 13.05	$ 14.89	$ 16.99	$ 19.39	$ 22.10	$ 25.20	$ 28.73	$ 32.69	$ 36.19
Annual change in stormwater rate	0.00%	14.10%	14.10%	14.10%	14.10%	14.00%	14.00%	14.00%	13.80%	10.70%
System development charge per ESU	$ 765	$ 765	$ 765	$ 765	$ 765	$ 765	$ 765	$ 765	$ 765	$ 765

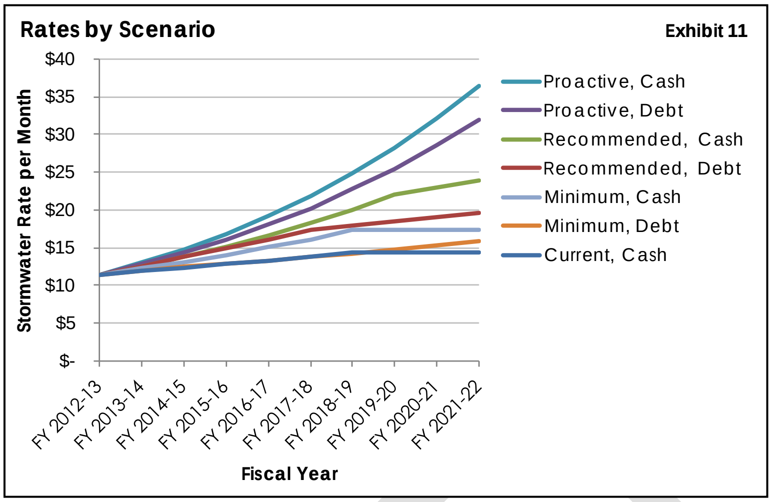
Source: FCS GROUP

Proactive Level of Service with Revenue Bonds — **Exhibit 10**

Description	FY 2012-13	FY 2013-14	FY 2014-15	FY 2015-16	FY 2016-17	FY 2017-18	FY 2018-19	FY 2019-20	FY 2020-21	FY 2021-22
Revenues:										
Stormwater rates	$1,970,000	$2,208,812	$2,474,364	$2,771,842	$3,105,084	$3,478,389	$ 3,886,138	$ 4,341,684	$ 4,846,289	$ 5,409,540
Other revenues	323,454	717,829	15,190	14,162	14,375	14,559	18,629	20,121	20,329	20,546
Bond proceeds	-	-	-	-	-	4,000,000	-	-	-	-
Total revenues	$2,293,454	$2,926,640	$2,489,554	$2,786,004	$3,119,458	$7,492,948	$ 3,904,767	$ 4,361,806	$ 4,866,618	$ 5,430,086
Expenditures:										
Personnel services	$ 433,000	$ 471,000	$ 718,189	$ 762,274	$ 793,993	$ 826,380	$ 869,765	$ 915,428	$ 963,488	$ 1,014,071
Materials and services	129,000	183,000	188,000	194,000	200,000	206,000	212,180	218,545	225,102	231,855
Capital outlay	350,000	789,714	938,517	487,079	788,441	2,376,970	2,474,934	2,904,013	3,118,238	3,469,756
Transfers	770,000	790,000	822,000	855,000	889,000	925,000	952,750	981,333	1,010,772	1,041,096
Debt service	-	-	-	-	-	324,714	324,714	324,714	324,714	324,714
Franchise fee	157,600	176,705	197,949	221,747	248,407	252,294	284,914	321,358	361,726	406,786
Total expenditures	$1,839,600	$2,410,419	$2,864,655	$2,520,100	$2,919,841	$4,911,359	$ 5,119,257	$ 5,665,391	$ 6,004,040	$ 6,488,278
Increase (decrease) in fund balance	$ 453,854	$ 516,221	$ (375,101)	$ 265,904	$ 199,617	$2,581,590	$(1,214,490)	$(1,303,585)	$(1,137,422)	$(1,058,192)
Stormwater rate	$ 11.44	$ 12.82	$ 14.36	$ 16.09	$ 18.02	$ 20.18	$ 22.54	$ 25.18	$ 28.10	$ 31.36
Annual change in stormwater rate	0.00%	12.10%	12.00%	12.00%	12.00%	12.00%	11.70%	11.70%	11.60%	11.60%
System development charge per ESU	$ 765	$ 765	$ 765	$ 765	$ 765	$ 765	$ 765	$ 765	$ 765	$ 765

Source: FCS GROUP

Exhibit 11 compares the rate impacts of the seven scenarios presented above:



Conclusion

Of the four levels of service presented in this plan, the recommended level of service strikes a balance between affordability, regulatory compliance, and the asset management practices required by the City's Capital Improvement Investment Policy 5. Whether this level of investment should be financed with debt or with rates alone is ultimately a policy decision that requires weighing the City's Capital Investment Policies 7 and 8.

On March 6, 2013, the CUAB gave its support to the recommended level of service with no debt (summarized above in **Exhibit 7**). We find that this is a sound recommendation.